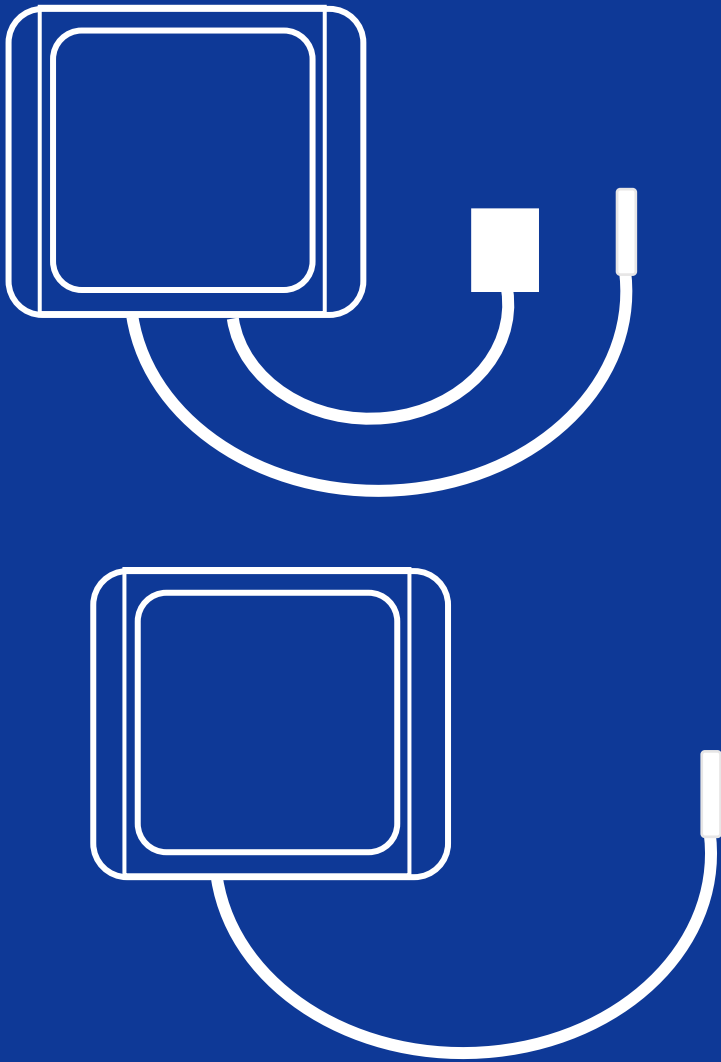


INSTRUCTION MANUAL

**Thermal Monitoring Kit
for Buildings**

QRU-100



EKO

1. Index

1.	Index	1
2.	Important User Information	2
2-1.	Contact Information	2
2-2.	Warranty and Liability	2
2-3.	About Instruction Manual	3
2-4.	Environment	3
3.	Safety Information	5
3-1.	WARNING/CAUTION	5
4.	Introduction	5
4-1.	About the QRU-100 Kit	6
4-2.	Theory	7
4-2.	Package Contents	9
5.	Getting Started	10
5-1.	Parts Name and Descriptions	10
5-2.	Preparation and Site Selection	11
6.	Software Configuration	13
6-1.	Starting Up (Windows)	13
7.	Sensor Installation	16
7-1.	Indoor Unit	16
7-2.	Outdoor Unit	16
7-3.	Uninstallation	17
8.	Data Acquisition and Analysis	17
8-1.	Data Acquisition	17
8-2.	Basic Data Analysis	18
9.	Maintenance & Troubleshooting	19
9-1.	Maintenance	19
9-2.	Troubleshooting	20
10.	Technical Specifications	21
10-1.	Specifications	21
10-2.	Dimensions	21

2. Important User Information

Thank you for using EKO Products

Make sure to read this instruction manual thoroughly and to understand the contents before starting to operate the instrument. Keep this manual at safe and handy place for whenever it is needed.

For any questions, please contact us at one of the EKO offices given below:

2-1. Contact Information

EKO INSTRUMENTS CO., LTD.

Asia, Oceania Region

https://eko-asia.com/	EKO INSTRUMENTS Co., Ltd.	Tel: +81 [3] 3469-6711
info@eko.co.jp	1-21-8, Hatagaya, Shibuya-ku Tokyo, 151-0072 Japan	Fax: +81 [3] 3469-6719

Europe, Middle East, Africa, South America Region

https://eko-eu.com/	EKO INSTRUMENTS Europe B.V.	Tel: +31 [0]70 3050117
info@eko-eu.com	Lulofsstraat 55, Unit 28, 2521 AL, Den Haag, The Netherlands	Fax: +31 [0]70 3840607

North America Region

https://eko-usa.com/	EKO INSTRUMENTS USA Inc.	Tel: +1 408-977-7751
info@eko-usa.com	111 North Market Street, Suite 300 San Jose, CA 95113 USA	Fax: +1 408-977-7741

2-2. Warranty and Liability

For warranty terms and conditions, contact EKO or your distributor for further details.

EKO guarantees that the product delivered to customer has been verified, checked and tested to ensure that the product meets the appropriate specifications. The product warranty is valid only if the product has been installed and used according to the directives provided in this instruction manual.

In case of any manufacturing defect, the product will be repaired or replaced under warranty. However, the warranty does not apply if:

- Any modification or repair was done by any person or organization other than EKO service personnel.
- The damage or defect is caused by not respecting the instructions of use as given on the product brochure or the instruction manual.

2-3. About Instruction Manual

Copy Rights Reserved by EKO INSTRUMENTS CO., LTD. Making copies of whole or parts of this document without permission from EKO is prohibited.

This manual was issued: 2021/11/30
Version Number: 2 (5/01/2026)

2-4. Environment

1. WEEE Directive 2002/96/EC [Waste Electrical and Electronic Equipment]

In August of 2005, the European Union [EU] implemented the EU WEEE Directive 2002/96/EC and later the WEEE Recast Directive 2012/19/EU requiring Producers of electronic and electrical equipment [EEE] to manage and finance the collection, reuse, recycling and to appropriately treat WEEE that the Producer places on the EU market after August 13, 2005. The goal of this directive is to minimize the volume of electrical and electronic waste disposal and to encourage re-use and recycling at the end of life.

EKO products are subject to the WEEE Directive 2002/96/EC. EKO Instruments has labeled its branded electronic products with the WEEE Symbol [figure Trash bin] to alert our customers that products bearing this label should not be disposed of in a landfill or with municipal or household waste in the EU.

If you have purchased EKO Instruments branded electrical or electronic products in the EU and are intending to discard these products at the end of their useful life, please do not dispose of them with your other household or municipal waste. Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling.

2. RoHS Directive 2002/95/EC

EKO Instruments has completed a comprehensive evaluation of its product range to ensure compliance with RoHS Directive 2002/95/EC regarding maximum concentration values for substances. As a result all products are manufactured using raw materials that do not contain any of the restricted substances referred to in the RoHS Directive 2002/95/EC at concentration levels in excess of those permitted under the RoHS Directive 2002/95/EC, or up to levels allowed in excess of these concentrations by the Annex to the RoHS Directive 2002/95/EC.

**DECLARATION OF CONFORMITY**

We: EKO INSTRUMENTS EU. B.V.
Lulofsstraat 55, Unit 28,
2521AL, Den Haag
The Netherlands

Declare under our sole responsibility that the product:

Product Name: Thermal Monitoring Kit for Buildings
Model No.: QRU-100

To which this declaration relates is in conformity with the following
harmonized standards of other normative documents:

Harmonized standards:

EN 61326-1:2006	[Emission]
EN 61326-1:2006	[Immunity]

Date: 23-08-23

Position of Authorized Signatory: Director

Name of Authorized Signatory: C.H. Hoogendyke

Signature of Authorized Signatory: 

3. Safety Information

EKO Products are designed and manufactured with consideration for safety; however, please make sure to read and understand this instruction manual thoroughly to be able to operate the instrument safely in the correct manner.



WARNING CAUTION

Attention to user; pay attention to the instructions given on the instruction manual with this sign.



3-1. WARNING/CAUTION

1. Setup

- Do not use any other power source or batteries other than what is indicated for this device.
- Do not expose heat flux sensors to temperatures higher than 100 or below -30 degrees Celsius.
- Do not expose temperature sensors to temperatures higher than 180 or below -60 degrees Celsius.
- Do not expose the dataloggers outside temperature range of -40 to +90°C.
- When using the outdoor datalogger, always make sure the cable glands are facing down.
- Do not expose the ventilation valve (between the cable glands) to water flow.
- If possible, it is advised to protect the outdoor unit from direct water flow heavy rain.
- In case there is a risk of high condensation (e.g. in cold and humid climates), user can use a small silicon bag inside the enclosure to minimize condensation risk.
- Do not connect any other sensor/power source to the probes or to the logger.
- Never charge the batteries. Once drained, recycle.
- Never submerge any parts of the units in any liquid (e.g. water).
- When performing uninstallation, never pull the sensors by the wires nor their terminals. Consult this manual first.

2. Handling

- Handle the device from the enclosures. Never grab the device hanging from the cables
- Always carry the unit in its transport case, making sure every part is secured.
- When the lid of the case does not close, do not apply force. Check for any cables/items blocking.
- Be gentle when pushing the parts into the compartments of transport case, not damaging the foam.
- The heat flux sensor is a sensitive element. Handle, attach, and detach with care. Follow the QSG.

4. Introduction

For many years, researchers and practitioners have been struggling to find the accurate values of heat loss in the buildings. In order to know the heat loss at a certain time, measurement is possible, however, to know the heat loss at any given time, one needs to know the exact thermal properties of that system. In case of an old building, there is no accurate information about the materials or the constructions applied. For newer buildings though, there is seldom little information available about the expected thermal properties. However, many studies and previous

experience have shown that this information is often unreliable. This is due to the fact that materials and constructions change during time and behave differently when on site and when in lab. In theory, the properties are based on the materials of which the wall consists. On site, there is always moisture, material degradation, corrosion and other effects. Accordingly, for many recent years, on-site measurements have become popular and in much higher demand. The current EKO QRU-100 is the tool to help you perform on-site monitoring and measurement perfectly. Using this device, a building's thermal behaviour can be monitored and upon determination of the thermal properties following this manual or another scientific method (e.g. standards, research articles), the most efficient and economical decisions regarding energy investments can be made. Furthermore, the device can be used to monitor any other relevant thermal system to study its thermal performance.

QRU-100 unique properties:

Wire-independent Unlike conventional U- and R-value kits, where a cross wiring between the two indoor and outdoor sensors is required, the QRU-100 comes with two independent measurement nodes, removing the hassle. This allows easy use of the device for inaccessible areas such as roofs and floors.

Lightweight and easy to handle The QRU-100 is only 670 grams. Easy to carry on the location. The setup is arranged within minutes and before you know it, your measurement course is started.

Standalone The QRU-100 is operated via battery. Both units can be left at their location without the need for an external power source.

Excellent accuracy level. The QRU-100 comes with the most accurate and reliable temperature sensors and heat flux sensor all complying with ISO 9869 Standard..

Customizable. Upon requests, the device can be customized to the client's needs by adding, removing, or changing sensors (e.g. adding a pyranometer) to meet the desired configuration needs.

Best Support Upon purchasing this unit, you are entitled to the best scientific support available from the experts in the field of building physics.

4-1. About the QRU-100 Kit

Monitoring heat flux and temperature is an inevitable task in determination of thermal performance. The current product, EKO QRU-100 is a cross connection-free unit to perform this task perfectly. With a plug-and-play solution, not only you can monitor the heat flux and temperature, but also you can measure thermophysical properties of constructions the thermal resistance and the thermal transmittance.

EKO QRU-100 is compatible with the world's leading international standards:

- ISO 9869 – 1: Thermal insulation - Building elements - In-situ measurement of thermal resistance and thermal transmittance - Part 1: Heat flow meter method
- ASTM C1046 – 95: Standard Practice for In-Situ Measurement of Heat Flux and Temperature on Building Envelope Components
- ASTM C1155 – 95: Standard Practice for Determining Thermal Resistance of Building Envelope Components from the In-Situ Data

These are the most important documents to follow when performing a reliable in-situ measurement of the thermal resistance R-value and the thermal transmittance U-value of building components. Following the

instructions given in the current manual, you will still be able to perform a simplified and yet fully reliable determination of these parameters. The instructions given here are according to and in-line with the three standards. For more detailed version of the experiments, please purchase the standards separately and follow the instructions given.

4-2. Theory

To better understand the concepts and acquire sufficient knowledge before starting this practice, a brief overview of the scientific phenomena and the definitions are given here.

Heat Flux

Heat is a form of energy. It flows from a point with higher temperature towards one with lower temperature. The rate of heat transfer is called the heat flow. The amount of heat flow per unit area A is called heat flux (\dot{q}). Heat flux is a vector in the direction of temperature gradient across to the surface:

$$\dot{q} = \frac{1}{A} dQ/dt$$

Where Q is heat and t is time. The heat flux can be estimated by engineering calculations for different heat transfer mechanisms. These include conduction, convection, advection, radiation, and accumulation. Heat flux can be measured on a surface, applying a heat flux sensor.

Thermal Resistance (R-value):

The thermal resistance of an object is a thermo-physical property defined as the ability of that object to resist heat. The term thermo-physical is used because this parameter relates to both thermal (thermal conductivity, k) and a physical property (thickness, l).

$$R = \frac{l}{k} = \frac{\Delta T_{surface}}{\dot{q}}$$

The thermal conductivity is the ability of the material to conduct heat. Opposite to thermal resistance, which is an object parameter, thermal conductivity is a material property. $\Delta T_{surface}$ is the temperature difference between interior and exterior wall surface and \dot{q} is the heat flux in the direction of positive temperature gradient.

Thermal Transmittance (U-value):

The overall thermal transmittance (U-value) between two points is defined as the ability of the medium in between to transfer heat between those two points. It is the opposite of the thermal resistance. Generally, unlike the thermal resistance which is often defined for solids and fluids separately, thermal transmittance is defined between a larger media. For a wall for instance, it is generally defined between indoor and outdoor air, including the wall itself. It therefore includes the resistances of the indoor air, the solid wall, and the outdoor air. The U-value between two points can be obtained as inverse of the sum of the resistances in between:

$$U = (\alpha_{in}^{-1} + R + \alpha_{out}^{-1})^{-1} = \frac{\dot{q}}{\Delta T_{air}}$$

In which α is the convective heat transfer coefficient between the indoor/outdoor air and the interior/exterior surface of the wall with thermal resistance R . ΔT_{air} is the temperature difference between indoor and outdoor air and \dot{q} is the heat flux in the direction of positive temperature gradient. For simplification purposes, sometimes, the radiative heat transfer coefficient is lumped into α . In this case, the two convective and radiative coefficients are simply summed.

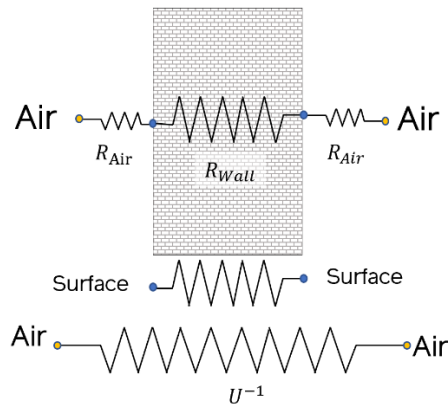


Figure 1. The sum of the resistances of the wall (R_{wall}) and the air layers (R_{Air}) making a total equivalent resistance which is the inverse of the thermal transmittance (U-value)

Heat Flux Sensor

A heat flux sensor is a transducer that measures the voltage in relation with the heat flux through the body of the sensor. This voltage can be converted into heat flux, using a parameter called “sensitivity” of the heat flux sensor. The sensitivity value is obtained through calibration of the sensor using an absolute measurement apparatus. For instance, Heat Flow Meter Apparatus (HFM) and Guarded Hot Plate (GHP), Thin film heater apparatus and guarded hot box apparatus are used. Obtaining the sensitivity, the heat flux \dot{q} can be found using the following equation:

$$\dot{q} = V/S$$

Where S is the sensor’s sensitivity and V is the output voltage, often in the order of μV . For instance, a measured voltage value of 0.170788 mV is converted to heat flux of 7.057 Wm^{-2} using the sensitivity of the heat flux sensor available from the calibration certificate.

Temperature Sensor

A temperature sensor measures the temperature of a specific point in a medium. Typical temperature sensor types include thermocouples, thermistors, and RTDs. In QRU-100 a highly accurate RTD (PT-1000) is used. RTDs are made with a range of quality and accuracy. EKO QRU-100 benefits from the highest accuracy level in the market (4-Wire, Class 1/10 DIN calibration). This allows an uncertainty as small as $0.1 \text{ }^\circ\text{C}$ in the operation range of buildings.

In-Situ Measurements

In contrast with in-lab measurements, in-situ (on-site) measurements take the advantage of including the realistic mechanisms of the physical phenomena. However, they come with more uncertainties and a greater deal of hassle and usually take much longer time due to the departure from steady-state conditions.

For in-situ measurement of the R-value and the U-value in building components, one needs to monitor the heat flux through the component as well as the temperature gradient at the two sides of the component for a sufficiently long period of time. The QRU-100 is the kit to perform this with minimum hassle and high accuracy.

4-2. Package Contents

Check the package contents first; if any missing parts or any damage is noticed, please contact EKO immediately.

Table 4-1. Package Contents

Contents	Model Description
Transport Case	EKO IP67 Transport case, shock proof, water tight, dust proof
Indoor Node	EKO Indoor Unit (Datalogger + Battery + USB Cable)
Outdoor Node	EKO Outdoor Unit (Datalogger + Battery + USB Cable)
Heat Flux Sensor	EKO HF-01S * (Quick Start Guide Print in the Case)
Temperature Sensor	EKO RTD PT-1000 (1/10 DIN) 4-wire*
Instruction Manual	[Please download from EKO Website]
Calibration Report	HF-01S heat flux sensor calibration report
Specification Sheet	[Please download from EKO Website]

*The standard cable length is 3 m for all sensors. For different length of cables [e.g. to meet your application needs] please contact EKO or your local distributor.



5. Getting Started

5-1. Parts Name and Descriptions

Each part name and its main function is described below, where the figure shows the two units. Opening the units using the handle, the datalogger can be observed, shown on the right.

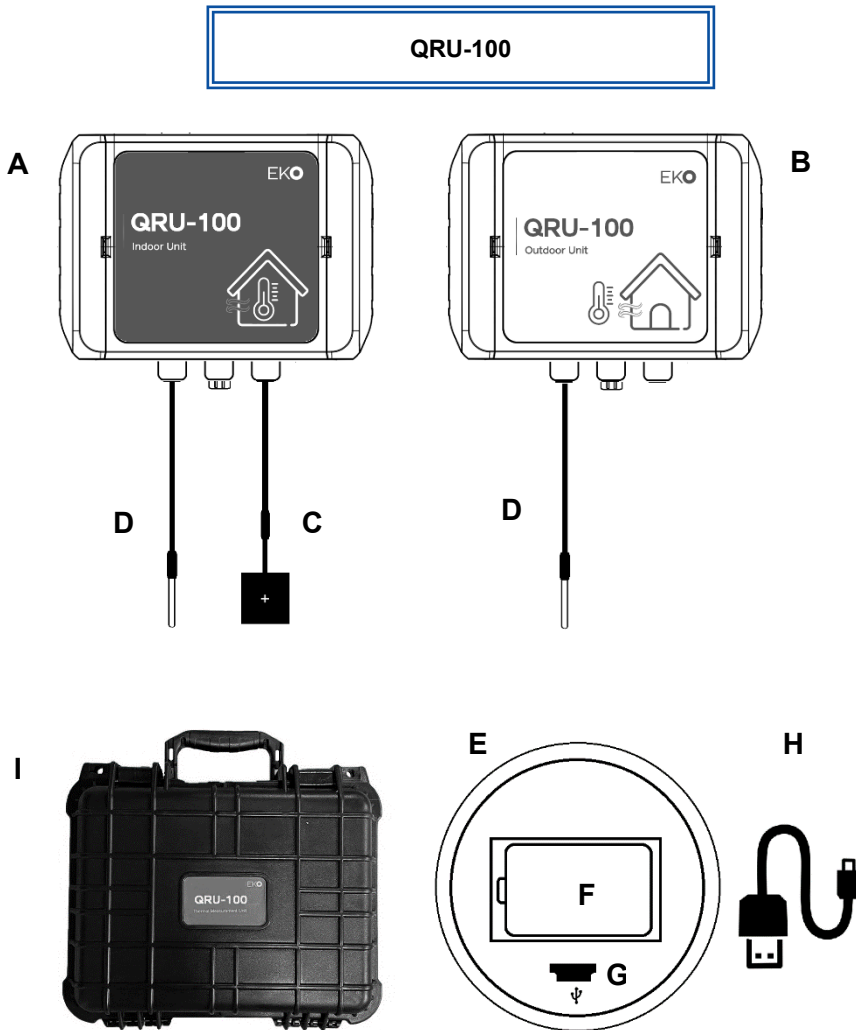


Table 5-1. Parts Name [QRU-100]

Parts Name	
A.	Indoor Unit
B.	Outdoor Unit
C.	EKO HF-01S
D.	EKO PT-1000 RTD (x2)
E.	Internal Datalogger (x2)
F.	Logger Battery (x2)
G.	USB Port (x2)
H.	USB Cable (x2)
I.	Transport Case

Figure 2. EKO QRU-100 main parts and names. When the lid of the units (A,B) are open, the internal loggers (E) and their batteries (F) and the USB port (G) can be seen

1. Indoor Unit

The indoor unit is used for recording the readings from heat flux and temperature inside the building. The unit has an internal data logger which is powered via a 3.6V lithium battery and connects to PC via a USB cable.

2. Outdoor Unit

The outdoor unit is used for recording the readings temperature from outside the building. The unit has an internal data logger which is powered via a 3.6V lithium battery and connects to PC via a USB cable.

3. EKO PT1000 Temperature Sensors

EKO QRU-100 is equipped with two PT1000 temperature sensors calibrated with the highest standard (1/10 DIN). This is the highest accuracy level available in the market. The sensors are meant to measure the air (when hanging) or surface temperature (when attached to the surface).

4. EKO HF-01S Heat Flux Sensor

An EKO HF-01S standard heat flux sensor is wired in the indoor unit for measurement of surface heat flux. For detailed instructions regarding this sensor, please refer to the printed QSG and EKO website.

5. Internal Dataloggers

Each of the Indoor/Outdoor units contains an internal individual data logger programmed in EKO. By opening the enclosure unit lids, the batteries and the USB ports can be accessed.

6. Transport Case

The QRU-100 comes in a light and yet robust shock-proof, dust-proof, and waterproof (IP67 rating) transport case with pressure regulation screw. This allows safe and easy transportation of the unit to the location.

7. Battery

The loggers are equipped with long-life batteries (Lithium type SL-750/S). The battery capacity is internally monitored and upon low capacity, a warning is given to the user. The batteries can be purchased separately. Please make sure not to use a different model battery. Never charge the batteries as they may explode.

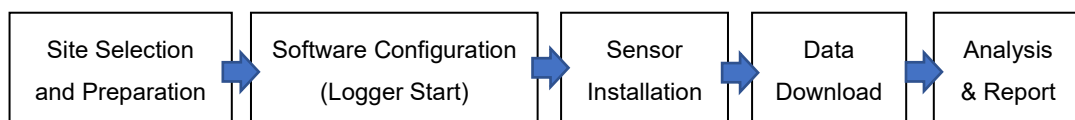
8. USB Cables

QRU-100 is shipped with two standard mini USB-2 cables for connection of the two datalogger units to PC.

5-2. Preparation and Site Selection

In order to achieve high accuracy, the operation too must be accurate: Please follow the installation guidelines carefully and follow the order given below. To optimize time and efficiency, follow the flow given below:

After selection and preparation of the site and the sensors (5.2) , configure the software (6). Then start with installation of the sensors (7) on the locations you selected in section 5.2. After the monitoring, read and download the data via the USB cables and a PC following section 8.1. Finally analyse the data according to 8.2 or any desired method such as ISO and ASTM standard practices.



1. Preparation:

Open the transport case and take out the components (indoor and outdoor unit). Prepare the required adhesives.

2. Site Selection:

Before configuring the software, find the location to install the sensors. When measuring on a specific surface, the installation spot must be representative for the whole surface. Therefore, use your knowledge or any additional instrument to make sure this is the case. For installation on the walls, avoid areas close to the windows and doors where the probability of multi-dimensional heat transfer is higher. Find a spot where temperature and heat flux are homogeneous with the area surrounding it. IR thermography can be used for this purpose. The area you select for the measurement should be representative for the whole component. For instance, when measuring on the surface of a wall, avoid the corners where cold junctions and thermal bridges can occur. The safest way to allocate the perfect location is to use an IR thermography camera. If not available, make an educated guess. The indoor unit is installed on the interior side of the wall and the outdoor unit is installed on the opposite side of the wall (same location). The outdoor sensor should be protected from direct solar radiation, rain, and snow. Use a protection such as artificial screening to guard a relatively large area on the exterior surface of the wall from such disturbances. The sensors should be mounted on the same location, on two sides of the wall.

3. Standard Sensor Configuration:

The EKO QRU-100 is compatible with the world's leading international standards ISO 9869 and ASTM C1155 and C1046. These are the most important documents to follow when performing a reliable measurement of the thermal resistance R-value and the thermal transmittance U-value. Following the current manual, you will still be able to perform a simplified determination of these parameters. The instructions given here are according to and in-line with the two standards. For more detailed version of the experiments, please purchase the standards separately and follow the instructions given.

As shown in Figure 3, according to the standards ISO 9869 and ASTM C1155 and C104, the sensors must be facing each other across the wall. The indoor unit is equipped with a temperature sensor and the heat flux sensor (wired to the indoor unit) and the outdoor side is equipped with a temperature sensor wired to the outdoor unit. While choosing the site, keep in mind that both sides of the element should be accessible. Thanks to the design with two independent units, no wiring in-between is required.

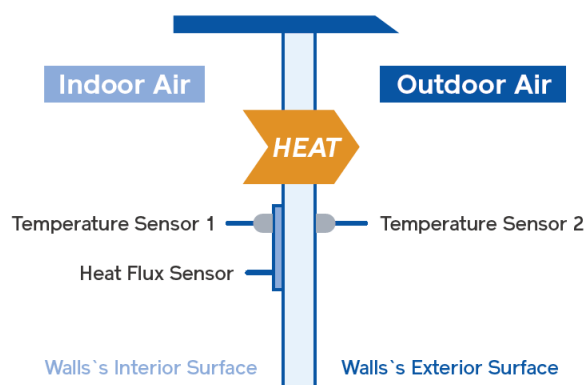


Figure 3. Schematic Configuration of sensor installation for R-value and U-value measurements according to the ASTM and ISO standards.

6. Software Configuration

6-1. Starting Up (Windows)

Download and Install the software Infralog V.5 or later EKO website or from Driesen-Kern website:

<https://www.driesen-kern.de/hilfe-und-support/updates/infralogupdate.php>. Note that this is the basic version of the software. More advanced versions of the software can be purchased separately from Driesen-Kern website. Unzip the file and click on run the .exe. Follow the instructions given and install the software. Once installed, launch the software with the name "Infralog".

Open the lids of the unit carefully by pushing the blue handle forward as shown in Figure 4.



Figure 4- Press the blue handle to open the lid of the Indoor Unit.

The internal blue datalogger with a battery and a USB port can be observed inside (Figure 5). Unscrew the lid gently and place the battery to activate the datalogger. Connect the unit to the PC via the USB cable provided in the case.



Figure 5- A round data logger is seen once the unit is opened. Unscrew the lid gently and place the battery in.

Connect the unit to the PC using the USB port. Repeat for the Outdoor Unit.

Once the USB cables are connected and configured, the two internal loggers should appear in the list. Double-click on each logger icon to see the name of the unit it belongs to.



Figure 6- Initial look of the software (left). Click on the logger images to see the names (right)

Right-click on each data logger and select “MeterMode” to open a small new window showing the live data. This step is taken in order to check if the connections are in perfect condition and the sensors are ready to start measuring. On the new window, you can see the temperature [DegC] and heat flux [W/m²] at the location of the sensors. Tip: To check the performance of the sensors, you can hold them with your hand and see the heat flux and temperature change.

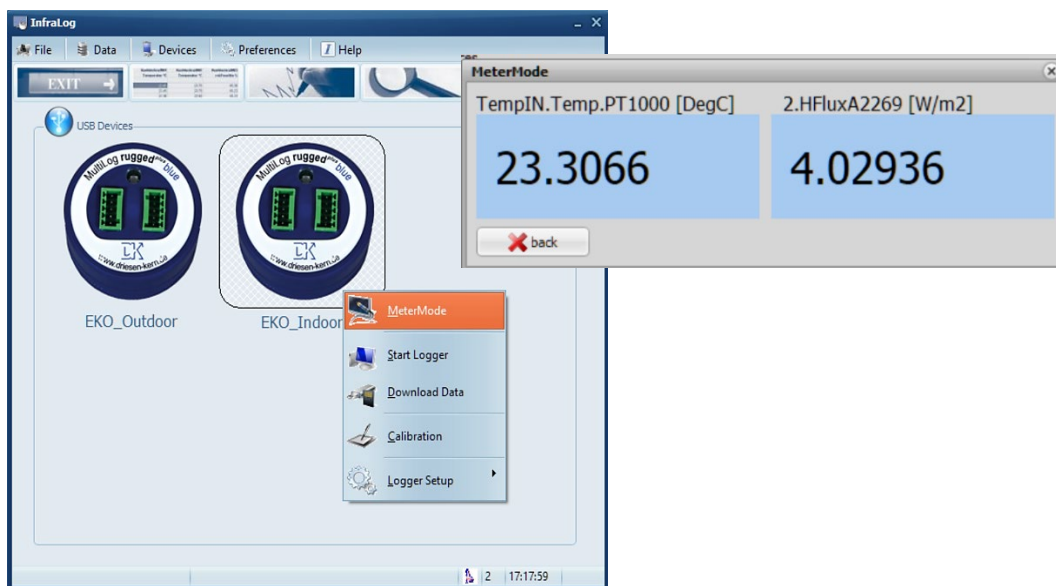


Figure 7- Right click on the logger and select MeterMode to observe heat flux and temperature. This is a test to check and see if the unit is working properly

Once the data is observed and the check is complete, close the MeterMode window, right-click again and this time select “Start Logger”. A new window (Start Data Logging) will open, showing the settings required for starting the logger. Click on Start logger at and change [Immediately] to [Select Date] and in the gap below, click on [...] to set the starting time. Tip: set the starting time at a later moment to allow enough time for starting the second logger and installation of the sensors.

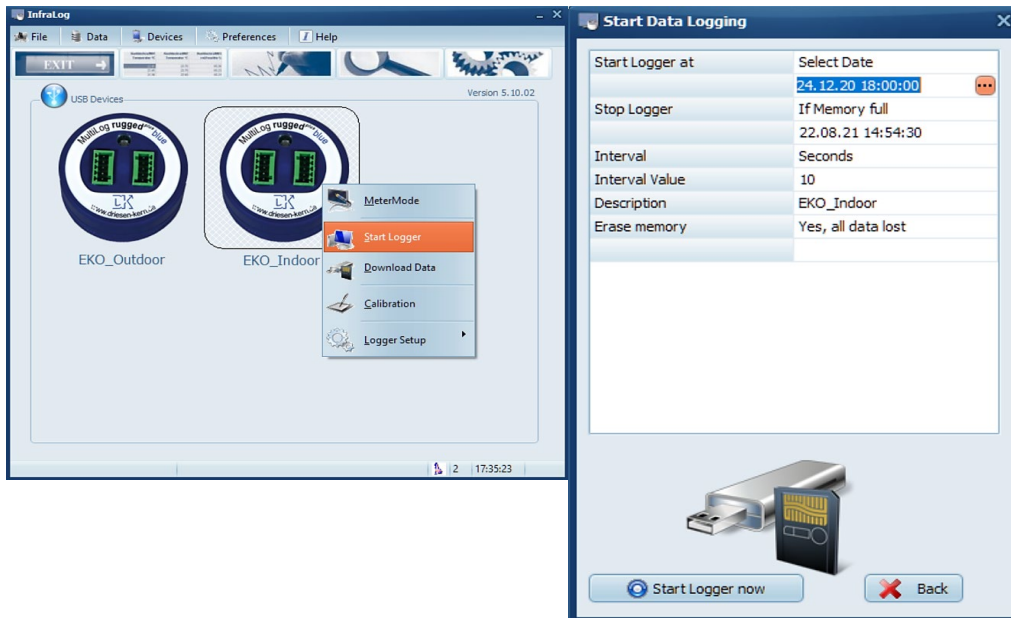


Figure 8- To start a unit, right-click on its name and select “Start Logger”. Adjust the settings regarding the starting time and the logging interval and press “Start the logger now”.

Further you can select the condition to stop the logger. Choose the interval value which indicates the time steps where the logger saves the measured data. Once completed, click “Start Logger now” and the information will be sent to the logger.

Remove the USB cable while holding the edges of the round datalogger, screw back the round lid gently, and close the lid of the enclosure. Do not pull the datalogger out of its holder as it may damage the wire connections.

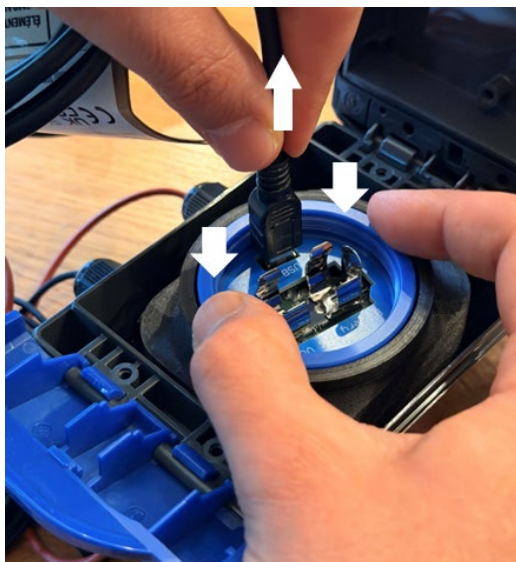


Figure 9- Remove the USB cable while holding the edges of the round datalogger

Repeat the same procedure for the second logger. Once the second unit is operated, close the lid and start installation of the sensors as described in 5.2.

7. Sensor Installation

7-1. Indoor Unit

Place the indoor unit in a location protected from direct solar radiation and draught. Choose a location where you will have this unit for the whole measurement period. This unit measures temperature and heat flux.

The heat flux sensor measures the total heat flux perpendicular to the surface of the wall. To install the heat flux sensor, a perfect thermal contact is required. Thermal pads can be used for this purpose. Alternatively, carpet double side adhesive, thermal compound (paste) and glycerol can be applied. Find the location to install the sensor. The surface should be flat and clean. Cover with a tape of the same emissivity as the rest of the measuring surface. For most walls, paper masking tape is a good choice. (Check the QSG and HF-01S Installation Video). It is recommended to recalibrate or replace the heat flux sensors every 1-2 years.

The indoor temperature sensor is to measure the indoor air or the interior surface temperature. To measure the air temperature, attach the wire near the tip to a surface to have the tip hanging in the air with a distance of minimum 5 cm from the surface. To use the temperature sensor for surface measurements, perfect thermal contact is required. Use thermal pads to make a bedding on the surface for the sensor probe and cover it with a tape of the same emissivity as the rest of the measuring surface (Figure 10).

7-2. Outdoor Unit

Place the outdoor unit in an appropriate location. Read Cautions Section of this manual about water exposure. Choose a location where you will have this unit for the whole measurement period. Make sure the unit will be stable during the measurement time. Avoid locations where the unit is at risk of falling due to the wind, animals, etc. This unit is equipped with a temperature sensor.

The outdoor temperature sensor is to measure the outdoor air or the surface temperature. To measure the air/surface temperature, follow the instructions above for the indoor temperature sensor. Finally, it is advised to protect the sensor from direct solar radiation. According to ISO 9869, artificial screening may be used for this purpose. Hang the protection in a way that the air can flow on the surface, not making a thermal bridge. See Figure 10 for better understanding.

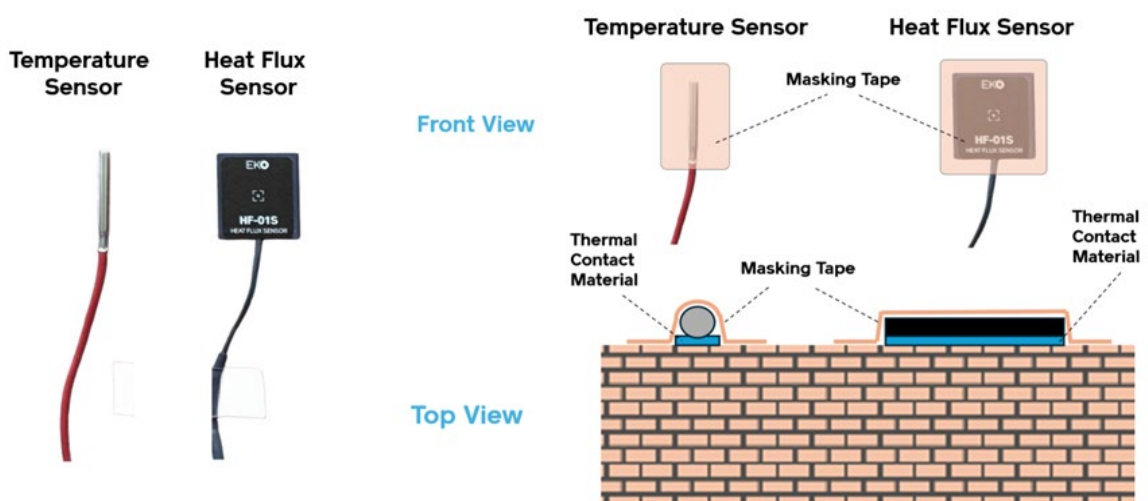


Figure 10- Configuration of the heat flux sensor and the temperature sensors on the wall

7-3. Uninstallation

When the experiments are finished (Check 8-2 before uninstallation), you may choose to remove the sensors. One has to be very careful not to damage the sensors and the finishing of the surface (e.g. wallpaper, paint). To perform a safe and clean uninstallation, use a blow drier (from distance) on low heat mode to slowly warm up (not heat up) and loosen the adhesive. Then carefully remove the sensors from the adhesive. Do not heat up the sensor to high temperatures as it can lead to permanent damage. Remove and dispose the adhesive and clean the residues on the sensor when needed.

8. Data Acquisition and Analysis

8-1. Data Acquisition

Once the system has measured for enough time (the time is determined by the standard requirements), it can be uninstalled according to 7-3 and the data can be used for analysis. For the determination of the thermal resistance and thermal transmittance, the system needs to log for a sufficiently long time. For building walls, according to the standard ISO 9869, a minimum measurement time of 72 hours is required (See 8-2). To read the data, connect the loggers to your PC via the USB cables and use the software. Right click on the desired logger and click on “Stop Logger” and then on “Download Data”. This may take a while until the data is obtained from the logger. The progress can be seen at the bottom of the window.

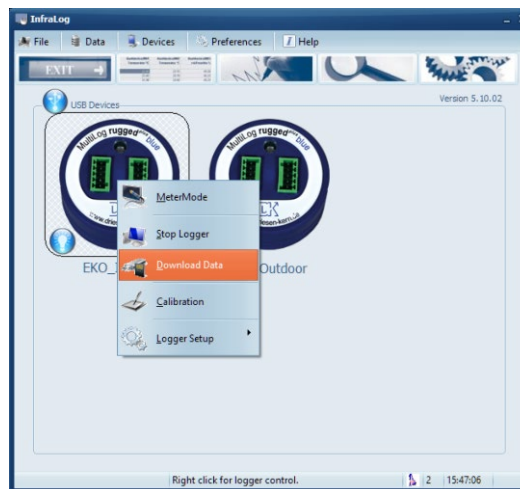


Figure 11- Right click on the logger after double clicking and select “Download Data”

A new window is opened, showing graphs and asking for a key. Click “OK” to close the window and go to:

C:/Users/USERNAME/Documents/InfraLog/Logger/EKO_Indoor

C:/Users/USERNAME/Documents/InfraLog/Logger/EKO_Outdoor

You can find this data location by clicking on “Preferences/Program/Location for Logged Data” in Infraclog.

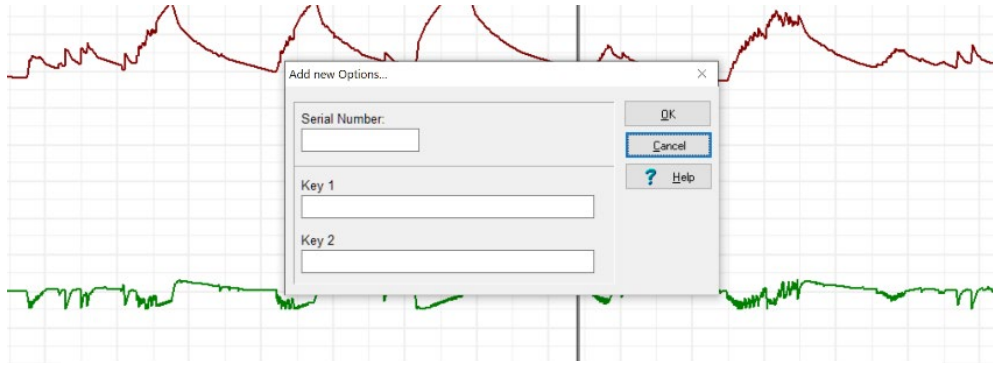


Figure 12- The data is shown in the screen. Close the screen and go to the data folder

Once the data file is found, open the relevant ASC file in MS Excel or other software to analyse. The raw data may be in intervals of seconds or minutes according to your choice when starting the loggers. To prepare the data for R-value and U-value measurement, the data should be averages of 1h. To make hourly-based time-series , programming can be used. In order to prepare the data using MS Excel, follow the steps below:

- 1- Open MS Excel and open the ASC file or simply drag the ASC file to your Excel Sheet.
- 2- Make the desired conversions and name all columns accordingly.
- 3- Once the data columns are ready, select them and from the “Insert” tab, insert a Pivot chart.
- 4- From Pivot chart fields, select time and the measured parameters to show.
- 5- From the values, click value field settings and select “Average” for each parameter.
- 6- The new table can be copied to a new sheet and further data analysis can begin.

8-2. Basic Data Analysis

Using heat flux and temperature data, the thermal properties such as thermal resistance and thermal transmittance (R- and U-values) can be determined using guidelines of the standards ISO/ASTM or to follow the instructions below. It is however highly recommended to read the original standard documents or any other literature for more details and instructions.

Note that the required duration of the measurement is not known in advanced and can only be determined by checking the data on a daily basis. If by analysing the data, certain conditions are met, then the test may stop. To proceed the calculations, aggregate the values on hourly basis averaged from the readings.

Determination of the R-value:

Using the hourly averaged heat flux and temperature data, the thermal resistance (R-value) of the wall where the sensors have been installed on, can be determined by:

$$R = \sum_{i=0}^N \frac{\Delta T_i^s}{\dot{q}_i}$$

Where ΔT^s and \dot{q}^t are surface temperature gradient and heat flux, at time t, respectively. N is the last reading according to the duration of the test, indicated below. Report an R-value for every 24h.

Determination of the U-value:

Similar to the R-value, the U-value of the wall (air to air) can be determined using the air temperature. Note that for this practice, the temperature sensors should be hanging with a distance from the surface of the wall and not attached to it.

$$U = \sum_{i=0}^N \frac{\dot{q}_i}{\Delta T_i^\infty}$$

Where ΔT^∞ and \dot{q}^t are surface temperature gradient and heat flux, at time t, respectively. k is the last reading according to the duration of the test (N days), indicated below.

After a minimum duration of 3 days, at day N (e.g. 10), check the following parameters to be below 5%:

- Difference between R values obtained from the last two days of the measurement period
- Difference between R-values from the first and last 2/3 periods of the measurement days
- Difference between the storage and the transmittance

If the conditions above are met, you will see a conversion similar to what is shown in Figure 12 (example). In that case you may report the final value obtained. Otherwise, continue measuring until the conditions are met.

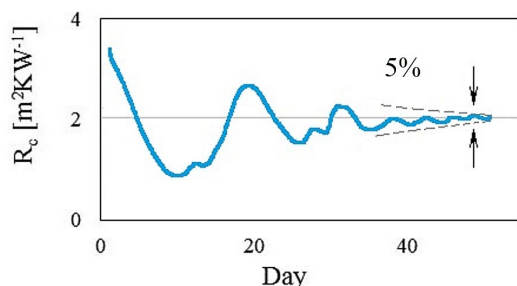


Figure 13- The test shall continue until the ISO 9869 standards' criteria are met

The test shall continue until the mentioned criteria are met. To see more advanced data analysis methods (e.g. Dynamic analysis), refer to the desired standard document.

The uncertainty of the determination of this method, as described in ISO 9869, is between 14% to 28%. Further instructions to improve the results by data analysis techniques can be found in the standards.

9. Maintenance & Troubleshooting

9-1. Maintenance

Using the EKO QRU-100, accurate results can be obtained if the components are at their best condition. Keeping the sensors clean and calibrated ensures the highest accuracy. Therefore, proper maintenance is needed. The following table describes the common maintenance tasks that should be performed:

Table 9-1. Maintenance Items

Maintenance Item	Frequency	How To	Effect
Clean Sensors	After Use	Keep the sensors clean by wiping with a soft wet wipe.	The residue from the paste and the tape glue dissolves.
Replace Battery	When needed	Remove and recycle the old battery and use a new one	A drained battery results in interruption in measurements.
Roll Cables	After Use	Make sure the cables are always free from tension. After use, roll them and use a wire strip to hold them together.	A damage to the wire results in measurement fault or failure
Keep the units in the case	When not in use	Keep the boxes and the sensors in their transport case to protect them from damage.	Loose instruments and/or mounting plates can lead to damages of the instruments and/or injury.
HFS Recalibration	Every 2 Years	To maintain the best possible measurement accuracy, replacing/recalibration of the heat flux sensor is recommended.	Due to natural aging of materials the properties of the sensors can change in time which affects the sensitivity.

9-2. Troubleshooting

Read the following in case of any sensor trouble. If any questions should remain, please contact EKO for further technical support.

Table 9-2. Troubleshooting

Failure	Action
Internal loggers not shown in the list	Make sure the USB cable(s) is connected to the USB port and the battery is inserted and working. Make sure the drivers are working.
Data files not found	Find the location of the saved data in Infraclog software
No signal from the sensors	Contact EKO EU for troubleshooting
Logger not working	Replace the battery
Cables are too short	Contact EKO for extension cables

10. Technical Specifications

10-1. Specifications

In Table 10-1, the specifications of the heat flux sensor and the temperature sensors are presented. For more details, see the specification sheet on EKO Website.

Table 10-1. Other Specification

Characteristics	Value
Heat Flux Sensor Type	Standard (ISO 9869)
Heat Flux Sensor Nominal Sensitivity	0.055 mV/Wm ⁻²
Temperature Sensor Type	RTD PT-1000 4-wire type
Temperature Sensor Accuracy Class	0.1 °C – Class 1/10 DIN
Data Logger Battery Life	Log Interval: >1 min: 4 years- 10 s: 230 days- 1 s: 25 days
Data Loggers' Memory Capacity	4 million Readings

* For full details of the HF-01S, refer to the product page at EKO Instruments website.

10-2. Dimensions

QRU-100

Table 10-2. Dimensions [QRU-100]

Component	Size
A. Indoor/Outdoor enclosure Units	110 X 80 X 60 mm
B. Internal Data Loggers	Φ 50 mm
C. Temperature Sensor	30 X Φ 3 mm
D. Heat Flux Sensor	21 X 24 X 2 mm
E. Temperature Sensor Cables	300 cm
F. Heat Flux Sensor Cable	300 cm
H. Transport Case	350 X 295 X 150 mm



EKO Asia, Oceania

1-21-8 Hatagaya,
Shibuya-ku, Tokyo
151-0072 Japan
P. +81.3.3469.6711
F. +81.3.3469.6719
info@eko-asia.com
www.eko.co.jp

EKO North America

111 North Market Street,
Suite 300, San Jose,
CA 95113, USA
P. +1-408-977-7751
F. +1-408-977-7741
info@eko-usa.com
www.eko-usa.com

**EKO Europe,
Middle East, Africa,
South America**

Lulofsstraat 55, Unit 28,
2521 AL, Den Haag,
The Netherlands
P. +31 [0]70 3050117
F. +31 [0]70 3840607
info@eko-eu.com
www.eko-eu.com