TK04

Thermal Conductivity Meter

TK04 is designed for fast and high precision thermal conductivity testing where steady state methods are too time-consuming and conventional transient methods do not meet the accuracy requirements.

It is based on the widely-used transient line source method. The improved evaluation method combined with software tools for checking sample preparation and measuring conditions achieves an excellent accuracy of ± 2%. TK04 yields absolute values without requiring any reference or calibration tests. The application range covers solids, fragments, powder and viscous liquids.

Features

- Transient line source method (needle probe method), ASTM D5334-08 / 14 compliant
- Modified line source method for plane surfaces
- High precision evaluation algorithm with accuracy of ± 2%
- No reference or calibration tests required
- Interchangeable probes for lab and field use available
- For solids, fragments, powder and viscous liquids in the range of 0.1 to 10 $Wm^{-1}K^{-1}$
- Unattended operation (fully software-controlled)
- Automatic monitoring and correction of the sample's temperature drift
- Software tools for checking sample preparation and measuring conditions
- Result presentation and analysis software
- Multi-user license for complete software package included
- Software updates free of charge

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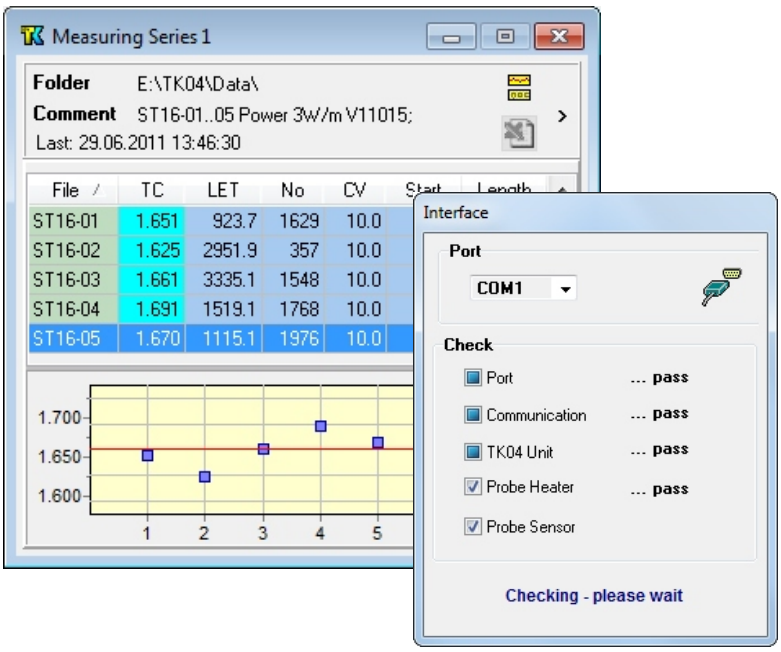
Software-controlled operation
TK04 is controlled by software running under Microsoft Windows on any PC or notebook.

After configuring and starting a measuring series, the instrument performs up to 99 successive measurements using the selected settings without requiring any user interaction.

Measuring progress can be monitored in detail on the screen. After finishing each single measurement, data are evaluated immediately and results are displayed.



Measuring data and evaluation results are saved to plain text files and an MS Access database for further processing with the TK04 evaluation and graphics software or third-party applications. The TK04 software package includes powerful graphical tools for evaluation, documentation and result analysis.

Service and Support
The warranty period is 2 years for the instrument and 6 months for the probes. During this time hardware defects are repaired free of charge. Prices include an unlimited support period for setup, installation and software problems. Software updates are free of charge.

Technical specifications

Model:	High Precision Thermal Conductivity Meter TK04
Measuring principle:	transient line source (needle probe method)
Standard:	ASTM D5334-08/D5334-14
Measuring range:	0.1 - 10 W $m^{-1}K^{-1}$ (probe dependent)
Accuracy:	± 2% (probe dependent)
Reproducibility:	± 1.5%
Heater current precision:	± 0.01%
Duration of 1 measurement:	60 / 80 / 240 s (probe dependent)
Automatic repetitions:	up to 99 (unattended)
Sample size:	no upper limit, minimum size probe dependent *
Sample shape:	any
Operating temperature:	0 to 45°C
Sample temperature:	-25 to 50°C / 70°C / 125°C (probe dependent)
Power supply:	220/240 V AC (50 Hz); 100/120 V AC (60 Hz)
Power consumption:	~ 40W
Size:	471 x 160 x 391 mm (W x H x D)
Weight:	11.2 kg (measuring unit)
Interface:	serial port (COM port) or USB port (USB-to-serial converter included)

* Minimum sample sizes depend on probe type and dimensions.
Please see the Probes and Samples pages for details.

Measuring Kits

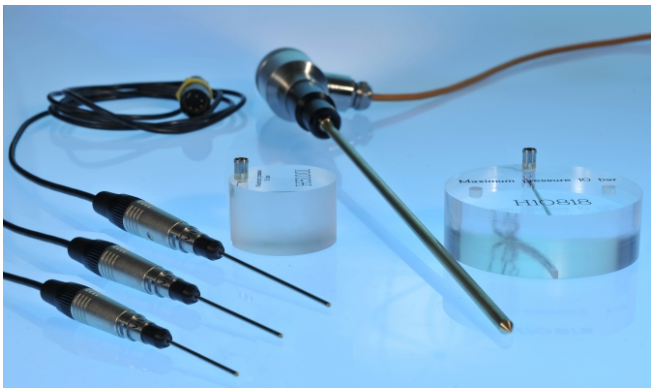
- TK04 Thermal Conductivity Meter
- Standard VLQ needle probe and / or Standard HLQ probe for plane surfaces
- Reference material
- Software package (measuring, evaluation, presentation and analysis)
- Cable set
- Contact fluid
- Manual

Options

- Standard size lab probes (Standard VLQ and Standard HLQ)
- Mini VLQ and Mini HLQ lab probes for small samples
- Field VLQ (large needle probe)
- Reference materials
- Sample container for fragments and powder
- Lever press for use with surface probes

TK04
Probes and Samples

TK04 probe types
Different probe types can be connected to a TK04 instrument. All probes consist of a heating device and a temperature sensor embedded in a metal tube, called source, whose dimensions depend on the intended use. In probes for plane surfaces the source is embedded in the underside of a poorly conducting probe body. All probes have a rugged design, are protected against moisture and come pre-calibrated and maintenance-free.

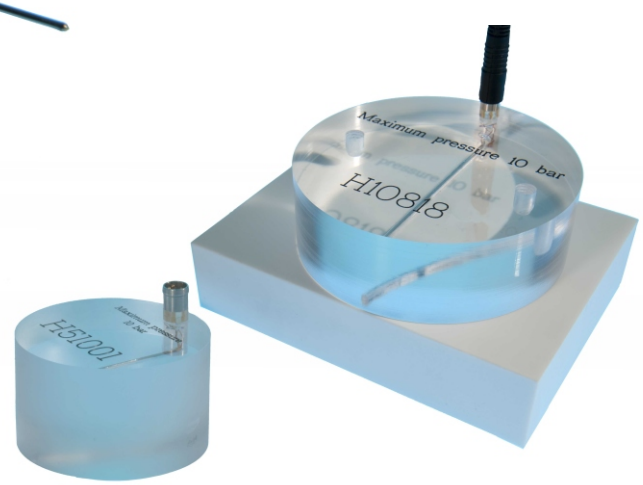


Standard/Mini VLQ needle probes
VLQ probes (needle probes) are inserted into the sample, hence the source is completely surrounded by the sample material. Preparation requires a drill hole matching diameter and length of the source. The use of contact fluid is recommended (included in the TK04 measuring kits).

Standard VLQ needle probe (Ø 2 mm, L 70 mm without handle)

HLQ probes for plane surfaces
A HLQ probe is placed on top of the sample in one-sided contact with the material and requires a plane and smooth surface. Moderate contact pressure should be applied (a lever press with pressure limiter is availabe as an option).

Right: Standard HLQ probe (Ø 88 mm, H 30 mm)
Left: Mini HLQ probe (Ø 50 mm, H 30 mm) for small samples



Choice of a suitable probe for each sample material
TK04 is designed for testing solids (like soil samples, rocks, plastics, glass, ceramics, building materials, wood, or foodstuffs), powder, fragments, viscous liquids and for in-situ tests in the measuring range of 0.1 to 10 W $m^{-1}K^{-1}$. Except for very few restrictions, all probe types can be used for all materials, hence the probe can be chosen depending on available sample sizes and preparation requirements.

Fragments and powder
The matrix thermal conductivity of fragments and powder (the thermal conductivity which a solid made from the sample material would have) is determined with so-called 2-phase tests.
The sample material is mixed with a fluid of known thermal conductivity (usually water) and the thermal conductivity of the mixture is measured. Then the thermal conductivity of the sample material is calculated from the test result, the known thermal conductivity of the fluid and the volume shares of solid material and fluid in the mixture. For 2-phase tests a sample container for the Standard HLQ probe is available.

Lever press
Use of the lever press is recommended for all HLQ tests to ensure good contact between probe and sample.

Calibration and reference standards
TK04 uses an absolute method of thermal conductivity determination. No calibration or reference tests are required. The TK04 measuring kits include one reference sample for occasional checking the instrument and probes. Additional reference materials are available as an option.

Probe specifications

Name:	**Standard VLQ**
Probe type:	needle probe / lab
Dimensions:	L 70 mm/60 mm, Ø 2 mm
Measuring range:	0.1 to 10 W $m^{-1}K^{-1}$
Accuracy:	± 2%
Duration of 1 measurement:	80 s
Min sample size:	(approx.) L 85/75 mm, Ø 40 mm

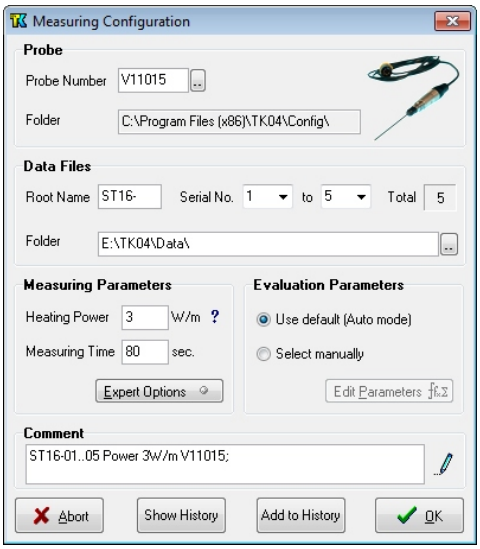
Name:	**Mini VLQ**
Probe type:	needle probe / lab
Dimensions:	L 50 mm, Ø 2 mm
Measuring range:	0.3 to 6 W $m^{-1}K^{-1}$
Accuracy:	± 5%
Duration of 1 measurement:	80 s
Min sample size:	(approx.) L 60 mm, Ø 40 mm

Name:	**Field VLQ**
Probe type:	needle probe / field
Dimensions:	L 300 mm, Ø 6 mm
Measuring range (tested):	0.6 to 4 W $m^{-1}K^{-1}$
Accuracy:	± 5%
Duration of 1 measurement:	240 s

Name:	**Standard HLQ**
Probe type:	probe for plane surfaces / lab
Dimensions:	Ø 88 mm, H 30 mm
Measuring range:	0.3 to 10 W $m^{-1}K^{-1}$
Accuracy:	± 2%
Duration of 1 measurement:	80 s
Min sample size:	(approx.) Ø 90 mm, H 20 mm

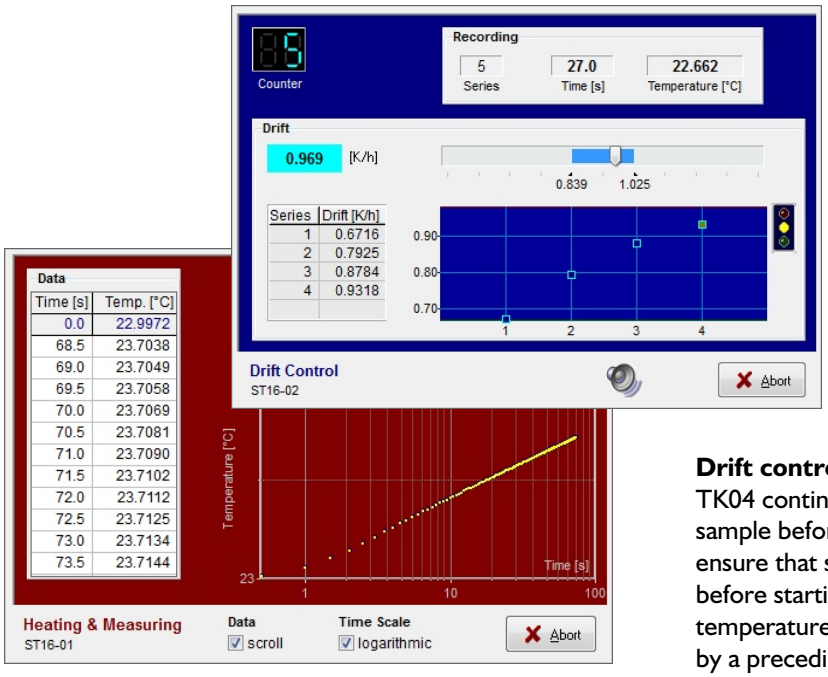
Name:	**Mini HLQ**
Probe type:	probe for plane surfaces / lab
Dimensions:	Ø 50 mm, H 30 mm
Measuring range:	0.3 to 3 W $m^{-1}K^{-1}$
Accuracy:	± 5%
Duration of 1 measurement:	60 s
Min sample size:	(approx.) Ø 50 mm, H 20 mm

TK04
Measuring and Evaluation Software



TK04 software package
TK04 is controlled by software running under MS Windows. The measuring kits include a multi-user licence for an unlimited number of computers. The modules for measuring / evaluation and for presentation / analysis can be installed and used independently.

Configuring measurements
The measuring software comes with a complete set of predefined default values for all measuring and evaluation parameters, chosen to cover a wide range of different sample materials and measuring conditions. Advanced users can customize settings to meet their individual needs.

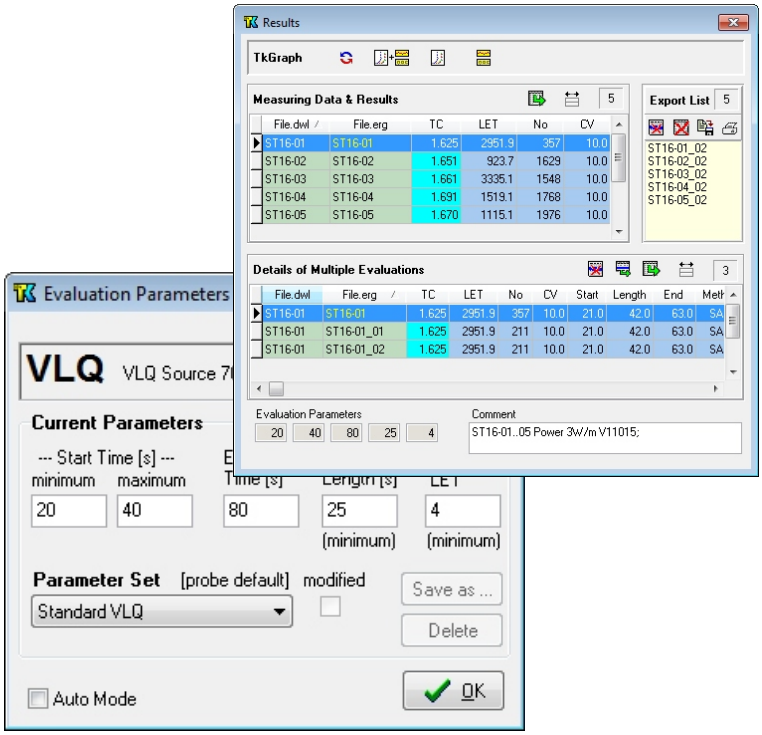


Complete automation
After configuring and starting a measuring series, the instrument operates fully software-controlled using the selected settings without requiring any user interaction. During measurements, the registered temperature rise is plotted in real time to the measuring window.

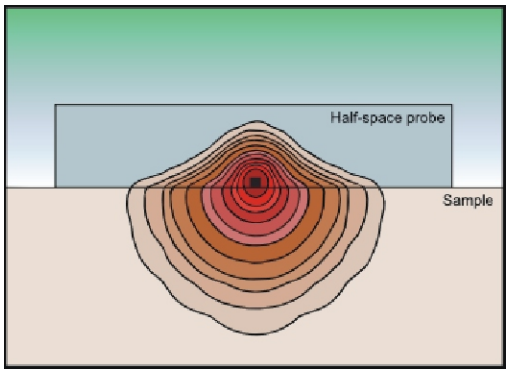
Drift control and drift correction
TK04 continuously monitors the thermal state of the sample before and between single measurements to ensure that sample temperature is sufficiently constant before starting a test. The software is able to correct a temperature drift as well as cooling processes caused by a preceding measurement. During drift phases, sample temperature, current temperature drift and drift history are displayed on the screen.

Data storage and processing
Measuring data and evaluation results are saved to standard file formats (plain text and MS Access files) for use with the TK04 evaluation and graphics software and for further processing with third-party programs. The measuring software can automatically start an external applications and pass it user-defined data and parameters after a measuring series is completed.

Automatic and manual evaluation
After finishing a single measurement, data are evaluated immediately and displayed on the screen. After completing the measuring series, additional evaluations can be generated, viewed, exported or printed. For beginners, the software provides default parameters valid for a wide range of sample materials and measuring conditions, while advanced users can choose individual parameters matching their particular measuring tasks.



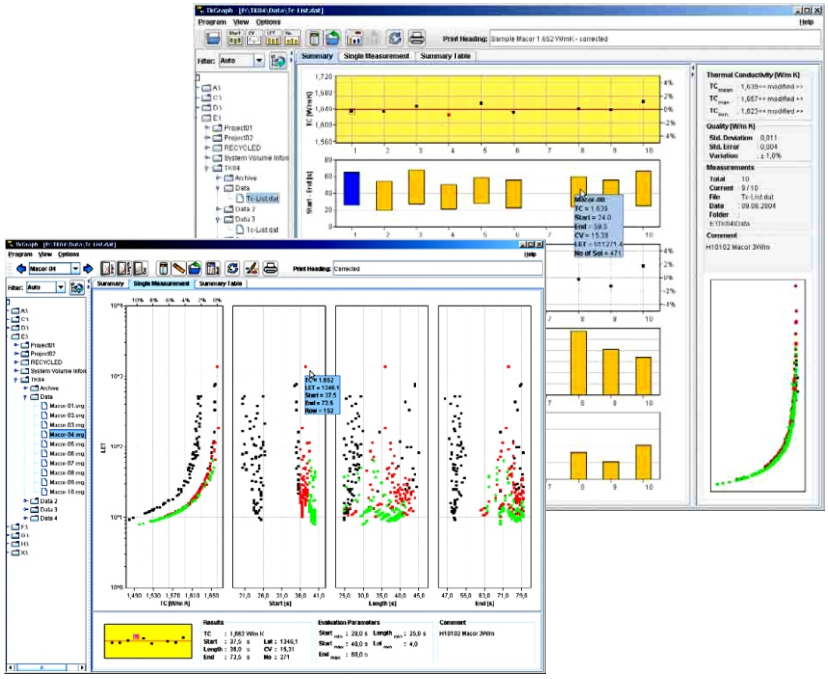
Accurate evaluation method
Needle probe methods calculate the thermal conductivity of the sample from the temperature rise with time registered by the probe by fitting a more or less complex approximation formula for the temperature curve to the measuring data. For TK04 a more accurate approximation than the widely used linear fit method is combined with techniques for detecting sample preparation problems and unstable measuring conditions, resulting in an accuracy of ± 2%.



Modified needle probe method
As hard or brittle sample are often difficult to prepare for inserting a conventional needle probe, the modified method uses a needle embedded in the underside of a disk-shaped probe body placed on top of the sample surface (probe for plane surfaces). TK04 can use both methods by simply changing the connected probe.

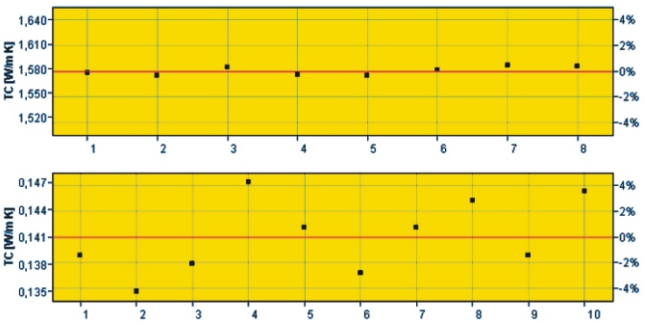
The amount of heat penetrating into the probe body instead of the sample material is corrected automatically using the thermal parameters of probe and sample.

TK04
Graphics Software and Quality Analysis

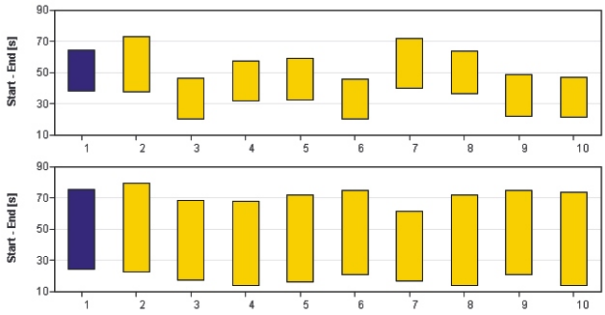


Presentation and analysis software
The graphics softwareTkGraph generates plots of completed tests from the result files generated by the TK04 software, serving to document measuring series and single measurements, and to check sample preparation and measuring conditions. TkGraph provides tools for manually correcting or excluding disturbed measurements.

Summary Plot
TK04 thermal conductivity tests are organized in measuring series of up to 99 single measurements. The Summary Plot is based on the TC list file which summarizes the results of a complete series.

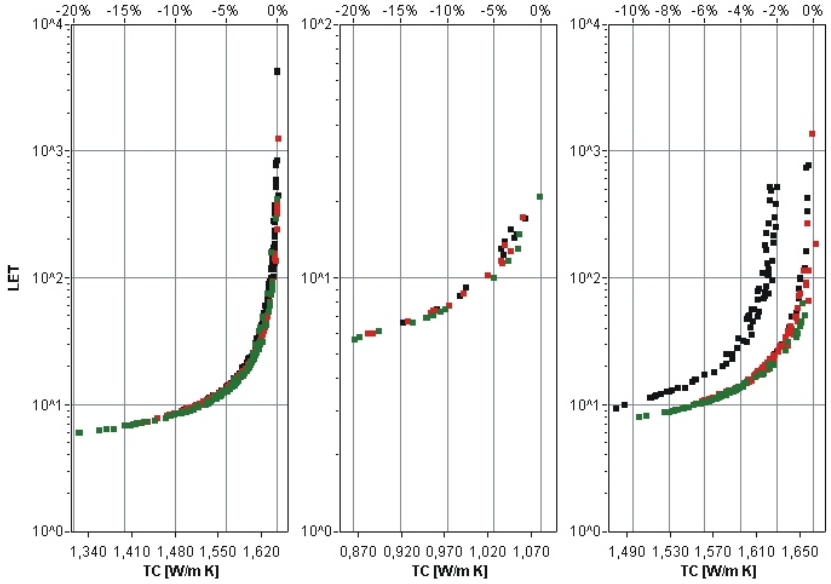


Scatter of a measuring series
The scatter of a measuring series can be used as an indicator of thermal disturbances, insufficient sample preparation or inadequate measuring parameters. Under optimal conditions, the scatter will usually stay below ± 0.5% (top). If it reaches ± 5% (bottom) you should check the measuring conditions.



Position and length of evaluation intervals
The TK04 software automatically detects the optimal time interval for thermal conductivity determination. If intervals are very short and/or are positioned relatively late in the temperature rise (top), this points to thermal disturbances, bad contact between probe and sample or too small probe sizes. In a good measuring series the intervals are long and are starting early (bottom).

The optimal evaluation interval
Typical sample preparation problems (like bad contact between probe and sample) can be detected by comparing the shapes of the theoretical and the measured temperature curve. The TK04 software automatically determines the part of the measured temperature rise that best corresponds to the theory by scanning it with evaluation intervals whose length and start time are increased in small steps. Similarity is measured by the so-called LET value, which is calculated from the coefficients obtained by fitting the theoretical curve to the measuring data: the higher LET, the more similar are the shapes and the more accurate is the thermal conductivity value determined from the interval in question.



The Single Measurement Plot
In addition to the optimal interval, thermal conductivity values are calculated from all intervals having a minimum LET value. For checking sample preparation and measuring conditions, the Single Measurement Plot displays the LET values of all evaluated intervals of a temperature curve plotted versus thermal conductivity. Undisturbed measurements show a typical asymptotic pattern (left diagram) where the optimal value is located at the top. Other distribution patterns indicate different types of disturbances.

Middle: unsufficient contact between probe and sample, **right:** reflection of the heat wave at the sample boundary.

System requirements

Operating system:	Windows XP, 7, 8, 10
CPU / RAM:	1 GHz / 512 MB or higher
Screen resolution:	1280 x 1024 or more

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