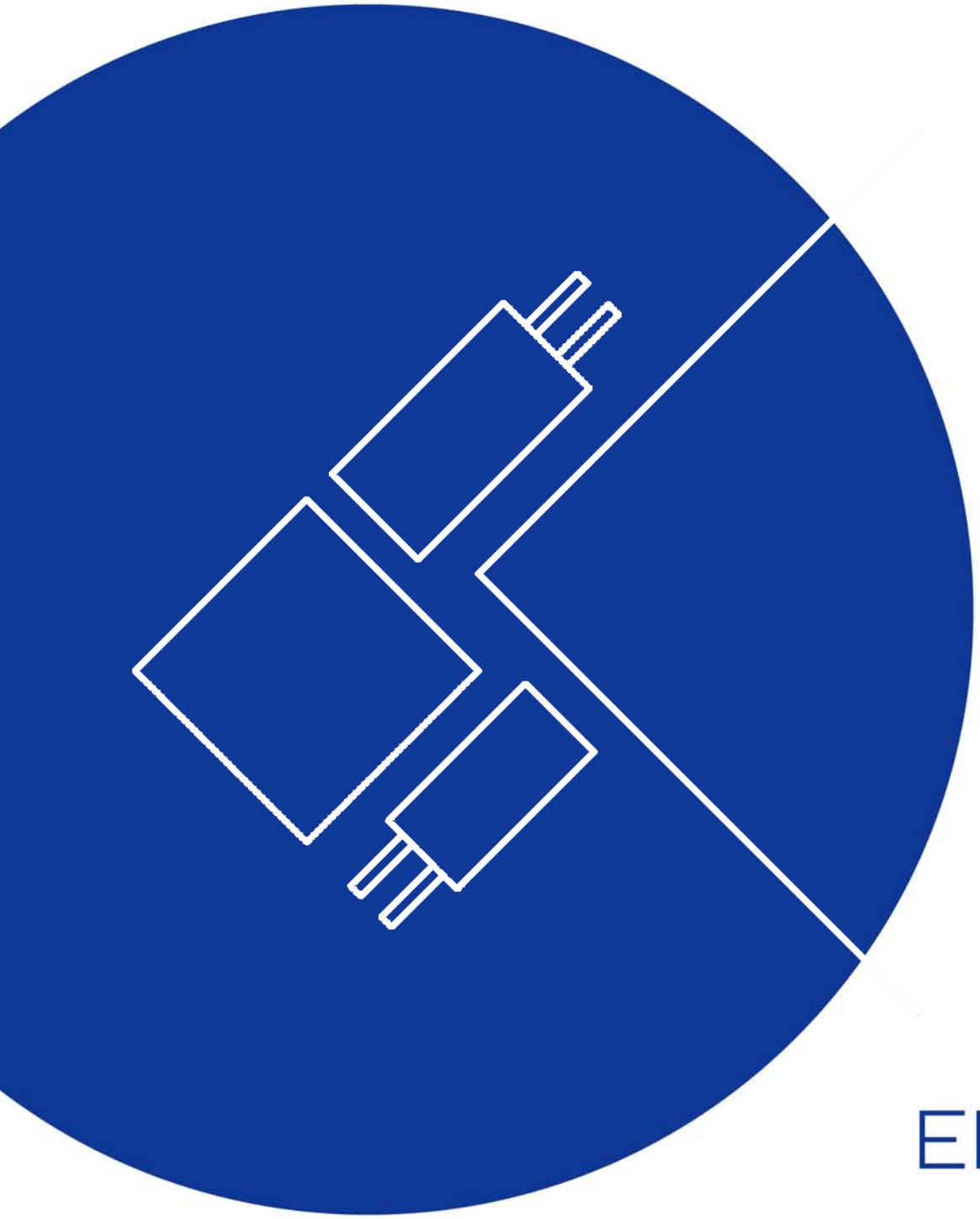
INSTRUCTION MANUAL

Heat Flow Sensor

MF-180
MF-180M
HF-30S
HF-10S



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 in a safe and handy place for whenever it is needed.
For any questions, please contact us at one of the EKO offices shown 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 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 This Instruction Manual

This manual was issued: 2018/5/18

Version Number: 7

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 the 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 under the consideration of the safety precautions. Please make sure to read and understand this instruction manual thoroughly in order to be able to operate the instrument safely and in the correct manner.

WARNING
CAUTION

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

3-1. WARNING/CAUTION

- Select an appropriate heat flow sensor for the application. If an indoor type heat flow sensor is used in an outdoor environment, water may leak into the heat flow sensor and cause disconnections and abnormal measurement values.
- Verify the upper and lower limit of operating temperature and use the heat flow sensor within this temperature range. If the heat flow sensors are used outside the operating temperature range, it may cause disconnections and the surface coating may peal apart.
- When using the Heat Flow Sensor by attaching it to a measuring surface, measurement error may occur due to air current contacting the surface of Heat Flow Sensor. Either to embed the Heat Flow Sensor into the measuring surface as deep as possible, or attach a material with high heat capacity (i.e. rubber sheet) on the surface. The error ratio becomes large when heat flow rate is small.

4. Introduction

Due to a strong drive for energy saving nowadays, obtaining accurate information on the thermal insulation of facilities such as buildings, offices, factories, and houses has increased. The MF and HF-Series Heat Flow Sensors are designed to directly measure the heat radiation or heat transmission from walls, floor/ground, stock storage walls, and freezer walls, as well as to measure the heat flow rate underground, by embedding or attaching the Heat Flow Sensor to the measuring part.

The MF-180 and MF-180M are compact type heat flow sensors with high sensitivity. MF-180M is designed for outdoor use. HF-Series are thin types of heat flow sensors. Both HF-30S and HF-10S can be attached on a curved surface. By combining several heat flow sensors with an insulated box, a calorimeter device can be created.

4-1. Main Functions

EKO heat flow sensors provide highly accurate measurements compared to heat flow measurements by a common thermometer.
Due to their high sensitivity, EKO heat flow sensors perform well even with low heat flow measurements.
The heat flow sensors are calibrated using the improved GHP method (JIS A 1412, ASTM C1777).

1. MF-180

The heat flow sensor is enclosed with a black polyester sheet.

- For general use, compact, high sensitivity

2. MF-180M

The heat flow sensor is molded with epoxy resin which is highly waterproof for burying underground and outdoor use for a long period of time.

- Compact design with high sensitivity
- For burying underground and high durability

3. HF-30S

300mm×300mm size heat flow sensor, both sides are coated with epoxy.

- Thin type with low heat resistance, Large area(300mm x 300mm)

4. HF-10S

100mm×100mm size heat flow sensor, both sides are coated with epoxy.
Suitable for measuring heat radiation and transmission from boiler/combustion room, heat radiation from lighting and heat source, and heating devices

4-2. Package Contents

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

Table 4-1. Package Contents

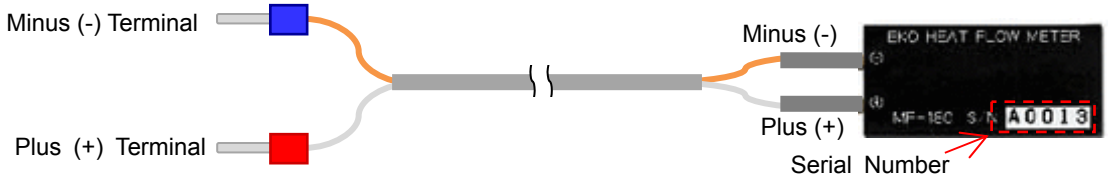
Standard Items	Qty.	Remarks
Heat Flow Sensor	1pc	10m cable attached (*)
Inspection Report	1	
Instruction Manual	1	

(*) HF-10S and HF-30S without cable are also available.

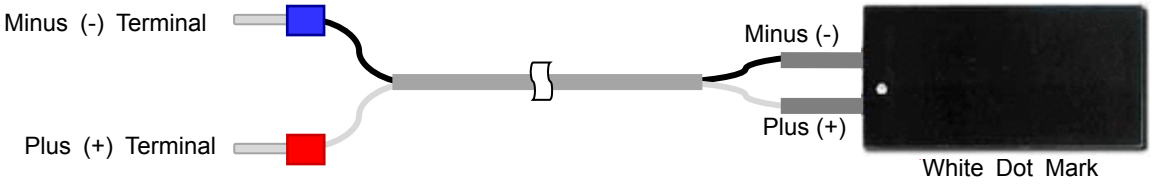
5. Getting Started

5-1. Parts Name and Descriptions

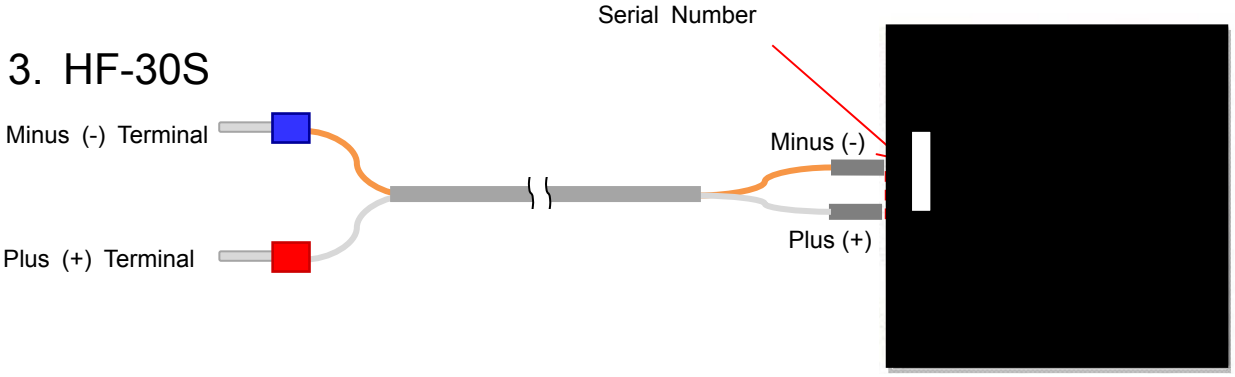
1. MF-180



2. MF-180M



3. HF-30S



4. HF-10S

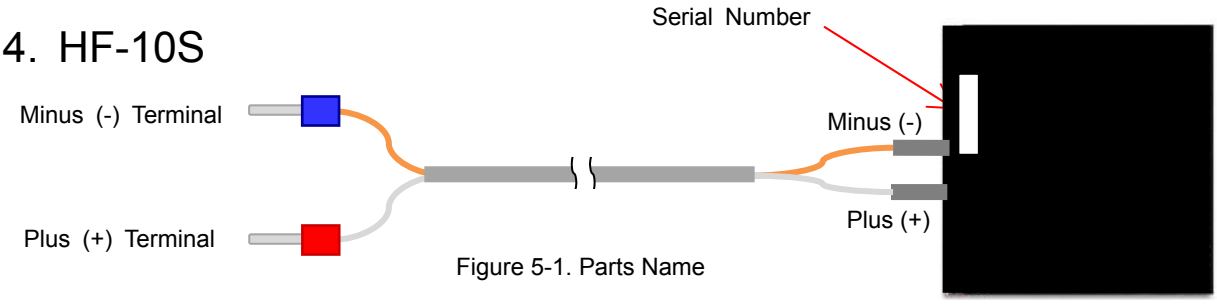


Figure 5-1. Parts Name

Heat Flow Direction:

MF-180、HF-30S HF-10S: When heat flows from the side with serial number is indicated, plus voltage is output.

MF-180M: When heat flows from the side with white dot marks is indicated, plus voltage is output.

5-2. Installation

Before installation, please carefully read the safety requirements stated in section [3-1. WARNING/CAUTION].

There are two ways to install the heat flow sensor:

The installation method will differ by installing permanently or temporarily.

Before installing the heat flow sensor, heat flux direction and polarity of the heat flow sensor output must be verified (see [5-2. Parts Name and Descriptions]). Polarity of the output voltage when heat flow enters from the black surface with model number (MF-180, HF-30S, HF-10S) of each heat flow sensor or surface with a white dot (MF-180M) is indicated

1. Permanent Installation

Embedding the heat flow sensor in a measuring surface

NOTE: This method of installation uses adhesive; once the heat flow sensor is adhered to the surface, the sensor cannot be peeled off or reused.

1. Place the heat flow sensor on the measuring surface so that the heat flows perpendicular to the heat flow sensor, and attach it with an appropriate adhesive* or similar material used on the subjected surface.
2. Avoid any air gaps between the heat flow sensor and the subjected surface; embed the sensor using the same material used on the subjected surface.
3. To avoid getting effects from the surrounding radiation, paint the surface with same color.

*Adhesive, such as One Component RTV (deoximation type), KE45W by Shin-Etsu Chemical Co.

2. Temporary Installation

Attaching the heat flow sensor on the measuring surface

1. Place the heat flow sensor on the installing surface and attach it with thermal conductive silicon grease**. Avoid using such as double-sided tape which would require strong force to remove the heat flow sensor from the surface.
2. Avoid any air gaps between the heat flow sensor and the subjected surface.
3. To avoid getting effects from the surrounding radiation, paint the surface with same color.

**Grease type silicon grease has high thermal conductivity and bonding effect. Optional accessories: YG6111 (200g、1kg)

Table 5-1. Installation Guide

Material of Installing Surface	Preparation	Installation Method
Smooth metal	Degrease the surface by organic solvent	Attach with silicon grease or silicon glue
Rough metal (cast metal)	Smooth out the surface as much as possible.	
Tatami Mat	Cut out or create a spot in advance for embedding.	Embed inside the tatami mat.
Curtain	---	Attach with silicon glue.
Concrete (smooth surface)	---	Embed with silicon glue or mortar.
Mortar (rough surface)	Smooth out the surface	Embed with mortar and even out the surface roughness with surrounding surface
Grass wool molded plate	Smooth out the surface as much as possible.	Attach with silicon glue
Wall Clay	Scrape the surface	Embed inside the surface or attach with silicon glue
Tuff	Smooth out the surface as much as possible.	Attach with silicon glue
Wood, lumber	Remember the direction of wood fiber (sense of direction required)	Attach with silicon glue
Pearlite plate (Asbestos cement plate)	Smooth out the surface as much as possible.	Attach with silicon glue
Tile or glass	Degrease the surface	Attach with silicon grease or silicon glue.
Expanded Ply-Ethylene	Smooth out the surface as much as possible	Attach with silicon grease or silicon glue
Expanded Urethane		Embed with expanded urethane

*Silicon grease with high thermal conductivity and bonding effect for temporary installation. Please see section 7-3. Accessory section and/or contact EKO for more details and purchasing.

5-3. Measurement

1. Data Collection

For typical measurements, the output of the heat flow sensor is very small; therefore, selecting an appropriate measurement device, such as a data logger is critical (in a typical indoor measurement, the heat flow is generally less than few a dozen W/m^2). The output from this heat flow sensor would be from a few dozen to a few hundred μV; thus it is ideal to have more than 10μV for the minimum resolution on the measuring device).

Although it depends on the installed location, there are large fluctuations in heat flow sensor output, thus an average or an integration value of a certain interval is used instead of using an instantaneous value.

It is important to select a measurement device which is suitable for the above purpose.

2. Measurement

By using the following equation, calculate the heat flow from the output voltage of the sensor.

$$Q = E / K$$

Where:

Q:	Heat flow flux	[W/m^2]
E:	Output voltage from a sensor	[mV]
K:	Sensitivity of the sensor	[mV/W･m^{-2}]

✧ Important Points of Measurement:

All of the Heat Flow Sensors are made of thermal resistive elements; therefore, the heat resistance of the object to be measured must be sufficiently larger than the Heat Flow Sensor, or it will cause an error. The table on the following page shows the examples of wall materials and measurement errors. Also, when the Heat Flow Sensor is attached on a surface, the convective flow by the air current and radiation of the surrounding area will cause a measurement error.

Table5-2. Examples of Heat Radiation Wall and Measurement Error

Heat Radiation Wall			Sensor		Measurement Value /True Value R/(R+Rs)
Material	Thickness (mm)	Thermal Resistance R (m^2·K/W)	Model	Thermal Resistance Rs (m^2·K/W)	
Wood	50	0.31	MF-180	0.014	0.96
			HF-30S, HF-10S	0.0016	0.99
Concrete	100	0.1	MF-180	0.014	0.88
			HF-30S, HF-10S	0.0016	0.98
Steel	5	0.001	MF-180	0.014	0.07
			HF-30S, HF-10S	0.0016	0.38

6. Maintenance & Troubleshooting

6-1. Maintenance

To maintain accurate measurements, the following is recommended:

1. Check for any air space and/or skinning of the sensor at the time of installation.
2. Check for any damage on the sensor and lead wires.

6-2. Calibration and Traceability

1. Calibration Method

The calibration of these heat flow sensors are performed at EKO according to the following procedure.

1) Set the calibrating heat flow sensor in between high temperature and low temperature plates.
2) Set the high temperature plate to 45℃ and low temperature plate to 15℃ and start the calibration measurement.
3) Taking approximately 3 hours, achieve static state where the outputs become constant among the high temperature plate, low temperature plate and the calibrating heat flow sensor.
4) Measure the output voltage from the calibrating heat flow sensor, and calculate the sensitivity using following formula:

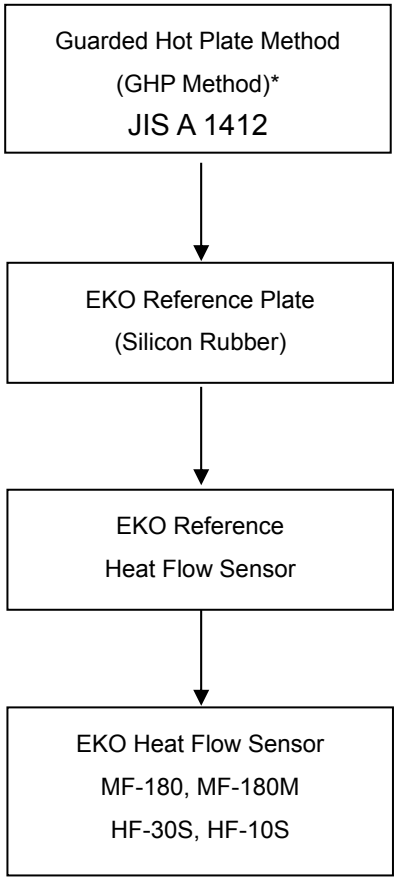
$$k = E/Q$$

Where

K:	Sensitivity of Calibrated Heat Flow Sensor	[mV/ (W/m^2)]
E:	Output Voltage of Calibrated Heat Flow Sensor	[mV]
Q:	Heat Flux measured using Reference Heat Flow Sensor.	[W/m^2]

2. Traceability

Traceability of EKO Heat Flow Sensor is as described below:



Calibrate EKO Reference Plate with the device which complies with GHP method.

Using calibrated EKO Reference Plate, calibrate the reference heat flow sensor periodically.

Calibrate the production heat flow sensor according to the HFM method complying with JIS A 1412.

Figure 6-1. Traceability

*The Guarded Hot Plate Method (GHP Method) is a thermal conductivity measurement method of insulation material by the absolute method based on JIS A 1412. By measuring the power applied to the main heat plate, calculate the heat flow which flows through the sample piece and determine the heat flow rate from the temperature difference and thickness of the sample.
By keeping the protecting plate around the main heat plate at same temperature as the main heat plate, the heat flow runs through the sample achieves the primary flow (the heat flows in perpendicular to the sample).

6-3. Troubleshooting

Check the following items in case of trouble with the instrument. If any questions should remain, contact EKO for further technical support.

Table 6-1. Troubleshooting

Failure	Action
There is no output.	Check the resistance. Check the connection of the lead wires.
Output is very low.	Check the sensor contacting and adhesion conditions.

7. Specification

7-1. Sensor Specification

Table 7-1. Sensor Specification

Model		MF-180	MF-180M	HF-10S	HF-30S
Characteristics		General Use Compact High Sensitivity	Waterproof High Durability	Low Thermal Resistance (Thin type) Middle size	Low Thermal Resistance (Thin type) Large size
Application Environment		Indoor	Soil / Outdoor	Indoor	Indoor
Waterproof		N/A	Applicable	N/A	N/A
Operation Temperature (℃)	Sensor	-30~+120	-30~+120	-20~+120	-20~+120
	Cable	-25~+60	-25~+60	-25~+60	-25~+60
General Sensitivity ($mV/W \cdot m^{-2}$) (Room Temp.)		0.028	0.025	0.01	0.1
Repeatability(%)		±2	±2	±2	±2
Internal Resistance(Ω) (Room Temp.)		300~450	300~450	90~180	400~800
Thermal Resistance ($m^2 \cdot ℃/W$)		1.4×10^{-2}	1.5×10^{-2}	1.6×10^{-3}	1.6×10^{-3}
Thermal Resistance Material		Teflon	Teflon	Glass Epoxy	Glass Epoxy
Coating Material		Polyester	Carbon FRP	Epoxy	Epoxy
Dimension (mm) (l×w×t)		42×20×0.9	50×25×1.2	100×100×0.5	300×300×0.5
Weight(g) without cable		1.1	1.8	12	100

Table 7-2. Cable Specifications

Model	Details		Terminal	Wire	Output
HF-10S HF-30S MF-180	Material: Diameter: Cable end:	MVVS $0.18mm^2 \times 2$pins φ3.2mm pin terminal	Red Blue	White Orange	(+) Plus (-) Minus
MF-180M	Material: Diameter: Cable end:	Teflon $0.24mm^2 \times 2$pins Φ3.2mm Y terminal	Red Blue	White Black	(+) Plus (-) Minus

7-2. Dimensions

1. MF-180

Thickness: 0.9mm

2. MF-180M

Thickness: 1.2mm

3. HF-30S

Thickness: 0.5mm

4. HF-10S

Thickness: 0.5mm

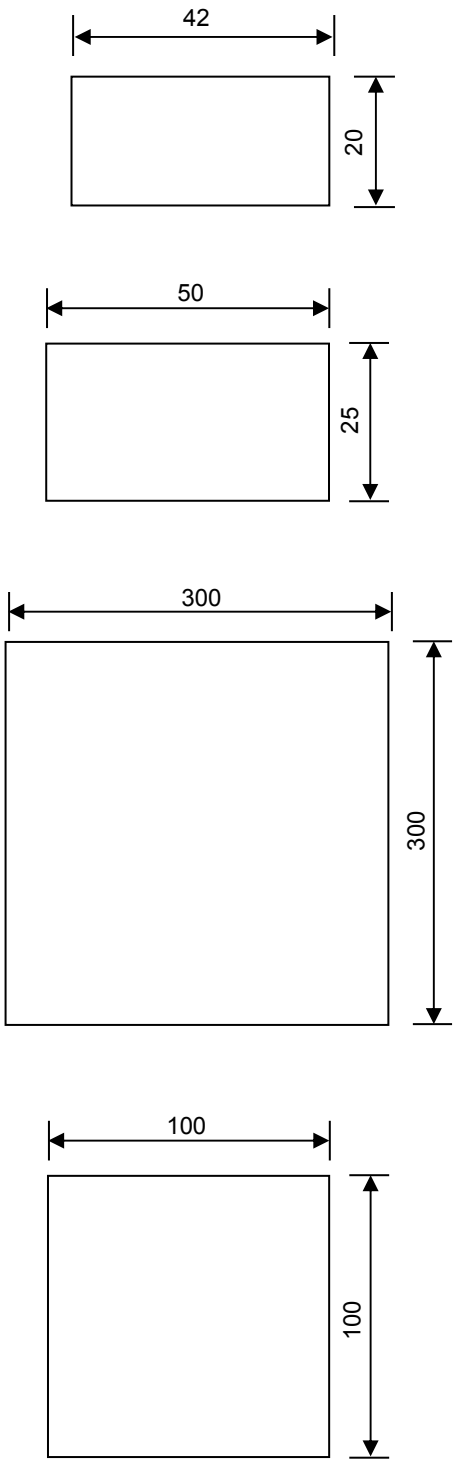


Figure 7-1. Dimensions (mm)

7-3. Accessories List

Table 7-3. Accessories List

Option Items	Remarks
Silicon Grease	YG6111(200g tube), YG6111(1kg metal can container)

APPENDIX

A-1. Applications

Table A-1. Applications

Environment	Application Example
Home	Heat penetration or loss from wall, window, ceiling, floor, or roof, degradation evaluation of insulation material
Office, Factory	Heat penetration or loss from wall, window, ceiling, floor, or roof, degradation evaluation of insulation material
Human Body	Surrounding environment and heat balance of human and animals, thermal radiation from human body, study for thermal resistance clothing, etc.
Storing and Preservation of Agricultural Crops	Thermal environment measurement for greenhouse, conservatory, storage, etc.
Building	Thermal environment measurement in area around subway, waste plant, department store, etc.
Research	Heat-transfer engineering research, education material, chemical reaction (heat generation and absorption) analysis
Thermal Conductivity of Machineries and Devices	Refrigerator, automobile, train cart
Applications on Devices	Thermal conductivity measurement device (HFM Method), Calorie Meter

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