Quick Thermal Conductivity Meter

QTM-500

Operation Manual

Ver.08
98-595-0009

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1. Introduction

1－1. Foreword

The Kemtherm QTM-500 is designed by the latest advanced electronic technology and meaures thermal conductivity easily in a short time. It features measurment of all kinds of sample from materials processed in manufacturing or construction industries to those for handcraft or food industry, etc. For example, QTM-500 can measure:

* Thermal insulating material like rock wool, glass wool, formed resin
* High heat insulation material or ceramics
* Bread dough, mashed food, powder, etc.
* Engine oil, silicone oil, etc.

and also for quality control of these materials.

Feature of QTM-500 Quick Thermal Conductivity Meter :

* Short measuring time
* Variety of thermal sensors to fit all types of sample and temperature
* Bright and clean LC display
* Temperature rising curve plotted during measurement
* Linear graphic by time-log conversion of temperature curve
* Automatic computation of heater current to heat sample (PD-11 only)
* Automatic temperature adjustment for measurement
* Thin sample like film or sheet can be measured.
* Printer(optional) can be connected.
* RS-232C port for connection to Computer
* Easy calibration of sensor probe
* Special functions:
  0. Printout stored date
  1. Recalculation
  2. Auto statistics
  3. Manual statistics
  4. Deletion of data
  5. Calendar function
  6. Options
  7. Memory all Clear
  8. Beep ON/OFF
  9. Recording Operator's name

1－2 About the Manual

The QTM-500 does not require complex procedure for operation, however, in order to make best use of its features, keep this manual near your system so that you can easily access to the information you need.

* It is prohibited to copy a part or all of this material.

* The QTM-500 Quick Thermal Conductivity Meter has been tested for the experiments and determinations in these operating instructions. However, this does not absolve you from the responsibility of performing your own tests and measurements regarding suitability of the methods and purposes you intend to use for. In no event, the Manufacturer is laibale for any loss or damage caused by the use of measurement results you have obtained from this instrument.

1－3 ⚠Safety measures

The instrument you have purchased has been tested in plant for the experiments and determinations documented in this manual, however, this does not absolve you from the responsibility of performing your own tests of the product supplied by us regarding suitability for methods and purposes you intend to use for. Therefore, you should observe the following safety measures:

⚠ WARNING This symbol indicates danger or death or severe injury.	⃠ This symbol means prohibition of certain act or action.
⚠ CAUTION This symbol indicates danger or physical or property damage.	● This symbol means mandatory act or action to be followed.

⚠ WARNING

Earth the ground wire of power cable.

Ground the green wire when 2-pin plug is used.

The 3-pin plug will automatically ground the earth.

If not grounded to the earth, there is a danger of electric shock.

⚠ WARNING

The power cable must be plugged out before power fuse is replaced.

For continued protection against risk or fire.
Replace only with same type and ratings of fuse.

If not, these is a danger of electric shock.

⚠ WARNING

Do not use combustible chemical or operate where combustible gas exists.

There is a danger of gas explosion inside the system.

⚠ WARNING

When hazardous chemical or sample is handled, wear safety gloves and glasses with protective mask, and ventilate the room well.

If such solution is splashed, it may hurt your eyes or skin. Toxic fume may hurt your windpipe if breathed in.

⚠ CAUTION

Do not use power source of voltage different from specified.

If power of wrong voltage is used, it may cause fire or shock, and may give damage to your instrument.

⚠ CAUTION

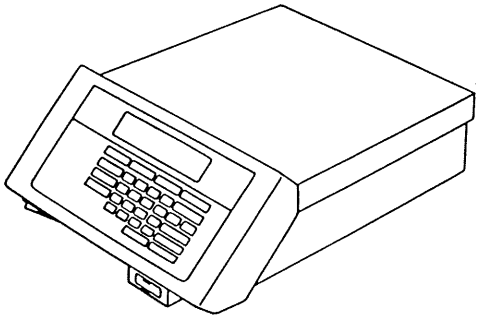
Casing or coverings of the instrument must be opened for servicing or maintenance work by authorized person only.

Otherwise it may cause fire, shock or abnormal functioning of the instrument.

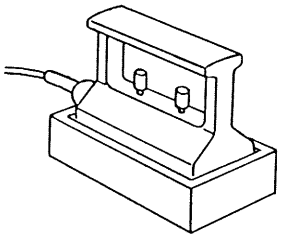
1－4 Supplied Parts and Accessories

Check the supplied parts and accessories with the list below:

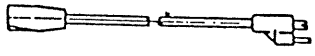
Main unit



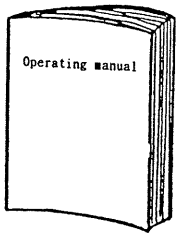
PD-11 and Probe case



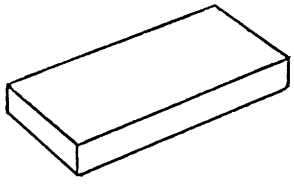
Power cord



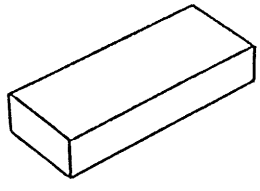
Operating manual



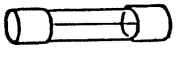
Reference plate(3 pcs)



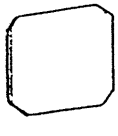
Cooling plate



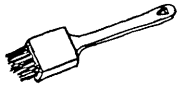
Fuse(2 pcs)
(T4A/250V)



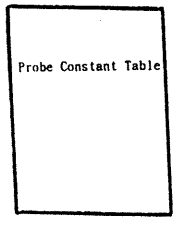
Intake filter



Brush



Probe Constant Table



1－5 Principle of Measurement (Hot Wire Method)

1－5－1 Principle of measurement

When a heater wire is extended through the center of an endless cylindrical homogenious sample and given constant power(heat), the temperature of the wire will rise at exponential rate of increase by time. (Chart 2)

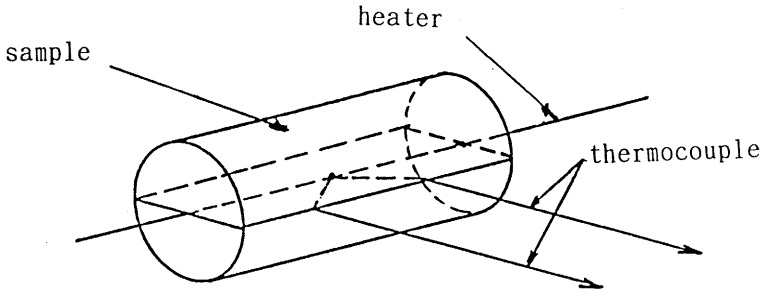


Fig 1. Hot wire method

If time axis is converted to log scale, the curve in Chart 2 will become alinear line shown in Chart 3. If a sample has low thermal conductivity, that isslow in temperature rise, linear angle will become large.
On the other hand, Ifit is high, the angle will be small.
What this means is the thermal conductivity can be obtained from the angle oftemperature line on time-log graphic chart.

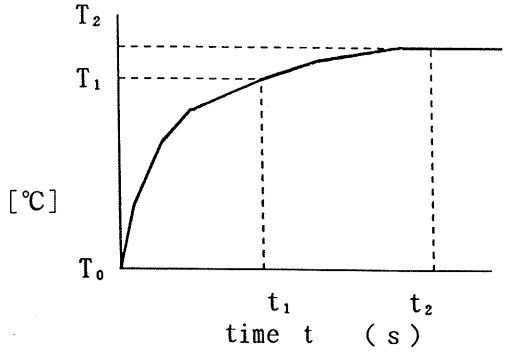


Chart 2.
Relation of time to temperature

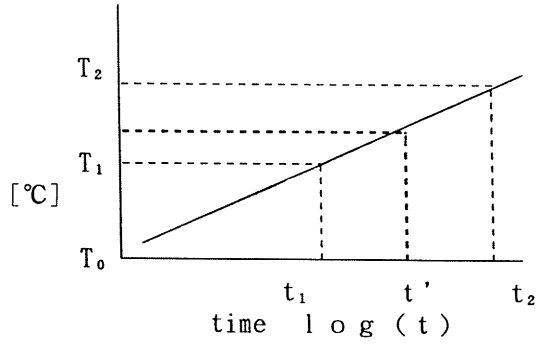


Chart 3.
log/time and temperature angle

Such method of measurement is called Hot Wire Method or Probe Method, and candetermine thermal conductivity of sample by the following formula:

$$\lambda = q \cdot \ln (t_2 / t_1) / 4\pi (T_2 - T_1) \quad --- \quad (1)$$

λ : Conductivity of sample [W/m•K]
q : Thermal unit of heater per time and length [W]
t_1, t_2 : time [s]
T_1, T_2 : temperature at t_1, t_2 [K]

(*) H.S.Carslaw and J.C.Jaeger
"Conduction of Heat in Solids" 2nd edition

Therefore, thermal conductivity can be obtained directly by Hot Wire Method. Another practical feature is it requires 10 to 200 seconds measuring time from start of loading heater current and during which time the temperature rises for only 20 degrees C. This means this method is very effective for a sample of high temperature effect.
Since measureing time is short, only the portion near surface of sample is heated, where the obtained thermal conductivity comes from, and the built-in processor of QTM-500 computes averaged value of obtained data of temperature curve so that reproducibility is secured even graphic reading is disturbed by unexpected noise.(see Fig 3. Averaging during t1-t', t'-t2)

1-5-2. Practical size of sample for measurement

According to the principle of measurement, an infinitely long and thick sample isrequired. If a sample is small in size, heat from heater wire travels through the sample and over to surrounding substance(i.e., air), which will be added to thermal conductivity of the sample, consequently causing measurement error. Recommended practical size of sample is listed in "15-3. Feature and Specification of Sensor(Probe) by Type".

Minimum required sample size depends on thermal conductivity of the sample, time for measurement and loaded thermal energy. To determine sample size, refer to the time length of linear portion in Fig 4. Temperature curve of measurement results can be displayed on QTM-500.("5-1-5. Temperature Curve 2")

If a sample is too small, add on the same to the sample or surround it with material of similar conductivity.

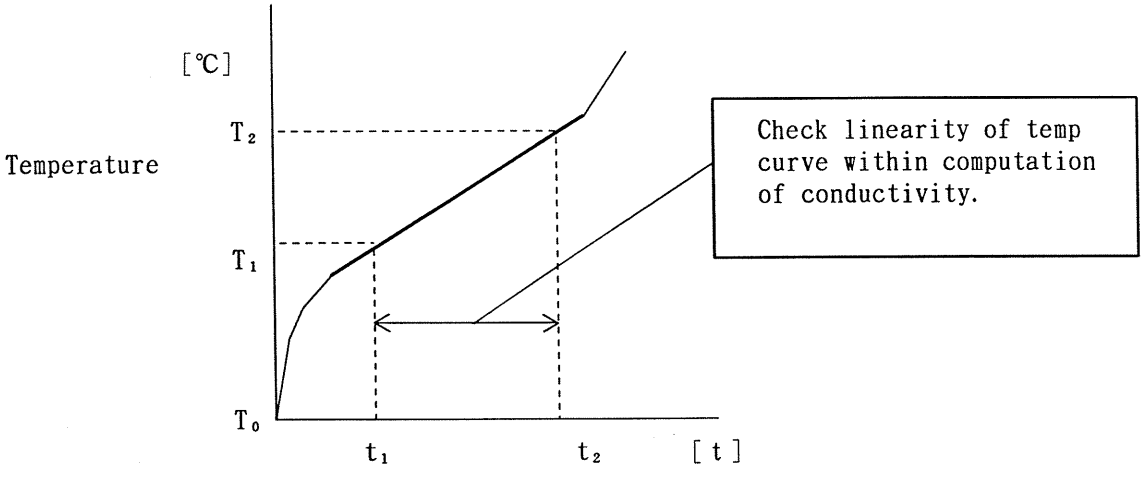


Fig 4. Log time and linearity of temperature curve

1－6．　Ｓｅｎｓｏｒｓ

Four kinds of sensor are available for use with QTM-500.　Their feature and specifications are described in "15-3. Specification of Sensor Probes".

1－6－1．　Ｓｅｎｓｏｒ　ｐｒｏｂｅ　ＰＤ－１１，　ＰＤ－１３

By Hot Wire Method, commonly practised way of sampling is to fasten probe by two pieces of sample material, however, by using PD-11, only one sample piece is required. Sensor PD-13 of which surface is covered with film sheet is used for sample of electrically conductive material.

$$\lambda = K \cdot R \cdot I^2 \cdot \ln(t_2 / t_1) / (T_2 - T_1) - H \qquad ---(2)$$

λ　　: Thermal conductivity (W／mK)
K, H　: Probe constant
R　　: Electric resistance of Probe heater (Ω／m)
I　　: Heater current (A)
t_1, t_2 : Time after heating started (s) ($t_1 = 30$、$t_2 = 60$)
T_1, T_2 : Temperature at t_1, t_2 (℃)

Constant K and H are determined by measuring materials of which thermal conductivities are known.(calibration of sensor probe)

Actual measurement reveals that Constant K and H will change their thermal conductivity by the sample, and there exists two sets of Constant K and H. For PD-11 and PD-13, use K1, H1 for sample of thermal conductivity smaller than 0.2W/mK, and K2, H2 for larger than this.

For routine measurement, conductivity values recorded on Probe Constant Card are used. When it is necessary to adjust constant value, refer to the thermal conductivity and electric current in "Reference Plate and Electric Current".

The structure of sensor porbe in Fig 5 shows heater wire and thermocouple can be seen over flexible material of which thermal conductivity is known. The flexible material can fit well over sample surface with force of springs housed inside the probe case.

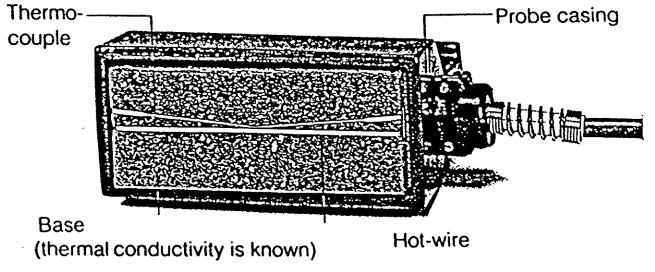


Fig 5. PD-11 Sensor probe

With this sensor probe, samples of the same size of probe face (50 ×100mm) or smaller size can be measured, and it is not necessary to smooth or polish sample surface for better contact.

Before measurement, remove dust on sample surface with the supplied brush. If the sample is wet, wipe off with soft cloths. Place the sensor probe on the sample lightly pressing on it so that they are in contact each other securely.

If the probe is going to used six times or more for measurement consecutively, place it on the cooling plate after each measurement for two minutes in order to avoid measurement error caused by stored heat inside the probe.

Always make it a point to start measurement only after sample temperature reaches equilibrium.

1-6-2. Sensor probe PD-N0 (option)

This sensor is a needle type which can go and probe inside sample material or is used for measurement of existing material in use, which cannot be detached or scraped off for sampling. Thermal conductivity (TC) can be obtained from the below formula.

$$\lambda = R \cdot I^2 \cdot In(t_2 / t_1) / 4\pi(T_2 - T_1) + H \quad \cdots\cdots\cdots\cdots\cdots\cdots (3)$$

λ	: Thermal conductivity
H	: Probe constant
R	: Electric resistance of Probe heater
I	: Heater current
t_1, t_2	: Time after heating started
T_1, T_2	: Temperature at t_1, t_2

Constant H is obtained by measuring a sample of which TC is known.
Probe constant can be calibrated as in "6-2. Input or Probe Constant".

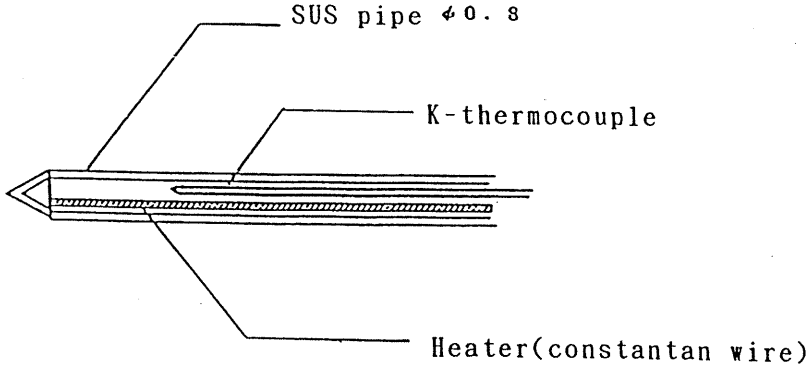


Fig 6. PD-N0 sectional view of needle type probe

Always apply the probe around the middle part of sample to avoid measurement error, and try not to squeeze it in to avoid breaking. If a sample is too hard to insert the probe, drill a hole tight enough to contact probe needle.

⚠Caution

1) **Use heater current "0.063" or more if necessary to raise temperature, but never too high in order to avoid breaking the sensor.**
2) **When detaching the probe from the measuring unit, be sure to do so keeping hold of the holder portion. Do not pull on the lead wire itself. Otherwise, it may be broken.**

1-6-3. Sensor probe PD-31 (option)

This is conventional type of sensor for Hot Wire method to be fastened by two pieces of sample, and can measure in high temperature range.

Equation to obtain TC by this sensor is as follows:

$$\lambda = K \cdot R \cdot I^2 \cdot In (t_2 / t_1) / 4 \pi (T_2 - T_1) \quad \cdots\cdots\cdots\cdots\cdots\cdots (4)$$

λ	: Thermal conductivity
K	: Sensor constant
R	: Electric resistance of Probe heater
I	: Heater current
t_1, t_2	: Time after heating started
T_1, T_2	: Temperature at t_1, t_2

Constant K is determined by measuring a sample of which TC is known.

Calibration of probe constant is detailed in "6-2. Input of Probe Constant".

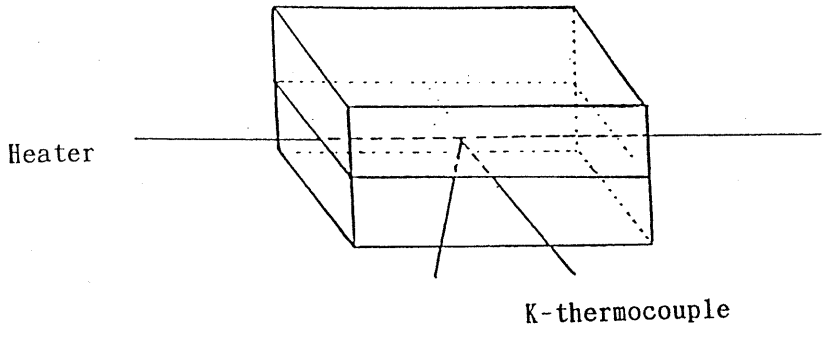


Fig 7. Structure of PD-31

How to set a sample for measurement:

Actual setting of a sample is illustrated in Fig 8. The thermocouple and heater wire have to be placed like in Fig 9. Two samples have to securely sandwich sensor wire and heater wire so that correct measurement results can be obtained.

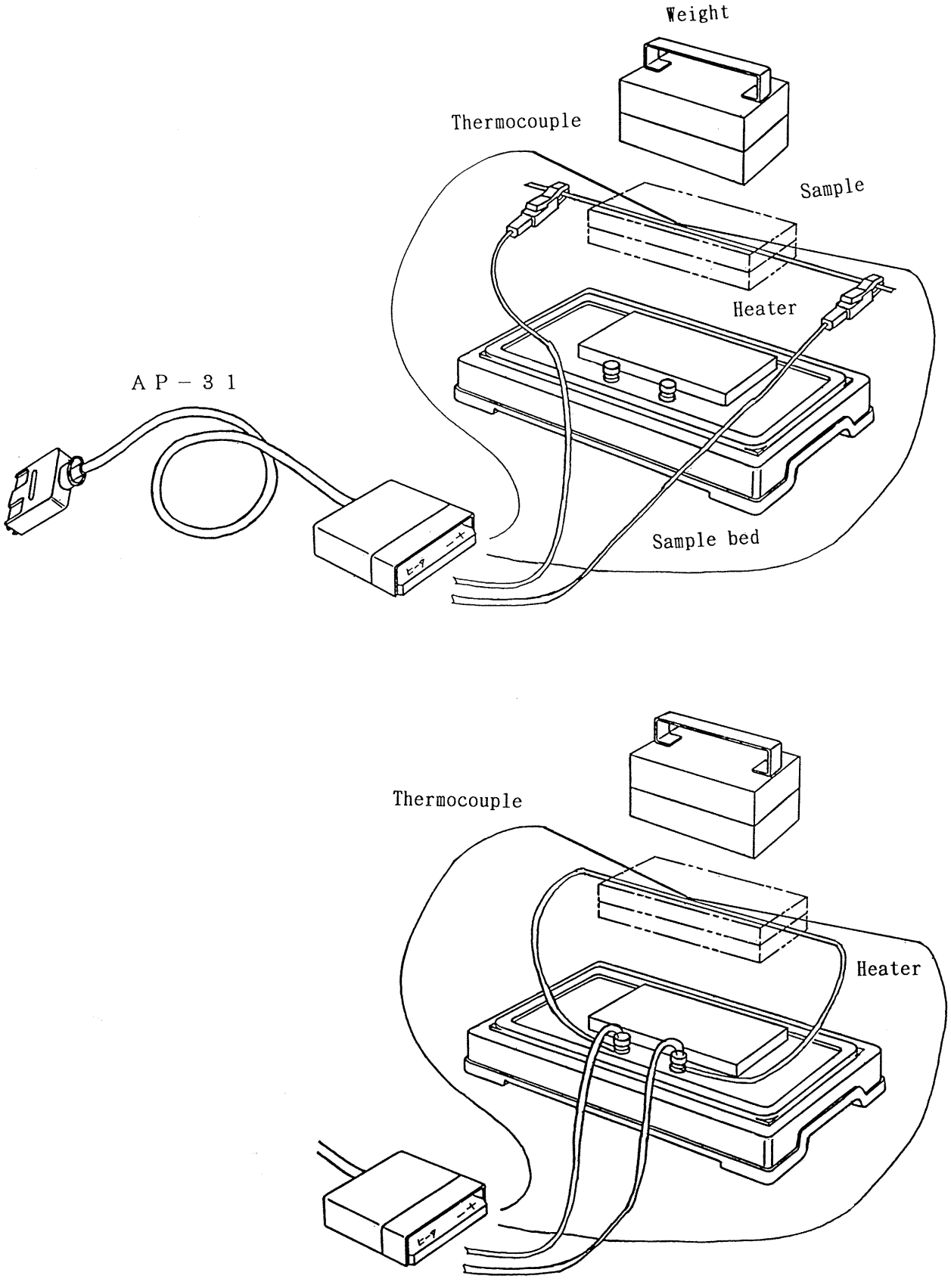


Fig 8. Sample setting with PD-31

Thermocouple leads have to be pulled out along heater wire.

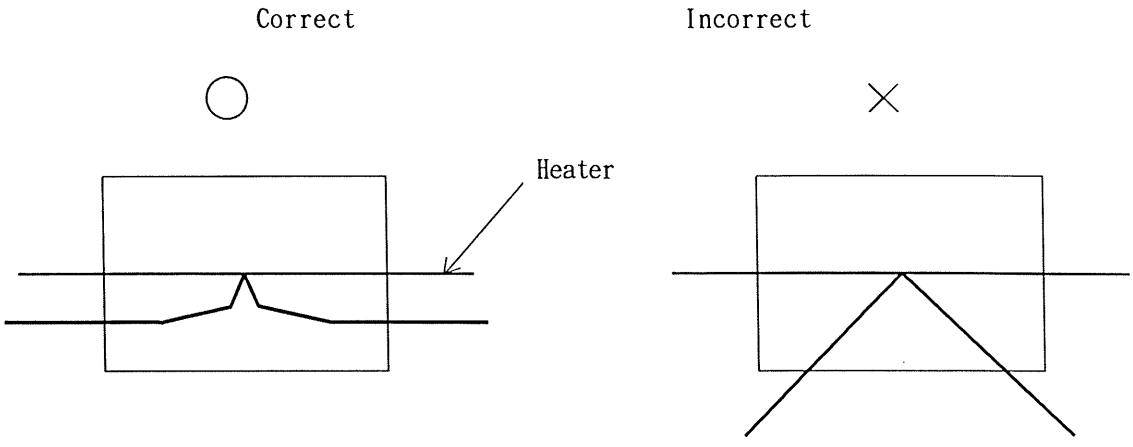


Fig 9. How to set thermocouple leads of PD-31

How to handle sensor:

① Polar of sensor lead can be checked by a magnet.
Almel lead(-) can be magnetized while chromel lead(+) cannot.
By this way, two leads can be connected to AP-31 correctly.
② Pay due care to welded part of heater and sensor which may break easily.
③ When sensor is used for measurement at high temperature more than 600° C, the sensor cannot be reused. The sensor in this case is for one time use.
④ Each one of sensor has to be calibrated.
⑤ For sensor calibration, use R2-2(silicone rubber) for TC below 1W/mK and R1-2(quartz glass) for above 1W/mK.

Caution when operating Electric furnace:

① A sample which reacts with thermocouple or heater wire inside furnace at high temperature will change its character and cannot be measured.
② A sample like carbon which reacts with oxygen at high temperature needs to be measured in inactive gas environment inside the furnace.
③ A sample which will generate heat and become unstable cannot be measured.
④ Use alumina glass tubes for protection and electrical insulation of thermocouple and heater.
⑤ Take sufficient wait time even after temperature reaches selected degree and start measurement only after confirming the temperature inside the furnace is stabilized.
⑥ Refer to Fig 10 on how to set sample inside the furnace.
⑦ Arrange the length of heater wire to be less than 1 meter inside the furnace.
⑧ Remove plastic cover around the weight(optional) before it is used. (See Fig. 11)
⑨ Temperatu re curve may be distorted due to resistance change of sample at high temperature more than 800 ℃ degree. The QTM has the built-in processor to average data so that correct results can be obtained.

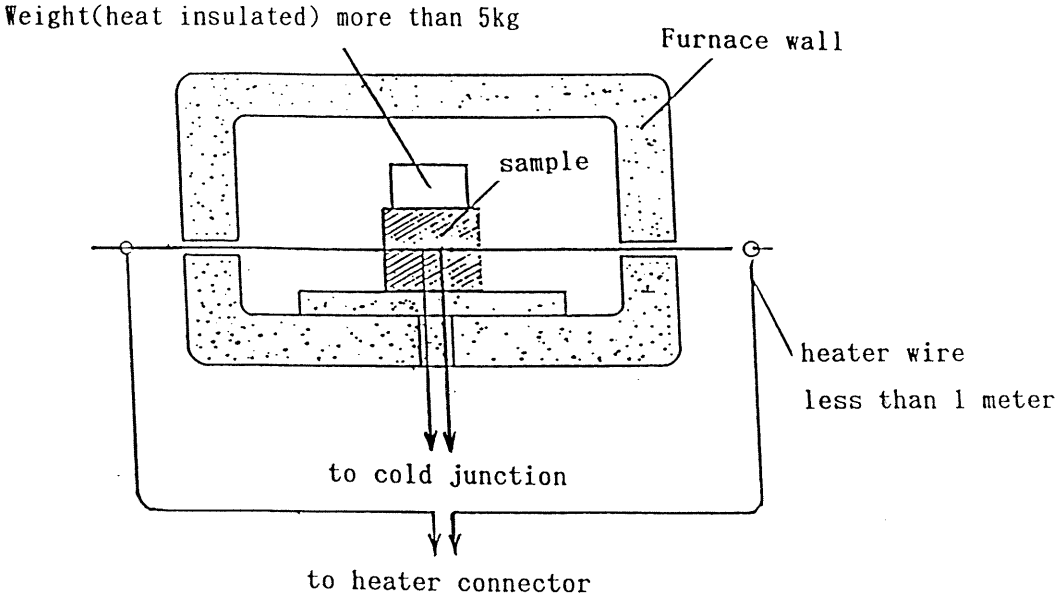


Fig 10. Sample inside Electric furnace

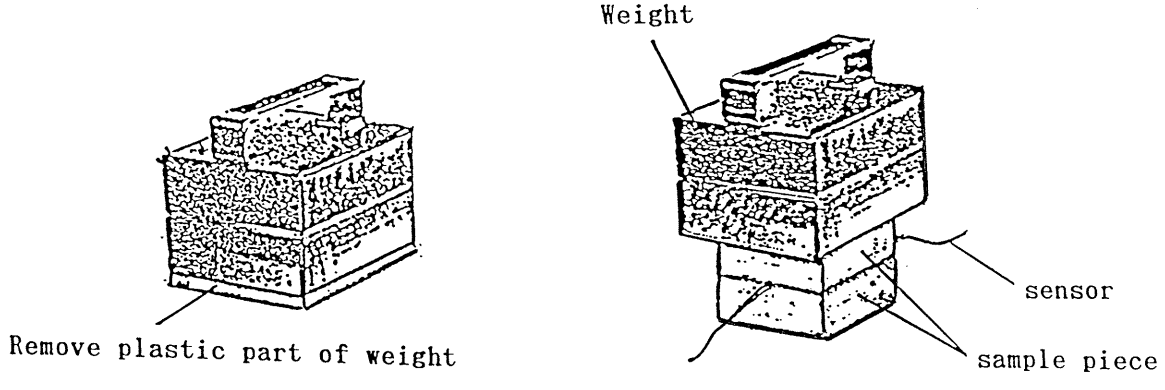


Fig 11. Weight used inside Electric furnace

Note!

The QTM-500, when measuring at 700°C or higher, may not reach "Fine" temperature stability level. In this case, measure in "Quick" mode, and check repeatability after running a series of measurements.

2. Parts Configuration and Function

2-1. Name of parts and explanation

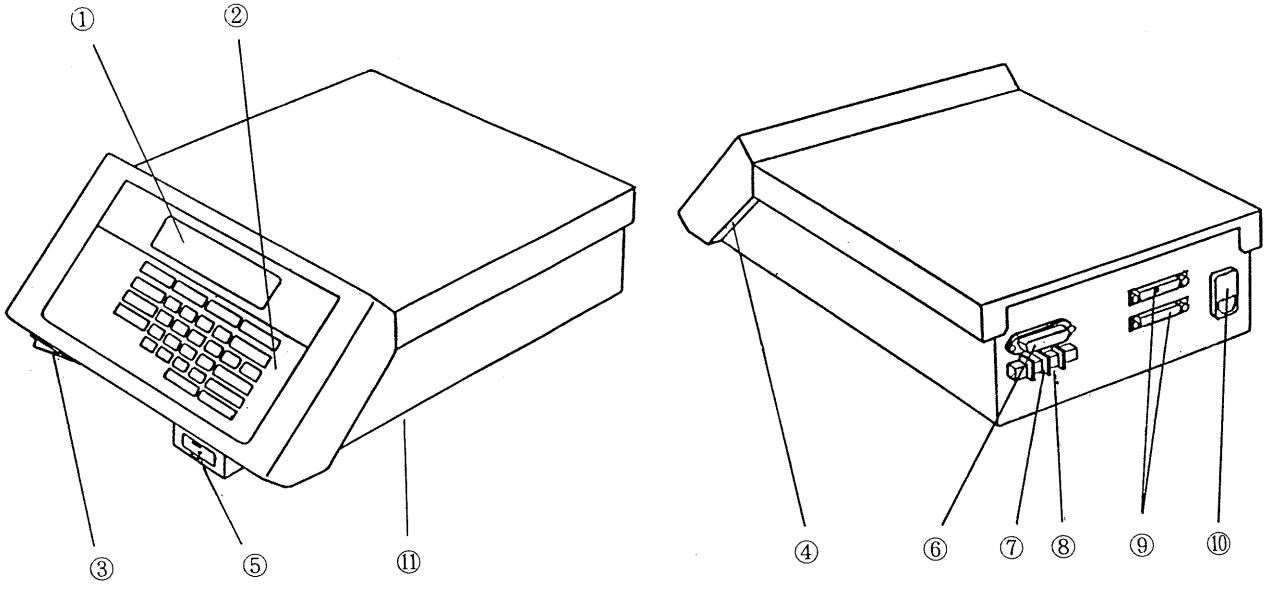


Fig 12. General view of QTM-500

① LC display (with backlight)	Display of measurement temperature and results, measurement parameters, etc.
② Operation panel	Keys to start measurement and to input parameters for measurement and printing, etc.
③ Power switch	Switch to turn ON-Off power of the unit
④ Contrast knob	Brightness of screen can be adjusted by this knob.
⑤ Probe connector	Connector for PD-11, PD-13, PD-NO, PD-31
⑥ External current	Connector for regulated DC current supply (for PD-11, PD-13, PD-31)
⑦ Recorder output	Terminal for output for probe(K-thermocouple)
⑧ Zero adjustment	To adjust zero point of recorder output
⑨ RS-232C1 connector	Connector for Printer or Computer(function 6)
RS-232C2 connector	unused (not be connected)
⑩ AC power	Power cord is plugged in for power supply to Unit
⑪ Cooling fan	To keep cooling inside instrument(at bottom)

2－2. Recorder Output

The QTM-500 is equipped with recorder output to monitor signal from thermocoupleat sensor probe.

① Recorder output	-3.55mV to 41.3mV	(K-thermocouple equivalent 100 to 1000℃)
② Zero adjustment	+/-48mV variable shifter	(270 degree turn)
③ Output impedance	1kΩ	

The related work of recorder output and QTM-500 is shown in graphic chart,"2-5. Basic Operation".

Note: DC power is supplied for heater inside QTM-500.
At the beginning of heating, the recorder will show a "jump"(see Fig. 13) due to electric resistance at the joint of heater and thermocouple, which does not appear on LCD. This jump will become larger by heater current.
The jump will not affect TC measurement since it occurrs only at the beginning, away from measurment range.

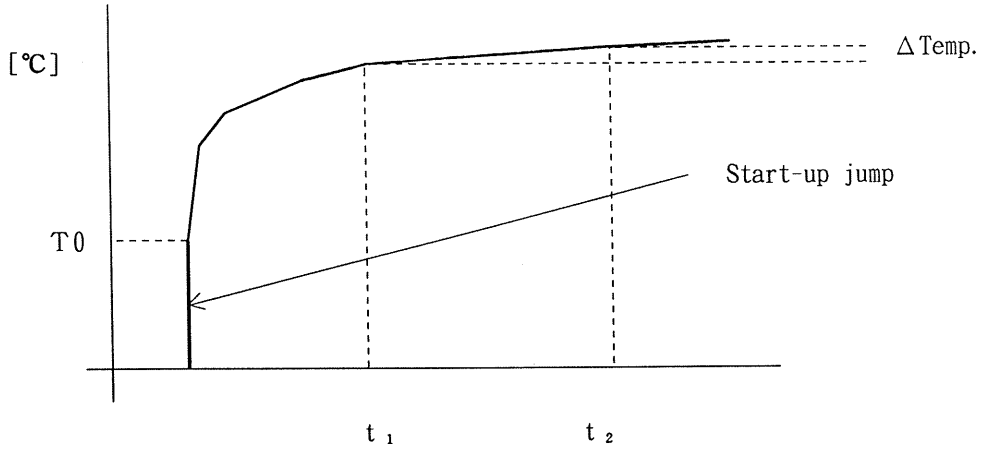
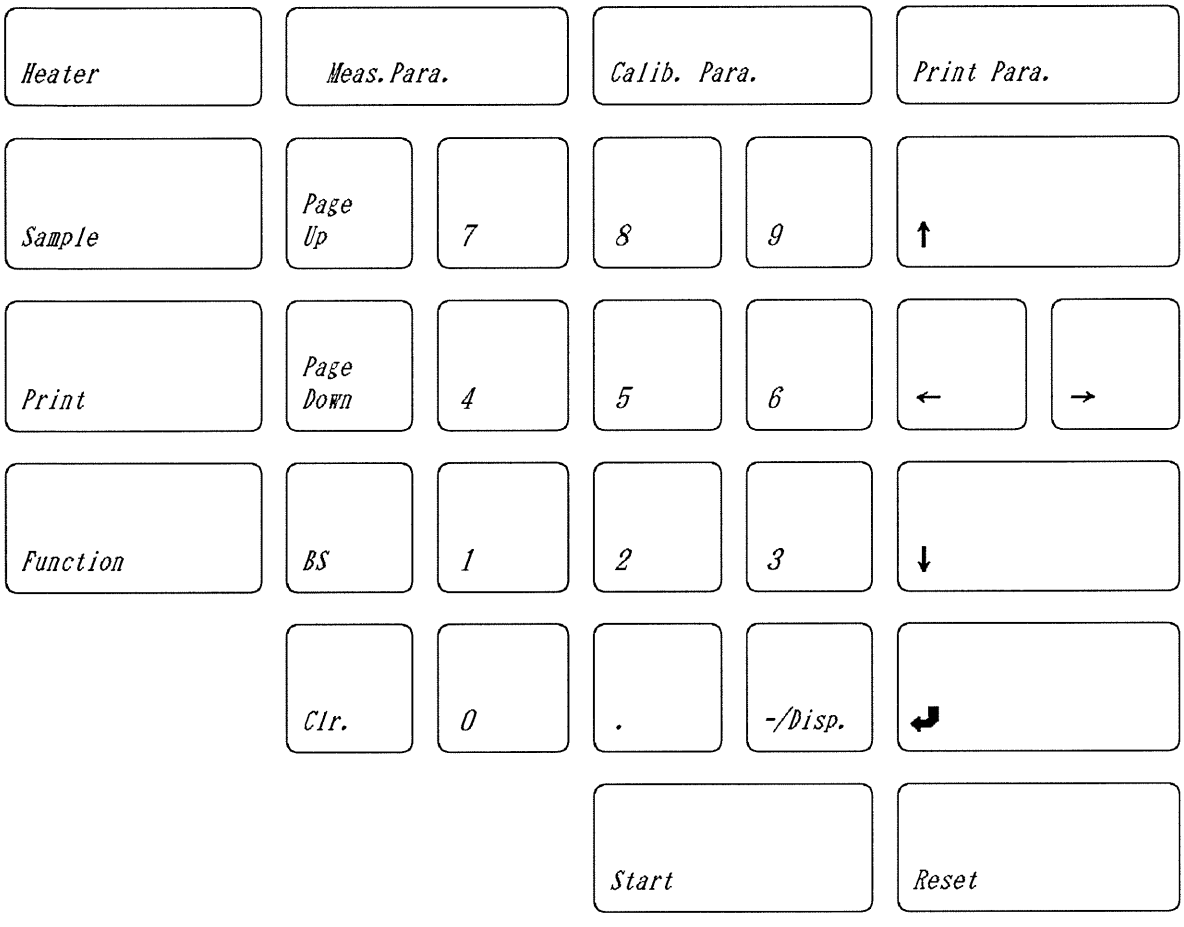


Fig 13. Start-up Jump appears in recorder output

2-3. Description of Keys and Function



Heater	Key to select current value	<p. 29>
Meas. Para.	Key to select parameter for measurement	<p. 32>
Calib. Para.	Key to select parameter for calibration	<p. 30>
Print Para.	Key to select parameter for print	<p. 38>
Sample	Key to select parameter for sample No. and Lot No.	<p. 39>
Function	Key to execute special funtion(0 to 9)	<p. 45>
Print	Key to print out	<p. 63>

[*Start*] Key to start measurement

[*Reset*] Key to reset

[*1*] ~ [*9*] [*.*] Key to select parameter value and probe constant

[*BS*] Key to erase preceding character

[*Clr.*] Key to clear an entry

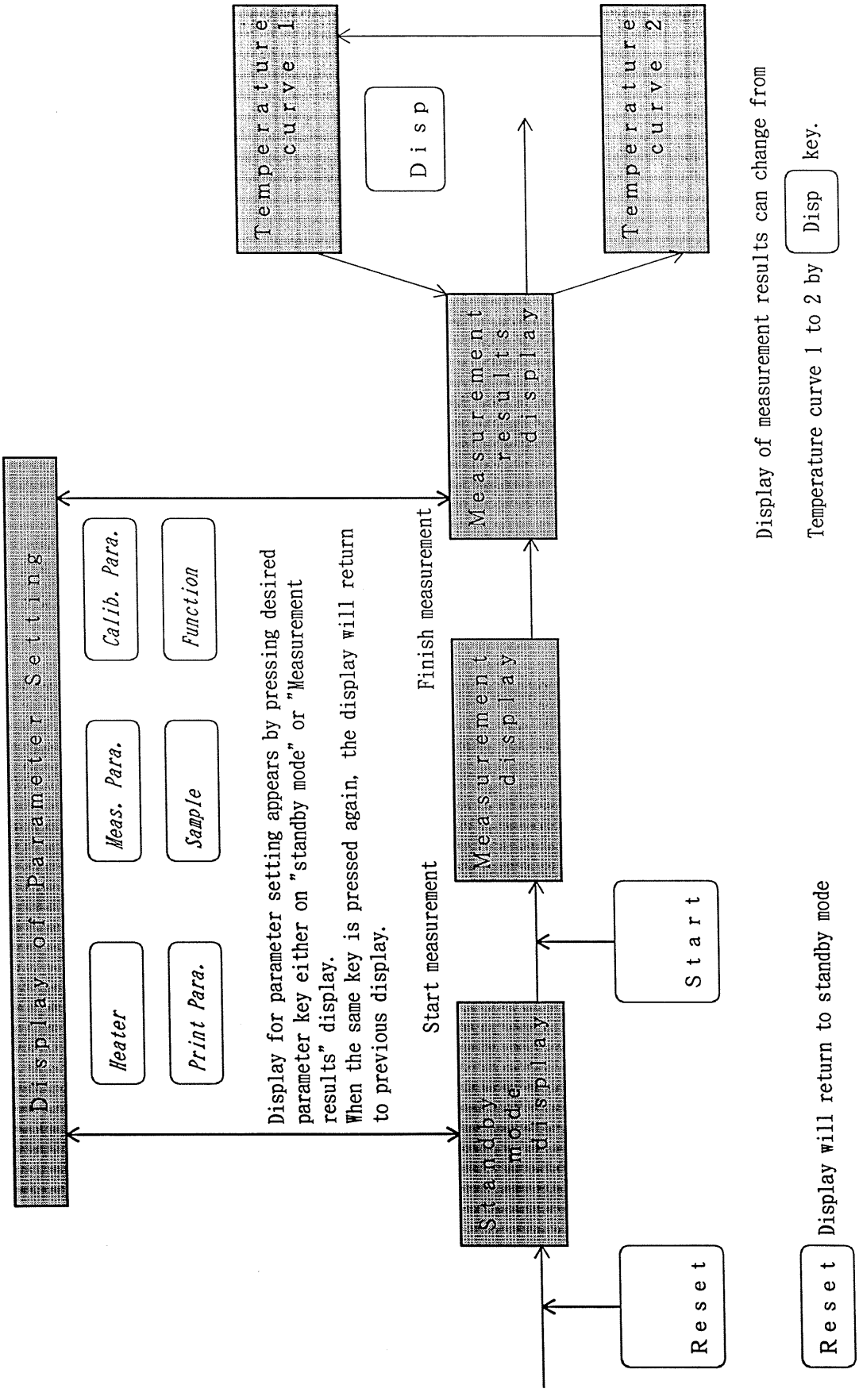
[↑] [↓] [←] [→] Key to move cursor

[↵] Key to confirm entry or execute

[*-/Disp.*] Key to delete or recall probe constant value or batch data on Function 4. Also, to select Temperature curve 1 or 2 of measurement results or recalculated results.

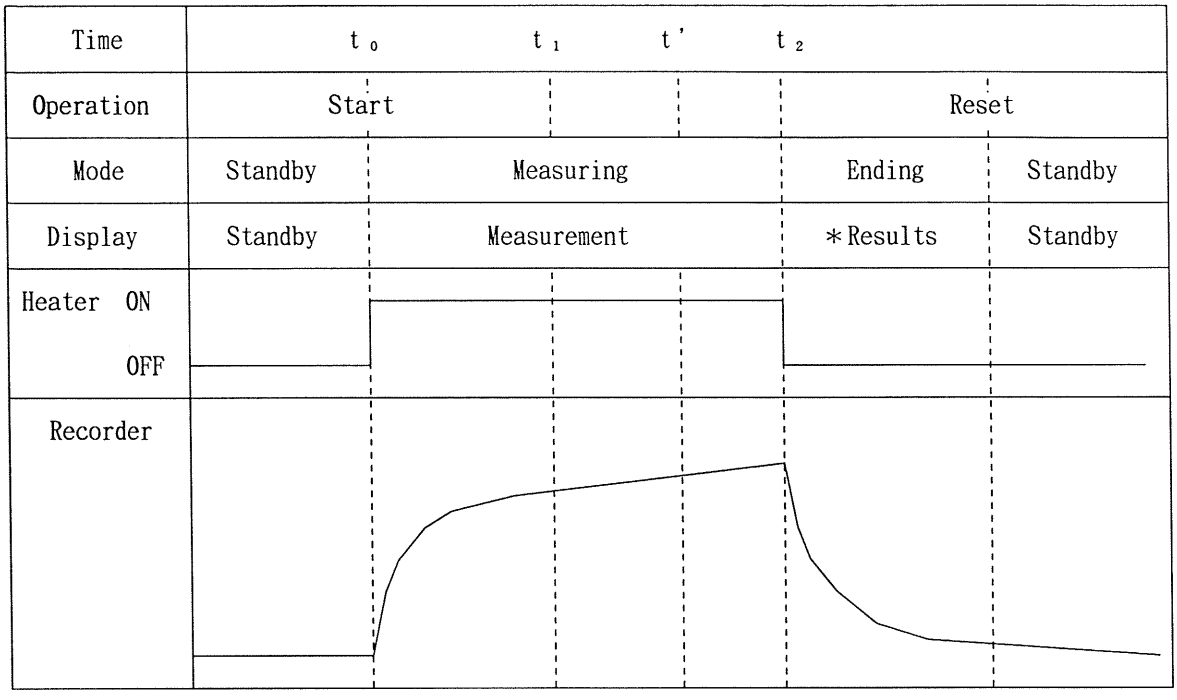
[*Page Up*] [*Page Down*] When ▲ or ▼ appears on display, it is used to return to previous page or jump to the next page. Thees keys will be shown by [Up] [Down] hereinafter.

2-4. Relation of Key and Display



2－5. Basic Operation

The below graphic chart shows basic relation of operating Main unit to Recorder and Heater:



＊ In addition to display measurement results, the display can show temperature curve 1 or 2 selected by [-/Disp key]

(For temperature curve 1 and 2, refer to "5-1-4. Temperature Curve 1" and "5-1-5. Temperature Curve 2")

3. Installation of Instrument

3-1. Cautions for installation

Avoid a place under any of the following conditions:

* near vibrating object

* Direct sunlight * near strong electromagnetic field

* Dusty surrounding

* Highly humid or poorly ventilated

* Directly exposed to air blown from airconditioners

The ambient temperature for use of this instrument is 5 to 35° C.

3-2. Cautions for safety

Power source:
Power for this instrument is AC100 to 240V and 50/60Hz. Do not use power source other than specified.

Power cord:
Do not pull out the cord to plug out. Always hold the plug.
Do not bend the cord or place a heavy weight on it.
Ground wire must be earthed. If 3-Pin plug is used, there is no need for earth since it has earth pin which is automatically grounded to the earth. If power source is 2-pin, use AC-3P adapter and ground the green wire to the earth.

Ventilation:
Ventilation of the instrument is necessary to avoid rising temperature. Do not clog its vent. Also, do not use the instrument in a room where it is dusty and not well ventilated.

Maintenance:
Clean the instrument with dry and soft cloth. To clean dirty spots, first wipe with cloth wet by neutral detergent and then wipe with dry cloth. To protect surface, never use benzene, thinner or alcohol.

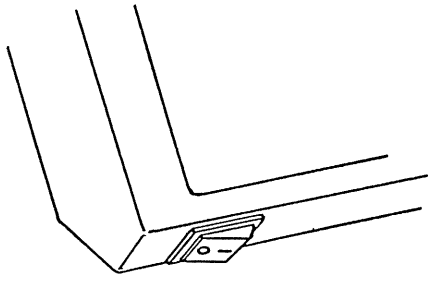
Storage:
First clean the instrument before keep it in storage. Use the packaging when the instrument was delivered. Refrain from a place for storage at too high or too low temperature or a humid or dusty room.

Replacement of sensor probe:
Before sensor probe of QTM-500 is replaced, turn off power first. the instrument

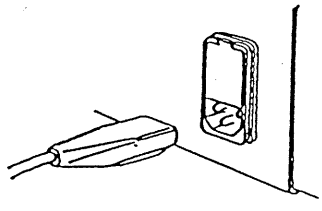
4. Preparation before Measurement

4－1． Ｓｔａｒｔ－ｕｐ

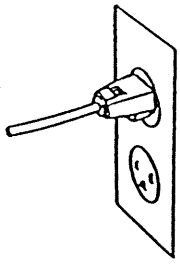
① Make sure the power switch is in OFF position.



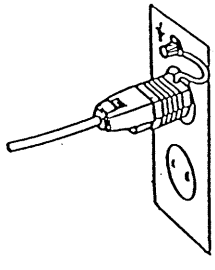
② Plug in the supplied power cord into the instrument.



③ Plug in the other end of the power cord into power outlet.

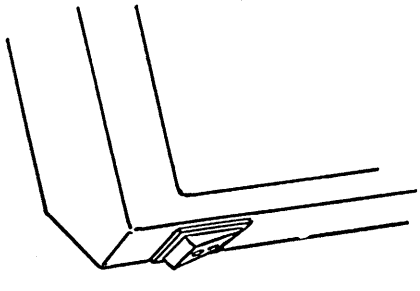


<3-P plug>
Earth terminal is automatically grounded to the earth.



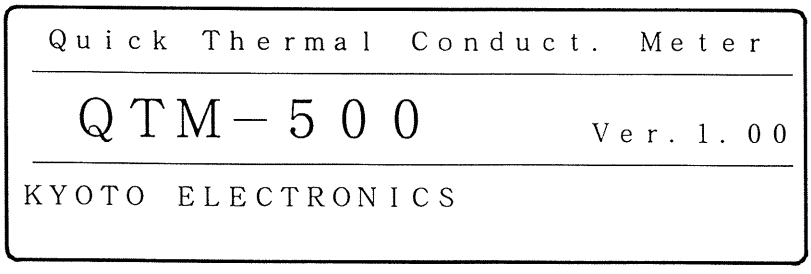
<2-P plug>
Use AC-3P adapter and ground the green wire to the earth.

④ Turn on power of the instrument.

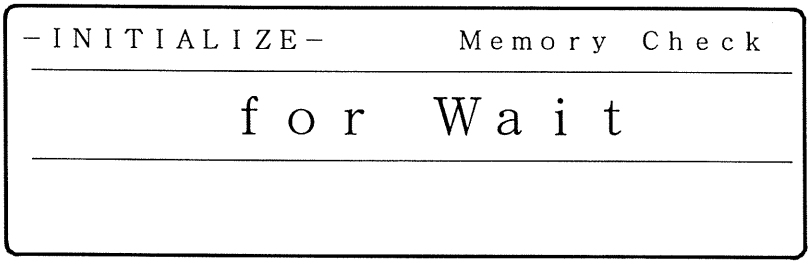


4－2. Initial Displays

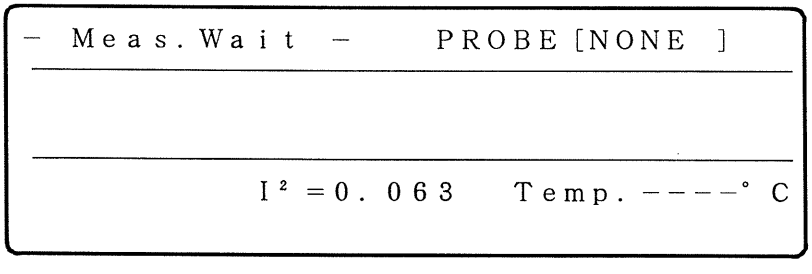
The LCD is backlit and will show the below message for a few seconds.



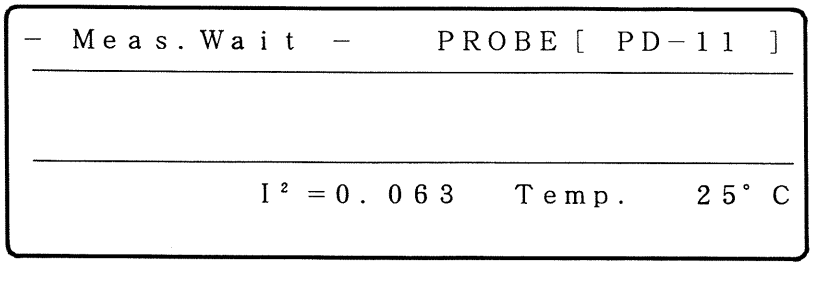
The below message will appear when memory is initialized("INITIALIZE" blinks).



When sensor probe is not connected:



When the probe is connected:



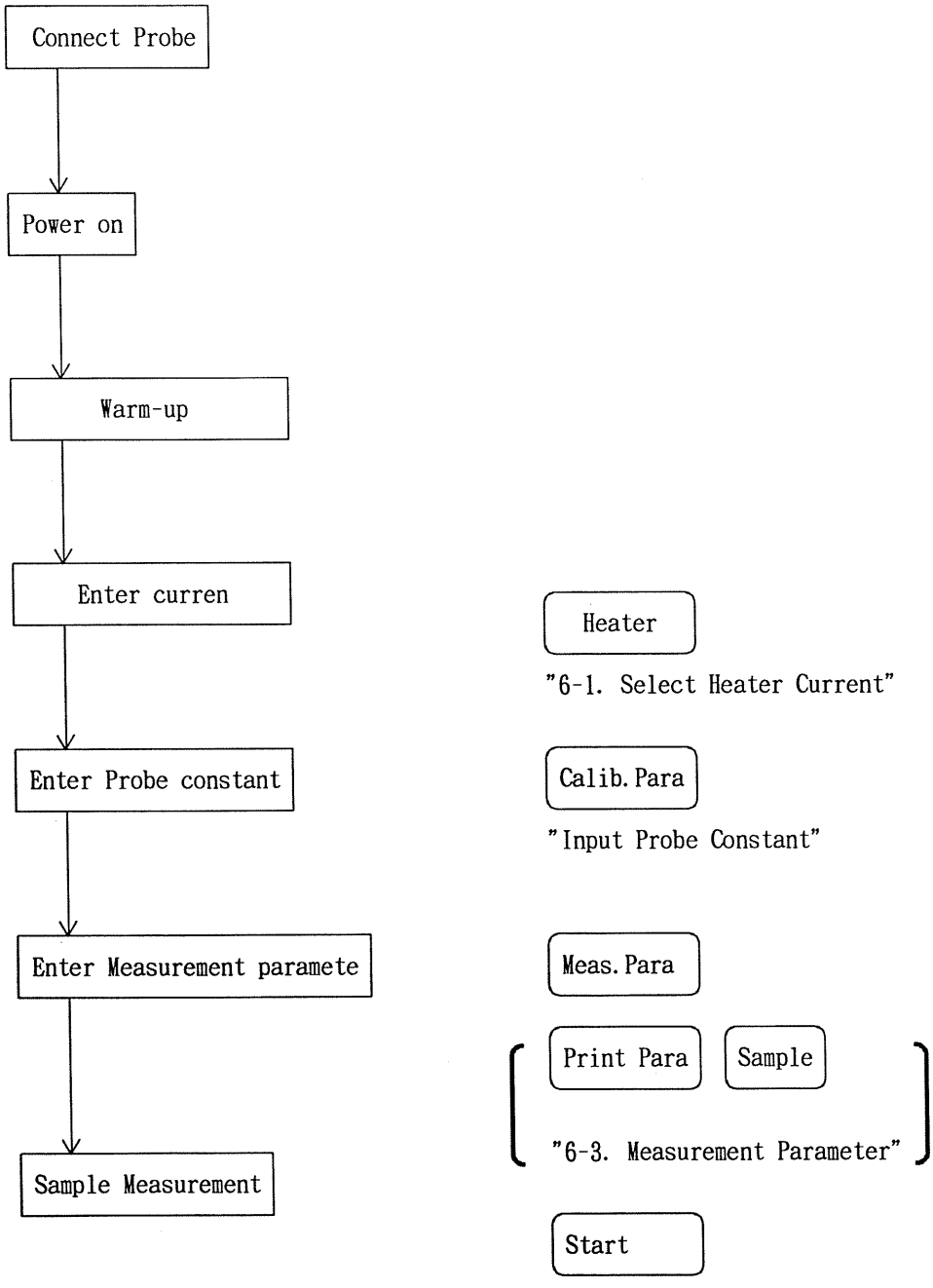
4－3. Warm－up and Start measurement

Warm-up is necessary until inside temperature is stabilized. It will take aboutthirty minutes to reach equilibrium though it depends on difference between ambient and selected temperature.

4－4. Starting measurement

Connect the probe before power is turned on. Wait for thrity minutes after power is turned on until temperature reaches equilibrium.
First select heater current, then enter probe constant(Calib.Para), measurement parameters(Meas.Para) and if necessary, select print parameter(Print Para) and sample parameter(Sample).
Then, it is ready to start measurement.

【Flow chart until measurement starts】 【Parameter】

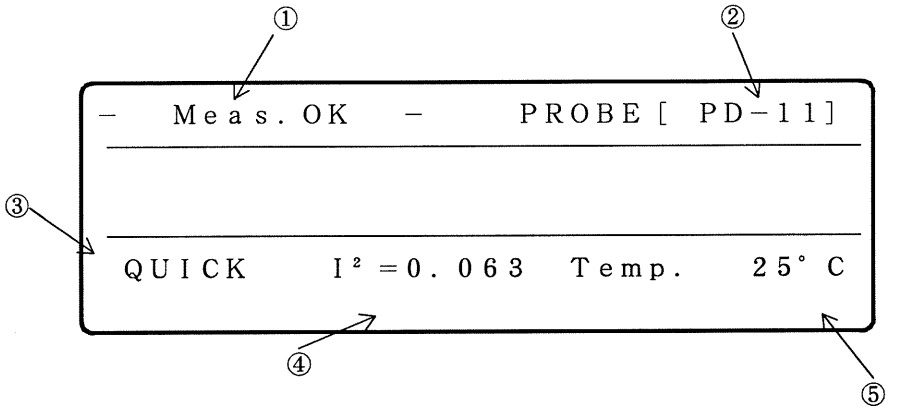


5. Measuring Sequence

5-1. Message of Display

5-1-1. Display of standby mode

Below message will appear in five seconds after power is turned on. When [Reset] key is pressed, the display will return to this mode.



① This shows the mode of QTM-500.

If it is "Meas. OK", measurement can be started by [Start] key. If it is "Meas. Wait", either Probe is not connected or tempeature is not stabilized yet. If [Start] key is pressed in this mode, "RESERVE"message will appear to start as soon as temperature becomes stable. If it is "RESERVE", measurement is reserved and will start after the temperature is stabilized.

② Type of probe connected to QTM-500 is shown here.

If it is not connected, "NONE" will be shown here.

③ This shows degree of temperature stability

If probe temperature is stable, it shows "FINE".
If it is stable to some extent, it shows "QUICK".
Reproducibility and absolute precison will not be guaranteed by measurement in "QUICK" mode. ("6-3-5. Determine Degree of Temperature Stability")

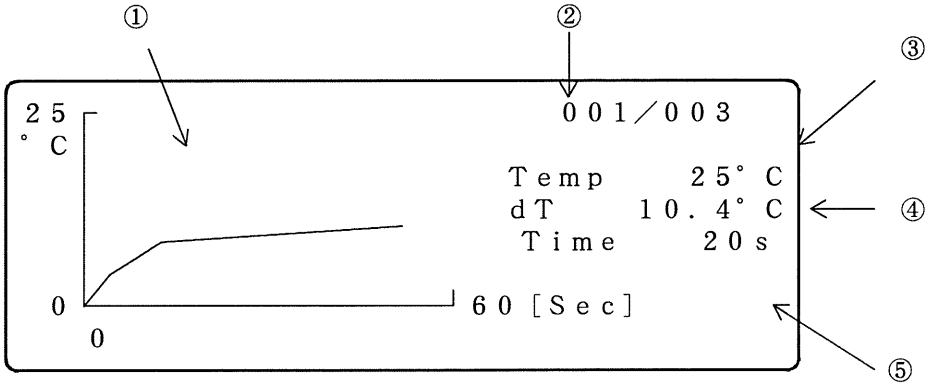
④ This shows squared value of heater current
If it is IxI=0.063, it means 0.250A.

⑤ This shows probe temperature

If sensor probe is not connected, it will show "----".
Temperature unit will show the unit used for measurement of thermal conductivity selected on Meas. Para.

5－1－2. Measurement Display

This is the display showing the performance during measurement.



① The graphic chart will plot temperature curve of sample in realtime.

Measurement time is shown on X-axis and temperature rise is Y-axis. When temperature goes above 25° C, [heater] current will be cut off and measurement terminates automatically.
("6-1. Setting Heater Current")

② This section shows the number of times of measurement against preset number.

"001/003" means the preset number of measurement is 3 and the first measurement is being performed.
("6-3-6. Repeat Function")

③ This is temperature of sample at time of starting measurement.

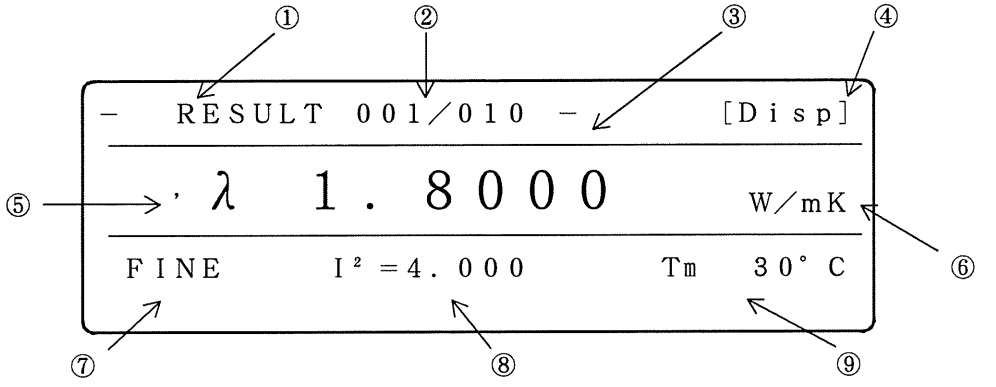
④ This is changed degree of temperature of sample from the start up till now. (unit° C or° F)

Select appropriate current to keep rising temperature fall within 5 to 20° C. Temperature rises in proportion to current value.
("6-1. Select Heater Current")

⑤ This shows time to go until measurement finishes. (unit:second)

5－1－3. Measurement Results Display

The display below shows the results of measurement or recalculation.



① This message shows the mode of QTM-500.

If it is "RESULT", it shows measurement results.
If it is "RECALCULATION", it shows recalculated results out of stored data.

② This shows the number of finished measurement and preset number.

"001/001" means a regular measurement is finished.

"001/010" means 10 measurements is preset and the first measurement is in process.

③ This shows the detected value of measurement results.

④ When [-/Disp] key is pressed, the temperature curve can be by checked two different graphics:

* T. curve 1: Graphic curve with X-axis for time and Y-axis for temp.
* T. curve 2: Curve 1 is expressed by X-axis of log time.

⑤ This means the measurement results show temperature compensated.

When it is temp compensated, it shows " ' ", which will not be shown for results without temperature compensation.
("6-3-4. Temperature Compensation")

⑥ This shows unit expressed for measurement results.
They are W/mK, Kcal/mh° C, cal/cms° C, Btu/fth° F, Btu/inh° F

⑦ This shows stability degree of temperature of probe at time of start.

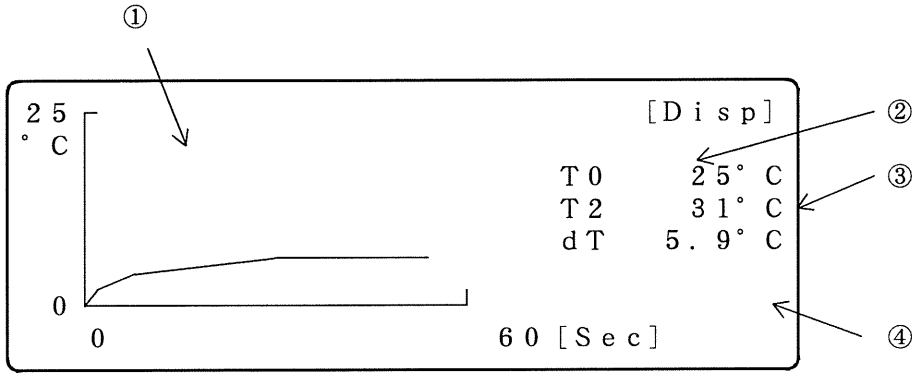
⑧ This shows current value loaded for the measurement.

⑨ This shows measurement temperature. ("6-3-2. Measurement Temperature")

Temperature unit is the same as selected in above(6).
(when W/mK is selected, it will be° C)
When temperature is compensated, Tm means the selected temperature.
("6-3-4. Temperature Compensation")

5－1－4. Temperature Curve 1

Temperature curve of the latest measurement results is shown.



① The graphic shows rising temperature curve of a sample that is measured.

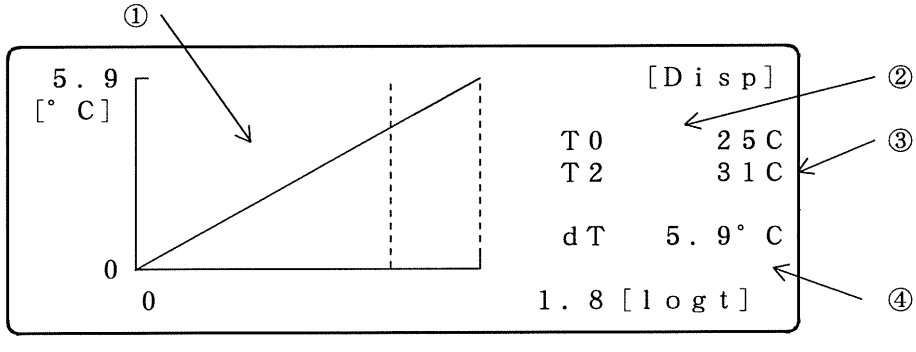
② This shows temperature of sample(probe) at time of start.

③ This shows temperature of sample(probe) at the end of measurement.

④ This shows the degree of increased temperature of sample(probe) from start to the finish.

5－1－5. Temperature curve 2

This graphic shows the angle of thermal conductivity of the measured sample.



① Temperature curve 1 is converted here to linear line by X-axis expressing log time with Y-axis showing temperature.

② This shows sample temperature at time of start.

③ This shows sample temperature at the end of measurement.

④ This shows degree of increased temperature from start to the end.

5－2. Prohibited Key Entry

1. Calibration cannot be performed by [Calib. Para] key during measurement.
2. Measurement parameter cannot be changed by [Meas. Para] key during measurement.
3. Current value cannot be changed by [Heater] key during measurement.
4. Special function cannot be used by [function] key during measurement.
5. Print parameter cannot be changed by [Print. Para] key during measurement.
6. Sample number cannot be changed by [Sample] key during measurement.

If any of the above keys is pressed, beep will be sounded.

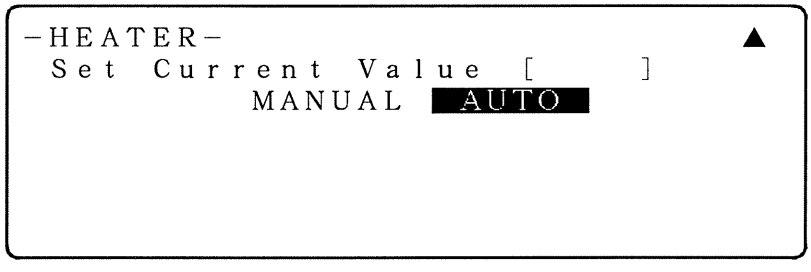
6. Operation for Measurement

6-1. Selection of Heater Current

Press [Heater] key.

Current value for probe heater is selected in two ways:manual and automatic. Appropriate current value must be selected to the sample so that temperature rises within 5 to 25° C range. But this is for PD-11. If it is PD-31 Probe, temperature may not rise than 5℃ even when the highest degreen is selected. It also depends on condition of the sample. Automatic selection of current value can be made only by using Probe PD-11. Automatic selection is made by first finding appropriate current, and then measurement will start after temperature stabilization is self-checked. The screen display is shown here. (This display is called <Heater Menu>)

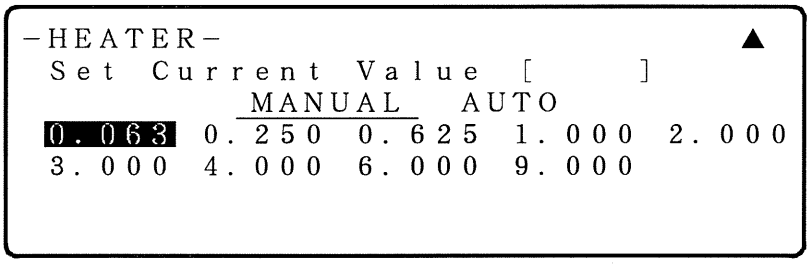
<Heater Menu>



* If AUTO was selected previously, current value for "Set Current Value" will not be shown. If MANUAL was selected previously, the current value previously selected will be seen here.

6-1-1. Manual Selection

(1) Make sure the display is Heater Menu.
Select MANUAL by ←, → key and confirm by ↵ key.
The display will show the below message:



(2) Select desired current value by ←, →, ↑, ↓ key and confirm by ↵ key.
The selected value will appear next to "Set current Value" in the [Heater] menu.
The display will return to standby mode or measurement results mode.

6－1－2. Auto Selection

(1)Make sure the display is [Heater] menu.
Select AUTO by ←,← key and confirm by ↵ key.
The display will return to standby mode or measurement results mode.

6－2. Input Probe Constant (Calibration)

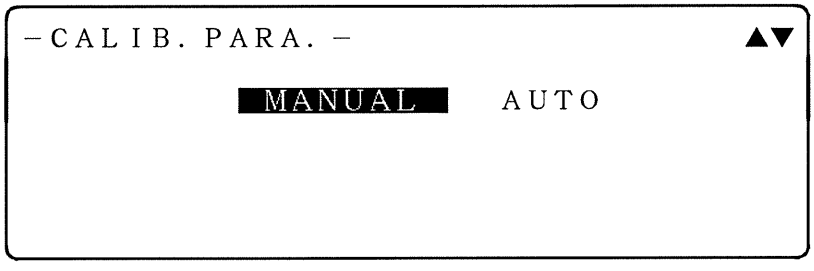
Each sensor probe has its own constant called Probe Constant, and it has to be input before measurement.
See[7-4. Adjustment of Probe Constant].

6－2－1. Manual calibration

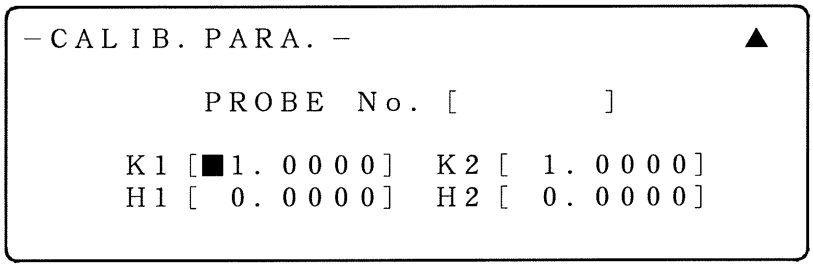
Enter constant direct by numeric key.

Press [Calib.Para] key.

Select MANUAL by ←, → key and confirm by ↵ key.
If the probe is PD-11 or PD-13, there is no AUTO and the display will go to K, H Constant Entry display.



When Probe PD-11 or PD-13 is connected, the display will be like below.
For other probe, enter K, H Constant.



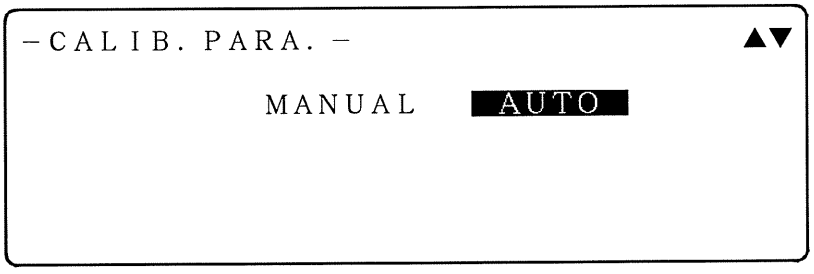
Enter each constant by numeric key and confirm by ↵ key. The numeric numbers that can be entered are -9.9999 to 9.9999.
The display will return to standby mode or measurement results display by [Calib.Para] key.

For PD-11 and PD-13, enter K and H constant.

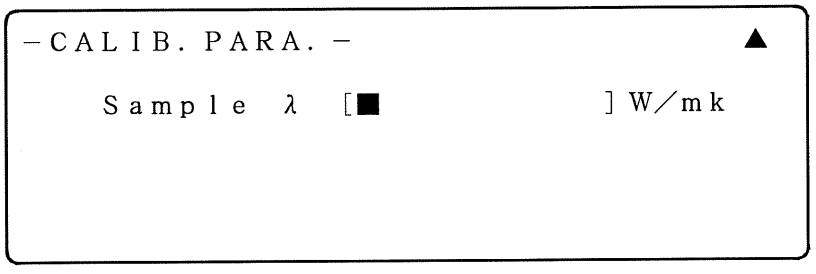
6－2－2. Auto Calibration

This is effective only for PD-N0 or PD-31, where sensor/probe constant is automatically determined by measuring the supplied reference plate(or a sample of which TC is known). Enter W/mK for unit by Meas. Para key, and follow the description of "7-4-2. PD-N0", "7-4-3. PD-31".

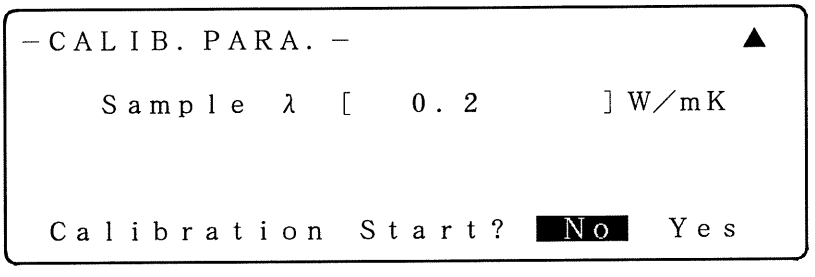
(1) Select AUTO by ⇦ , ⇦ key and confirm by ↵ key.



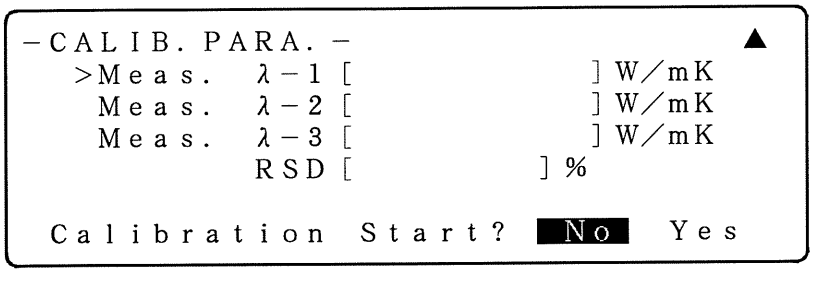
(2) Input λ of the sammple (reference plate).



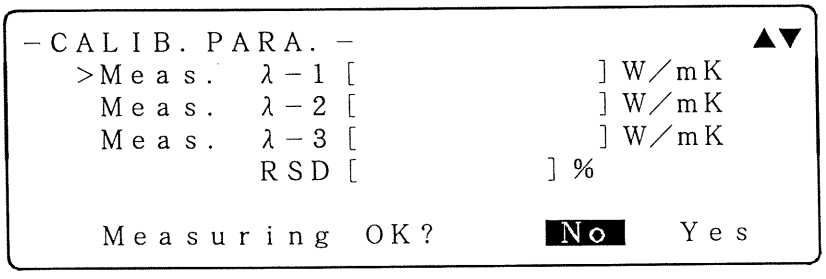
(3) Before calibration starts, make sure the probe(PD-N0) is well inserted into sample or the sensor(PD-31) and fastened by a weight.



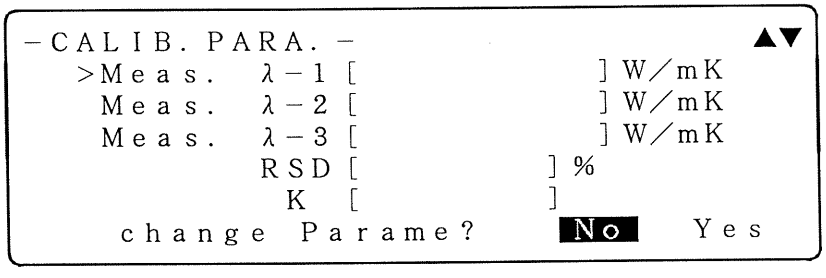
(4) The ">" mark shows current measurement. When measurement is finished, the symbol will move to the next, showing the results. Total three measurements will be performed with RSD(Relative Standard Deviation = CV value) calculated at the end.



(5) When RSD exceeds 3%(bad reproducibility), the message will ask you if you will accept the results or not. If not, return to standby mode. If RSD is more than 3%, this message will not appear.



(6) A new probe constant is shown for confirmation. If it is not accepted, return to standby mode. If accepted, the constant will be stored.



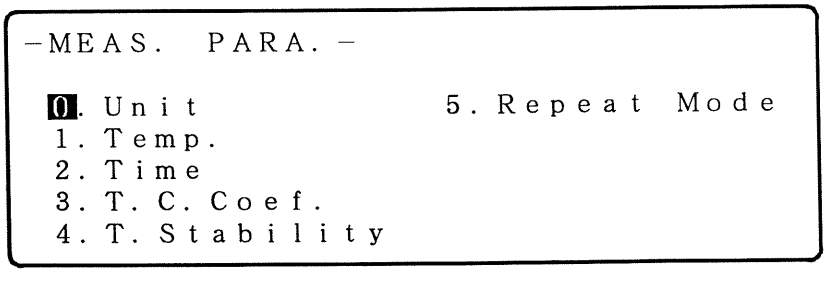
6-3. Selection of Measurement Parameter

Press [Meas. Para] key.

Measurement parameter consists of six(6) parameters:

0: Measurement unit
1: Measurement temperature
2: Measuring time
3: Temperature compensation coefficient
4: Degree of temperature stability
5: Repeat mode

Select necessary parameter on Meas. Para. menu as in below:

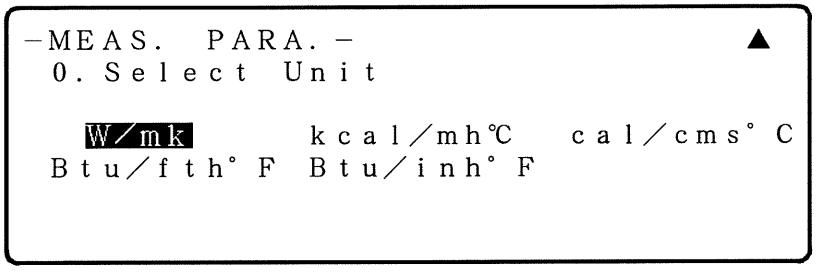


* Cursor key stays on previously selected position.

6－3－1. Unit for Measurement Results

Unit for thermal conductivity is selected here. The temperature unit selected here will be reflected in measurement temperature and increased temperature, except for W/mK which will be expressed in° C.

(1) On Meas.Para display, select "0. Unit" by numeric key or ⇧, ⇩ key and confirm by ↵ key.



(2) Select desired unit by ⇧, ⇩ key and confirm by ↵ key.
The display will go to Measurement Parameter display. The display will return to standby mode or measurement results display by [Meas.Para] key.

Conversion table of unit is shown below:

	W/mk	kcal/mh℃	cal/cms℃	Btu/fth°F	Btu/inh°F
W/mk	1	0.8598	2.388×10^{-3}	0.5778	0.04815
kcal/mh℃	1.163	1	2.778×10^{-3}	0.6720	0.05600
cal/cms℃	418.7	360.0	1	241.9	20.16
Btu/fth°F	1.731	1.488	4.134×10^{-3}	1	0.08333
Btu/inh°F	20.77	17.86	0.04960	12.00	1

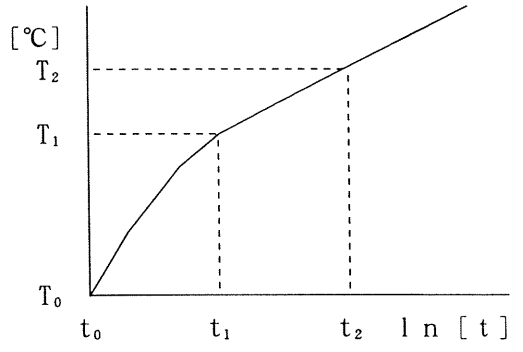
Note: When cal/cms° C is used, the display will show significant value $\times10^{3}$ cubic and when Btu/inh° F is used, the display will show significant value $\times10^{1}$, that is:

2.388 cal/cms° C means 0.002388 cal/cms° C
2.388 Btu/inh° F means 0.2388 Btu/inh° F

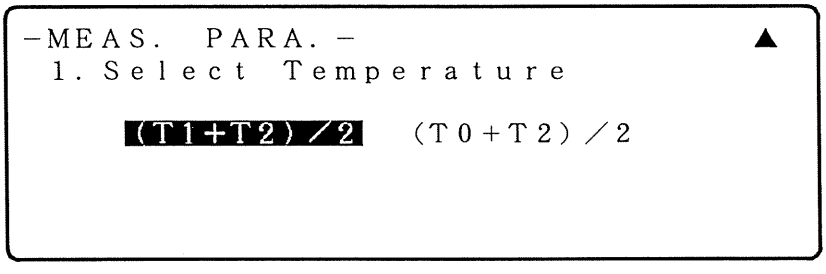
6－3－2. Measurement Temperature (Tm)

Select equation for measurement temperature at which thermal conductivity is obtained. There are two ways of expressing the temperature by formulas below:

1) Tm = (T1 + T2)/2: average temp during which TC is measured.
2) Tm = (T0 + T2)/2: average temp from start to the end of measurement



(1) On Meas. Para display, select "1. Temperature" by numeric key or ↑, ↓ key and confirm by ↵ key.



(2) Select measurement temperature by ←, → key and confirm by ↵ key.
When [UP] key is pressed, the display will go to Meas.Para menu, and the display will return to standby mode or measurement results by [Meas.Para] key.

6-3-3. Selection of Measuring Time (Time)

T1 and t2 of Equation(1) in "1-5. Principle of Measurement" for thermal conductivity are selected when PD-NO or PD-31 is connected. Select time within linear range(1 to 200 seconds) of temperature cuve 2(log-time X-axis).

(1) Make sure the display shows "MEAS. PARA. 2. Set Measure Time".

(2) Enter t1 and t2 with numeric key, and confirm by ↵ key.
The display will go to [Meas Para] menu by [UP] key, and will return to standby mode or measurement mode.

```
-MEAS.  PARA. -
 2. Set  Measure  Time


          t 1 [■2 0] Sec
          t 2 [  4 0] Sec
```

6－3－4. Temperature Compensation Coefficient (T. C. Coef)

If temperature dependency of thermal conductivity of a sample is known, TC at desired temperature can be obtained from measurement results. For example, if a sample was measured at 20° C, its thermal conducvity at 100° C can be obtained by computation. (For temperature dependency of TC of sample, refer to data book or actual measurements data)

Temperature compensation by temperature dependency of TC can be expressed in general by the following equation.

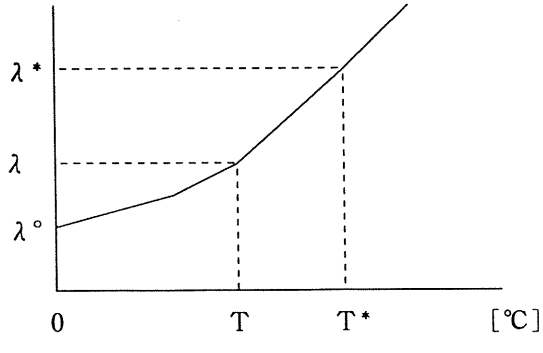
$$\lambda = \lambda^0 + AT + BT^2 + CT^3 \qquad (\lambda^0 = \text{Const.}) \qquad \text{Eq (5)}$$

Where: λ :Thermal conductivity at T° C
$\lambda°$:Thermal conductivity at 0° C
T :Temperature[° C]

Where measurement temperature is T and temperature to be corrected is T*, TCλ* in search can obtained from the following equation:

$$\lambda^* = \lambda^0 + AT^* + BT^{*2} + CT^{*3} \qquad \text{Eq (6)}$$

This can be expressed by graphic curve as in below chart.

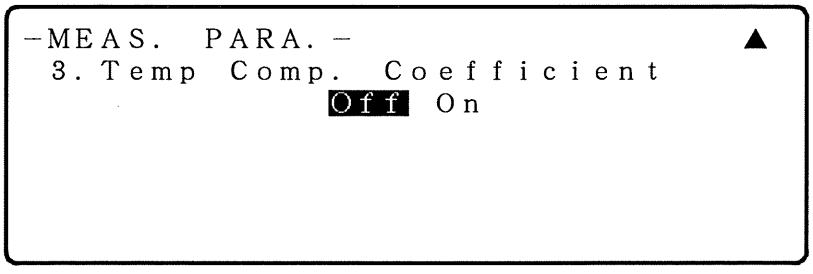


Now, from Eq(6) - Eq(5),

$$\lambda^* = \lambda + A(T^* - T) + B(T^{*2} - T^2) + C(T^{*3} - T^3)$$

temperature compensation is obtained from below equation:
Most of insulating materials are $A=10^{-4}$, B=C=0.
Hard urethane form is $A=10^{-5}$, $B=10^{-6}$, $C=10^{-8}$.

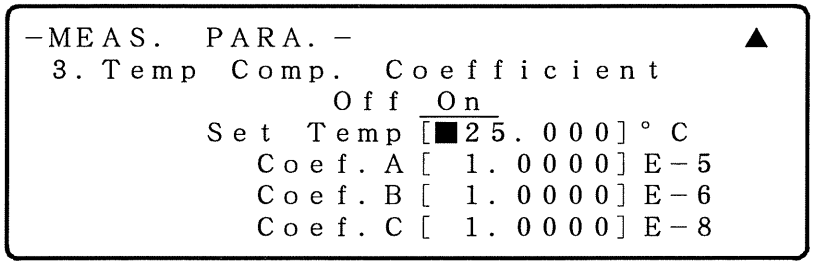
(1) Make sure the display shows -MEAS. PARA. -3. Temp Comp Coefficient. Select "3. T. C. Coef" by numeric, ↑, ↓ key and confirm by ↵ key.



* Cursor key stays at previously selected position.

(2) Select On or Off of temperature compensation by ←, → key and confirm by ↵ key. When Off is selected, the display will return to standby mode or measurement results mode by [Meas. Para] key.

The display when On is selected:



(3) Enter Set temperature and Coefficient by numeric key and confirm by ↵ key. The display will go to Meas. Para. menu, and it will return to standby mode or measurement results by [Meas. Para.] key.
Enter coefficient A as follows:

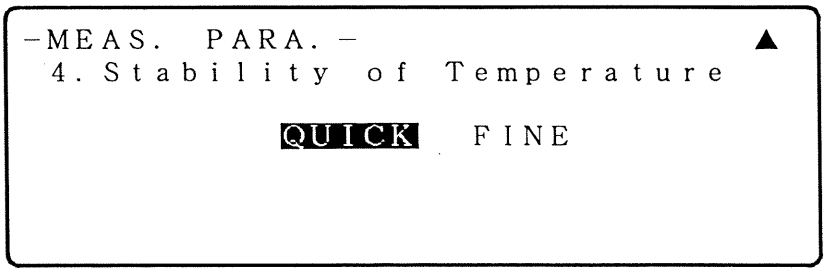
Coef. A = ○○○○○ $\times 10^{-5}$

For example, when 1.000 is entered, coef. A=0.00001 will be input.

6-3-5. Degree of Temperature Stability

Before measurement is started, stability of probe temperature can be checked. Stability can be checked by QUICK or FINE. FINE means better stability and reproducibility. In routine measurement, probe temperature can be checked by this way, and for continuous measurement, sequence will continue according to this setting. While in standby mode FINE set up, if temperature stability changes to QUICK, measurement can be started by pressing Start button before the mode reaches FINE.
Measurement precision is guaranteed in FINE mode.

(1) On Meas. Para. display, select "4. T. Stability" by numeric, ↑, ↓ key and confirm by ↵ key.



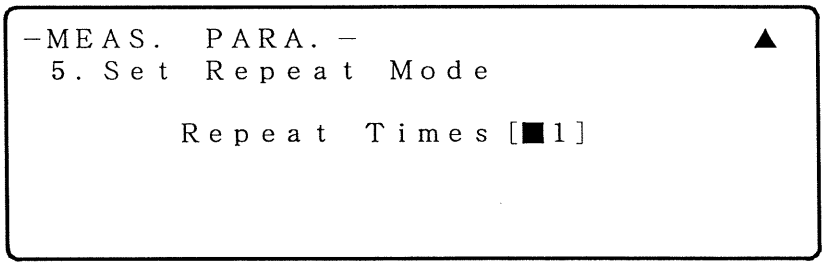
* Cursor stays at previously selected position.

(2) Select ←, or → key and confirm by ↵ key. The display will go to Meas. Para., and it will return to standby mode or measurement results mode by [Meas. Para.] key.

6-3-6. Repeat Mode

For automatic continuous measurement, desired number of measurement can be selected by this function. "1" means routine measurement, and "0" cannot be entered. TC value displayed shows previous measurement results.

(1) On Meas. Para. display, select "5. Repeat Mode" by numeric key or ↑, ↓ key, and confirm by ↵ key.



* Previously selected number appears on display.

(2) Enter repeat times by numeric key or ↑, ↓ key, and confirm by ↵ key. The display will go to Meas. Para. by [UP] key, and the display will return to standby mode or measurement results mode by [Meas. Para.] key. Maximum 100 times can be selected.

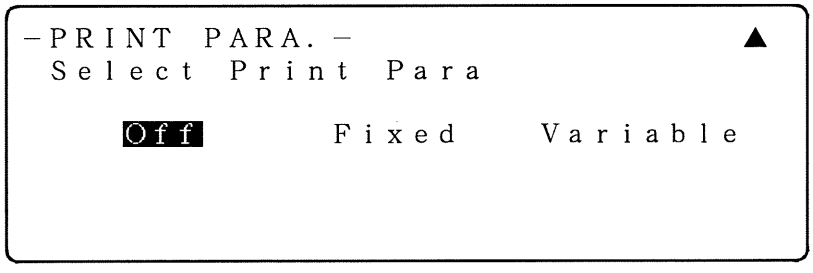
6-4. Print Parameter

Press [Print Para] key.

Printing and print format can be selected. Either fixed format or variable can be selected.

<Fixed> Sample No., date, Lot No., Measurement temperature and results are printed out.
<Variable> The following items can be selected:
Sample No., date, Lot No., Probe, Current value, Repeat times, Temp stability, Meas temperature, Meas results.

The display below is called <Print Parameter display>.



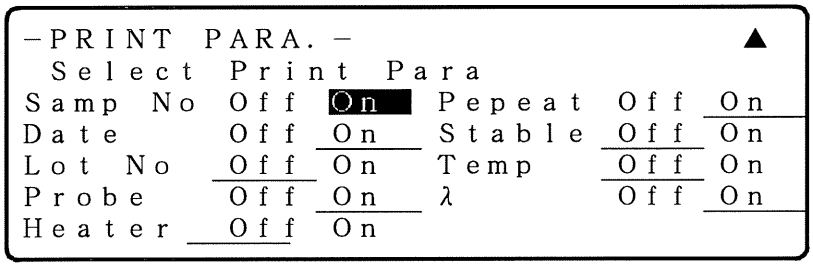
* Cursor stays at previously selected position.

(1) How to select each item on print format:

Select Off if printing is not selected.
For printing, select Fixed or Variable by ←, → key and confirm by ↵ key.

When either Off or Fixed is selected, the display will go to standby mode or measurement results mode by [Print Para] key.
When Variable is selected, the display will go to (2) below:

(2) The display when Variable is selected:



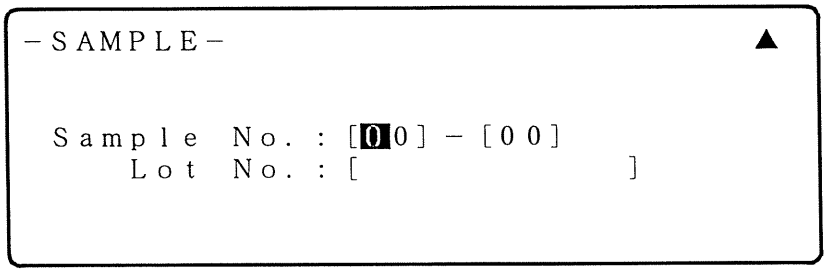
* Cursor remains at previously selected position.

(3) Select item by ↑, ↓ key, and select On or Off by ←, → key, and confirm by ↵ key.
The dislay will go to standby mode or measurement results by [Print Para] key.
Each item means: Sample number, Date, Lot number. Probe, Heater current, Repeat number of times, Temperature stability at start, Measurement temperature, Measurement results.

6-5. Selection of Sample Number

Press [Sample] key.

Sample No. and Lot No. are selected here.
Sample number is expressed by [00]-[01] with high order and low order number. The low number is incremented each time after measurement. When it goes over [99], the low number returns to [00]. High order number is not affected here. The below display is called <Sample display>.



(1) First, sample number of high order is entered by numeric key. Then, enter low sample number, and lot number. Sample number both high and low is two digits, and lot number can be entered in up to 10 digits.

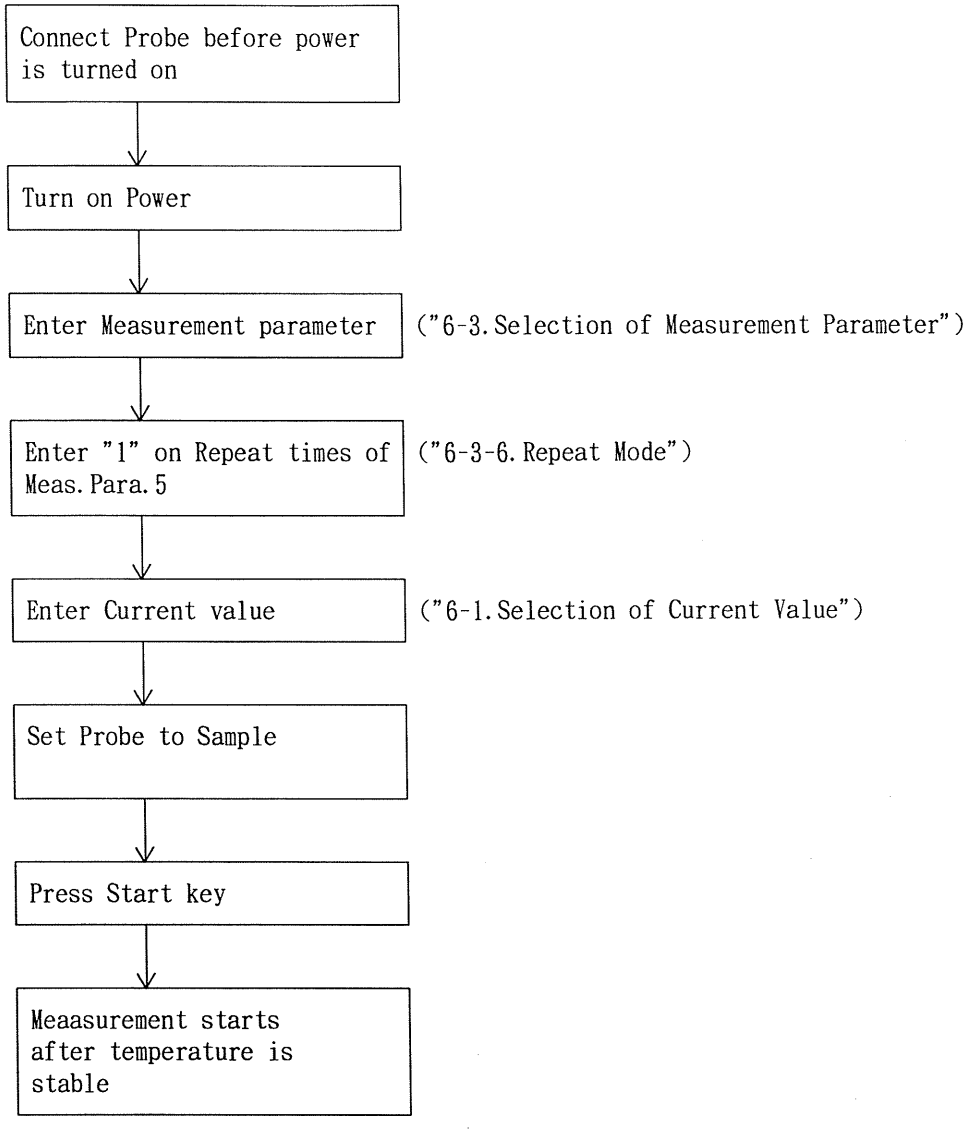
* When sample number of high order is changed, stored data of the number will be erased.
Press ↵ key if the high number is not changed.

(2) The display will return to standby mode or measurement results mode by [Sample] key.

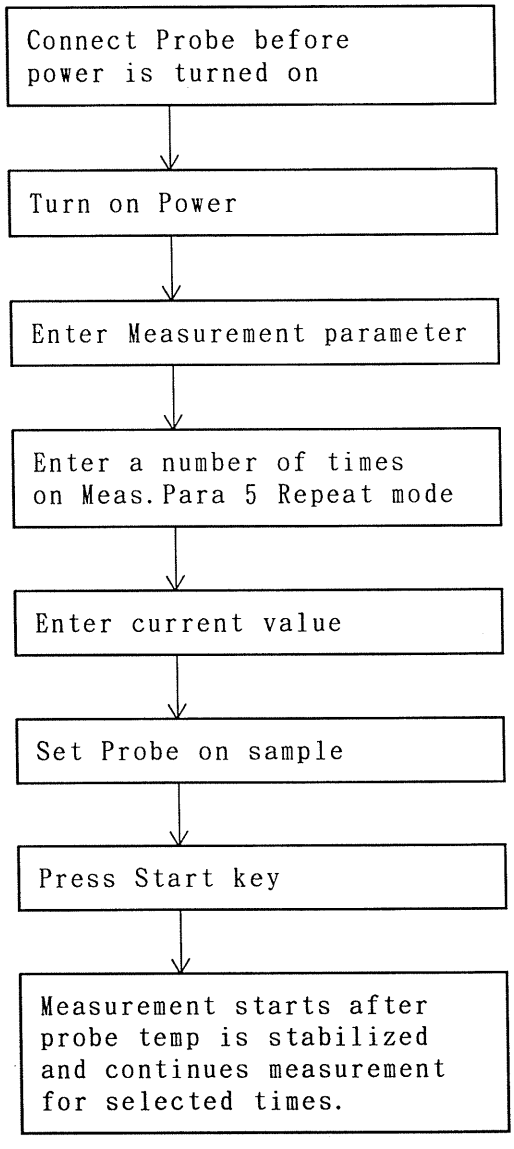
7. Example of Measurement

Before measurement is started, prepare to "4. Preparation for Measurement".

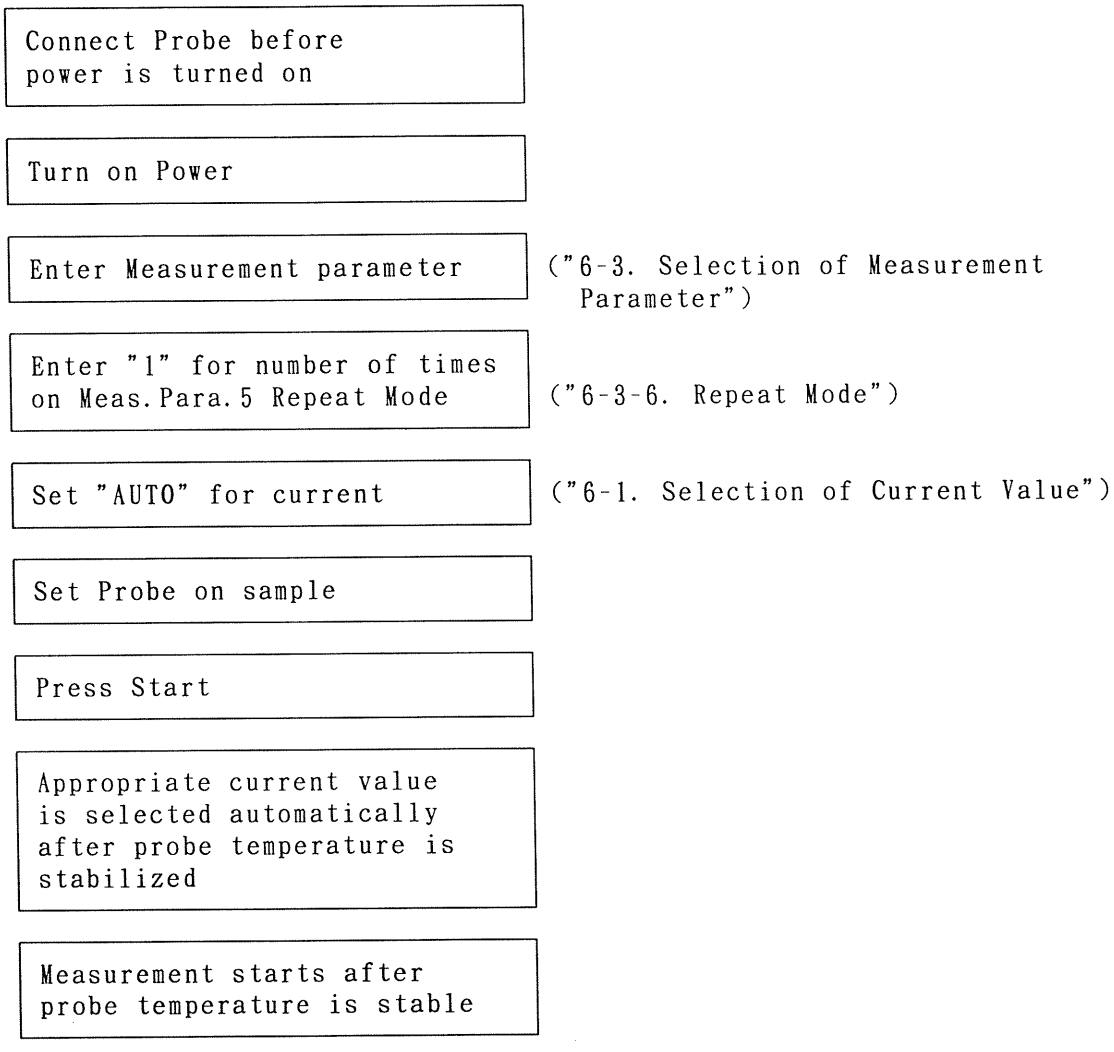
7－1. Routine Measurement



7－2. Measurement by Repeat Mode



7－3. Measurement by Auto Current Selection



* ("6-1. Selection of Heater Current Value")

7－4. Adjustment of Probe Constant (Determine Constant)

7－4－1. PD－11, PD－13

If measurement error exceeds the limit, adjust probe constant by the following procedure. If further adjustment is found to be necessary, consullt with your local dealer.

(1) According to step "6-2. Input Probe Constant", enter K1=K2=0.05, H1=H2=0.

(2) Perform measurement for 3 to 4 times of three reference plates, R1-2, R2-2, R3-2. Use the below listed current value for each plate.

Reference plate and Current value

Reference plate	Thermal conductivity (W/mK)	Current value (A2)
R1-2	about 1.4	4
R2-2	about 0.2	2
R3-2	about 0.03	0.25

(3) Determine Probe Constant by the following equations:

$$H_1' = (\lambda_{P2} \cdot \lambda_{M3} - \lambda_{P3} \cdot \lambda_{M2}) / (\lambda_{M2} - \lambda_{M3})$$

$$K_1' = K_1 (\lambda_{P2} + H_1') / \lambda_{M2}$$

$$K_2' = K_2 (\lambda_{P1} - \lambda_{P2}) / (\lambda_{M1} - \lambda_{M2})$$

$$H_2' = K_2' \cdot \lambda_{M1} / K_2 - \lambda_{P1}$$

where, K1(=K2):Probe Constant used for measurement(=0.05)
λ_{P1} 1 :Thermal Conductivity recorded for R1-2
λ_{P2} 2 :Thermal Conductivity recorded for R2-2
λ_{P3} 3 :Thermal Conductivity recorded for R3-2
λ_{M1} 4 :Measured value(average) of R1-2
λ_{M2} 5 :Measured value(average) of R2-2
λ_{M3} 6 :Measured value(average) of R3-2

7－4－2.　PD－NO　(option)

(1) According to step "6-2. Probe Constant", enter H= for probe constant.

(2) Insert the needle of Probe to R3-2.

(3) Perform measurement by current 0.063A2.

(4) Determine probe constant by the following equation:

$$H = \lambda_P - \lambda_M$$

λ_P : value of R3-2
λ_M : measured value

7－4－3.　PD－31　(option)

(1) According to "step 6-2. Probe Constant", enter K=1 for probe constant.

(2) Set Probe to R2-2(or R1-2).
Use Reference plate R2-2(silicone rubber) for TC below 1W/mK, and use Reference plate R1-2(quartz glass) for TC above 1W/mK.

(3) Perform measurement with current $1A^2$. (or $6A^2$)

(4) Determine probe constant by the following equation:

$$H = \lambda_P / \lambda_M$$

λ_P : value of R2-2(R1-2)
λ_M : measured value

8. Function Key

Press [Function.]

There are ten(10) kinds of function:

0: Printout stored data
1: Recalculation
2: Auto statistics
3: Manual statistics
4: Delete data
5: Calendar
6: Option
7: Memory All Clear
8: Beep On/Off
9: Operator's name

Below is the display of Function menu, called <Function menu>.

```
-FUNCTION-

 0. Mem. Data Out      5. Calendar
 1. Recalculation      6. Option
 2. Auto Statis.       7. Clr. Memory
 3. Manu. Statis.      8. Buzzer
 4. Data Deletion      9. Name Input
```

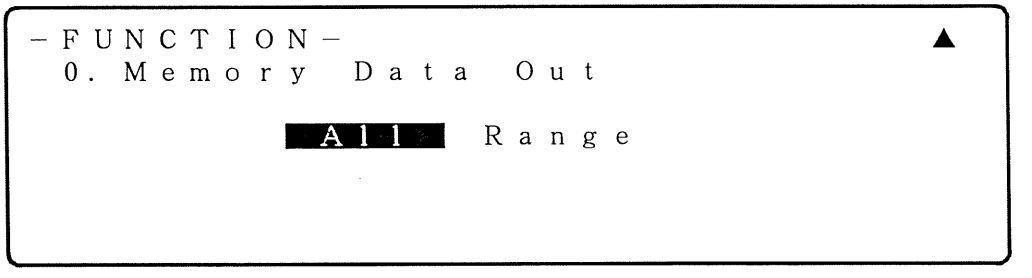
* Cursor stays at previously selected position.

8－1. Printout Stored Data (Mem. Data Out)

Stored data in QTM-500 of measurement results are printed out. There are two kinds of printing, and printed contents come from selected item on Print Para. First, connect Printer and set up parameters according to "8-7. Option".

8－1－1. Printout All Stored Data

(1) On Function display, select "0. Mem. Data Out" by numeric key or ↑ , ↓ key, and confirm by ↵ key.

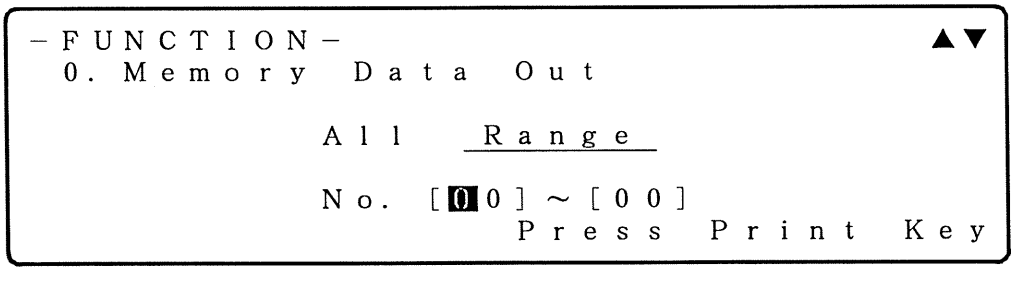


＊ Cursor remains at previously selected position.

(2) Select "All" by ← , → key and confirm by ↵ key. The display will go to Function menu by [UP] key, and it will return to stand by mode or measurement results by [Function] key. All stored data will be printed out by [Print] key.

8－1－2. Printout Selected Data

(1) Select "Range" at step 8-1-1 (2).



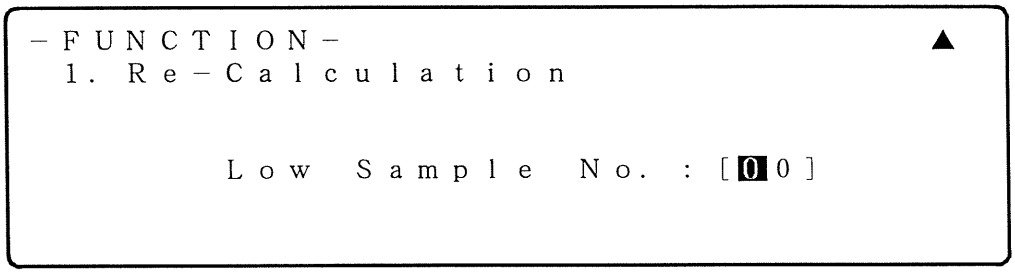
＊ Numbers are previously selected values.

(2) Enter desired range of low sample number for printout by numeric key.
The data of selected number of sample will be [printed] out.
The display will go to standby mode or measurement results mode by [function] key.

8－2. Recalculation

Data in memory can be recalculated. The parameters that can be changed are:Measurement unit, Measuring temperature, Temperature compensation and Measuring time.

(1) On Function display, select "1. Recalculation" by numeric key or ↑ , ↓ key and confirm by ↵ key.



＊ Sample No. is the number of last measurement.

(2) Enter by numeric key the low sample number for recalculation. If the sample number is not stored, it will return to (1) display. Recalculated results are shown in accordance to the parameters when measured.

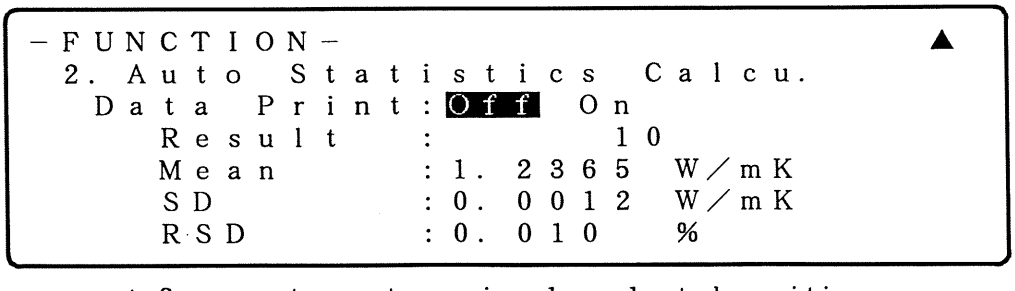
(3) Enter again desired items for recalculation(measurement unit, measuring temp 、 temperature compensation, measuring time). Entry of selection is the same as in step "6-3. Measurement Parameter". After measuremnt parameters are changed, return the display to Recalculation results by [Meas.Para] key. If [Reset] key is pressed, the display will go to standby mode or measurement results display and cannot perform recalculation. The display shows recalculated results.

(4) When [Print] key is pressed, the recalculated data will be printed out.

8－3. Auto Statistics

All stored measurement results(except those selected on Function 4) can be batch calculated in measurement unit currently selected.

(1) On Function menu, select "2. Auto Statis" by numeric key or ↑ , ↓ key, and confirm by ↵ key.



＊ Cursor stays at previously selected position.

(2) For printout data with statistical results, select On by ⇦ , ⇨ key and confirm by ↵ key.
If it is not printed, select Off.
If there is no stored data, the display will show the below message(for one second) and will return to Function menu.

```
-FUNCTION-
2. Auto Statistics Calculation

Data not exist!
```

(3) Press [Print] key to print out batch results.

A) Statistics show below items.

Results:Number of data
Mean: Average value
SD: Standard deviation
RSD: Relative standard deviation

B) Maximum number of data that can be recalculated is 100 data.

Data Print On

```
<RESULT>
No. Data        W/mK
01   3.4821
02   3.4544
03   3.5619
04   3.5109
05   3.5437

[Statistics]

Date  : 95/12/26 06:02

Sample No.(High) 01
Results:          5
Mean: 3.5106    W/mK
SD  : 0.0438    W/mK
RSD :  1.249 %
```

Data Print Off

```
[Statistics]

Date  : 95/12/26 06:02

Sample No.(High) 01
Results:          5
Mean: 3.5106    W/mK
SD  : 0.0438    W/mK
RSD :  1.249 %
```

Mean value

$$\bar{X} = \frac{X1+X2+\cdots\cdots+Xn}{n}$$

Standard Deviation

$$SD = \sqrt{\frac{\sum_{i=1}^{n}(Xi-\bar{X})^2}{n-1}}$$

Relative Standard Deviation

$$RSD = \frac{SD}{\bar{X}} \times 100(\%)$$

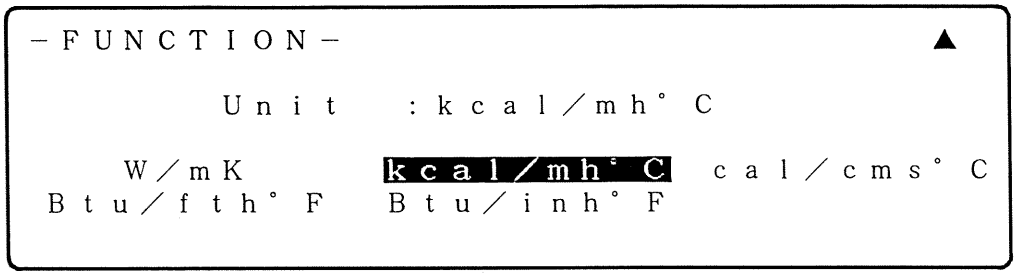
8－4. Manual Statistics

Batch calculation is made by manual input of measurement results.

(1) On Function display select "3. Manu. Statis" by ↑ , ↓ key, and confirm by ↵ key.

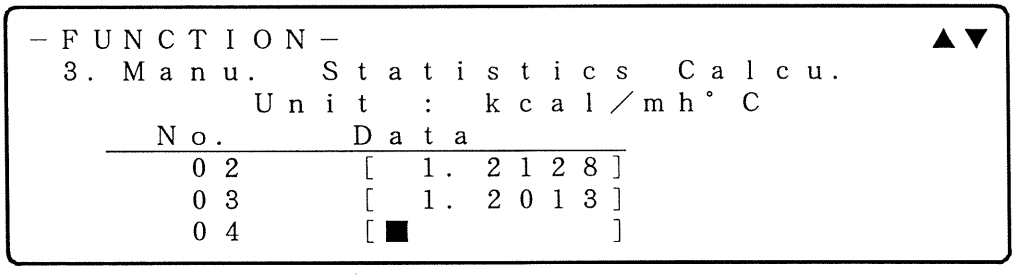
```
－FUNCTION－                                    ▲▼
  3. Manu. Statistics Calc
          Unit    : kcal/mh°C
          No.          Data
          01      [            ]
          02      [            ]
          03      [            ]
```

(2) Enter unit of data. Select the desired unit by ↑ , ↓ key, and press [-/Disp] key to confirm just like unit for measurement. The display is shown next.

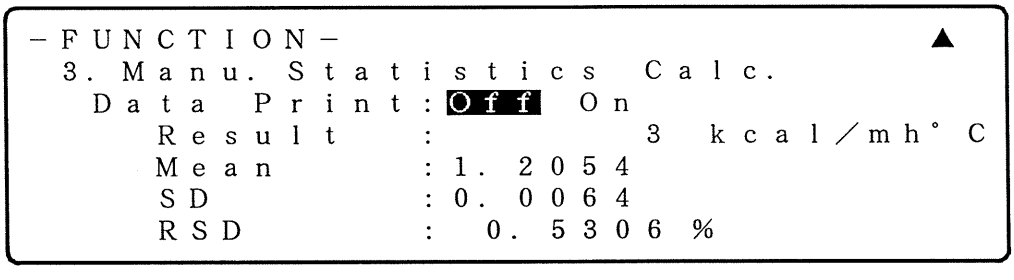


＊ Cursor remains at previously selected position.

(3)Enter data desired for batch calculation by numeric key, and confirm by ↵ key. Continue entry likewise until last one. Display after entry:



(4) After the last data is entered, press ↵ key again. The display will show the results of batch calculation.



＊ Cursor stays at previously selected position.

(5) For printout of both input data and statistics, select On by ← , → key, and confirm by ↵ key. If printing is not desired, select Off.

(6) Press Print for [printout] of statistics. If not printed, the display will return to standby mode or measurement results display.

Data Print On

```
<RESULT>
No. Data        W/mK
001   0.0355
002   0.0356
003   0.0354
004   0.0355
005   0.0356

[Manual Statistics]

Results:        5
Mean: 0.0355    W/mK
SD  : 0.0000    W/mK
RSD :  0.235 %
```

Data Print Off

```
[Manual Statistics]

Results:        5
Mean: 0.0355    W/mK
SD  : 0.0000    W/mK
RSD :  0.235 %
```

8－5. Deletion of Data

The data that are no more necessary to be stored can be deleted by the followingprocedure.

(1) Select "4.Data Deletion" by numeric or ↑, ↓ key, and confirm by ↵ key.

```
－FUNCTION－                    ▲▼
 4. Data Deletion
  Low Sample No. : [ 6]
    No.      Data
    06     1.4080
    07     1.4123
    08     1.4099
```

＊ Cursor shows previously selected sample number.

(2) Select the data you wish to delete either by ↑, ↓ key or by numeric key, selecting the low sample number.

(3) When the cursor comes to the low sample number to be deleted, press [-/Disp] key. The display will show "*" mark before the sample number that has been deleted.

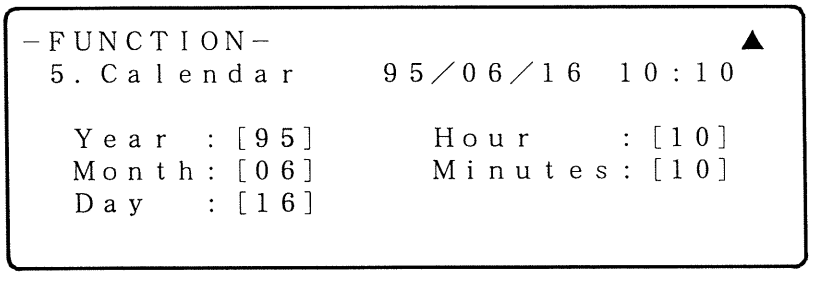
```
－FUNCTION－                    ▲▼
 4. Data Deletion
  Low Sample No. : [ 8]
    No.      Data
    06     1.4080
    07     1.4123
   *08     1.4099
```

(4) A deleted data can be recalled by pointing cursor on the deleted data, and press [-/Disp] key. The "*" mark will be erased and the data is saved.

8－6. Setting of Calendar

Year, Month, Day, Hour and Minute can be entered to fucntion calendar clock.

(1) Select "5. Calendar" by numeric key or ↑, ↓ key, and confirm by ↵ key.



(2) Select the item to be changed by cursor and enter numeric, and confirm by ↵ key.

Year	:last two digits of the year
Month	:month by number
Day	:day
Hour	:hour
Minutes	:minute

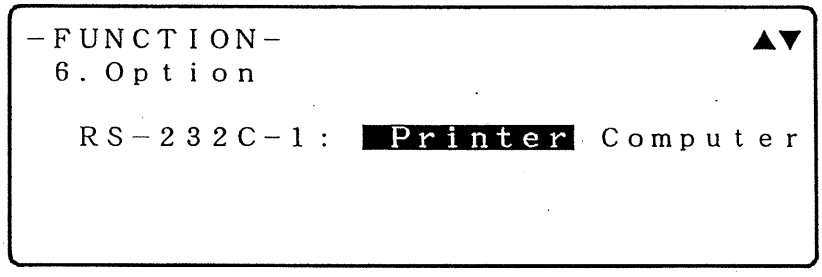
(3) The display will return to standby mode or measurement results display by [Function] key.

8-7. Connection of Optional Peripheral

Optional peripherals that can be connected to QTM-500 are Printer and RS232C.

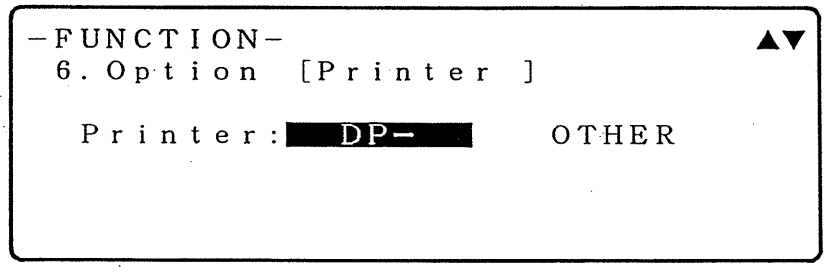
8-7-1. Connection to Printer

(1) Select "6. Option" by numeric key or ↑, ↓ key, and confirm by ↵ key.



* Cursor remains at previously selected parameter.

(2) Point cursor to RS-232C-1 by ←, → key, and confirm by ↵ key.



* Cursor remains at previously selected parameter.

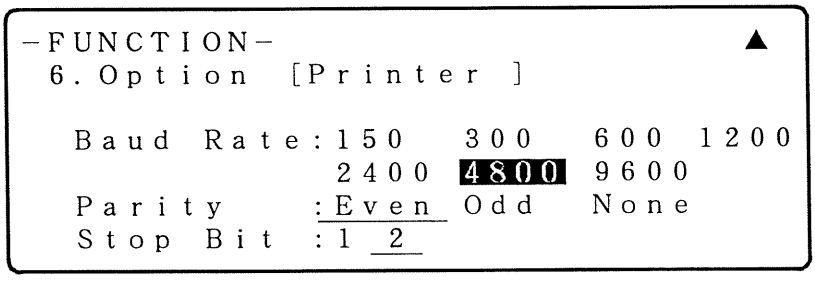
(3) Select Printer that you are going to use. If the printer is IDP-100, select "DP-". For other printer, select "OTHER" by ←, → key, and confirm by ↵ key.

(4) When "DP-" is selected at step 3, the display will show the below message:

The display will return to standby mode or measurement results display by [Function] key.

DP- :KEM IDP-100
OTHER- :other printer

(5) When "OTHER" is selected at step 3, the display will show the below message: Select item of protocol by ↑, ↓ key, and select digital amount by ←, → key, and confirm by ↵ key. The display will return to standby mode or measurement results display by [Function] key.

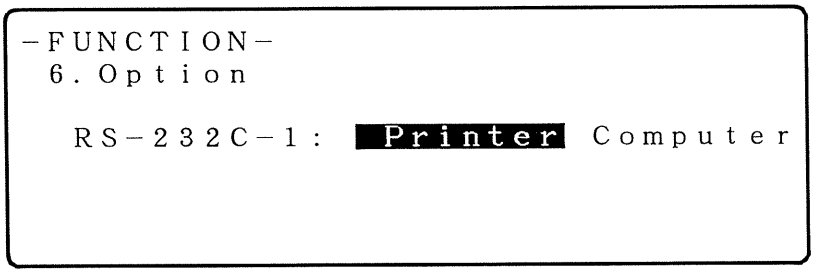


* Cursor remains at previously selected parameter.

8-7-2. Connection to Computer

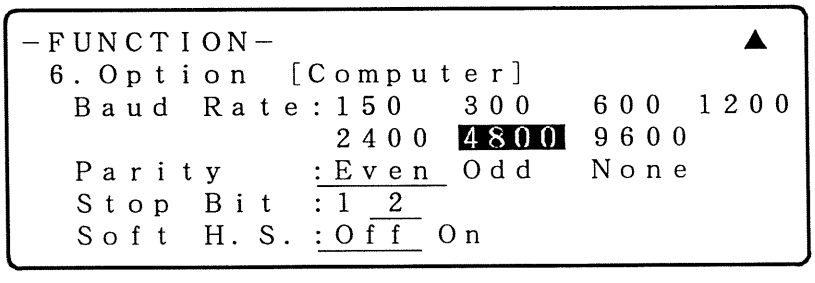
Set up protocol to Computer.

(1) Select "6. Option" by numeric key or ↑, ↓ key, and confirm by ↵ key.
The display will show the below message:



* Cursor stays at previously selected parameter.

(2) Select "Computer" of RS-232C-1 by ←, → key, and confirm by ↵ key.
The display will show the below message.



* Cursor stays at previously selected paramter.

(3) Enter digital configuration to Computer; baud rate, parity, stop bit and hand shake. Select item by ↑, ↓ key, and select amount by ←, → key, and confirm by ↵ key.
The display will return to standby mode or measurement results display by [Function] key.

8－8．　Initialization of Memory

All the data and parameters that are stored in QTM-500 can be erased.

8－8－1．　How to initialize memory

(1) Select "7.Mem.All Clr." by numeric key or ↑, ↓ key, and confirm by ↵ key.
The display will show the below message:

```
－FUNCTION－                              ▲
 7.Memory All Clear

  Press ENTER, turn OFF Power
  and turn ON again.
  All parameters can be
  initialized by those steps.
```

(2) Press ENTER again. When electronic beep is sounded, turn off the power, and then, turn on power again.
If any key is touched before the power is turned off, initialization will not be processed even if power is turned from off to on.

8－8－2．　Default value of Parameter

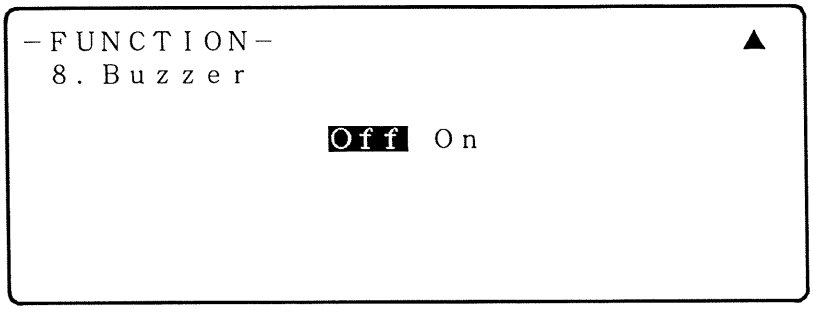
The below chart shows default value of each parameter.

Parameter		Default value
Heater		Manual 0.063A²
Meas.Para.	0. Unit	W/mK
	1.Temp.	(t0+t2)/2
	2.Time	Sensor probe PD-1 not applicable Sensor probe PD-NO t1 20 sec t2 40 sec Sensor probe PD-31 t1 10 sec t2 100 sec
	3.T.C.Coef.	Off On When On is selected, Temp.T25. Coef.A 1.0000 Coef.B 1.0000 Coef.C 1.0000
	4.T.Stability	FINE
	5.Repeat Mode	[1]

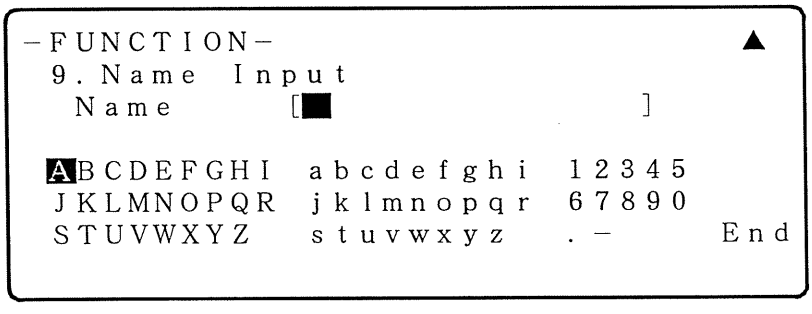
Sample	.	Sample No. [00]-[00] Lot No. [ ] .
Print Para.		off Variable when selected Samp No. On Data On Lot No. On Probe On Heater On Repeat On Stable On Temp On λ On
Function	0. Mem. Data Out	All
	1. Recalculation	[00]
	2. Auto Statis.	Data Print Off
	3. Manu. Statis.	Data Print Off
	4. Data Deletion	[00]
	5. Calendar	95/12/15 12:00
	6. Option	RS-232C1 When Printer is selected, DP-. When Computer is selected, Baud Rate : 4800 Parity : Even Stop Bit : 2 Soft H.S. : Off
	7. Clr. Memory	none
	8. Buzzer	On

8－9．　Beep　On／Off

Turning On or Off of electronic beep sound can be selected by ←, → key, and confirmed by ↵ key.



8－10．　Operator's Name



Operator's name or code can be registered:
Select desired characters by the four kinds of keys, and confirm by ↵ key:

↑key (move cursor upward).　　↓ key (move cursor downward).

←key (move cursor to left).　　→ key (move cursor to right).

After entry of name or code, move cursor to the "End", and press ↵ key.
The display wlll return to Function menu.

9. RS-232C1 port

The RS-232C1 port is provided for connecting optional printer (IDP-100) or personal computer.

To connect IDP-100 printer, refer to "10.Connecting Printer".

To connect your computer, optional operating manual [External I/O Control Interface for QTM-500] is necessary.

The computer can control various of QTM-500 including Calib. Para., Heater, Sample, Meas. Para. And Function when connected to the unit.

10. Printer

10-1. Connection to QTM-500

① Turn off power of Printer and QTM-500.

② Connect Printer to QTM-500 by Interface cable.

③ Fasten the cable by the screw.

④ Make sure the dip switch is set to the initial setting at plant before shipment.

⑤ Turn on power of QTM-500 and Printer.

⑥ Select the type of printer on display of QTM-500 that you are going to use.

("8-7-1.Connection to Printer")

10－2. Operating Printer

The below chart shows combination of keys and printout materials:

Select Printer by these key entries; [Function] [6] [↵] Printer [↵]

Print preset current value: [Heater] [Print]

Print present measurement parameters: [Meas. Para.] [Print]

Print present calibration parameters: [Calib. Para.] [Print]

Print present printing parameters: [Print Para.] [Print]

Print recalculation results: [Function] [1] [↵] [Print]

Print auto statistics results: [Function] [2] [↵] [Print]

Print manual statistics results: [Function] [3] [↵] [Print]

Print current year, month, day, hour, minute: [Function] [5] [↵] [Print]

Print parameters for RS-232C: [Function] [6] [↵] [Print]

Print selection of beep: [Function] [8] [↵] [Print]

11. Maintenance and Troubleshooting

11-1. Error Messages and Remedies

Message	Trouble	Remedies
Error[01] " Heater Over"	Temperature exceeds range.	Set lower current value.
Error[002] " Non Probe"	Sensor probe is detached during measurement.	Check the connection, and if error message appears, contact local dealer.
Error[03] " Range Over"	Measurement results overshoots.	Measurement results exceeds guaranteed precision range.
Error[04] " Temp. Over"	Probe temperature exceeds spec.	Lower temperature. Check connection of sensor/probe.
Error[05] " Sensor Error"	A/D for temperature exceeds limit.	Lower temperature. Check connection of sensor/probe.
Error[06] " Burn Out"	Heater resistivity exceeds range.	Heater resistivity is excessive. Check connection of sensor/probe.
Error[07] " Mes. Time Error"	Input error of Meas. Para. 2(time).	Input again correctly.
Error[08] " In. Temp Error"	Thermister lead is broken or short.	Turn off power and contact dealer.
Error[09] " Range Over"	Measured value exceeds 150mV/mK.	Out of measurement range.

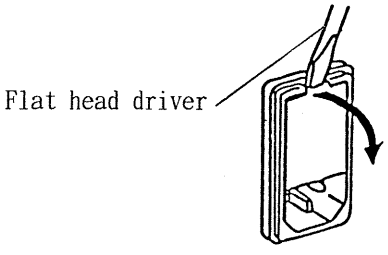
11-2. Replacement of Fuse

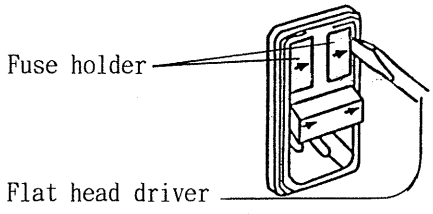
① Turn off power of QTM-500, and plug out the power cord.

Warning!

Danger of electric shock if power is connected.

② Open fuse holder cover above power cable with a flat head screw driver.
③ Remove two fuses by the driver.
④ Replace the fuse and insert the new fuse into holder, and close the cover.
⑤ Use same type and rating of fuse for safety.



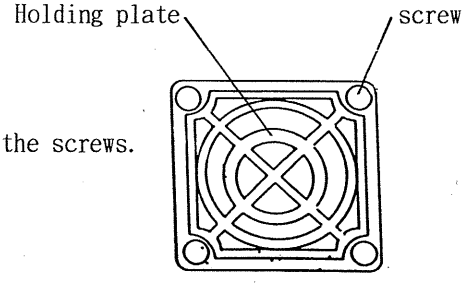


11-3. Replacement of Backup Battery

The parameters necessary for measurement are stored in the backup battery insideQTM-500. If the battery should run down, contact your local dealer.

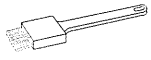
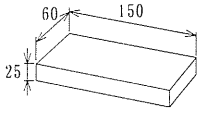
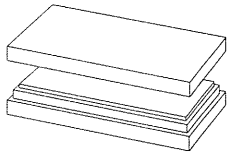
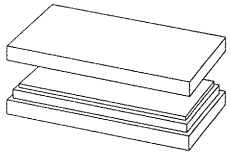
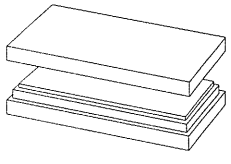
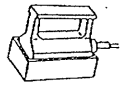
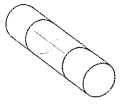
11-4. Replacement of Air Filter

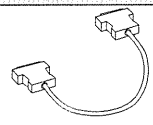
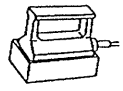
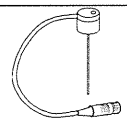
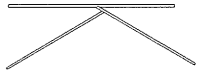
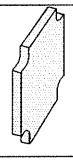
Replace the filter every six months.
Remove the fan base while holding cooling fan in the bottom.



Caution: Do not undo the screws.

12. Parts List

Part code	Part name	Qty	Remark	Sketch
98-655-7522	Brush	1		
98-650-7521	Alumi cooling plate	1		
#R1-2	Reference plate	1	(Quartz glass)	
#R2-2	Reference plate	1	(Silicone rubber)	
#R3-2	Reference plate	1	(Polyethelene foam)	
PD-11	Probe	1	Standard	
98-338-9502S	Power fuse	1set	(T4A/250V) 5pcs/set	
98-320-3198	Power cord	1	With AC/3P adapter	
98-595-0009	Operation manual	1		

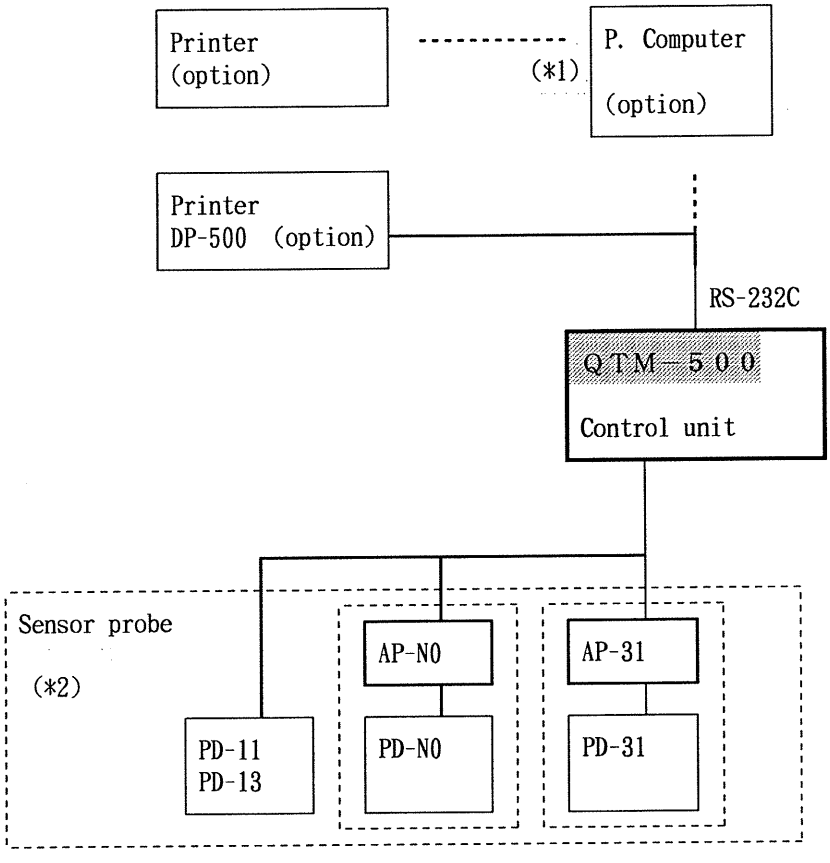
Part code	Part name	Qty	Remark	Sketch
98-032-5305	RS-232C cable	1	NEC PC-9801series	
PD-13	Insulated probe	1	Insulated probe	
98-439-0003	Needle probe PD-N0	1	Common with TCM-101	
98-529-0002S	Hot wire sensor PD-31	1set	PD-31 10pcs/set	
98-529-0001S	Ceramic tubes	1set	for PD-31 100pcs/set	
QTM-PA1	Vessel for powder	1	for PD-11	
98-595-0010	RS-232C Operation manual	1	RS-232C for external I/O	
98-501-6864S	Air filter	1	5 sheets	

Options

Part code	Part name	Qty	Remark	Sketch
IDP-100-01	IDP-100 Printer	1	Impact Dot Printer AC120V (with connecting cable)	
IDP-100-02	IDP-100 Printer	1	Impact Dot Printer AC230V (with connecting cable)	

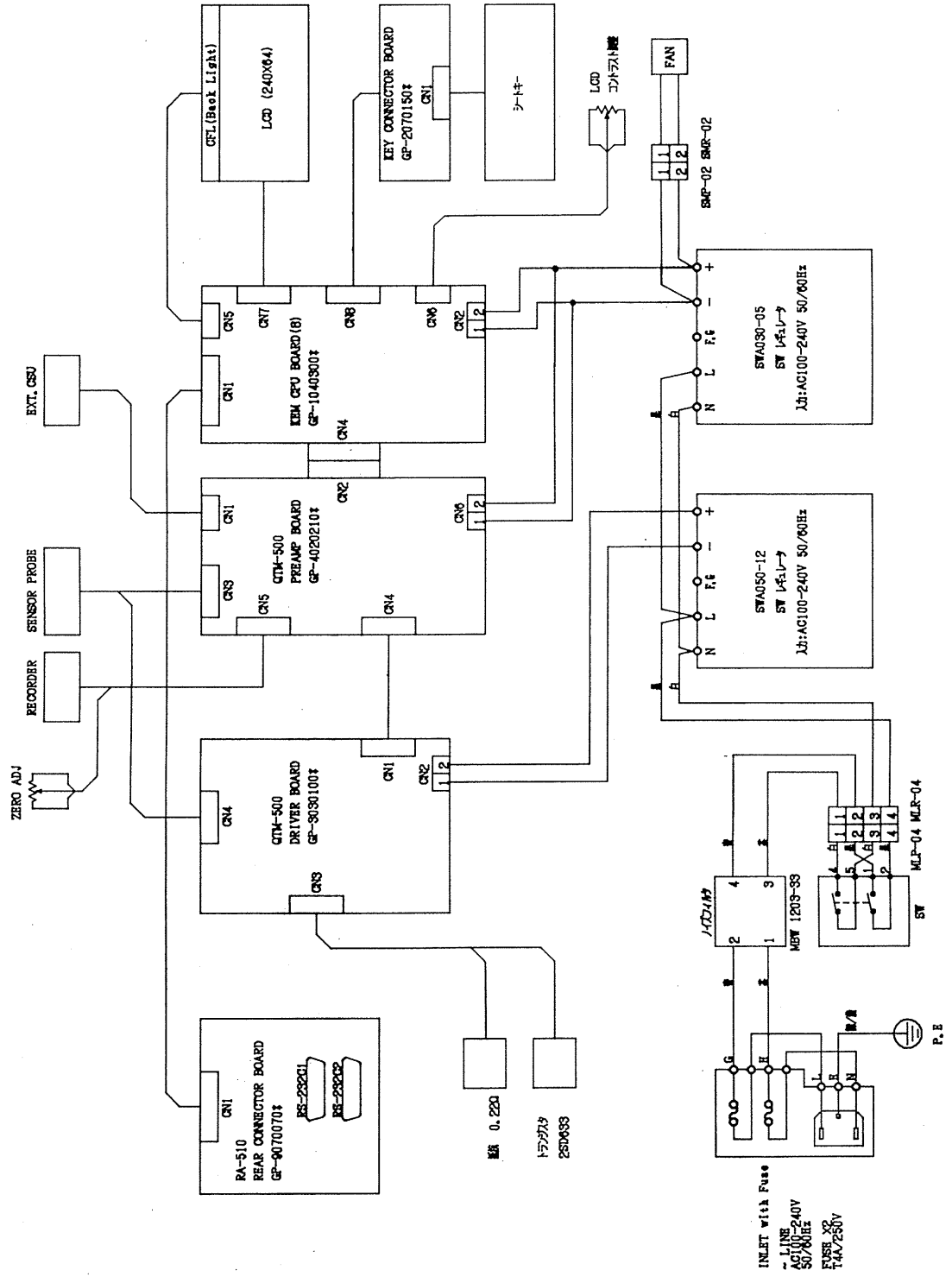
13. System Flow Chart

The QTM-500 can build up the integrated system as illustrated below:



*1) P. Computer shown here is NEC PC-98 series.
*2) Adapter is not necessary for Prove PD-11, but AP-N0, AP-31 is necessary for PD-N0, PD-31 respectively.

14. Connection Diagram



15. Specification and Supplied Parts

15－1. Specification

(1)	Designation	Model QTM-500 Quick Thermal Conductivity Meter
(2)	Measurement method	Hot Wire Method
(3)	Guaranteed precision	Referred to in Chart 2 Specification of Probe
(4)	Measurement precision	Referred to in Chart 2 Specification of Probe
(5)	Reading resolution	Thermal conductivity 0.0000 to 150.0000[W/m•K]
(6)	Reproducibility	Referred to in Chart 2 Specification of Probe
(7)	Ambient condition	5 to 35° C, below 85%RH
(8)	Measuring objects	Referred to in Chart 2 Specification of Probe
(9)	Minimum sample required	Referred to in Chart 2 Specification of Probe
(10)	External I/O	RS-232C 1ch, Recorder output 1ch
(11)	Recorder output	-3.55mV to 41.3mV (CA-thermocouple -100～1000° C)
(12)	Precision of	Within +/- 0.1% Heater current
(13)	Warming-up time	Approximately 30 minutes
(14)	Display	64x240 dot, LCD display
	(1) Measurement results, temperature and condition	
	(2) Temperature curve - 2 kinds	
	(3) Error message	
(15)	Degree of stability	By temperature stability and measurement precision
(16)	Repeat mode	Maximum 100 times
(17)	Selection of current	9 steps by key entry
(18)	Statistics function	Auto or Manual batch calculation
(19)	Recalculation	Measurement unit, temperature and time
(20)	Temperature compensation	Based on temperature dependency of TC
(21)	Memory of data	Maximum 100 measurement results stored
(22)	Power source	AC100 to 240V 50/60Hz
(23)	Power consumption	70W
(24)	Dimension	300W x 475D x 175Hmm
(25)	Weight	8.5kg

15－2. Supplied Parts

Chart 1. Supplied Parts

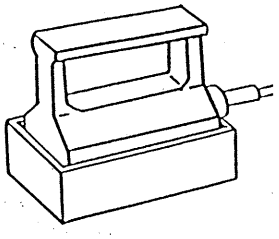
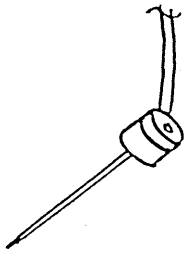
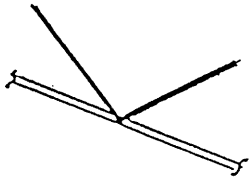
PD-11(Standard)	
Probe PD-11	1 set
Reference plate (R1-2, R2-2, R3-2)	total 3 pcs.
Auminum cooling plate	1 pce
Power cord	1 pce
Fuse	2 pcs
Brush	1 pce
Probe Constant table	1 copy
Operating Manual	1 copy
Air intake filter	1 shee

PD-NO(option)	
Sensor PD-NO	1 pce
Probe adapter AP-NO	1 pce
Reference plate R3-2	1 pce

PD-31(option)	
Wire Sensor PD-31	30 pce
Probe adapter AP-31	1 pce
Reference plate R1-2	1 pce
R2-2	1 pce
Ceramic insulation tube	100 pcs
Sample bed	1 set
Weight	1 pce

15－3. Specification of Probe

Chart 2. Specification of Probe (Precision and reproducibility of No.3 and 4 by Fine mode)

Feature	PD-11, PD-13	PD-NO	PD-31
Dimension (sketch) (mm)	110Wx50Dx100H 	ϕ0.8×needle 60L 	
Measuring method	Reference method	Reference method	Reference method
Measuring range(W/mK)	0.023 to 11.63	0.012 to 0.1	0.06 to 5.0
Reproducibility ±%	+/-3%	+/-3%	+/-5%
Precision	within +/-5% of thermal conductivity of reference plate		
Measuring temperature ℃	-10- to 200	-100 to 180	-100 to 1000
Measuring time sec	60sec	40sec	100sec
Temperature sensor Heater	K (CA) thermocouple constantan	K (CA) thermocouple nichrome	
Measuring objects	Insulating material Resin Ceramics, Bricks Rubber, Concrete etc.	Insulating material Food Viscous liquid Powder, etc	Insulating material Ceramics, Brick, Heat insulating materials, etc.
Minimum sample size mm^3	more than 100×50×20	more than 20×20×80	2 pcs of more than 100×50×20
Equation for thermal conductivity	$\lambda = K \times I^2 \times \frac{\ln(t2/t1)}{(T2-T1)} - H$	$\lambda = \frac{R \cdot I^2}{4\pi} \times \frac{\ln(t2/t1)}{(T2-T1)} + H$	$\lambda = \frac{K \cdot R \cdot I^2}{4\pi} \times \frac{\ln(t2/t1)}{(T2-T1)}$

16. About Data Capture Software

If you cannot establish data communication between a PC and the QTM-500, i.e. if clicking [Command transmission | start measurement] will not initiate the measurement, please carry out the manipulation according to the following steps.

Checks:

1) Check and see whether the hardware protector attached to the Data Capture Software is connected with the printer port.
2) Check and see whether the communication cable is securely connected.
3) Check and see which communication port, COM1 or COM2, is used on a PC.
   Note: The port assigned for communication should not be used for other device.
4) For other check items, please see the paragraphs, "Notes" and "Troubleshooting", in the Operation manual for the Data Capture Software.

Manipulation:

1. Start the "Data Capture Software":
   Click [Start] button and point [Program]. Then, click [Data Capture Launcher] under the group [KYOTO ELECTRONICS] – [Data Capture].

   Select the communication port (either COM1 or COM2) that is connected with the QTM-500 under the [Data Capture Launcher].

2. Select [QTM-500] in the model settings:
   1) Click the [Settings | Model] command or [Model] button on the toolbar.
   2) Select "QTM-500" in the listing and click the [OK] button.

3. Set the Communication conditions:
   1) Click the [Settings | Communication conditions] command or [Communication conditions] button on the toolbar.
   2) Set the Communication conditions and click the [OK] button.
      · Transmission speed : 4800
      · Parity : Even
      · Stop bit : 2
      · Data length : 7

Memo

Make settings for communication conditions on the QTM-500.
About the settings for communication conditions on the QTM-500, please follow the directions of the paragraph, "8-7-2. Connection to Computer" in the Operation manual for QTM-500.

4. Make settings on the manipulation method for receive data:
   1) Click the [Settings | Manipulation method] command or [Manipulation method] button on the toolbar.
   2) Select the manipulation method and click the [OK] button.
      · Description of receive data : Measurement results
      · Transmit receive data to Microsoft Excel : Select
      · Save receive data in the CSV format : Not select
      · Only display receive data : Not select

Note:

Failure to place the checkmark in the "Transmit receive data to Microsoft Excel" will result in the unsuccessful data transmission to the Microsoft Excel spread sheet.

If the Microsoft Excel is not installed in the PC, the data transmission cannot be accomplished.

5. Start measurements and receive data from the QTM-500:
   1) Click the [Transmit command | Start measurement] command.
      The QTM-500 will start measurements.
   2) When measurements are completed, the results will be displayed on the monitor display of the PC.
   3) The Data Capture Software will automatically start the Excel and transmit the data to it.

17. Warranty and after-sale service

1. The product you have purchased passed factory inspection and testing prior to shipment, and its quality is guaranteed by free of charge replacement during warranty period except consumable parts provided the instrument has been under normal use and operation, however, depending on operational and environmental condition under which the instrument has been in use may require chargeable service work.

2. For service during and after warranty period, please contact your local dealer or distributor.

3. Read the manual thoroughly before you decide to call for service.
   When you should need servicing, please provide with the following information:
   Production number of unit
   Description of the trouble
   Person to contact

4. Parts and spares can be purchased separately and will be available for seven (7) years after termination of production of the model.

5. This warranty does not cover claims due to any of the following conditions:
   1) Any modification or specification change by an unauthorized person
   2) Damage by splashed water (the instrument is not water-proof)
   3) Use in range or condition other than specified
   4) Operated in other way than specified in the manual or negligence of maintenance
   5) Physical force given to the instrument during transportation or move
   6) Use of parts or reagent other than specified
   7) Caused by use under extreme ambient or environmental condition
   8) By fire, riots, earthquake, lightning, or Act of God in any form or manner

6. Escape clause
   Under no circumstances will Manufacturer be liable for any damage, whether incidental, consequential or other, or for any other remedy arising from any loss, damage, expenses or inquiry in connection with use of the article.