Quick λ
Thermal Conductivity Tester

HC-10

EKO

1.   Index

2. Important user information

Make sure to read this instruction manual thoroughly and to understand the contents before starting to operate the instrument.

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

2-1. Contact information

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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 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

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2-4. Environment

1. WEEE Directive 2002/96/EC (Waste Electrical and Electronic Equipment)

This product is not subjected to WEEE Directive 2002/96/EC however it should not be mixed with general household waste. For proper treatment, recovery and recycling, please take this product(s) to designated collection points.

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.

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.
⚡	**High Voltage**	High voltage is applied. Ignoring this indication there is a possibility of serious injury or death due to injury such as electric shock.
🔥	**Hot surface**	Hot surface – risk of burning

⚠️ 3-1. Set-up

- ➢ Store in a cool and dry place
- ➢ Handle the sensor unit with care. Avoid any strong mechanical impact. Any scratch or dent to the sensor unit can cause inaccuracies in the measurements.

⚡ 3-2. Static Electricity / Noise Caution

- ➢ Please use measures to prevent any static electricity
- ➢ It may cause noise (inaccuracies) if the equipment is operated close to large machines or high voltage equipment. Avoid using it in an unstable position.

4. Introduction

The HC-10 easily measures the thermal conductivity of homogeneous samples and vacuum insulation plates (VIP), and quantifies differences in heat transfer behavior near the surface of a material. The difference in the heat transfer behavior near the surface is influenced by various differences, such as, the thickness of the thin film layer, degree of vacuum, bulk density, surface roughness, and so on in case of VIP. Besides the material difference, and thermally checking these effects, we can check the quality and status of the test specimen.

It is also possible to check the vacuum density of the vacuum insulation material and the bulk density which becomes one of the indicators of powder fluidity within 1 minute.

4-1. Main Function of Product

1. Measure the difference in heat transfer behavior near the surface of a material in 1 minute.
2. Portable and standalone use possible (however AC100V to 240V is required)
3. Creating calibration and determining the evaluation threshold.

4-2. Packing Contents

First of all, please check the packing contents. If there are any missing or damaged items, please contact EKO immediately.

Table 4-1. Packing Contents

Standard Accessories	Quantity	Details
Quick Lambda Main Unit	1	
Sensor Unit	1	The sensor head is a consumable item. After replacement, recalibration is required.
AC Adaptor	1	
Power Cable	1	
Standard Samples	3	EPS, Acrylic, TEMPAX Glass
Carrying Case	1	Standard (cardboard material)
USB Cable	1	A type
Software CD	1	
Inspection Certificate	1	
Instruction Manual	1	

5.   Product Handling Method

5-1．Name and Function of Each Part
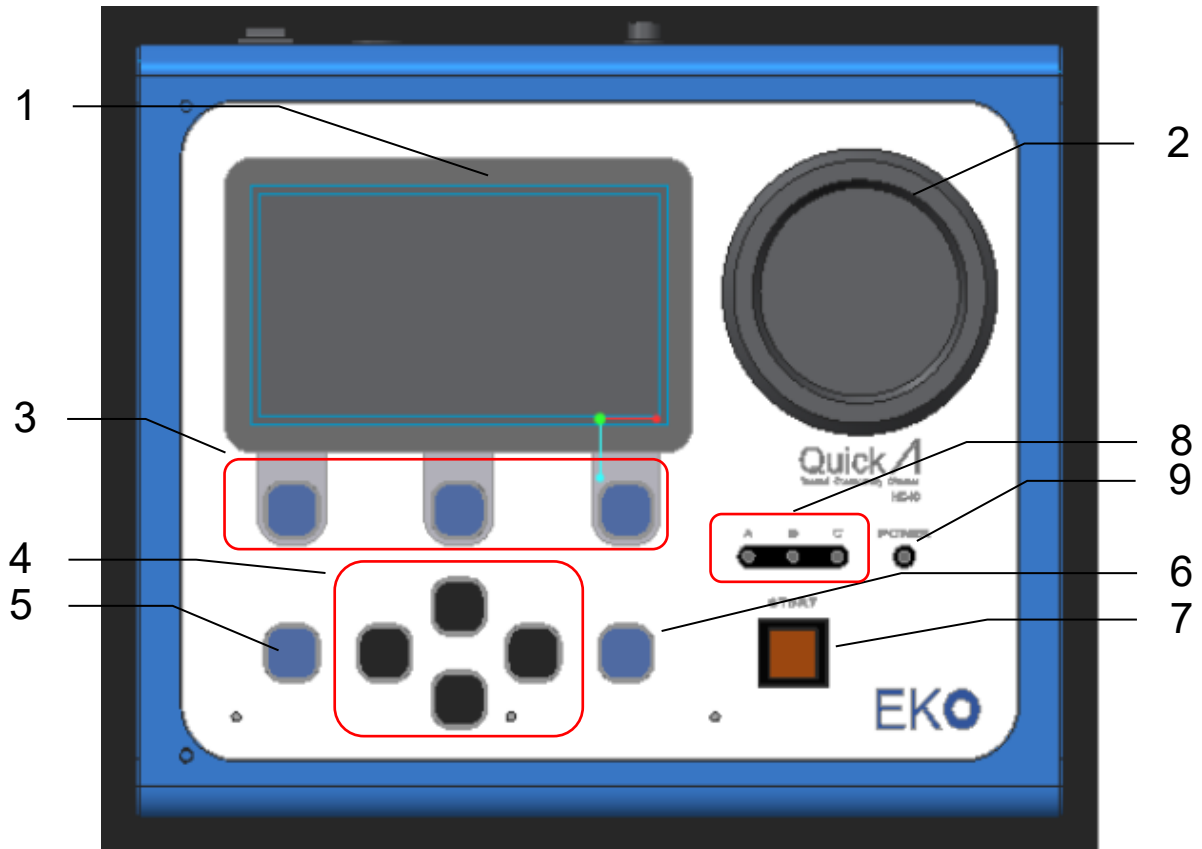
1. Front of Main Unit

Table 5-1 Main Unit - Front

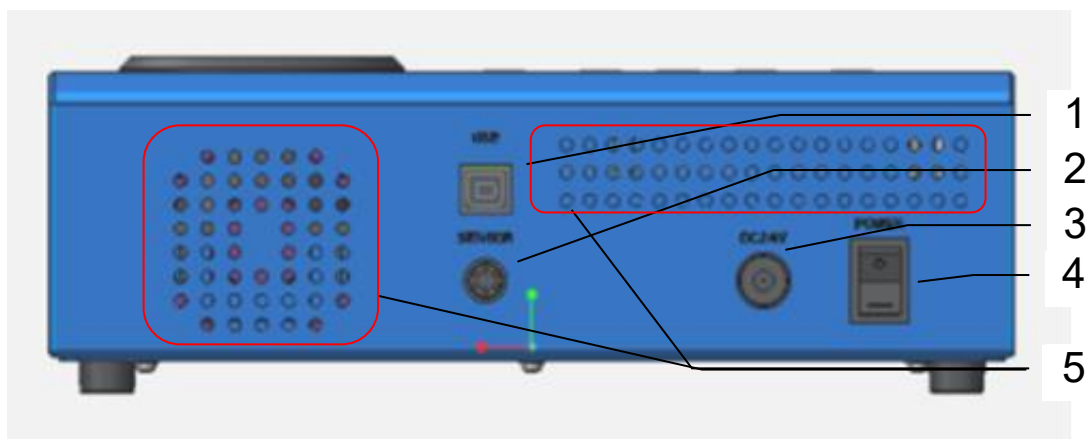|	Name	Function
1	LCD	Displays operation and measurement result
2	Cooler	Cooling of sensor
3	Function Button	Execute the function displayed on the LCD
4	Arrow Keys	Move Cursor Left /Right arrows: Move part of screen Up/Down arrows: Change numerical value
5	ESC Button	Return to previous screen
6	ENTER Button	Confirmation and execution
7	START Button	Start Measurement / Cooling Status Indication
8	Class Indicator lamp	Lights according to result
9	Power Indicator	Power confirmation

2. Rear of Main unit

Table 5-2. Main Unit – Rear

	Name	Function
1	USB Port	To connect to PC
2	Sensor Port	Connection port for sensor
3	Power port	Connection port for AC adaptor
4	Power switch	ON/OFF
5	Ventilator	Ventilation

3. Sensor Unit
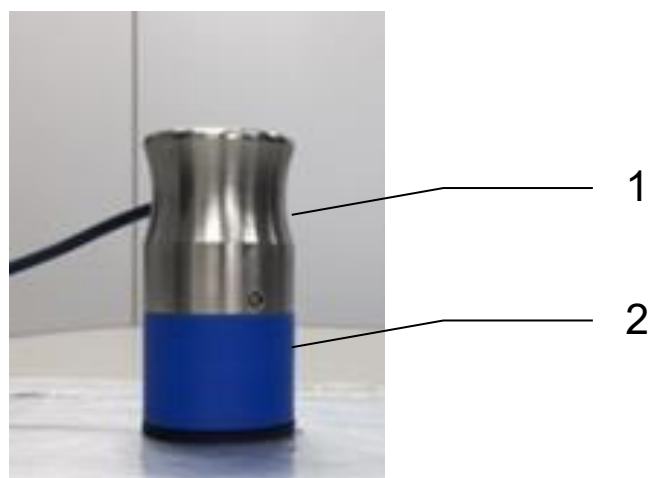
Table 5-3. Sensor Unit

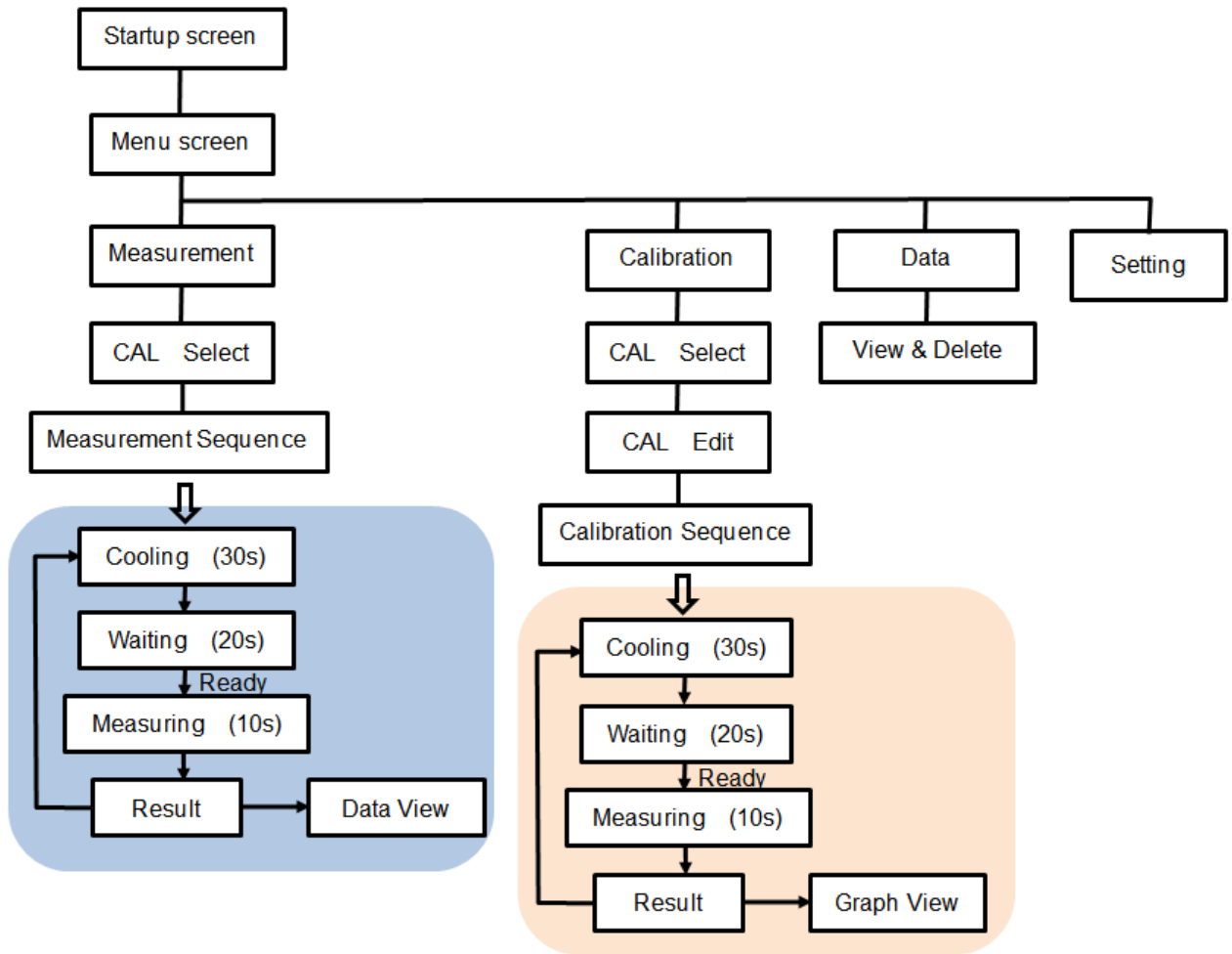|	Name	Function
1	Sensor Weight	Weighted section to improve contact between the sensor and the sample
2	Sensor head	Heats and measures sample

4. Menu

Table 5-4. Menu Display

| Menu Display	Contents
Measurement	• Measurement is performed using the calibration already created. • Select calibration • Confirmation of calibration contents already created • Measurement status display • Measurement result display (thermal conductivity · output data · temperature class determination) • Up to 99 measurements can be saved.
Calibration	• Create a new calibration (Input and measurement of thermal conductivity of standard board, confirmation of linearity Change of calibration name) • Unit input (W/m·K or mW/m·K, or no unit) • Class determination threshold input • Calibration • 20 Calibrations can be created
Data	• Confirm Data or Delete Data • Delete Calibration
Setting	• Date Setting • LCD setting • Sound Settings • Temperature limit (to prevent instrument overheating)

5-2. Measurement condition

1. Conditions for measurement

➢ Samples to be measured are homogeneous materials and are limited to samples with thermal conductivity ranging from 0.001 to 5.0 [W/m・K].

➢ Even substances that are not homogeneous, those made under the same conditions, such as vacuum insulation materials can be measured. At least three VIP samples of the same construction but different vacuum and thermal conductivity have to be prepared for this application.

➢ The section of the sample where the sensor unit is placed must be flat.

➢ Measure in a place where there is no air flow. Measurement error will result if air, for example, from an air conditioner is directed at the sample.

➢ The sample to be measured must be well suited to the ambient temperature in the room. If the ambient temperature and the sample temperature are different, a measurement error will occur.

➢ Foamed materials such as Styrofoam can only be measured if the bulk density is the same and only the difference in thermal conductivity is to be observed. **However, it is impossible to determine the difference in thermal conductivity in a very narrow range by measuring samples which have the different bulk density. Even if calibration is performed, correlation of voltage output with thermal conductivity cannot be obtained. Therefore, in this case it cannot be measured correctly with this device.**
Customers wishing to measure such samples should contact us.

➢ As for thin materials such as films, please stack the sample to a certain thickness before taking any measurements. The thickness of the sample to be measured will be limited by the thermal conductivity. Adjust the thickness of the sample by referring to the graph below. However, if air enters between the film layers, the error will increase, so please ensure the samples are properly joined together.

Thickness of measurable sample (estimated value)
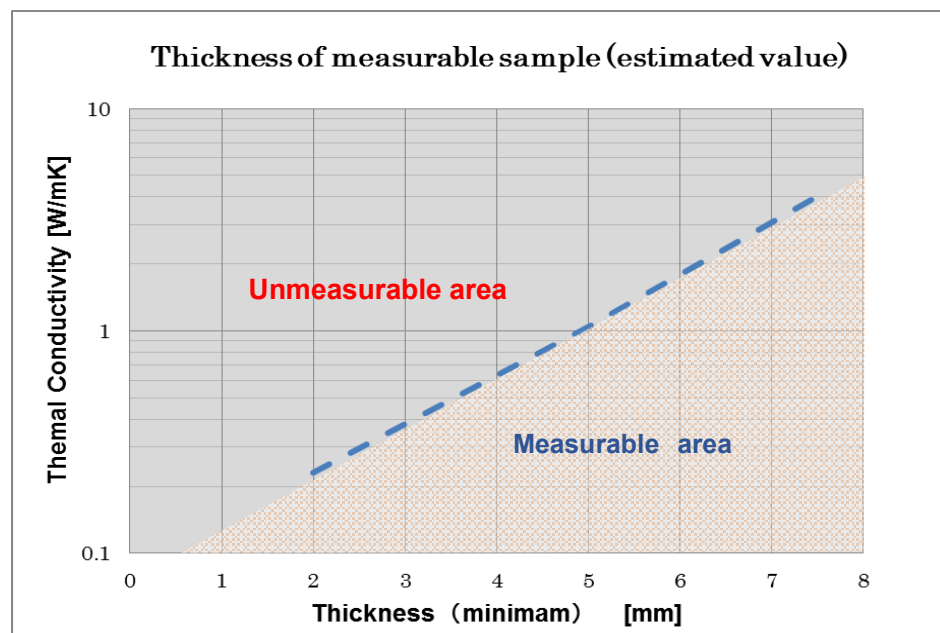
➢ This device is not designed for measuring thermal conductivity directly. A standard reference sample should be a material with known thermal conductivity value or should be measured by another thermal conductivity measuring device. This device estimates the thermal conductivity by the calibration curve based on the thermal conductivity of the standard reference sample and the output value from the sensor.
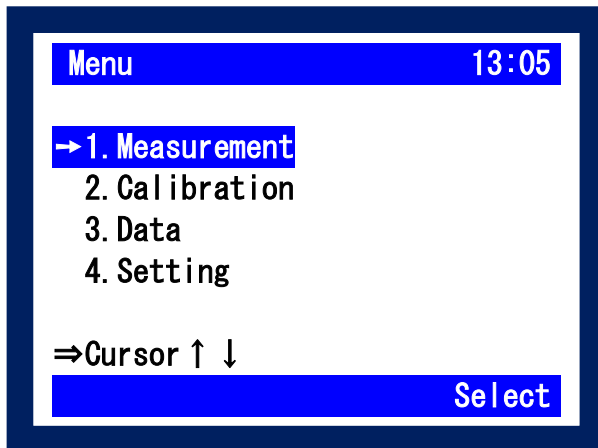
5-3. Installation

1. Usage Environment/ Precautions for Measurement

The following steps should be taken into account to ensure accurate measurements are taken:

1) Place the sensor on a flat surface
2) Keep sample away from any external sources that could have an effect on the measurement such as an air conditioning unit
3) Measurement should be taken away from any machinery that could cause vibration
4) Keep away from dust
5) No equipment to be placed close to the instrument that generates high voltage
6) Use indoors and away from anything that could cause static interference
7) Sample temperature must be the same as room temperature
8) The measured value is the thermal conductivity near the surface
9) The standard sample should be similar to the sample being evaluated

2. Device Startup

1) Connect the sensor to the AC adaptor
2) When you turn on the power, the startup screen will be displayed, and the menu screen will appear after a few seconds as below:
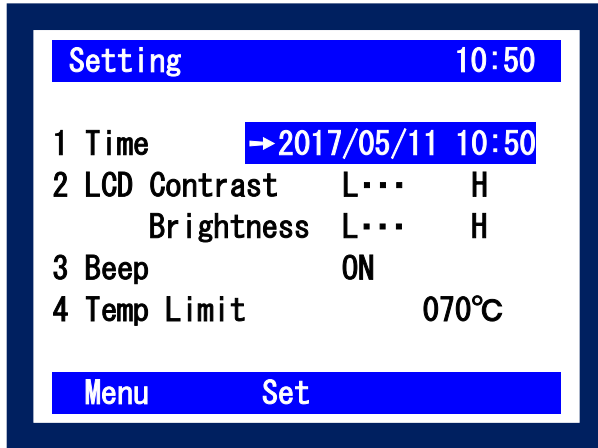
```
Menu                    13:05


→1. Measurement
  2. Calibration
  3. Data
  4. Setting

⇒Cursor ↑ ↓
                      Select
```

5-4．Configuration

1. Setting

1) Menu selection (move with ▲ ▼ button, select Enter or Select) select Setting.

```
Setting                10:50

1 Time        →2017/05/11 10:50
2 LCD Contrast    L···    H
     Brightness   L···    H
3 Beep            ON
4 Temp Limit          070℃


  Menu         Set
```

2) In the settings menu the following actions can be conducted:

Table 5-5. Setting Menu

Setting	Contents
Time	Change date and time ⇒Use the SET button and the cursor buttons to change the value.
LCD	Adjust Contrast and Brightness ⇒ Use the left/right buttons ◀ ▶ to adjust the contrast and brightness
Beep	On/Off ⇒ Use the left/right buttons ◀ ▶ to switch on/off the sound
Temp Limit	Sensor temperature limit setting must be < 70°C or less ⇒Use the SET button and the cursor buttons to change the value.

How to adjust numerical values

Press the Set button to change the black and white of the number, change the number with ▲ ▼ buttons and change the input position with ◀ ▶.

After entering the desired numerical value, press the Set button again to confirm the number.

5-5．Calibration

1. About Calibration

Ensuring samples are properly calibrated is critical, as improper calibration will affect the accuracy of the measurement. Calibration, CALSTD, is a pre-configured calibration performed at the time of shipment with 3 standard samples (EPS, Acrylic, TEMAPX glass). The calibration data of CALSTD cannot be modified by the end user and is password protected. If the calibration data of CALSTD needs to be modified, please contact your EKO Instrument representative.

Calibration, CALSTD is useful for checking the deterioration of the sensor. Periodically using CALSTD, you can check to see if there is any deterioration of the sensor. This is done by measuring the thermal conductivity of the standard sample and comparing this value to the displayed thermal conductivity.

Additionally, if you cannot prepare samples for calibration, it is possible to measure the thermal conductivity of a homogeneous sample in the thermal conductivity range of 0.03 to 1.0 [W/m・K] by using CALSTD.

When measuring non-homogeneous samples like a Vacuum Insulated Panel (VIP), to measure the thermal conductivity in a narrow range with the same material, samples for calibration need to be prepared. 3 to 4 samples with different thermal conductivity are required, for the calibration. Up to 19 calibrations can be stored on the device; CAL001 to CAL019. When a PC is used, there is no limit to the number of calibrations.
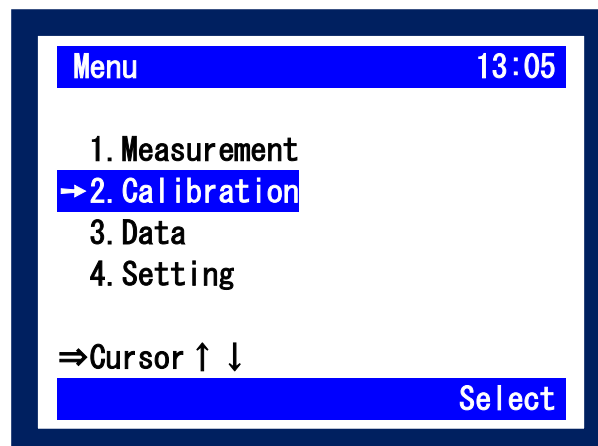
2. Preparation of calibration sample (example of VIP)

When measuring a Vacuum Insulation Panel (VIP), calibration CALSTD of standard sample cannot be used.
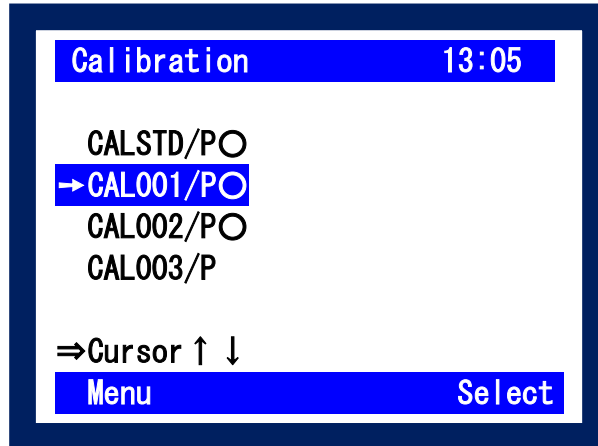VIP is a non-homogeneous material with a very low thermal conductivity. To measure VIP, it is necessary to prepare 3 to 4 proof plates (user samples) of VIP of the **same shape** and **different thermal conductivity**. The thermal conductivity of the VIP samples must be accurately measured by another thermal conductivity measuring device.

3. Calibration Operation

1) Menu selection (move with ▲ ▼ buttons, select Enter or Select) select Calibration.

```
Menu                13:05


  1.Measurement
→ 2.Calibration
  3.Data
  4.Setting

⇒Cursor ↑ ↓
                   Select
```

2) Select Calibration number (move with ▲ ▼ buttons and select Enter or Select)

Select the calibration number to create. Items that have already been calibrated are marked with a circle. "CALSTD" can be used when using the supplied standard sample (Thermal conductivity has already been entered).
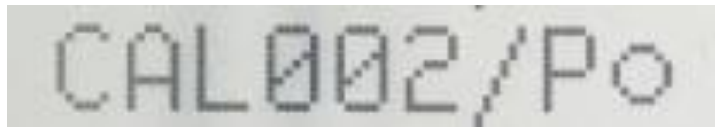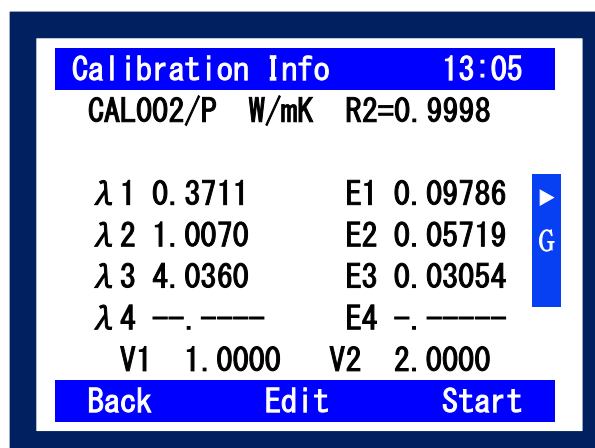
```
┌─────────────────────────────┐
│ Calibration        13:05    │
│                             │
│   CALSTD/PO                 │
│ ➡CAL001/PO                  │
│   CAL002/PO                 │
│   CAL003/P                  │
│                             │
│ ⇒Cursor ↑ ↓                 │
│ Menu             Select     │
└─────────────────────────────┘
```

Description of Calibration Name

CAL002/Po

Table 5-6. Calibration Name Definitions

Display	Contents
CAL	Abbreviation of Calibration
002	ID 3 Characters ⇒It is possible to change to letters and numbers in ID Edit The ID and thermal conductivity cannot be changed for STD.
P	Approximate Symbol P: Power Low (Power Approximation) L: Linear Low (Linear Approximation) ⇒Can be changed in the calibration graph
○	Presence/absence of calibration ⇒○ means already created

3) Unit, standard value input λ, class threshold V 1, V 2 input as required. When you press the Edit button, the cursor will appear.

```
┌─────────────────────────────┐
│ Calibration Info    13:05   │
│ CAL002/P  W/mK  R2=0.9998   │
│                             │
│  λ1 0.3711      E1 0.09786 ▶│
│  λ2 1.0070      E2 0.05719 G│
│  λ3 4.0360      E3 0.03054  │
│  λ4 --.----     E4 -.----   │
│    V1  1.0000   V2  2.0000  │
│ Back      Edit      Start   │
└─────────────────────────────┘
```

3-1) Unit Change

When you press the Edit button, the cursor is displayed in the unit position. "Edit" switches to "Set".

Each time you press the Set button, the unit and decimal point position are switched as shown below. ① "mW / m·K" → ② "W / m·K" → ③ " W / m·K" → ④ "- - -" → ⑤ " - - -".

Please select the desired unit and decimal point position.

For items without units, even with physical quantities other than thermal conductivity, it means that measurement can be performed with this system only when correlation with thermal conductivity is found between the reference sample and the sensor output by either linear approximation or power approximation　Please measure it assuming the unit of the physical quantity which the customer wants to measure.

Calibration Info　　13:05			Unit	Decimal point position
CAL002/P →W/mK　R2=0.9998			"mW/m·K"	"0000. 00"
			"W/m·K"	"00. 0000"
λ1 0.3711　　E1 0.09786			" W/m·K"	"0000. 00"
λ2 1.0070　　E2 0.05719			"---" (No unit)	"00. 0000"
λ3 4.0360　　E3 0.03054			" ---" (No unit)	"0000. 00"
λ4 --. ----　　E4 -. ----				
V1　1.0000　V2　2.0000				
Back　　　Set　　　Start				

3-2) Change the standard value

Move the cursor to λ1 ~ λ4, press the Set button to invert the black and white of the number, change the number with ▲ ▼ buttons,Use ◄ ► to change the input position. After entering the numerical value, press the Set button again to decide the number.It is recommended to include at least three standard values. (In case of linear approximation Linear Low, it is possible to create a calibration even with 2 points.)

3-3) Class threshold change E (Voltage)

If necessary, enter the value in the same way as 3-2. Please input V1 <V2.

A class ≦ V1 <B class ≦ V2 <C class

3-4) Change ID

If necessary, press the ID Edit button to change the ID of the Calibration.

Using the cursor and the Set button, enter three letters or numbers then Save.

```
Calibration              13:05
  CAL003/P
            0123456789
            ABCDEFGHIJ
            KLMNOPQRST
            UVWXYZ



Cancel        Set         Save
```

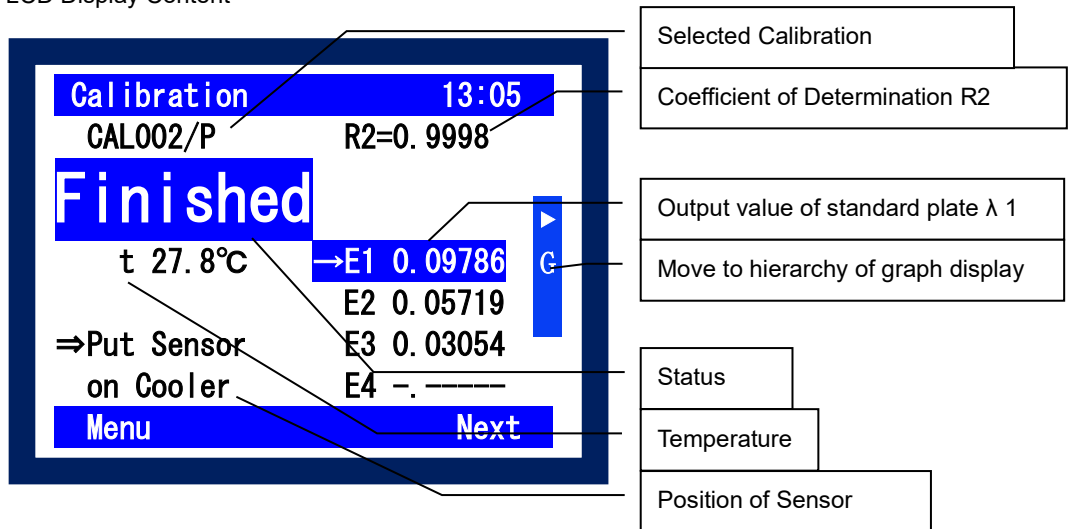## 3-5) Calibration Procedure

Use the Back button to exit the Edit screen and press the Start button to commence calibration.

Follow the procedure below to measure E1 to E4 with standard values and calibrate.

```
Calibration Info      13:05
 CAL002/P   W/mK   R2=0.9998

 λ1 0.3711      E1 0.09786   ▶
 λ2 1.0070      E1 0.05719   G
 λ3 4.0360      E1 0.03054
 λ4 --.----     E4 -.-----
    V1  1.0000     V2  2.0000
  Back      Edit      Start
```

3-6) LCD Display Content

```
Calibration          13:05
 CAL002/P      R2=0.9998
Finished
   t 27.8℃      →E1 0.09786  ▶ G
                E2 0.05719
 ⇒Put Sensor    E3 0.03054
   on Cooler    E4 -.-----
  Menu               Next
```

Callout	Description
	Selected Calibration
	Coefficient of Determination R2
	Output value of standard plate λ1
	Move to hierarchy of graph display
	Status
	Temperature
	Position of Sensor

3-7) Calibration Procedure

Table 5-7. Calibration Procedure

Measurement Procedure Number	Sensor Movement	Main Unit Operation	Announcement		
			Status	Light	Beep
1		When the start button is pushed	Finished	Blink Button	on
2	Move to cooler	When the start button is pushed	Cooling		
3		30 seconds later	Ready	Button Lit	on
4	Move to Sample	Select E1 to E4 with ▲ ▼			
5		When the start button is pushed	Measuring		
6		30 seconds later	Result	Blink Button	on
7		Confirm Output value and check linearity			
8	Move to Cooler	When the Start button is pushed	Cooling		
9		Return to 3			

## 3-8) Confirmation of Calibration

To check the quality of the calibration, check the R2 value (coefficient of determination).

The closer R2 is to 1, the better the calibration is.

Press the cursor button ▶ to display the graph.

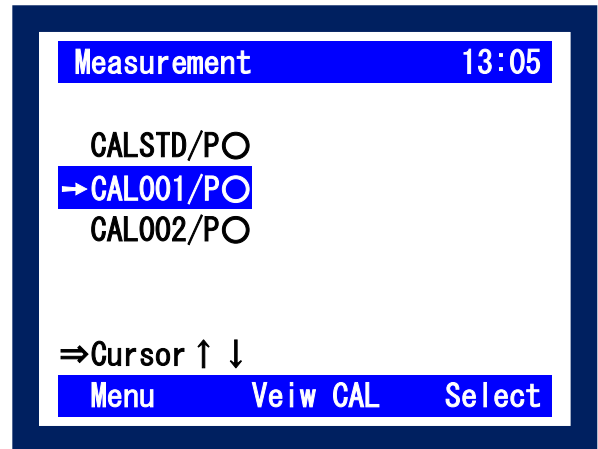Change power approximation (POWER) and linear approximation (Linear) if necessary.

Slope and intercept of the straight line are also displayed. To return, press ◄.
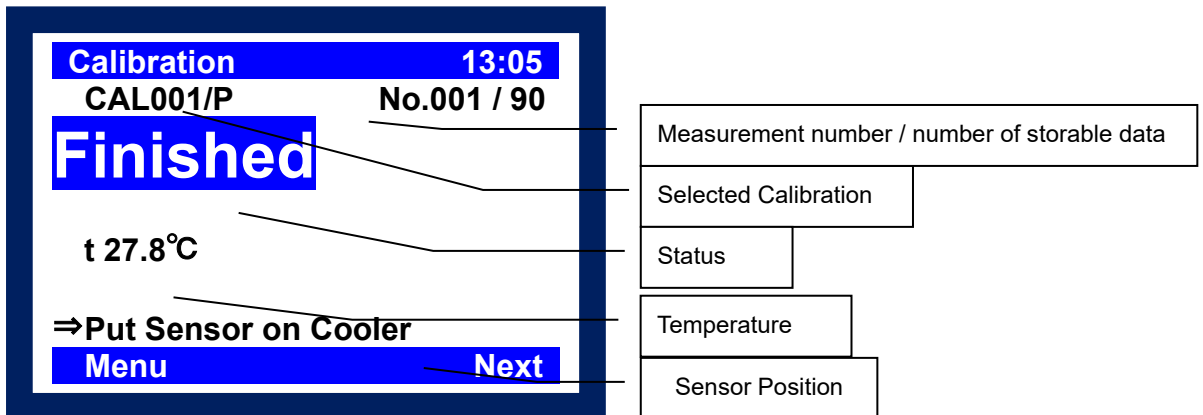
Calibration Graph	13:05
CAL002/P	
Power Low	
R2=0.9998	
a=-2.05056	
b=-5.76661	
Linear	Power
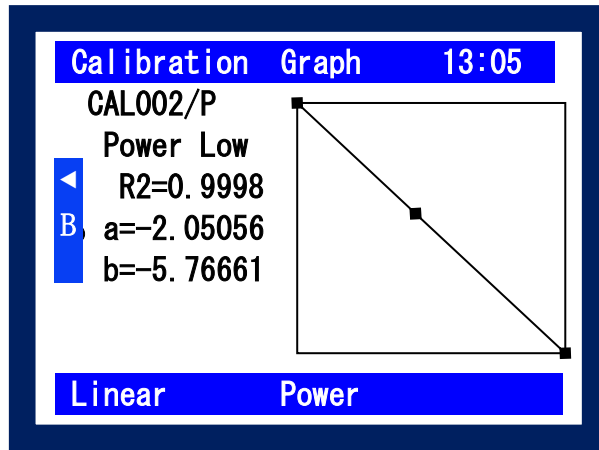
5-6．Measurement and Operation

1. Measurement operation

1) Menu selection (move with ▲ ▼ button, select Enter or Select). Select Measurement.

2) Select Calibration number (move with ▲ ▼ button and select Enter or Select) Select the calibration number to use. Only calibrated files (marked with a circle) will be displayed. If you need to check the calibration contents before selecting it, press ViewCAL 3. If you select it, proceed to 4.

```
┌──────────────────────────────────┐
│ Measurement            13:05     │
│                                  │
│   CALSTD/P○                      │
│  ➡CAL001/P○                      │
│   CAL002/P○                      │
│                                  │
│                                  │
│ ⇒Cursor ↑ ↓                      │
│  Menu     Veiw CAL   Select      │
└──────────────────────────────────┘
```

3) Here, you can check the units, thermal conductivity of the standard board, the class threshold, linearity etc. If there are no issues with the values stated press the Start button.

4) LCD Indicates Content

```
┌──────────────────────────────────┐
│ Calibration            13:05     │
│  CAL001/P        No.001 / 90     │
│  Finished                        │
│                                  │
│  t 27.8℃                         │
│                                  │
│ ⇒Put Sensor on Cooler            │
│  Menu              Next          │
└──────────────────────────────────┘
```

- Measurement number / number of storable data
- Selected Calibration
- Status
- Temperature
- Sensor Position

Caution: Data is automatically saved with the measurement date and measurement number.

5) Follow the procedure below to measure an unknown sample:

Table 5-8. Measurement Procedure for Unknown Sample

Measurement Procedure	Sensor Movement	Main Unit Operation	Announcement		
Number			Status	Light	Beep
1		When the start button is pushed	Finished	START button flashes	on
2	Move to cooler	When the start button is pushed	Cooling		
3		30 Seconds Later	Ready	START button is on	on
4	Move to sample	Select E1 to E4 with ▲ ▼			
5		When the start button is pushed	Measuring		
6		30 Seconds Later	Result	START button flashes	on
7		Confirm the measurement number, measurement result, class judgment, etc.			
8	Move to cooler	When the start button is pushed	Cooling		
9		Return to 3			

6) Confirm the data

After the measurement is completed, the measurement result is displayed.

It is possible to check the measurement result up to that point by the right arrow key.
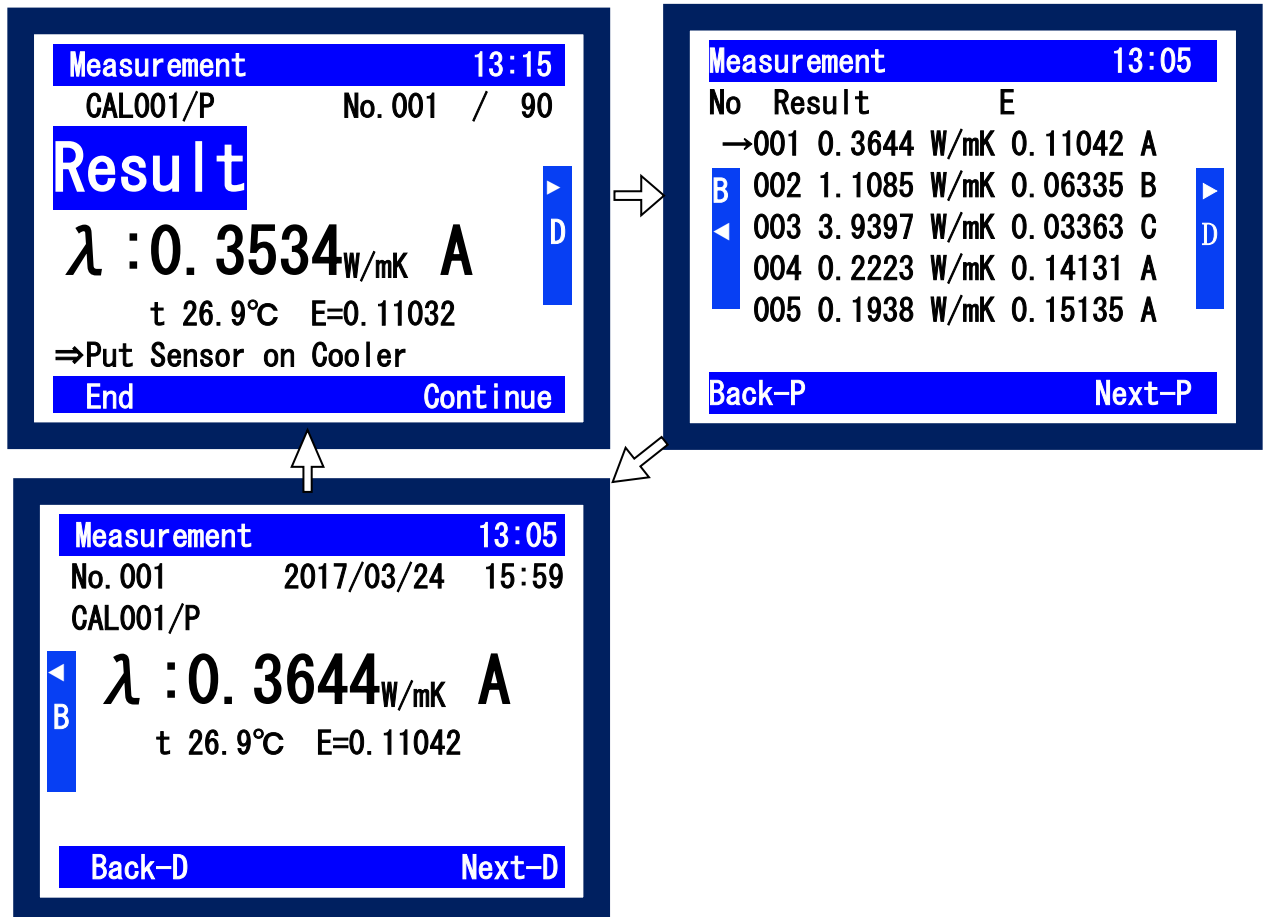
5-7. Confirm/ Erase Data

1. Confirmation of Data

1) Menu selection (move with ▲ ▼ button, select Enter or Select).

Select Data.

Table 5-9. Data Confirmation

Display	Contents
View	Display the data. It is automatically saved with date and number.
Delete Select Data	Deletes the selected data. You can delete items of the same date at once. You can delete data one by one. (Caution: There is no reconfirmation for deleting each data.)
Delete Select Cal Data	Deletes the selected individual calibration data. It is possible to delete while checking the contents of data with the View button. When deleting, a confirmation message will be displayed.
Delete All Data	Delete all data. However, the calibration will not be deleted.

2) Take the following steps to view the order of the measured data and to delete specific data :

◀ ▶ to change the order, confirm and erase the result.

```
Data View              18:57
  Data      Number
→170324      9
 170328      4
 170404      7
 170406      4
              Capacity   69
⇒Cursor ↑ ↓
  Back              Select
```

```
Data View              13:05
170324
   No  λ            E
→001 0.3644 W/mK 0.11042 A
 002 1.1085 W/mK 0.06335 B
 003 3.9397 W/mK 0.03363 C
 004 0.2223 W/mk 0.14131 A
 005 0.1938 W/mK 0.15135 A
  Back    Back-P    Next-P
```

```
Data View Single Data  13:05
No.001        2017/03/24   15:59
CAL001/P
   λ:0.3644 W/mK  A
   t 26.9℃   E=0.11042
   a=-2.00248 b=-5.42198
  Back-D             Next-D
```

Time
File Number
Calibration
Thermal Conductivity Classification
T: temperature E: Output
Calibration Coefficient

Function key	
Back	Go back to previous page
Select	Select data
Back-P	Go back one page
Next-P	Go to next page
Back-D	Go back one data
Next-D	Go to next data
▶ D	Display data
◀ B	Return to data selection

6. How to use the software

Although the HC-10 can be used as a stand-alone instrument, you can perform operations such as, measurement and calibration from the software on a PC via USB connection. 99 measurements and 20 calibrations can be saved on the main unit, but by using the software, data management can be performed without restriction on the number of data items. In addition, the measured data can be saved in CSV format and processed by spreadsheet software such as Excel.

The HC-10 software is also available on our website. If you have problems downloading the software, please contact your local EKO Instruments representative.

6-1. Installation and Uninstallation

1. Software Installation

1) Turn on the PC and start up Windows.
2) Once the Windows is started up, insert the installation disk in the CD drive.
3) Find the file [setup.exe] from [HC-10_Software_Installer Verxxxx] → [English], double click to start up.

a. Once the [setup.exe] file is started up, the following window is displayed to start the installation preparation. Click Next > button to continue.

Installation Wizard Start-up Window

b. Thoroughly read the "License Agreement" and select "I accept the terms in the license agreement" as shown below, then click Next > button to continue.
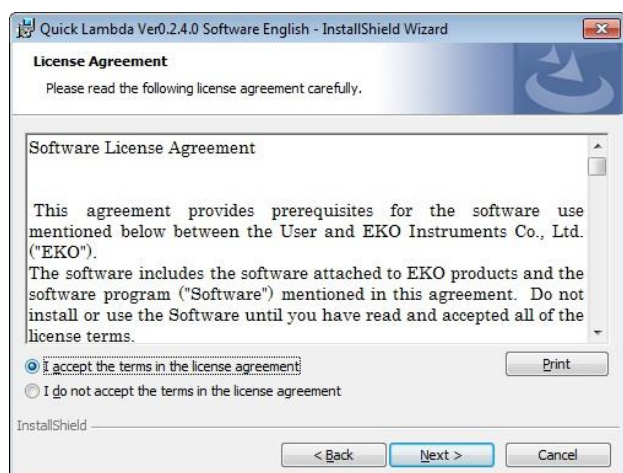
Software Usage Agreement Window

c. Select an installation folder.   To select a folder, click the Change… button and specify a suitable installation folder.   If a folder is not selected, it automatically creates a folder "C:¥EKO¥HC-121" and the software is installed under this folder.

Click the Next > button to continue.

Select Installation Folder Window

d. Confirm the installation folder; if the selected folder is correct, click Install button.
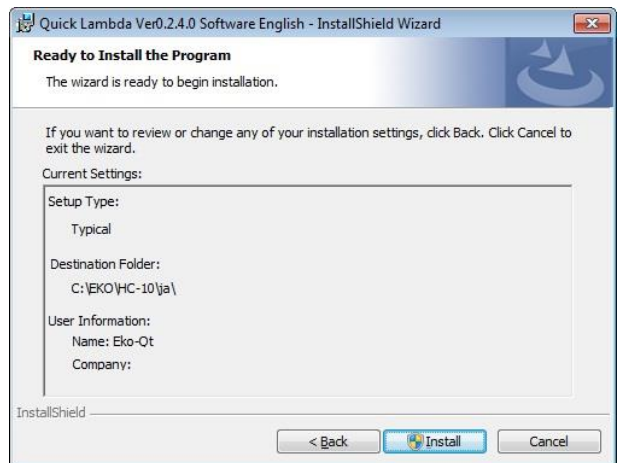
Confirm Installation Window

e. A warning message of the user account control will be displayed. Please click the Yes button.
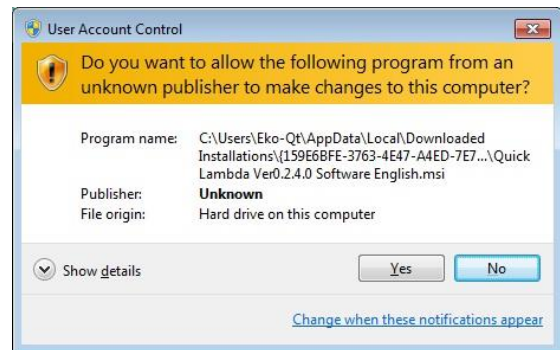
User Account Control Window

f. The software installation starts; after a period of time, the window changes to the "installation complete".   Click the Finish button to complete the installation.
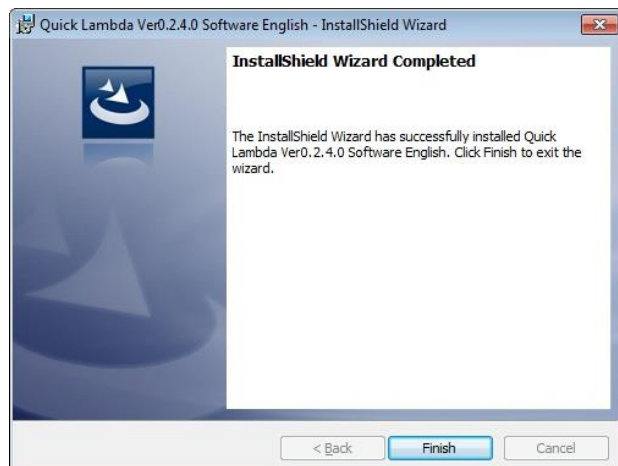
Installation Complete Window

g. When the installation is completed, a shortcut icon will appear on the desktop.

Shortcut Icon

2. USB Driver Installation

The USB for HC-10 uses the device driver software by Future Technology Devices International Ltd. (FTDI).

There are 2 driver software provided by FTDI. The driver software are included in the HC-10 software download from the EKO Instrument Website.

One is EXE-run type driver software, which is installed in Windows prior to connecting the USB device to the PC. The other USB driver commences installation when the USB connector is inserted to the PC; a wizard appears to process the installation.

Driver software can be found in the "USB" folder within the HC-10 software download.

When "CDM2XXXX_Setup.exe" has started up, the window shown below is displayed. Please press Extract to execute the installation. USB Serial Converter driver and USB Serial Port driver will be installed.

USB Driver Installation Start Window
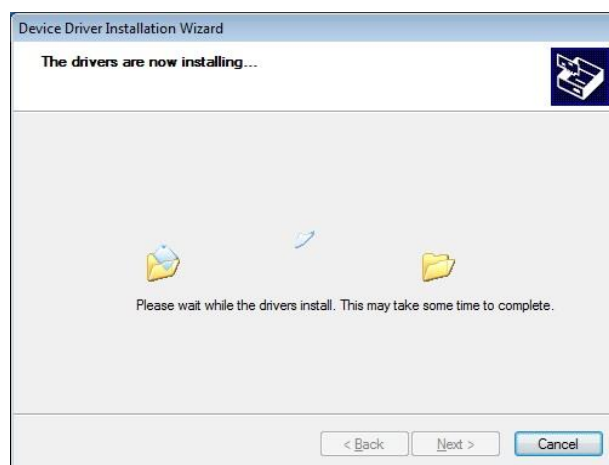
USB Drier Installation Window

USB Driver Installation Compete Window

There are some cases where there are difficulties installing the driver, this could be caused by several factors, such as an older version device installer already installed on the PC or another USB device driver is installed and conflicting the port numbers. In such case, change the port number to an unoccupied port to avoid conflicts or uninstall and reinstall both drivers.

The Wizard type installation automatically starts up the installation wizard when the USB connector is inserted into the PC.

Depending on the type of PC, the wizard may not appear; in such cases, the USB driver must be installed manually from the Device Manager. The device driver needs to be updated and reinstalled also from Device Manager.

For further details, refer to the following URL for FTDI Ltd.

URL: http://www.ftdichip.com/Documents/InstallGuides.htm

For installation and updating the driver software in the wizard format, assign the following folder which is in the HC-10 software download for the original driver installation folder:

¥CDM 2.XX.XX_WHQL Certified

3. Confirming Completion of USB Driver Installation

1) After restarting the PC, connect the PC to the HC-10 Main Unit with the USB cable.

2) Open the [Control Panel] from Windows.

3) Click the [System] icon. Click the [Device Manager] which is in the System window.

4) Check the Port is assigned with USB Serial Port (COM*). The COM number will vary depending on the PC type.

5) Open the USB Serial Port property window and verify there is a statement on the Device status section stating "this device is working properly".

Now the USB serial converter driver and USB Serial Port Driver software installations are complete.
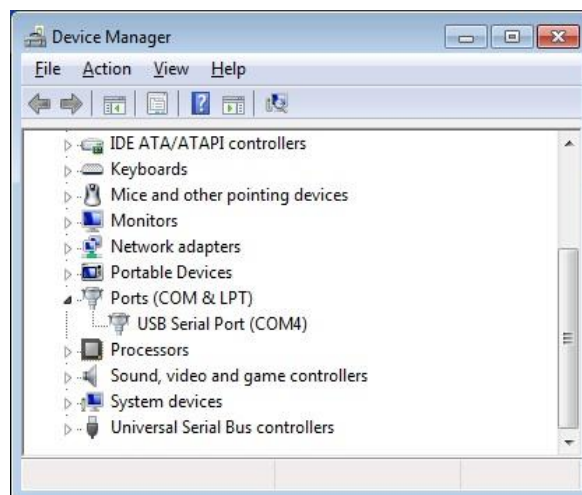
USB Driver Install Confirmation
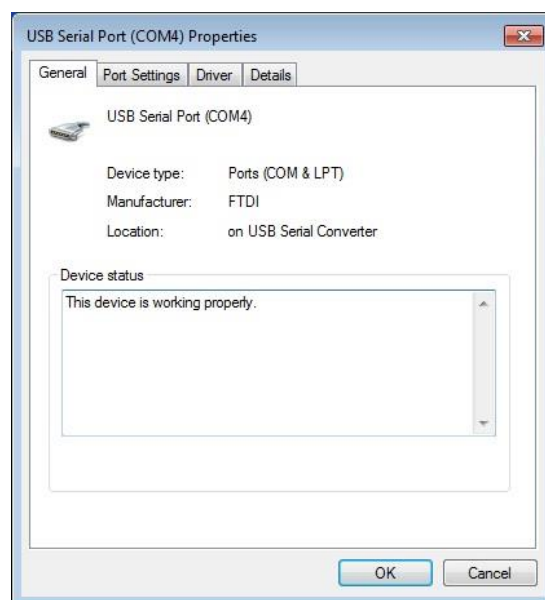
USB Serial Port Property Window

4. Software Uninstallation

There are 2 methods to uninstall the software.

1) Uninstalling from [Programs and Features]

Go to [Control Panel] → [Program] → [Programs and Features].
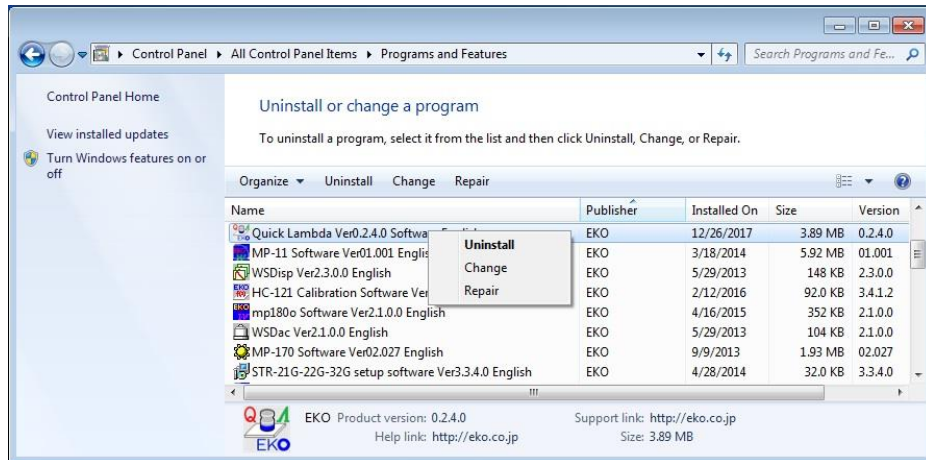
Uninstallation from "Program & Function"

Select the program to be deleted; when the selected program is right-clicked with mouse, pop-up menu appears.

2) Select "Uninstall" from Program Maintenance.

Double click and start up the "setup.exe" file.

If the software is already installed, there will be a window displaying "Modify", "Repair" and "Remove".

Select "Remove" on this window and click the Next > button.

Follow the instructions provided to uninstall the software.

Uninstalling from the CD-ROM

5. Vendor information of the USB Driver

Depending on the PC's OS version and USB driver software version, the installation steps may vary.

For more details of the installation guide for each OS type, see the below URL provided by FTDI Ltd.

URL: http://www.ftdichip.com/Documents/InstallGuides.htm

The newest driver software can be downloaded from FTDI Ltd. (Future Technology Devices International Ltd.) website at below URL.

URL: http://www.ftdichip.com/Drivers/VCP.htm

6. Install software libraries

Problems installing the software on PCs purchased before 2015 as the version of the OS is most likely outdated and libraries necessary for software operation may not be installed

In that case, install the software by running CD-ROM or "vc_redist.x64.exe" (for 64 bit OS) or "vc_redist.x86.exe" (for 32 bit OS).

7. Installing .NET Framework 4.6.X

If .NET FRAMEWORK is not installed on the PC or if the version is older than 4.6, the software may not be able to start up.

Display the PC's control panel → program → program and function and if "Microsoft .NET Framework 4.6" is not installed, please download "NDP462-KB3151800-x86-x64-AllOS-ENU.exe" from the CD- Please run and install. Installation takes several minutes.

6-2．Software Operations

1. Software settings

1) Startup software

Connect the PC and Quick Λ main unit with a USB cable and turn on the power switch.

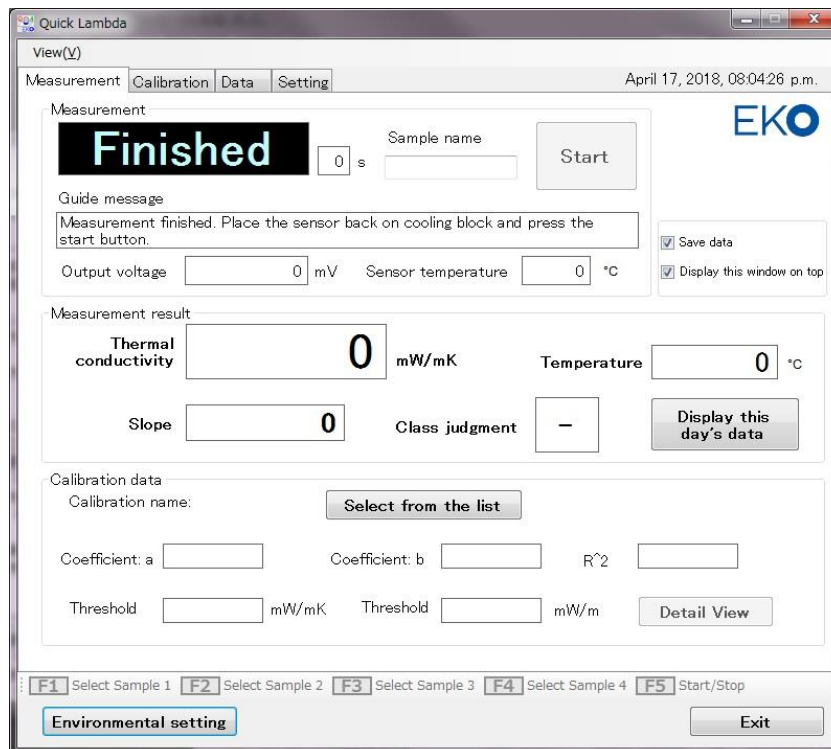Click on the "Quick Lambda.exe" shortcut on the PC screen with the mouse.

Alternatively, from the start menu, select "All Programs" → "EKO" → "Quick Lambda Ver0.2.x.x" → "QuickLambda.exe".

When launching the software, the startup screen will be displayed for a few seconds.

Startup screen

After a few seconds the following screen will be displayed.

Measure tab screen

2) Communication port setting

If no communication port is selected, the following message will be displayed. In that case, click the OK button and erase the message, then click on the environment setting button and select the COM port on the environment setting screen.

Error Message: Communication port connection failure

Please select USB communication port. Click ▼ button on the communication port on the configuration screen and select the displayed COM port number. If there is more than one and it is not known, please click the "Cancel" button once, disconnect the USB cable, click the configuration again and check the communication port. At this time, the COM port number which disappeared from the pull-down menu should be set to COM port. Please click "Cancel" button again, connect the USB cable again and try setup again.

3) Setting of data storage folder

On the Environmental setting screen, set the data save folder.
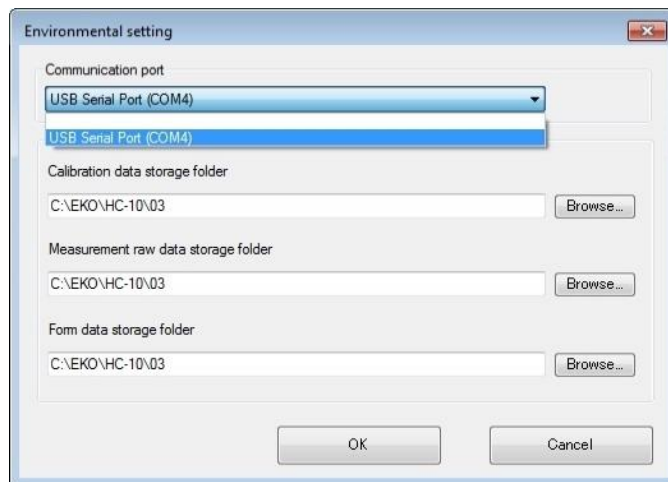
Environment setting screen

The following three types of folders can be set in the data storage folder. You can select or create an arbitrary folder with the Browse button for folder name. The default folder name is shown in Table 6-1.

Table 6-1. Type of data folder

	Folder name	Contents
1. Calibration data storage folder	C:¥EKO¥HC-10¥CalibrationData File extension: *.qcl	Save the calibration file.
2. Measurement raw data storage folder	C:¥EKO¥HC-10¥MeasurementData File extension: *.qrd & *.qmd	Save the measured raw data.
3. From data storage folder	C:¥EKO¥HC-10¥MeasurementDataCSV File extension: *.csv	Save the CSV data file of list data and individual data.

2. Measure tab screen functions

The functions of each part on the measure tab screen are detailed out below.
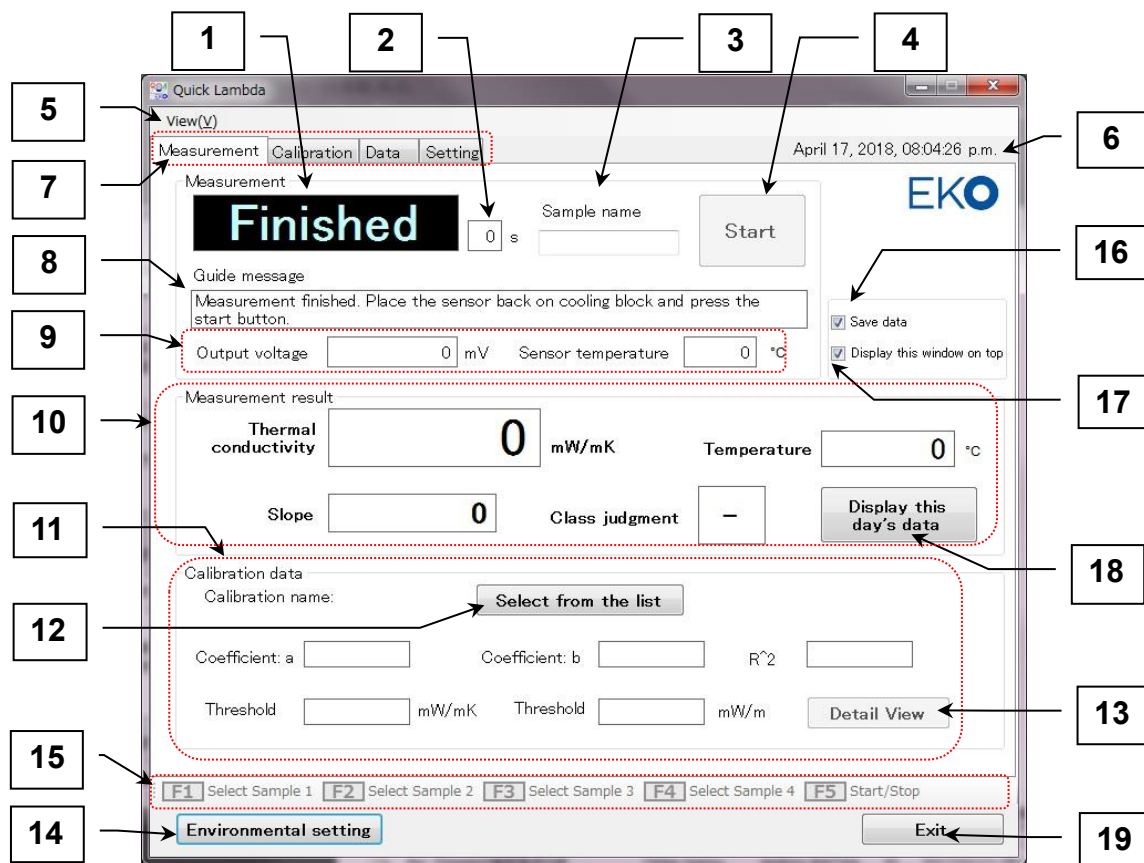
Measurement tab screen functions

Table 6-2. Measurement tab screen function list

|	Item	Function
1	Status display window	Displays the status of the measurement sequence. There are five states below. Finished: End of Measurement sequence Cooling: Sensor cooling Ready: Standby state Waiting: Measuring Heating: During measurement (heating of the heater)
2	Countdown display window	In the state of each measurement sequence, the remaining time is displayed in seconds.
3	Measurement sample name input window	Enter the name of the sample you are currently trying to measure.
4	[Start / Stop] button	Tells you to start and stop measurement. Start and Stop are toggle display.
5	Display Menu	Select display / non-display of function guide.
6	Date and time display area	Display date and time.
7	Operation mode selection tab	Select the operation mode. Four operation modes "Measure", "Calibration", "Data" and "Setting" are selectable.
8	Guide message	Window operation message displayed
9	Sensor status display	Displays the output voltage of the sensor and the sensor surface temperature in real time every 1 second. It keeps monitoring the state of the sensor all the time except during measurement.

Table 6-2. Measurement tab screen function list - Continued

	Item	Function
10	Measurement result display frame	At the end of the measurement, the gradient, sensor temperature, thermal conductivity or other physical quantity, and class judgment are displayed.
11	Calibration data display frame	Displays the selected calibration name. "CALxxx / X": xxx is a three-letter number or alphabet, "X" after "/" is "P" or "L", P = Power, L = Linear Represents a method.
12	[Select from the list] button	Select the calibration data to be used for measurement from the list of valid calibration data.
13	[Detail View] button	Displays detailed information on the calibration data.
14	[Environmental setting] button	Displays the configuration screen. COM port, data save folder.
15	Function Guide	Selection buttons corresponding to samples 1 to 4 up to the F1 to F4 keys. The F5 key has the same function as the Start button (the same applies to the PC function key)
16	Saving the data	To save the measurement data always, put a check mark.
17	Display this window at the top	If you want this window to be displayed at the top, put a check mark.
18	[Display this day's data] button	Displays the measurement data list for the day.
19	[Exit] button	Exits software.

1) Measurement method

   a. Check that the PC and the main unit are connected with the USB cable.

   b. "CONNECT" is displayed on the LCD of the main unit.

   c. Prepare the sample to be measured.

   d. The sample should be well adapted to the ambient temperature.

   e. Click the "Select from the list" button in the calibration data frame on the screen to display the calibration list. Left clicking on the target calibration data column with the mouse will result in a blue display confirming selection. Click the "OK" button to complete the selection.
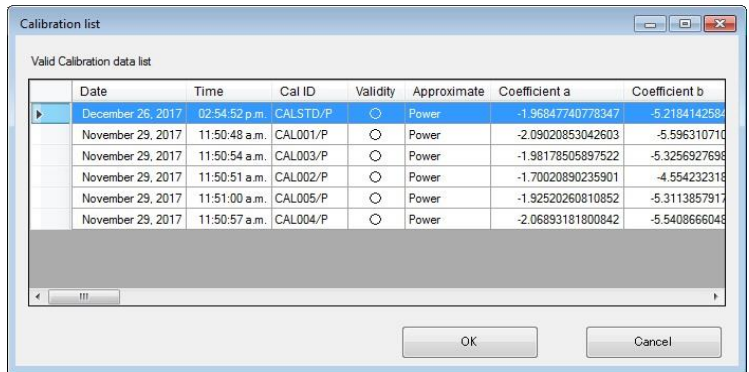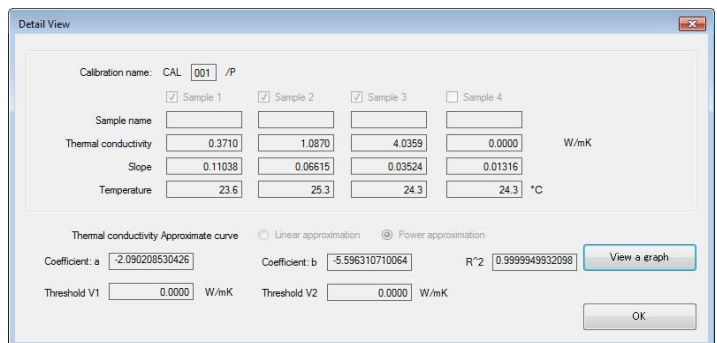

Display calibration data list

   f. Click the "Detail View" button in the calibration data frame to display detailed information on the selected calibration data. (It is not a required operation.)

   g. Input the sample name on the measurement tab screen.

   h. Place the sensor on the cooler.

   i. Click "Start" button on the PC screen or press PC function "F5" key.

Calibration data detailed information display

   j. The status display on the software screen changes from "Finished" to "Cooling".

   k. After 30 seconds, it shifts to "Ready" state.

l. Place the sensor on the sample. Click the "Start" button on the PC screen or press PC function "F5" key.

m. The status display on the software screen changes from "Ready" to "Waiting".

n. When 20 seconds have elapsed, it will shift to the "Heating" state.

o. After 10 seconds, the measurement is completed, it changes to "Finished", and the measurement result is displayed on the screen.

2) How to check data

    a. Click on the "Display list of the day" button, you can check the data list measured on the current day.

Date	Time	Measurement instruction	Sample name	Thermal conductivity
November 16, 2017	05:46:51 p....	Main Unit	1	0.4454[W/r
November 16, 2017	05:48:10 p....	Main Unit	2	0.4453[W/r
November 16, 2017	05:50:31 p....	Main Unit	3	1.0418[W/r
November 16, 2017	05:51:49 p....	Main Unit	4	1.0768[W/r
November 16, 2017	05:53:04 p....	Main Unit	5	1.0836[W/r
November 16, 2017	05:54:23 p....	Main Unit	6	1.0712[W/r
November 16, 2017	05:55:56 p....	Main Unit	7	1.0706[W/r
November 16, 2017	05:57:26 p....	Main Unit	8	1.0826[W/r
November 16, 2017	05:59:12 p....	Main Unit	9	0.4441[W/r

Data list measured on that day

3. Functions of the calibration tab screen

The following describes the functions of each part on the calibration tab screen.
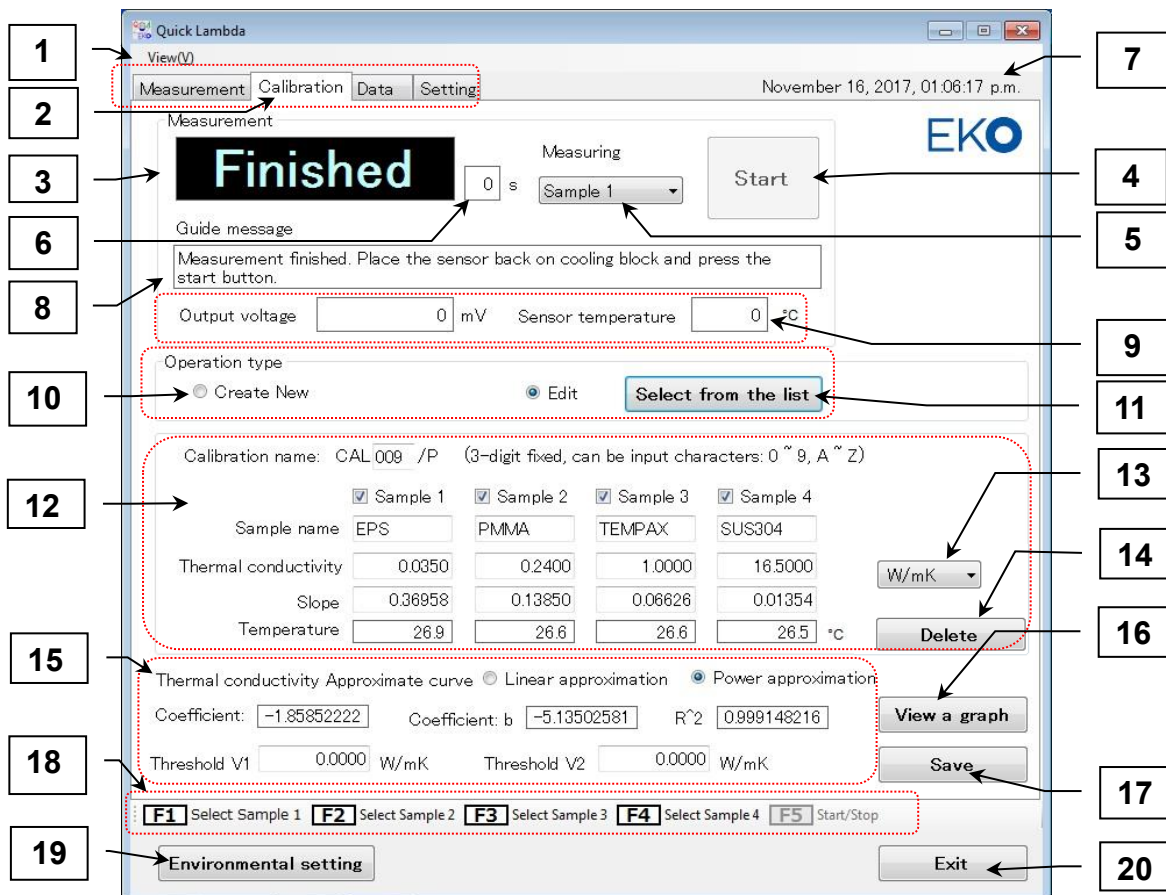
Functions of the calibration tab screen

Table 6-3. Calibration tab screen function list

	Item	Function
1	Display Menu	Select display / non-display of function guide.
2	Operation mode selection tab	Select the operation mode. Four operation modes "Measure", "Calibration", "Data" and "Setting" are selectable.
3	Status display window	Displays the status of the measurement sequence. There are four states: Finished, Cooling, Waiting, and Heating.
4	[Start / Stop] button	Specifies start and stop of measurement. Start and Stop are toggle display.
5	Measurement target	Select the sample that is currently being measured. (Sample 1 to Sample 4)
6	Countdown display window	In the state of each measurement sequence, the remaining time is displayed in seconds.
7	Date and time display area	Display date and time.
8	Display status of sensor	Display operation message
9	Sensor status display	Displays sensor output voltage and sensor surface temperature in real time every 1second. It keeps monitoring the state of the sensor all the time except during measurement.
10	Select operation type	Select whether to create new calibration data or edit from existing data.
11	[Select from the list] button	When "Edit" is selected, an editing target can be selected from the calibration data list.

12	Display and edit calibration data	●Calibration name:
		Display the selected calibration name or enter the name of the new registration.
		"CALxxx / X": xxx is a three-letter number or alphabet, "X" after "/" is "P" or "L", P = Power, L = Linear Represents a method.
		●Sample number setting
		Samples 1 to 3 are used when calibrating with three standard samples,
		To perform with 4 standard samples, put a check mark in Sample 1 ~ 4.
		●Register sample name
		Enter the name of the standard sample.
		●Input of thermal conductivity or reference physical quantity
		Enter the thermal conductivity or reference physical quantity of the standard sample.
13	Select unit	●Select the standard sample unit and decimal point position.
		Select the unit and decimal point position from the following five types in the pull-down menu at the right end of the unit.

	Unit	Decimal point position
①	[mW/m·K]	0000.00
②	[W/m·K]	00.0000
③	[W/m·K]	0000.00
④	[---] (No unit)	00.0000
⑤	[---] (No unit)	0000.00

Note: Items 4 and 5 with no unit should be selected when measuring physical quantity other than thermal conductivity.

14	[Delete] button	Delete the selected calibration file from the folder specified in "Environment setting".
15	Display of calibration result	●Selection of approximate curve
		Select either linear approximation or power approximation.
		●Calculation result display of approximate curve
		Approximate calculation result: Display coefficient a, coefficient b, R ^ 2.
		●Input of threshold values V1, V2
		Enter thermal conductivity V1, V2 for use in class determination.
		Determination condition: class A $\leqq$ V 1 <class B $\leqq$ V 2 <class C
16	[View a graph] button	Displays the finished calibration data in a graph.
17	[Save] button	Saves the calibration data.
18	Function Guide	F1 to F4 keys are the Select buttons corresponding to samples 1 to 4.
		The F5 key has the same function as the Start button (the same applies to the PC function key)
19	[Environmental setting] button	Displays the environment setting screen. COM port, data save folder.
20	[Exit] button	Exits software.

1)   Calibration method

    a. Check that the PC and the main unit are connected with the USB cable.

b. "CONNECT" is displayed on the LCD of the main unit.

c. Prepare three or four samples to be measured.

d. The sample should be well adapted to the ambient temperature.

e. Select "Create New" or "Edit" from the "Operation type" frame on the screen.

➢ When "Create New" is selected, the following operations should be performed.

· Enter three characters (letters or numbers) for the calibration name.

· Register the sample to be used. Check marks from Sample 1 to Sample 4.

In case of 3 types, remove the check mark of Sample 4.

· Enter sample name.

· Select the unit [mW/m・K] or [W/m・K] from the pull-down menu.

· Enter the thermal conductivity of each sample.

➢ If you select "Edit", click the "Select from the list" button to display the calibration list. Left clicking on the target calibration data column with the mouse will result in blue display indicating that it is selected. Clicking the "OK" button loads the calibration data and displays it on the screen.

Display calibration data list

f. Select the sample from the pull-down menu for the measurement target. Or you can select with function "F1" to "F4" key. Normally select from Sample 1 in order.

g. Place the sensor on the cooler.

h. Click the "Start" button on the PC screen. Or press PC function "F5" key.

i. The status display on the software screen changes from "**Finished**" to "**Cooling**".

j. After 30 seconds, it shifts to the "**Ready**" state.

k. Place the sensor on the sample. Please click "Start" button on the PC screen. Or press PC function "F5" key.

l. The status display on the software screen changes from "**Ready**" to "**Waiting**".

m. When 20 seconds have elapsed, the system enters the "**Heating**" state.

n. After 10 seconds, the measurement is completed, it changes to "**Finished**" and the measurement result is displayed on the screen.

2) Processing of calibration result

a. When measurement results are displayed, select the type of approximate curve. Line approximation or power approximation can be selected. Please compare the value of the decision coefficient R^2 and select the one closer to "1".
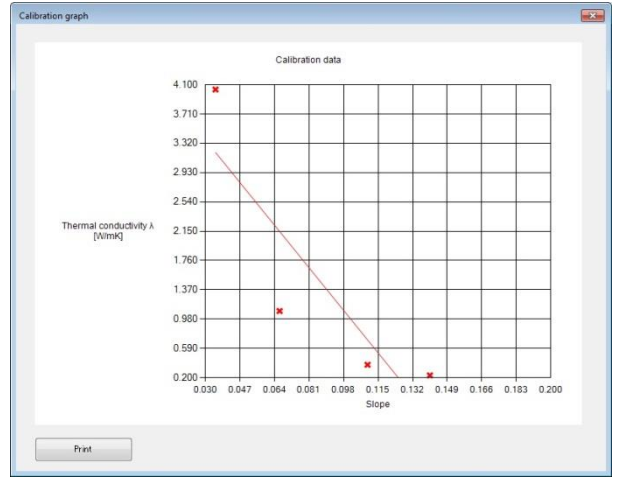

Display of calibration result

b. Determining whether the calibration is good or not depends on the value of R^2. This also affects the

accuracy of measurement. If the calibration is not close to "1", it is recommended to redo the calibration to avoid any inaccuracies with the measurements. You can judge which sample you want to measure again from the graph.

c. Click the graph display button to display the calibration graph. If there is a measured value of a sample that is far from the straight line, re-measure the sample so that it is close to a straight line.
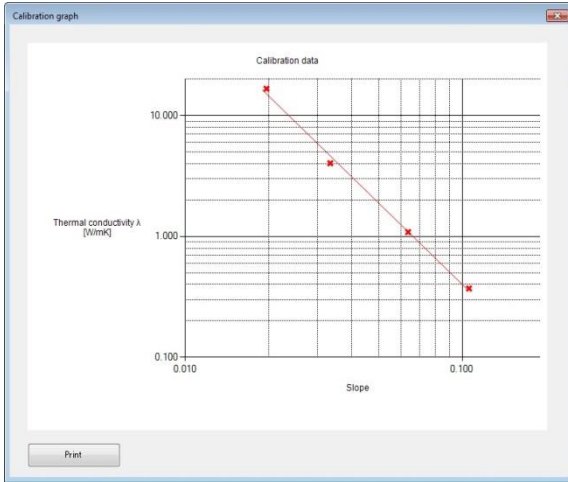
Calibration graph display (power approximation)   Calibration graph display (linear approximation)
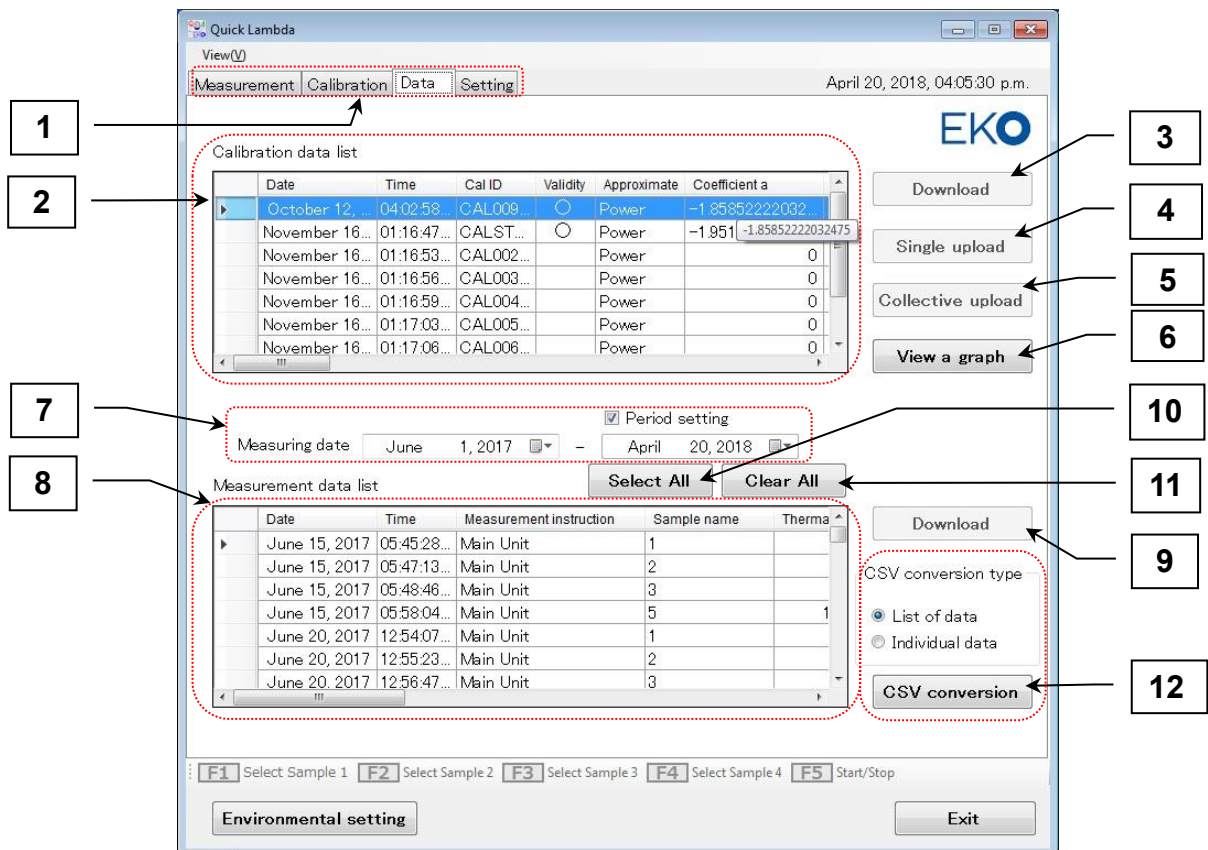
d. If class judgment is required, determine the thresholds V1, V2 and input after considering the judgment condition below.

Determination condition: class A $\leqq$ V 1 <class B $\leqq$ V 2 <class C

e. Click the "Save" button and save the calibration data.

4. Functions of the Data tab screen

The following describes the functions of each part on the calibration tab screen.

Data tab screen functions

Table 6-4. Data tab screen function list

|	Item	Function
1	Operation mode selection tab	Select the operation mode. Four operation modes of "Measure", "Calibration", "Data", and "Setting" are selectable.
2	Calibration data list	Display the calibration data list.
3	[Download] button.	Read calibration data from the main unit.
4	[Single upload] button	Write the selected calibration data to the main body.
5	[Collective upload] button	Write all the data of the calibration list to the main body.
6	[View a graph] button	Graphically display the selected calibration data.
7	Measurement date setting, period setting	Set the measurement date of the data to be displayed. Also, when specifying the period, put a check mark in the period setting and set the measurement end date.
8	Measurement data list	Display a list of measurement data.
9	[Download] button	Download all measured data from the main unit.
10	[All select] button	Select all data.
11	[All cancel] button	Release all data selection.
12	CSV conversion type and [CSV conversion] button	With respect to the data selected in the data list, it is converted into a CSV file in each format of "List of data" or "Individual data" selected by the CSV conversion type, and stored in the specified folder.

1) Calibration data download method

   a. To download the calibration data from the main unit, click the "Download" button on the right side of the calibration data list. A progress bar and the download status are displayed.
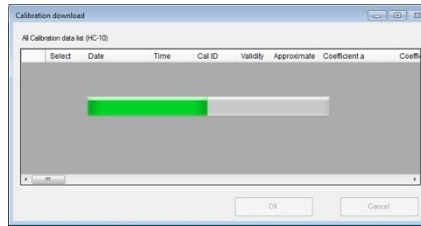

Download status display

   b. A calibration data list of the main unit memory is then displayed. Calibration data is not yet loaded at this point. Only the list information is read and displayed.
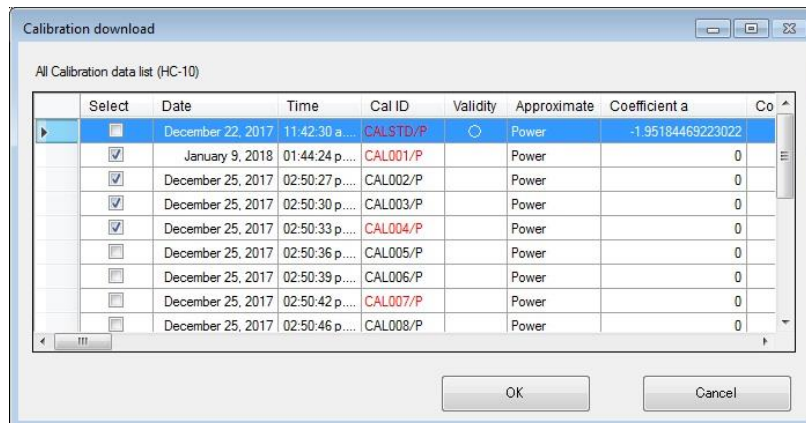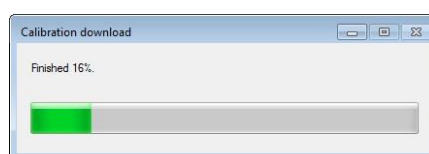

Calibration data list

   c. Put a check mark in the "Select" item for the data to be downloaded. At the time of loading, the check mark ("✔") is automatically attached to the data with "○" in the "valid" item. Data in which "Cal ID" is displayed in red indicates that calibration data of the same "Cal ID" already exists on the main unit side. When you press "OK" button, the following message will be displayed.
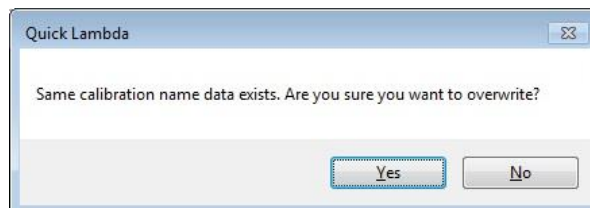
Overwrite warning message

   Caution is necessary as downloading this will overwrite the calibration data already existing on the PC and it cannot be restored. If you do not want to overwrite select "No" and uncheck "Select" or change the saving folder by environment setting.

   Click "Yes (Y)" button to start the download, the progress bar will be displayed again. When it reaches 100%, the message "download is completed" will be displayed. Click the "OK" button to finish.
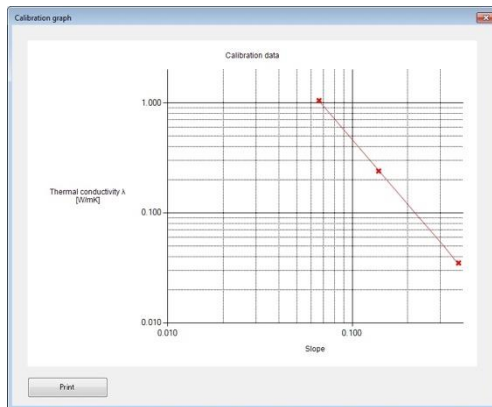

Download status display

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2) How to upload the calibration data
   a. The calibration data created by this software can be used as the main unit is connected to the PC. When using the main unit alone, it is required to send the calibration data in the PC folder to the main unit. In this case, click the "Single upload" button or "Collective upload" button. A progress bar is displayed, and the data list of the upload source (PC side) and upload destination (main unit side) is displayed.
   b. Shows batch upload procedure.
      ➤ Click the blank button under "Destination corresponding serial number" of the data you want to upload from the list data of the upload source and make it "selected".
      ➤ When you click on the place you want to register in the upload destination data list, the blank button is numbered, and the same number is also attached to the "selected" button of the upload source.
      ➤ Repeat the same procedure for the data you want to upload.
      ➤ Click the OK button to display the progress bar.
         ✧ When the upload reaches 100%, the message "Upload finished" is displayed. Click the "OK" button to finish.
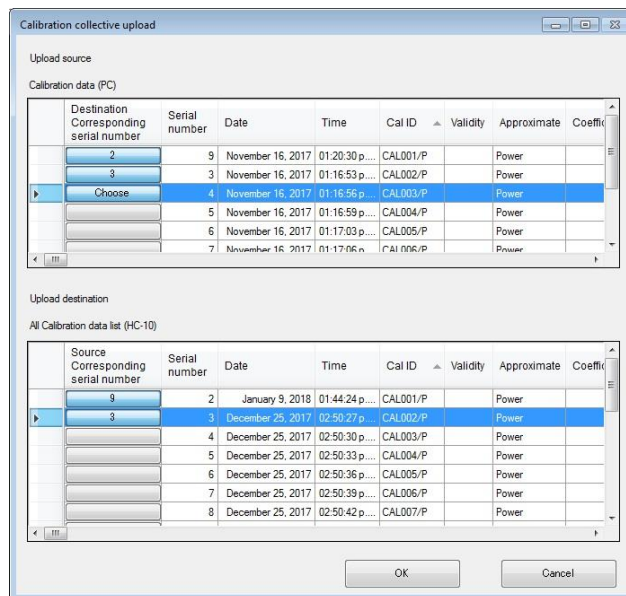
Batch upload setting screen of calibration data

   c. In a single upload, select only one set of data you want to upload from the calibration data list and click the "Single upload" button. The subsequent operation is the same operation as bulk upload.
   d. In the graph display, select the data you want to display from the calibration data list and click the "graph display" button. A calibration graph will be displayed. Printing to the printer is also possible with the print button.

Graph display

3) Measurement data download method

   a. To download the measurement data from the main unit, click the "Download" button on the right side of the measurement data list. A progress bar is displayed, and the download status is displayed. When it reaches 100%, the message "download is completed" is displayed. Click the "OK" button.
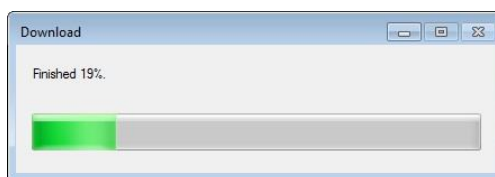
Download status display

   b. It is vital to specify a measurement date, as the data will not be displayed on the measurement data list even if it is downloaded. Please set the measurement date with the calendar. It is also possible to set a period such as the measurement start date to the measurement end date by putting a check mark in the period setting.
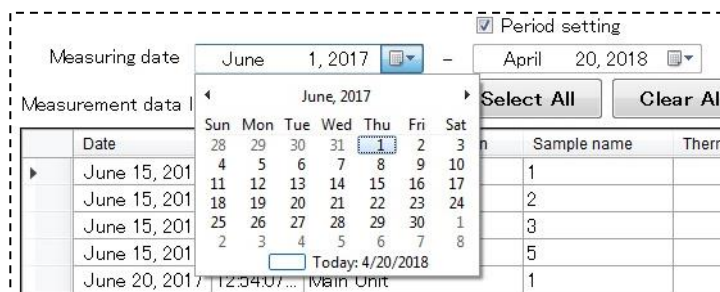
Measurement date setting and period setting

4) Conversion method of measurement data to CSV file

   a. Measurement data is binary data; therefore, it cannot be opened with spreadsheet software such as Excel. To open the measurement data in Excel etc., it needs to be converted to CSV file. Select the data displayed in the data list. To select all displayed data, click the "All select" button. To cancel, click the "All cancel" button.

   b. Select "List of data" or "Individual data" of the CSV conversion type frame.

   c. Click the "CSV conversion" button.

   d. The message "Output finished" is displayed. Please click "OK" to close.
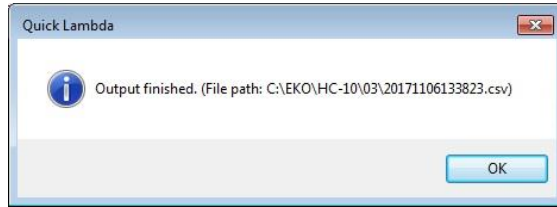
CSV file output completion message

e. The CSV conversion data is saved in the folder specified in "From data storage folder" in the environment setting. The following is a list of the data formats of the list data and individual data.

● List data file format

(For example)

Date	Time	Measurement instruction	Sample name/Data No.	Measurement value	Unit	Slope	Temperature [deg.C]	Cal ID	Approximate	Coefficient a	Coefficient b	R^2	Threshold V1	Threshold V2	Class judgment
15/5/2017	9:08:49	ManUnit	1	952.21	[mW/mK]	0.064	26.1	CAL005	Power	-2.07569	1.1442072	0.9999	1000	1100	A
15/5/2017	9:11:28	ManUnit	2	984.64	[mW/mK]	0.063	26.9	CAL005	Power	-2.07569	1.1442072	0.9999	1000	1100	A
15/5/2017	9:12:50	ManUnit	3	1040.32	[mW/mK]	0.061	27	CAL005	Power	-2.07569	1.1442072	0.9999	1000	1100	B
15/5/2017	9:14:12	ManUnit	4	1062.23	[mW/mK]	0.06	27.2	CAL005	Power	-2.07569	1.1442072	0.9999	1000	1100	B

● Individual data file format

(Details)

Quick Lambda	HC-10	Software Version
Date	Time	
Firmware Version	Sample name	Sensor temperature
Measurement value	Slope	Class determination
Cal ID / P or L	Number of samples for calibration	
Unit		
Types of approximate curves		
a coefficient	b coefficient	R^2
Threshold V1	Threshold V2	
Output 1	Sensor temperature 1	
Output 2	Sensor temperature 2	
Output 3	Sensor temperature 3	
Output 4	Sensor temperature 4	
Output 5	Sensor temperature 5	
Output 6	Sensor temperature 6	
Output 7	Sensor temperature 7	
~	~	
Output 100	Sensor temperature 100	

(For example)

Quick Lambda	HC-10	Ver:0.2.4.0
18/5/2017	20:24:03	
Ver:0.0.2.0	12	28.8
1.0958	0.06254 B	
CAL010/P	4	
W/mK		
Power		
0.005039546	-1.941574216	0.999369979
1	1.1	
0.2432335	28.8	
0.2610334	28.8	
0.2877624	28.9	
0.3148546	29	
0.34014	29.1	
0.3646152	29.1	
0.3885688	29.3	
~	~	
1.272578	33.3	

5. Functions of the setting tab screen

The explanation of the function of each part on the setting tab screen is shown below.
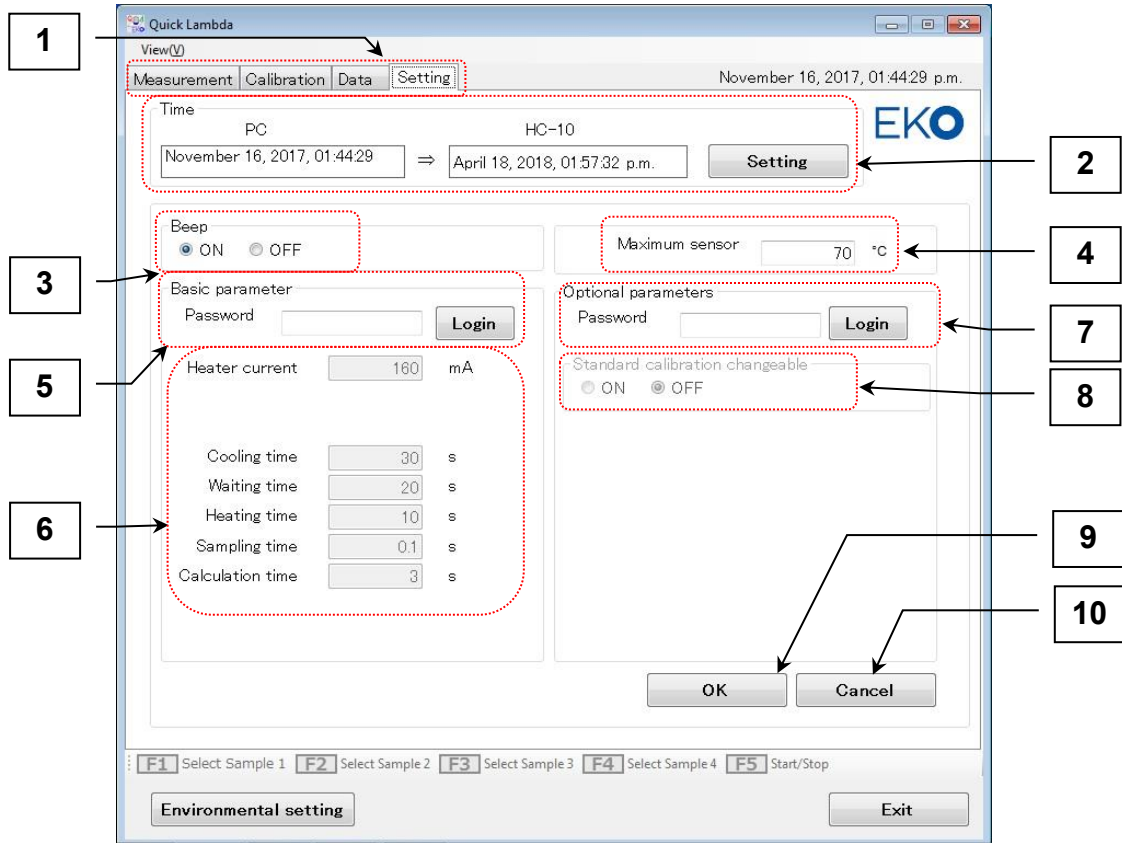
Functions of the setting tab screen

Table 6-5. Setting tab screen function list

	Item	Function
1	Operation mode selection tab	Select the operation mode. Four operation modes of "Measure", "Calibration", "Data", and "Setting" are selectable.
2	Time frame	Clicking the "Setting" button sends the PC date and time to the main unit, and adjust the date and time. In the "Time" frame of the screen, the date and time of the PC, the date and time of the main unit in the frame of HC-10 are displayed.
3	Beep sound frame	Select ON / OFF and put a check mark. It is adapted to the main unit with the "OK" button.
4	Maximum sensor temperature	Set the maximum temperature of the sensor. If it reaches a higher temperature, it is judged as abnormal and the measurement is interrupted. (It is set at 70°C at the time of shipment.)
5	Within the basic parameter frame password input	Enter the password for setting basic parameters and click on login to change it. (It is set at factory shipment, so it is not publicly available in general.)
6	Basic parameters	Set the six basic parameters.
7	In option parameter frame password input	Enter a password to set optional parameters and click on login to change it. (It is set at factory shipment, so it is not publicly available in general.)
8	The thermal conductivity of standard calibration (CALSTD) can be changed	Select ON to change contents of CALSTD, OFF to disable.
9	[OK] button	Please click the "OK" button if you want changes to be applied to the main unit.
10	[Cancel] button	To cancel changes to the main unit, please click the "Cancel" button.

7. Measurement Principle

7-1. Measurement Principle

Measurement principle of the thermal conductivity measuring device Quick Λ is as follows.

The structure of the sensor head is shown in Figure 1. Both ends of the heat insulating material 1, are sandwiched with a differential thermocouple, one end is a cold junction, sandwiched between the heat insulating material 1 and the heat insulating material 2, to ensure the change in the surrounding temperature is minimized.
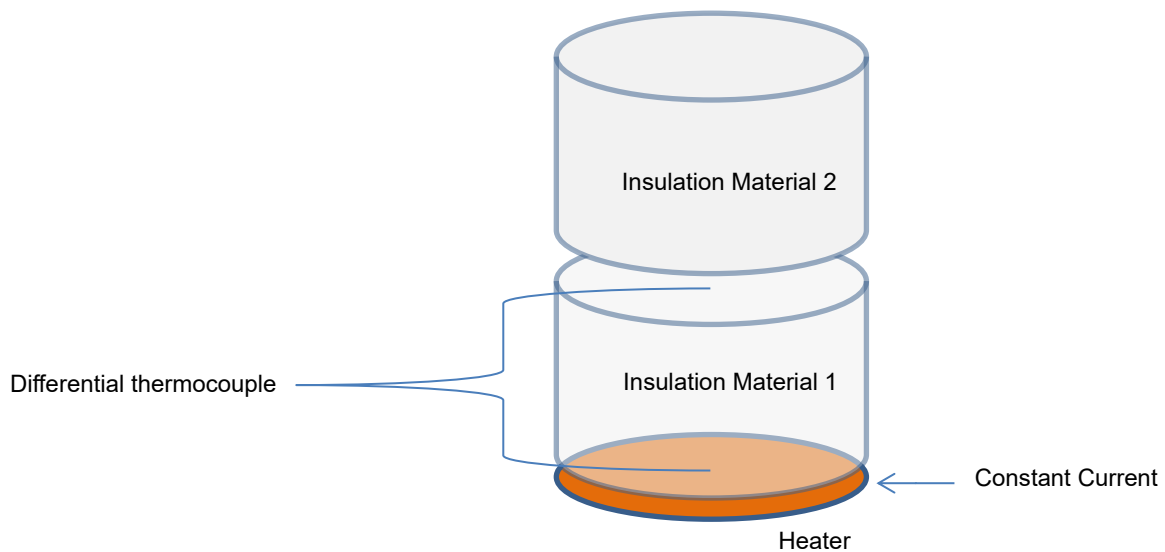

Figure 1. Structure of sensor head

A film-like heater is attached to the other end of the differential thermocouple so that a constant current can flow through the heater. When the sensor head is placed on the sample to be measured, and when a contact surface between the sample and the sensor head becomes thermally stable, a constant current is applied to the heater. The output voltage of the differential thermocouple monitored and the rate of change of the output voltage is measured. The change rate $\Delta E / \triangle t$ of this output voltage is the change rate of the temperature of the sensor surface. (We assume that the temperature on the cold junction side of the differential thermocouple does not change in a short time.)
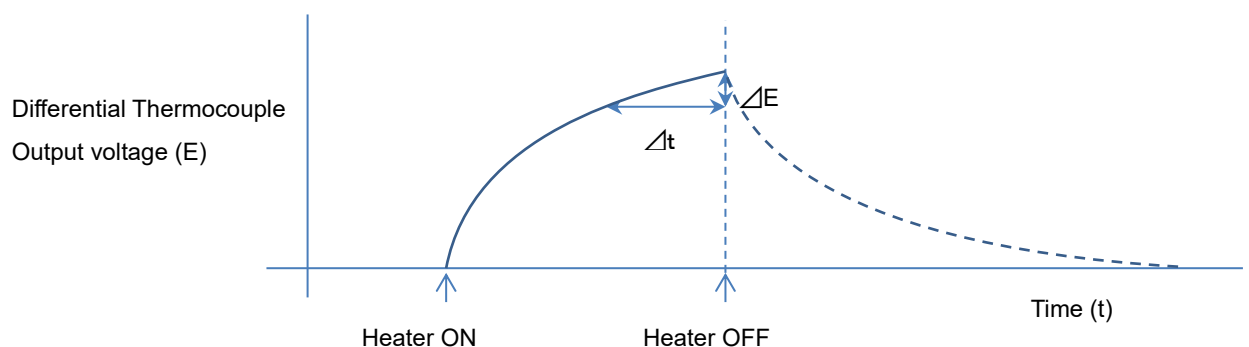

Figure 2. The output voltage E of the differential thermocouple and the elapsed time t

The relationship between ΔE / △t and thermal conductivity λ is shown in Table 1 using the materials with the known thermal conductivity and samples with the same shape. When this table is represented by a logarithmic graph, as shown in Fig. 3, R ^ 2 = 0.999977 is almost a perfect straight line.
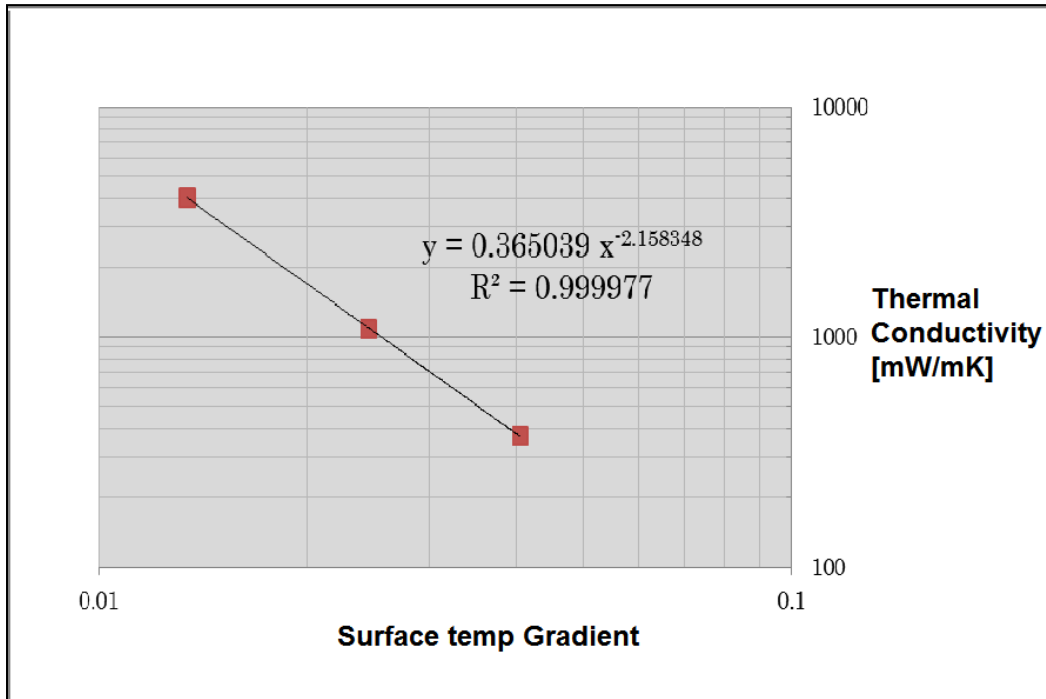

Figure 3. Thermal conductivity vs Temp gradient

Table 7-1. The material whose thermal conductivity is known and the change rate of sensor surface temperature

	Thermal Conductivity [mW/m·K]	Temperature Gradient [-]
Vespel	371.1	0.0405
Pyrex	1087	0.0245
Pyroceram	4036.4	0.0134

Although the approximate curve that fits this phenomenon is a power approximation, linear approximation is better suited for materials with extremely low thermal conductivity such as vacuum insulation materials. An approximate test curve is stored on the device side, measure the object to be measured in the same way, and calculate the thermal conductivity from the result value using the above relational expression.

The relationship between A coefficient and B coefficient and thermal conductivity of each approximate curve displayed by this software is as follows:

● Approximate straight lines: Thermal Conductivity $\lambda = a\,X + b$

X: Temperature Gradient

● In the case of power approximation: $\log_e(\lambda) = a\,\log_e(X) + b$

Therefore, thermal conductivity $\lambda = (e^{\wedge}b)\,X^{\wedge}a$

8. Maintenance & Troubleshooting

8-1． Maintenance

To ensure accurate measurements are obtained, we recommend that the following should be conducted on a regular basis.

1. How to handle and manage each part:

1) Sensor unit

- Please be careful not to damage the sensor surface. The surface of the sensor unit is made of a thin film with a heater. For this reason, unevenness will be formed on the surface if it is treated roughly, which will interfere with measurement.
- Avoid moisture, dust, dirt, etc. on the surface of the sample to be measured. Friction occurs on the surface of the sensor or scratches are attached, which will cause failure and shorten the life of the sensor.
- Avoid getting moisture, dust, dirt, etc. on the sensor unit.　Please wipe with a dry cloth before and after each measurement.
- Hold the sensor weight for carrying. Please do not pull the cable. Although the cable is connected to the connector and fixed to the load part, it may break if it is pulled strongly.
- Handle the sensor unit with care. Carefully place the sensor unit into the cooling unit or sample when taking measurements. If there is a dent or scratch on the sensor surface, measurement errors could occur.
- Pay attention to the routing of the sensor cable. If the cable is twisted or bent for a long period of time, there is a possibility that the core wire inside the cable may be disconnected.

2. Main unit

- Do not press the key with excessive force.
- Do not touch the LCD surface to avoid scratches and soiling.
- The body panel sheet is not waterproof.
- Do not use it in a place where there is dust. Dust can enter from the inlet of FAN and causes malfunction.
- If there is dust on the cooler, there is a possibility of damaging the sensor surface when the sensor head is placed on the cooler.

2. Replacing the built-in lithium battery

1) When to replace the lithium battery

This device has an internal lithium battery (CR2032) to back up the clock and retain data. Depending on the conditions of use, the internal lithium battery may wear out as early as five years after purchase. When the battery is depleted, the date and time may be out of date or the clock may stop. If left unattended, all data and calibration information will be lost.

Before this happens, it is recommended to back up important data and calibration information to a PC. For information on how to back up and transfer the data, see pages 39-41 of this instruction manual.

2) Before replacing the lithium battery

It is recommended to download the measurement data and calibration information to a PC before replacing the batteries. After battery replacement, the date and time should be adjusted. The data cannot be returned to the unit, but the calibration data can be restored if it has been backed up on a PC. Please note that if the data and calibration information is not backed up, it will be lost and cannot be restored.

3) How to replace the lithium battery

With the unit switched off, remove the three screws on the back of the unit and open the back cover to reveal the lithium battery on the circuit board. Push it in with a finger (as shown by the arrow in the image below) to remove it.

Replace the battery with a commercially available CR2032 lithium battery and close the back cover.

back side of main unit
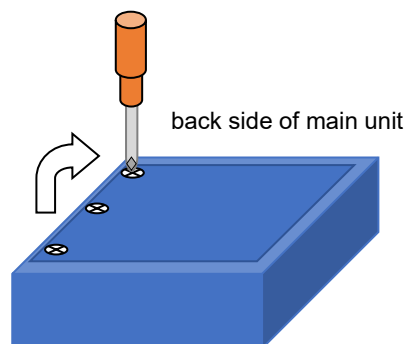
To open the back cover of the main unit, remove the three screws on the back of the unit and open the back cover.
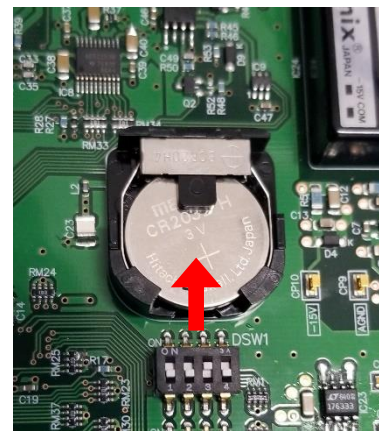
To remove the lithium battery on the board, push it in with a finger as shown above.

8-2. Troubleshooting

Please check the following before contacting EKO or your distributor for repair.

Table 8-1. Troubleshooting list

Symptom	To do Action
When starting the software, the message "Serial port open failed" appears.	➢ Make sure the measuring unit is turned on. ➢ Make sure that the USB cable is properly connected. ➢ Check the COM port number in Device Manager and select the correct COM port number. ➢ Check the main unit is displaying the default menu screen. ➢ It is possible that the USB driver is not correctly installed. Please try installing again.
The measured value is less than 1.0 [mW / m·K].	This is a possible phenomenon when measuring samples with extremely low thermal conductivity such as vacuum insulation material and using linear approximation. If the thermal conductivity is lower than that of the standard sample, it will protrude from the curve approximation and there is a possibility that it will be less than 1.0 [mW / m·K]. In such cases we recommend using power approximation.
Incorrect date and time are displayed (not updated).	This is likely due to the life of the lithium battery inside the unit. The lithium battery must be replaced. However, when the lithium battery is removed for replacement, all data and calibration information will be deleted. If the data and calibration information are still on the unit, back up the data and calibration information to a PC before replacing the battery. (For instructions on how to replace the lithium battery, see page 48 of this instruction manual).
Data and calibration information have been lost.	

9. Technical Specifications

9-1. Main Unit

Table 9-1. Main Unit Specifications

Item	Details	
Model	HC-10	
Reproduction Accuracy	0.03 to 5.000 W/m·K	Within ± 5% (uniform, isotropic sample)
	For VIP sample 0.001 to 0.015 W/m·K	Within ± 5% (calibration required for VIP sample, same kind of sample, by measurement at the same position)
Measurement Accuracy	Depending on the accuracy of calibration sample	
Operating Temperature Limit	+10 to 40℃	
Heater Current	160mA	
Number of Sensor Channels	1ch	
Measurement Time (s)	Standard 60 seconds Waiting: [standard 20 seconds] Cooling: [Standard 30 seconds] When Heating: [Standard 10 seconds]	
Standard Samples (For main unit calibration, EKO internal calibration value)	Sample Dimension: φ60 x 15mm 1. EPS (0.03 W/m·K) 2. Acrylic (0.23 W/m·K) 3. TEMPAX Glass (1.05 W/m·K)	
Measurement Capacity	99 measurement data and 20 calibration data	
Buzzer built-in	It will sound at the end of sensor cooling and measurement termination. (Buzzer can be turned off)	
LCD	240 dots x 128 dots monochrome with LCD backlight	
Communication	USB compliant (using FTDI virtual COM port driver)	
Backup Battery	Lithium battery CR2032（3V, D20 × H3.2 mm）	
Size	250(W)x85(H)x200(D)mm	
Weight	2.3kg	
Power Supply	DC24V, (Dedicated AC Adapter AC90V to 240V, 50 to 60Hz) Power Consumption approximately 3W	
Fuse	For power supply: 1.5 A (5 φ x 20 mm), for sensor heater: 0.3 A (5 φ x 20 mm)	
USB Cable	USB cable (2 m)	

Table 9-2. Sensor Unit Specifications

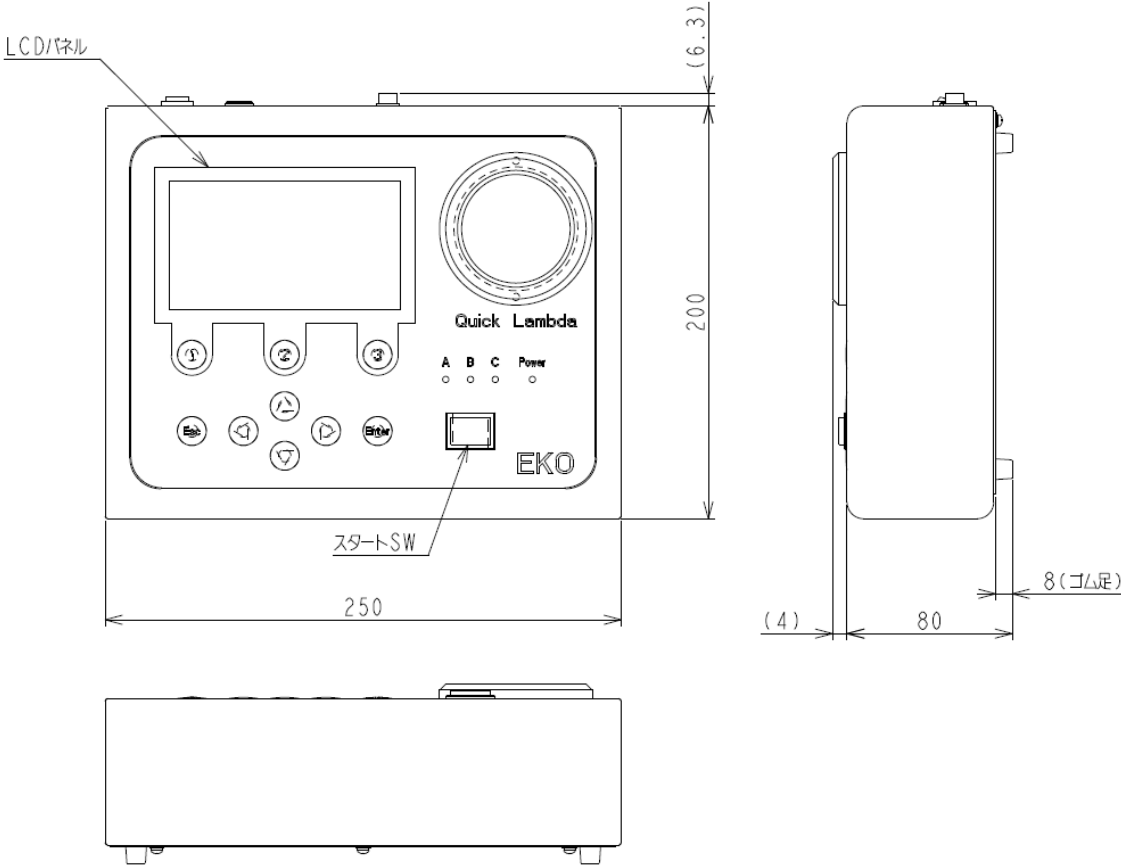| Item	Details
Heater	About 85 Ω (about 10 W)
Temperature Measuring Sensor	Copper Constantan Thermocouple
Cable	1.5 m with 6-core cable
Size	Φ52 x 117(H) mm
Weight	Approx. 1kg

9-2. Software Specifications

Table 9-3. Software Specifications

Item	Details
Operating System	Microsoft Windows 7 / 8 / 8.1 / 10 (32-bit, 64 bit) Japanese / English OS compatible
Operating Environment	CPU: Equivalent to Pentium / Celeron 100 MHz or more memory: 64 MB or more Free hard disk space: 300 Mbytes or more Display Resolution: 1024 x 768 dots or more interface: USB port (virtual COM port, COM 1 to 16) 1 port available
	In order to use it, unnecessary resident software is not activated Power management function, turning off the screen saver (It causes such as missing data.)
Program Name	QuickLambda.exe
Software Version Number	Ver 0.2.x.x
Firmware Version Number	Ver 0.0.2.x
Soft Function	Measurement of thermal conductivity, class judgment of thermal conductivity, creation of calibration, browsing of data, data storage, conversion of data into CSV file Save
Measurement Item	Thermal Conductivity, Sensor Temperature

9-3．Dimension

1. Main Unit Dimension

LCDパネル

Quick Lambda

A B C Power

Esc Enter

EKO

スタートSW

(6.3)

200

250

(4) 80 8(ゴム足)

2. Sensor Unit Dimension
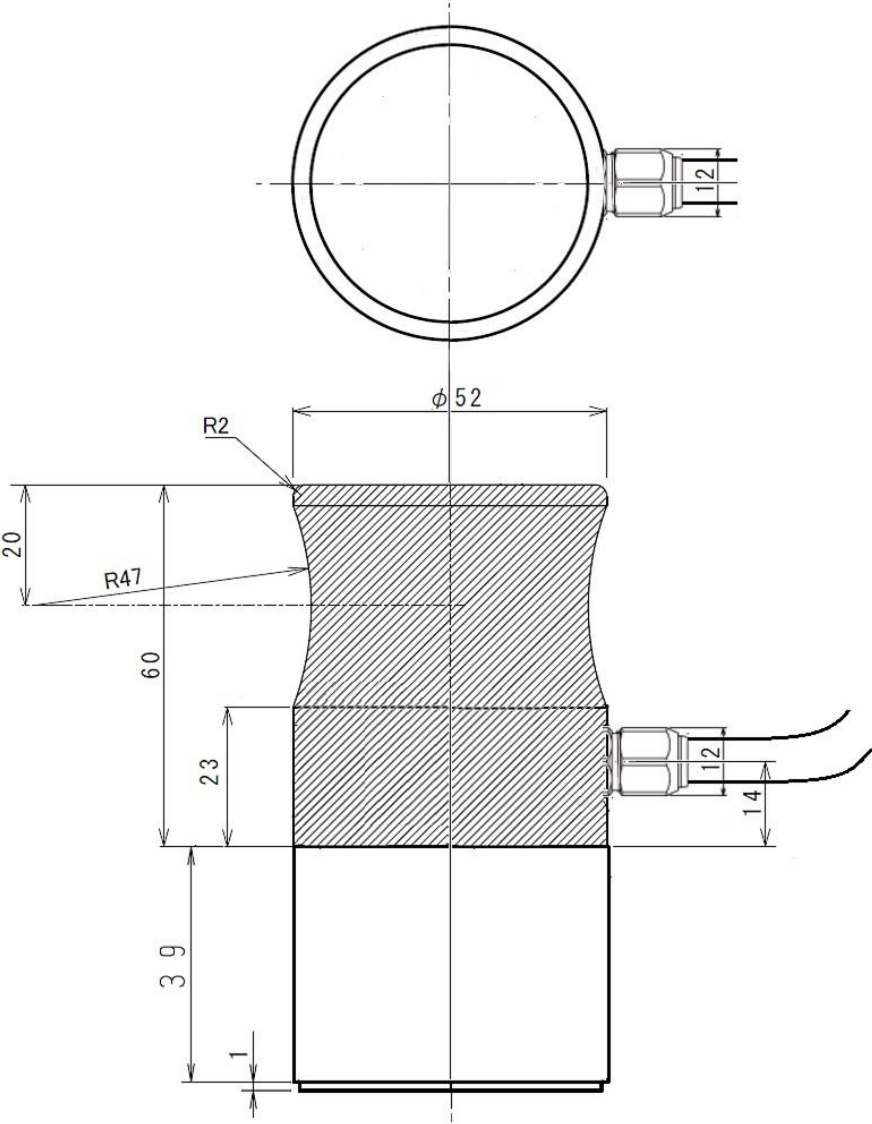
9-4．Accessories List

Table 9-4. Option item list

Option item	Details	
Standard sample (EKO Internal Testing Sample)	SUS304 φ60 x 15mm 15W/m・K	
	Zirconia φ60 x 15mm 3.3W/m・K	
Special Carrying case	Trunk type, Size: 530 x 360 x130	
Sensor Head	For replacement	

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