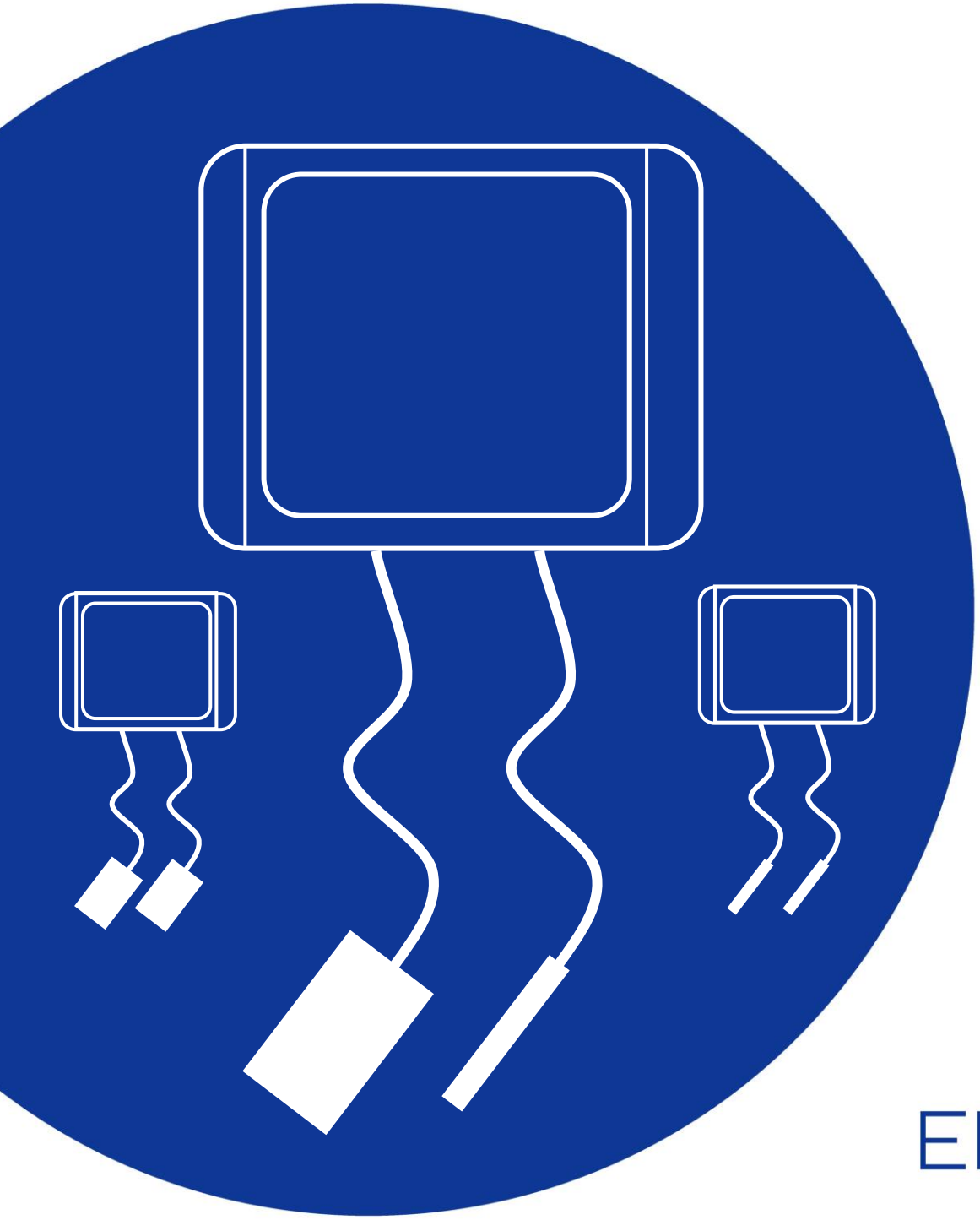
INSTRUCTION MANUAL

QHT-10

Thermal Monitoring Kit:
Monitoring of Heat Flux and/or Temperature
QHT-10-HT
QHT-10-HH
QHT-10-TT



EKO

1. Index

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:

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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

This manual was issued: 2021/07/06
Version Number: 1

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.

CE

DECLARATION OF CONFORMITY

We: EKO INSTRUMENTS EU. B.V.
Lulofsstraat 55, Unit 28,
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The Netherlands

Declare under our sole responsibility that the product:

Product Name: Thermal Monitoring Kit
Model No.: **QHT-10**

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: 06-07-21

Position of Authorized Signatory: Director

Name of Authorized Signatory: C.H. Hoogendijk

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.

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 120 or below -30 degrees Celsius.
- Do not expose temperature sensors to temperatures higher than 180 or below -60 degrees Celsius.
- Do not connect any other sensor/power source to the probes or to the logger.
- Never charge the batteries. Once drained, dispose and 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 measurement unit. Never grab the device hanging from the cables
- Always carry the unit in its transport case, making sure every part is secured in its individual interior space inside the case.
- When the lid of the case does not close, do not apply force. Check for any cables/items blocking
- Be gentle when pulling or pushing the parts into the compartments in the transport case, not damaging the foam.
- The heat flux sensor is fragile and sensitive. Handle, attach, and detach with extra care.

4. Introduction

Heat flow and temperature are the most basic and most important parameters in a thermal system. They can be calculated, estimated, or guessed. However, in many situations, it is critical to measure these values with a certain degree of accuracy. For this purpose, sensors are used. There is a variety of sensors in the market. Temperature sensors are very common and are available in a wide range of models, technologies, and accuracy levels per application. Heat flux sensors are less common as they are more advanced and generally come at a higher price. EKO Instruments has a very long history in the field of thermal testing and measurement including the production of heat flux sensors. While sensors are available to purchase, there is always a need for a data acquisition unit to match the specifications required to read the sensors. For instance, the resolution of microvolts is required for reading the measurement data from a heat flux sensor. EKO QHT-10 (3 models) is a plug-and-play turn-key solution

to measure heat flux and/or temperature. The unit may consists of one heat flux sensor and one temperature sensor(model QHT-10-HT), two heat flux sensors (Model QHT-10-HH), or two temperature sensors (Model QHT-10-TT). Using this product, one can easily monitor heat flux and/or temperature in a thermal system, considering the operation range of the sensors.

QHT-10 unique properties:

Lightweight and easy to handle The QHT-10 is only 335 grams. Easy to carry on the location. The setup is arranged within minutes the measurement course is started.

Standalone The QHT-10 is operated via battery. It can be left at the location without the need for an external power source.

Excellent accuracy level. The QHT-10 comes with the most accurate temperature sensor(s) and reliable thin heat flux sensor(s).

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

4-1. About the QHT-10 Kit

Monitoring heat flux and temperature is an inevitable task in determination of a sytem's thermal performance. The current product, EKO QHT-10 is the solution to perform this task perfectly. With this plug-and-play unit, one can monitor the heat flux and/or temperature at a given location. Depending on your order, your unit may measure the following parameters on two location points A and B:

- A: Heat Flux, B: Temperature (QHT-10-HT)
- A: Heat Flux 1, B: Heat Flux 2 (QHT-10-HH)
- A: Temperature 1, B: Temperature 2 (QHT-10-TT)

4-2. Theory

To better understand the concepts and acquire sufficient knowledge before starting this practice, a brief overview of the physics and 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 which often is perpendicular 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.

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 Guarder Hot Plate (GHP), Thin film heater apparatus and 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 (in this case S=0.0242 mV/ Wm^{-2}) 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 QHT-10 a highly accurate RTD (PT-1000) is used.

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.

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
Monitoring Unit	EKO_QHT-10 with internal Data Logger
Heat Flux Sensor	EKO HF-01S * (Models: QHT-10-HT and QHT-10-HH)
Temperature Sensor	EKO RTD PT-1000 (1/10 DIN) 4-wire * (Models: QHT-10-HT and QHT-10-TT)
Instruction Manual	[Please download from EKO Website]
Calibration Report	EKO HF-01S calibration report (Models: QHT-10-HT and QHT-10-HH)
Specification Sheet	Print – Also downloadable from EKO website
Accessories	4x Thermal Pads, 1x extra battery, 1x USB Cable

*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. Opening the measurement unit using the handle, the datalogger can be observed. Based on the specific model, the unit can come by default (Figure 1) in model HT: one heat flux sensor (B) and one temperature sensor (C), or model HH: two heat flux sensors (2xB), or model TT: two temperature sensors (2xC). In Figure 1, QHT-10-HT is shown as it contains all the elements.

QHT-10

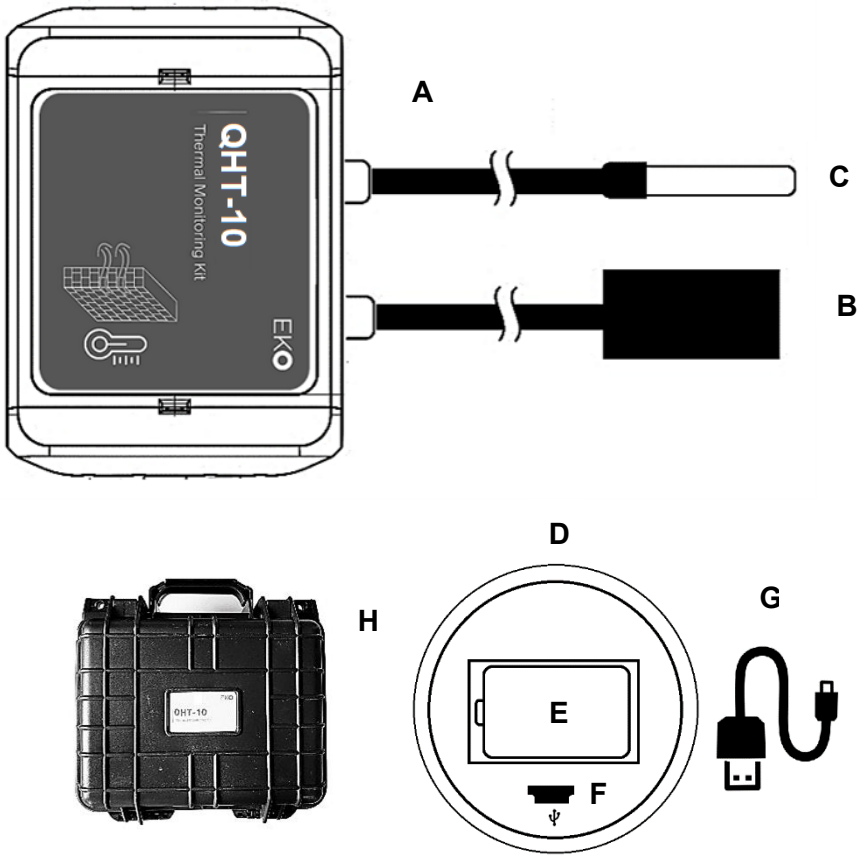

Table 5-1. Parts Name [QHT-10]

Parts Name	
A.	Measurement Unit
B.	EKO HF-01S
C.	EKO PT-1000
D.	Internal Datalogger
E.	Logger Battery
F.	USB Port
G.	USB Cable
H.	Transport Case
I.	Thermal Adhesive (x4)
J.	Extra Battery

Figure 1. EKO QHT-10 main parts and names. When the lid of the measurement unit (A) is open, the internal logger (D) can be seen.

1. Measurement Unit

The measurement unit is responsible for recording the readings from heat flux and/or temperature from the sensors. The unit has an internal data logger which is powered via a 3.6V lithium battery and connects to a PC via a USB cable.

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2. EKO PT1000 Temperature Sensors

EKO QHT-10 (Models QHT-10-HT and QHT-10-TT) is equipped with a PT1000 temperature sensor calibrated with the 1/10 DIN standard. This is the highest accuracy level available in the market. The sensor can measure fluid's or solid's temperature.

3. EKO HF-01S Heat Flux Sensor

The EKO HF-01S standard heat flux sensor is used for measurement of surface heat flux (available in models QHT-10-HT and QHT-10-HH). For detailed instructions regarding this sensor, please refer to the HF-01S instruction manual in EKO website.

4. Internal Data logger

The measurement unit contains an internal data logger. The logger is wired and programmed by EKO and there is no need for further action. By opening the measurement unit's lid, the logger can be accessed.

5. Transport Case

The QHT-10 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.

6. Battery

The logger is equipped with long-life battery (Lithium type SL-750/S). The battery capacity is internally monitored and upon low capacity, a warning is given to the user. In addition to the existing battery, an extra battery is included in the package. The battery can be purchased separately. Please make sure not to use a different model battery. Never charge the battery as it may explode.

7. USB Cable

QHT-10 is shipped with a standard mini USB-2 cable for connection of the datalogger unit to PC.

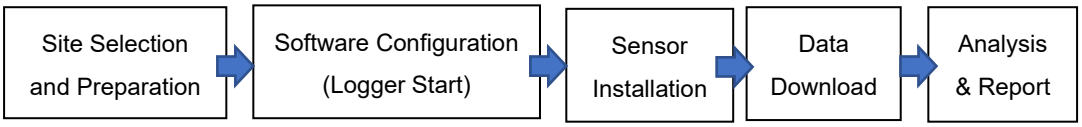
8. Thermal Adhesive

In addition to the units and sensors, 4 thermal pads are included to assist installation. These pads can be used to install the sensors providing thermal contact. Other options are thermal pastes and adhesives. All thermal contact solutions can be purchased separately. For uninstallation, use a blow drier (from distance) to warm up (not heat up) and loosen the adhesive. Then remove the sensors very carefully from the adhesive.

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.

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 selected in section 5.2. After the monitoring, read and download the data via the USB cable and a PC following section 8.1 and analyse accordingly.



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1. Preparation:

Open the transport case and take out the components carefully. Prepare the required adhesives (included in the box).

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. Avoid areas close to thermal bridges and junctions 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. The safest way to allocate the perfect location is to use an IR thermography camera. If not available, make an educated guess. Mark the desired location. Do not attach the sensors yet.
When the above steps are taken, you are ready to set up the logger.

6. Software Configuration

6-1. Starting Up (Windows)

Download and Install the software Infralog V.5 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 using two thumbs: Hold the unit with two hands (cables at left side), push the blue handle forward as shown in Figure 2.

Figure 2- Push the blue handle to open the lid of the measurement Unit.

The internal blue datalogger with a battery and a USB port can be observed inside (Figure 3). Place the battery to activate the datalogger. Connect the unit to the PC via the USB cable provided in the case.

Figure 3- A round logger can be observed once the unit is opened. Locate the USB port and connect the unit to the PC using the USB port.

Once the USB cable is connected and configured, the internal datalogger should appear in the list. Double-click on the logger icon to see the name. “EKO_QHT-10XXX” will appear in the list (Figure 4). The extension 2HF here for instance, means the unit has 2 heat flux sensors (Model QHT-10-HH).

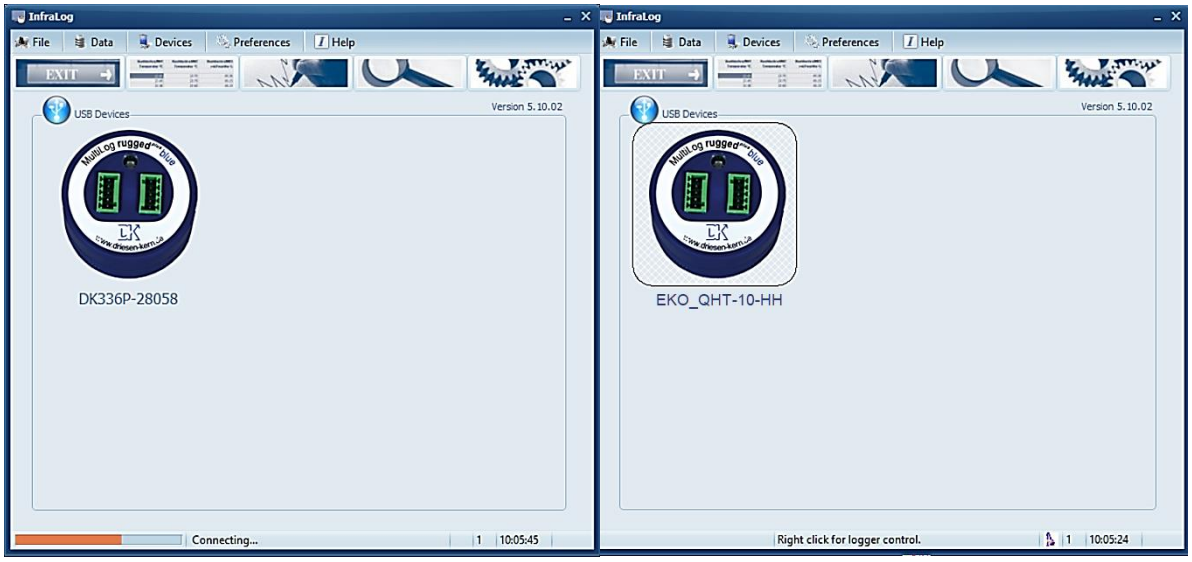

Figure 4- Initial look of the software (left). Click on the logger image to see the name (right)

Right-click on the EKO_QHT-10XXX and select “MeterMode” to open a small new window showing the live data (Figure 5). 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(s) as “Temp.PT1000 [DegC]” and/or heat flux(es) as “HFlux XXX [W/m2]” at the location of the sensors. The extension A2067 here is the serial number of the heat flux sensor. To check the performance of the sensors, hold them with your hand and see the heat flux and temperature change.

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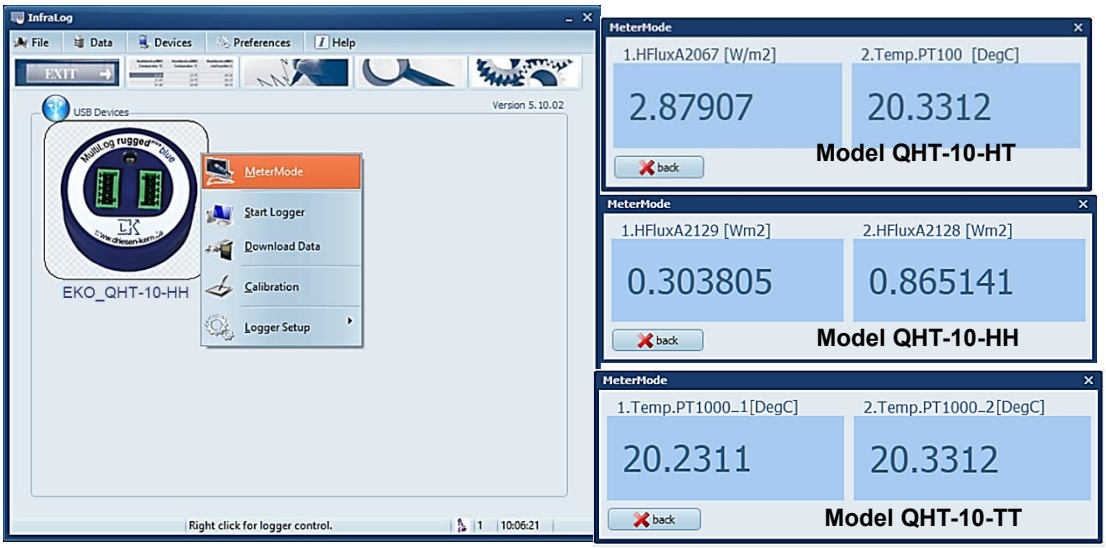

Figure 5- Right click on the logger and select MeterMode to observe heat flux(es) and/or temperature(s) (depending on the model). This is a test to check and see if the unit is working properly.

Once 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 (Figure 6). Click on Start logger at and change [Immediately] to [Select Date] and in the gap below, click on […] to set the starting time. Remember to set the starting time at a later moment to allow enough time for installation of the sensors. The logger will start automatically at the time specified. 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.

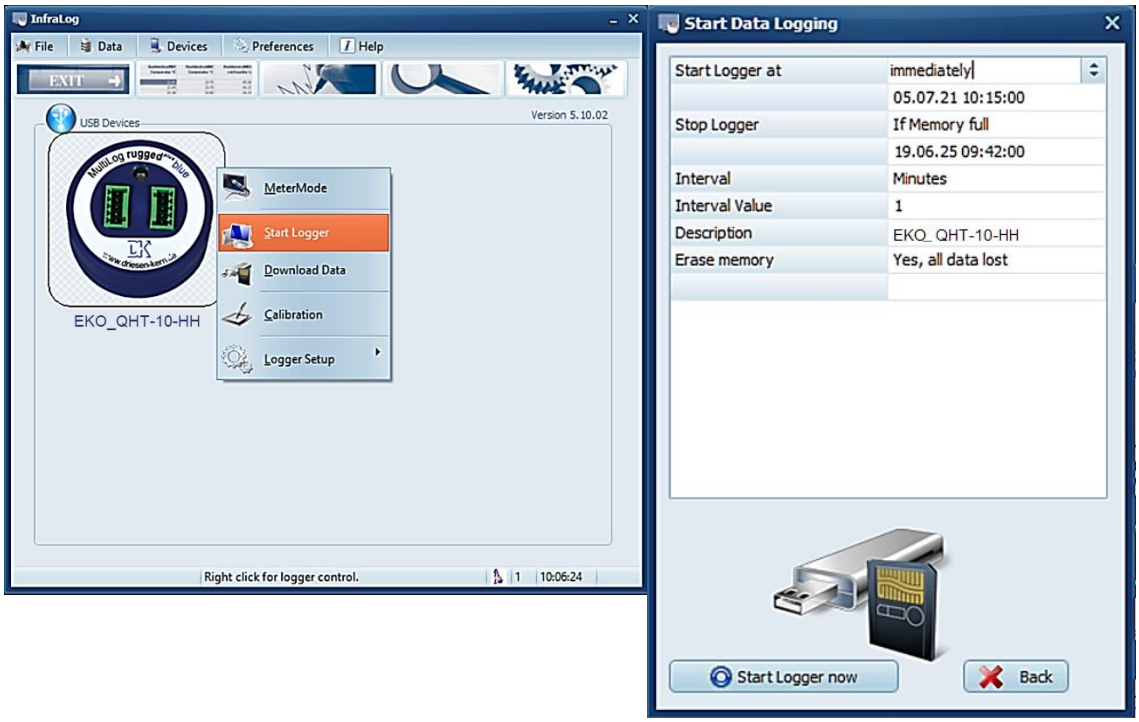

Figure 6- To start a unit, right-click on its name and select “Start Logger”. Adjust the settings regarding the starting time and the logging interval and press “Start the logger now”.

Once completed, click “Start Logger now” and the logger is ready. Once completed, disconnect the USB cable gently, close the lid and start installation of the sensors according to Section 7, at the locations found in 5.2.

7. Sensor Installation

7-1. Installation

Place the measurement 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.

The temperature probe is to measure the air or the surface temperature. To measure the air temperature, attach the wire near the tip to a surface to have the tip hanging in the air. To use the temperature sensor for surface measurements (See Fig 7), perfect thermal contact is required. Use the pads to make a bedding on the surface for the sensor probe and cover it with a second layer. Finally. Cover the sensor with a masking tape of the same emissivity as the rest of the measuring surface.

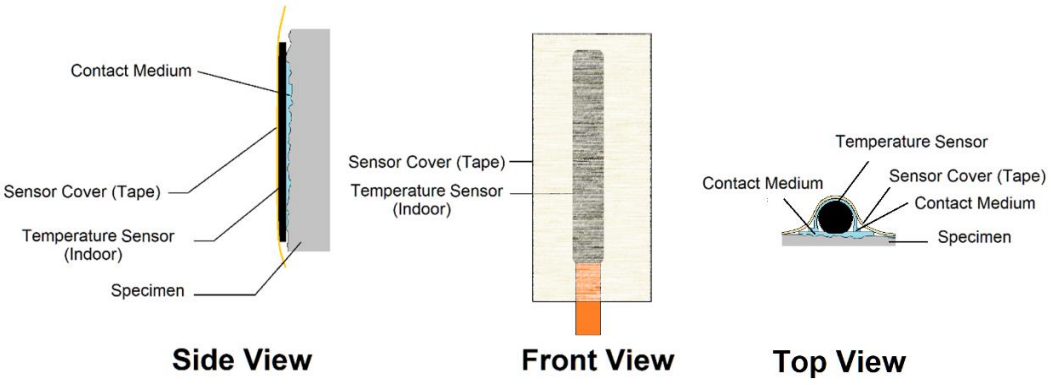

Figure 7- Configuration of the temperature sensor on the surface (QHT-10-HT and QHT-10-TT)

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. The thermal pads can be used for this purpose. Alternatively, carpet temporary double side adhesive or thermal compound (paste) can be used. The surface should be flat and clean. Cover the sensor with a masking tape of same emissivity as the rest of the surface being measured (See Figure 8). It is recommended to recalibrate the heat flux sensors every 1-2 years.

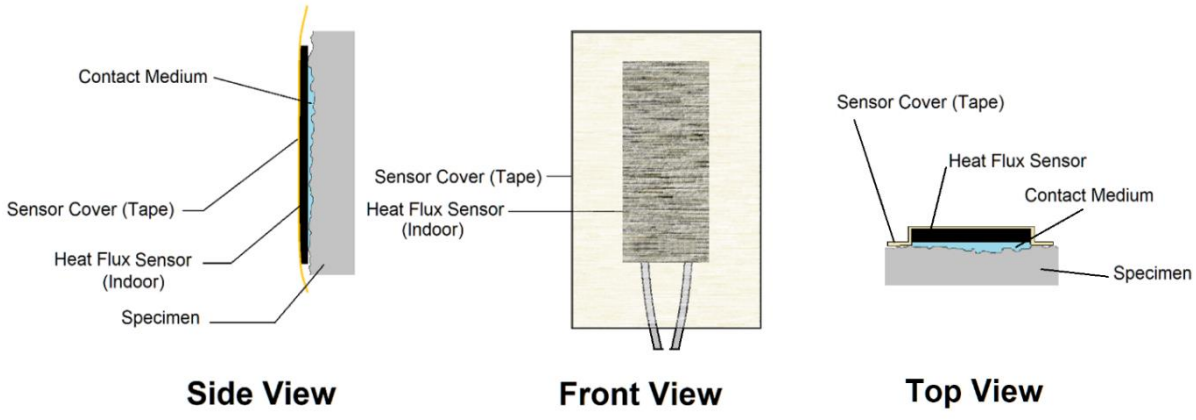

Figure 8- Configuration of the heat flux sensor on the surface (QHT-10-HT and QHT-10-HH)

7-3. Uninstallation

When the experiments are finished note the uninstallation time to skip the data measured after this point. Detach and remove the sensors from the surface. 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, slowly warm up the sensor using a heating device (e.g. blow dryer). After a short time. The adhesive becomes loose and you can carefully remove the sensor. Remove and dispose the adhesive and clean the residues on the sensor.

8. Data Acquisition

8-1. Data Acquisition

To read the measured data, note the uninstallation time, reconnect the logger to your PC via the USB cable. Launch the software Infralog and double click on the two logger icon to see the name “EKO_QHT-10”. Right click on the logger and select “Stop Logger” and then select “Download Data” (Figure 9). This may take a while until the data is obtained from the logger. The progress can be seen at the bottom of the window.

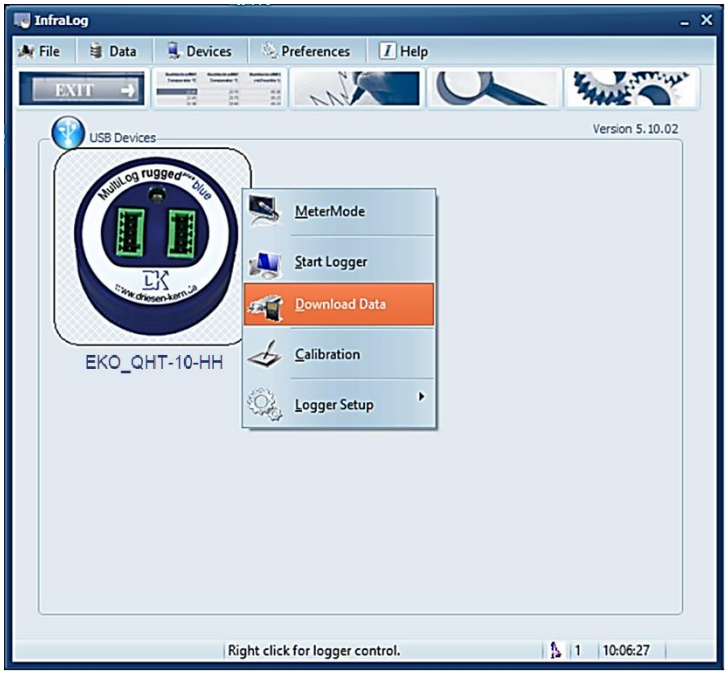

Figure 9- Click “Download Data” to download the measured data in the PC

A new window is opened (Figure 10), showing graphs and asking for a key. Click “OK” to close the window and go to the address below.

C:/Users/USERNAME/Documents/InfraLog/Logger/EKO_QHT-10.

You can find the data storage location by clicking on ”Preferences/Program/Location for Logged Data” in Infralog software.

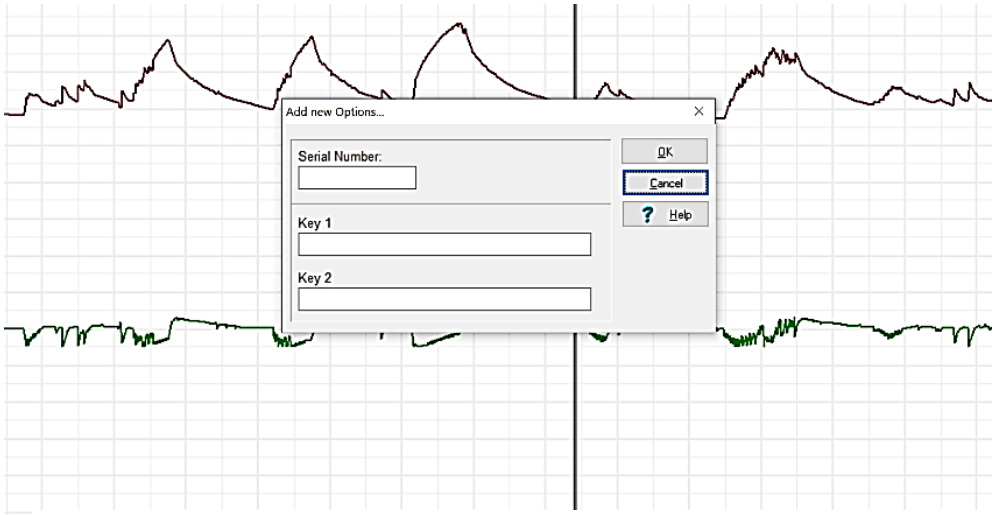

Figure 10- After clicking on "Download Data", this graph will automatically pop up. Close it and refer to the file location.

Once the data is found, open the relevant ASC file in MS Excel. The data is ready to analyse.
The raw data may be in intervals of seconds or minutes according to your choice when starting the logger.

9. Maintenance & Troubleshooting

9-1. Maintenance

Using the EKO QHT-10, accurate results can be obtained if the components are at their best condition. Keeping the sensors clean and calibrated ensures the highest accuracy of this kit. 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 cloth and little alcohol.	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.
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. Be careful not to damage the sponge foam	Loose instruments and/or mounting plates can lead to damages of the instruments and/or injury.
Recalibration	Every 2 Years	To maintain the best possible measurement accuracy, recalibration is recommended. Contact EKO for recalibration and maintenance service.	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 logger not shown in the list	Make sure the USB cable is connected to the USB port and the battery is inserted and working.
Data file not found	Find the location of the saved data in Infralog software (Section 8.1)
No signal from the sensors	Contact EKO EU for troubleshooting
Logger not working	Replace the battery with the ones provided / purchased separately
Sensor cables are too short	Contact EKO for custom lengths

10. Technical Specifications

9-1. Specifications

The accuracy of the system is dependent on the accuracy of the components. In Table 10.1, the specifications of the heat flux sensor and the temperature sensors are presented.

Table 10-1. System Specification

Characteristics	Value
Heat Flux Sensor Model	EKO HF-01S
Heat Flux Sensor Nominal Sensitivity	Approx. 55 µV/W/m²
Heat flux range	±10000 W/m²
Heat flux sensor's temperature range	-30-100 ˚C
Temperature Sensor Type	RTD PT-1000 4-wire type
Temperature Sensor Accuracy Class	0.1 ˚C – Class 1/10 DIN
Temperature Sensor Range	-60 -180 ˚C
Data Logger Battery Life	Log Interval: >1 min: 4 years- 10 s: 230 days- 1 s: 25 days
Data Logger Memory Capacity	4 million Readings
Datalogger operating temperature range	-40 +90°C

10-2. Dimensions

QHT-10

Table 10-2. Dimensions [QHT-10]

Component	Size
A. Enclosure Unit	110 X 80 X 60 mm
B. Internal Logger	Φ 50 mm
C. Temperature Sensor	30 X Φ 6 mm
D. Heat Flux Sensor	25 X 24 X 2 mm
E. Temperature Sensor Cable	300 cm
F. Heat Flux Sensor Cable	300 cm
G. Thermal Pad	55 X 20 mm
H. Transport Case	270 X 245 X 120 mm

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