

Hot Disk[®] Thermal Constants Analyser



TPS 500 S



hotdiskinstruments.com

Hot Disk® Instrument

TPS 500 S

The Hot Disk® TPS 500 S rapidly and accurately measures the Thermal Conductivity, Thermal Diffusivity, Thermal Effusivity and Specific Heat Capacity of a wide range of materials and is therefore an excellent step-in thermal conductivity meter, and uniquely suitable for QC testing. The TPS 500 S adds powerful new features to the 500-series, in accommodating e.g. more measurement modules and sensor models. The TPS 500 S can handle bulk sample sizes down to a thickness of a few millimeters, has a Thermal Conductivity range of 0.03 to 200 W/m/K, and its temperature span is from -100°C to 300°C. It is partly based on ISO 22007-2 and is CE marked.



For the small-scale lab

The compact Hot Disk TPS 500 S Thermal Constants Analyser rapidly and precisely measures the Thermal Conductivity, Thermal Diffusivity, Thermal Effusivity and Specific Heat Capacity of a wide range of materials and is therefore a powerful thermal conductivity meter for the small-scale laboratory or QC testing set-up.

The TPS 500 S instrument condenses our patented and powerful TPS technology (now ISO standardised) with our elegant test and analysis software, arguably resulting in the simplest-to-use and versatile thermal conductivity meter on the market.

The TPS 500 S measures the Thermal Transport Properties of solids, powders, pastes, gels and liquids over a temperature range of -100 °C to 300 °C. The instrument encompasses similar accuracy and sample size flexibility as the benchmark TPS 2500 S and workhorse TPS 1500 (the latter two instruments are designed according to ISO 22007-2).

Advantages of the TPS technology as realized in the TPS 500 S:

- Poursous, transparent samples are easy to measure.
- Surface roughness or surface color does not influence measurement results.
- Contact pressure of sensor to sample surface does not influence measurement results.
- The method is non-destructive.
- Minimum- or no sample preparation (single-sided testing).
- Instant and fully consistent thermal conductivity results.
- Four thermal properties extracted from a single transient reading.
- No calibration or reference sample verification required (as it is an absolute technique).

Hot Disk® instrument users now number in the thousands world-wide. They appreciate our TPS technique for its unmatched measurement capability, together with its ease-of-use and simple or no sample preparation. The operative simplicity of the TPS 500 S instrument and the performance achieved when using optimally designed Hot Disk® sensors, makes the instrument uniquely suitable for QC applications, in particular automated production line QC via the capability of single-sided testing.

The test and analysis software (Hot Disk Desktop App) for the TPS 500 S instrument incorporates tools for scheduled measurements as well as automatic ambient temperature control, using our temperature control unit accessories (e.g. Bath Circulator and Convection Oven). For precise ambient temperature readings optional PT100 Temperature Sensors are available.

The TPS 500 S test and analysis software also includes automated sensor switching functionality applying our Sensor Switch Unit accessories. It also incorporates tools for exporting measurement data and results to xlsx- or txt-files, for further processing or more advanced statistical analysis. With the optional Automation Module it is possible to remotely control the TPS 500 instrument. This facilitates isolation of the testing set-up from the operator, which is particularly useful for QC-testing at robotic controlled production line applications.

Key Features

Simplicity: Our latest user friendly, yet sophisticated, test and analysis software simplifies testing, making the learning curve very short. Also, normally no sample preparation is necessary. This makes the TPS 500 S a smart, simple-to-use tool, easy to integrate.

Rapidity: The TPS 500 S will test most materials in less than 20 seconds. For multiple measurements on the same sample, a cooling time between tests is recommended.

Versatility: The TPS 500 S adds powerful new features to the 500-series. For example, slab samples with thickness down to 100 μm , and rod-shaped samples of width down to 5 mm, can be analyzed. In addition, the Specific Heat Capacity of tiny arbitrarily shaped samples can be determined very accurately.

Sensors: The TPS 500 S includes three specially selected Hot Disk[®] sensors suitable for the specified range of materials and applications, with a respective radius of 2.0 mm, 3.2 mm and 6.4 mm.

Single-Sided Testing: When two pieces of a sample for optimized double-sided testing is not available, the included single-sided background insulation material can be used to measure on a single sample piece. This ability lends itself for QC operations at near-line or in-line production workflow.

Temperature Control: Using our test and analysis software, automatic series of measurements at different ambient temperatures (isothermal steps) are easy to perform using our optional Bath Circulator and Convection Oven accessories.

Everything to get you started: The basic TPS 500 S configuration includes everything to get you started making measurements. The instrumentation includes the Isotropic, Single-Sided Testing, Specific Heat Capacity (only measurements without a Hot Cell[®] sensor), Slab and One-Dimensional Modules, three Hot Disk[®] sensors, a Stainless Steel verification sample for data verification, a single-sided background insulation for single-sided testing, and a room temperature sample holder (without protective hood).

Optional Measurement Modules: In addition to the included Isotropic, Single-Sided Testing, Specific Heat Capacity (only measurements without a Hot Cell[®] sensor), Slab and One-Dimensional Modules, the optional Automation Module is available for remote control of the TPS 500S instrument.



TPS 500 S

Made In Sweden



TPS 500 S Specifications¹

Measurement

| | |
|-------------------------------------|---|
| Sample Types | Bulks, rods, slabs, wafers, sheets, fine granules, powders, pastes, creams, gels, liquids, and foams. |
| Evaluation | |
| Anisotropy | No. |
| One-Dimensional | Yes, axial estimations possible for a complex sample configuration. |
| Sample Dimensions | |
| Smallest | Bulk sample: 3 mm thick x 8 mm wide (circle or square). Rod sample: 10 mm long x 5 mm wide (circle or square). Slab sample: 100 µm thick x 12 mm wide (circle or square). Thin film sample: 10 µm thick x 22 mm wide (circle or square). |
| Largest | Bulk sample: unlimited. Rod sample: unlimited length x 14 mm wide (circle or square). Slab sample: 0 mm thick x unlimited wide (circle or square). |
| Sample Temperature Range | -100°C to 300°C. |
| Core Instrument | RT. |
| With Optional TCU | Cryostat: -100°C to RT. Low-to-High Temperature Chamber: -60°C to 300°C Bath Circulator: -40°C to 200°C. Convection Oven: RT to 300°C. Muffle Furnace: RT to 300°C. Tubular Furnace: RT to 300°C. |
| Measurement Time² | 2.5 to 2560 seconds (depending on sample material and sensor dimensions). |
| Measurement Range | |
| Thermal Conductivity | Bulk sample: 0.03 to 100 W/m/K. Rod sample: 1 to 200 W/m/K. Slab sample: 5 to 200 W/m/K. |
| Thermal Diffusivity | Bulk sample: 0.02 to 50 mm ² /s. Rod sample: 1 to 100 mm ² /s. Slab sample: 2 to 100 mm ² /s. |

| | |
|--|---|
| Thermal Effusivity | 40 to 25000 W√s/m ² /K. |
| Specific Heat Capacity | Up to 5 MJ/m ³ /K. |
| Measurement Accuracy | |
| Thermal Conductivity | Better than 5%. |
| Thermal Diffusivity | Better than 10%. |
| Measurement Reproducibility³ | |
| Thermal Conductivity | Typically better than 2%. |
| Thermal Diffusivity | Typically better than 10% (Kapton-insulated Hot Disk [®] sensor model 5501). |
| Measurement Repeatability⁴ | |
| Thermal Conductivity | Typically 0.34% (Stainless Steel bulk sample, Kapton-insulated Hot Disk [®] sensor model 5501, and 22°C sample temperature). |
| Thermal Diffusivity | Typically 1.4% (Stainless Steel bulk sample, Kapton-insulated Hot Disk [®] sensor model 5501, and 22°C sample temperature). |
| Measurement Sensitivity⁵ | |
| Temperature | Typically 620 μK (Stainless Steel sample, Kapton-insulated Hot Disk [®] sensor model 5501, and 22°C sample temperature). |

Notes:

1. Hot Disk AB reserves the right to make changes without prior notice, whether due to misprints, improved hardware, or extended software capabilities.
2. Time of transient temperature reading. An additional temperature settling time that depends on the sample material and TCU (if applied) is required to ensure isothermal condition before the reading.
3. Comparing measurements performed by different instrument set-ups.
4. Variation in consecutive measurements performed by a single instrument set-up. Note that this value depends on sample material, sensor model, and sample temperature.
5. Standard deviation in fitting $\Delta T(\tau)$ -function to the transient temperature reading. Note that this value depends on sample material, sensor model, sample temperature, and can vary considerably.

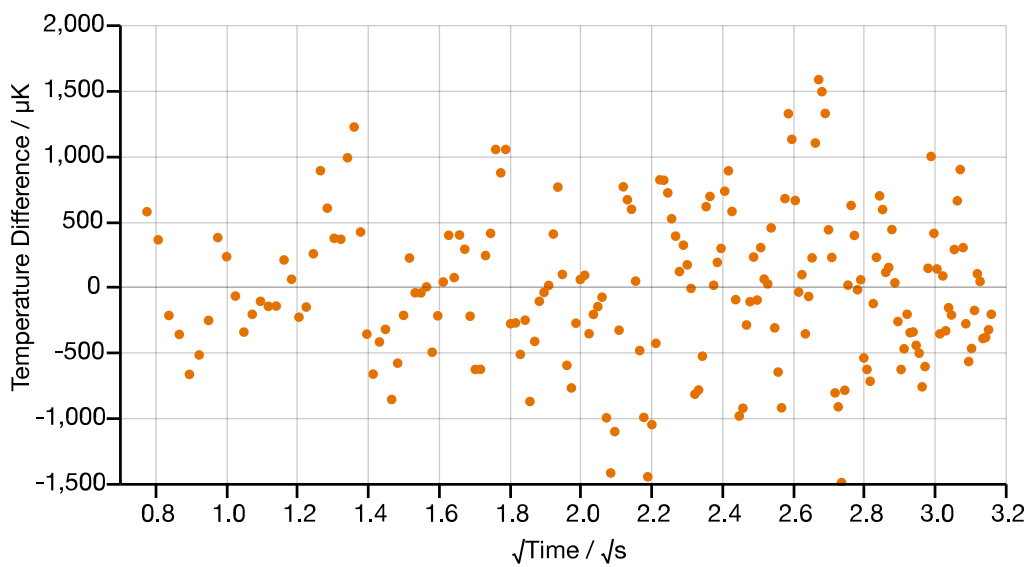
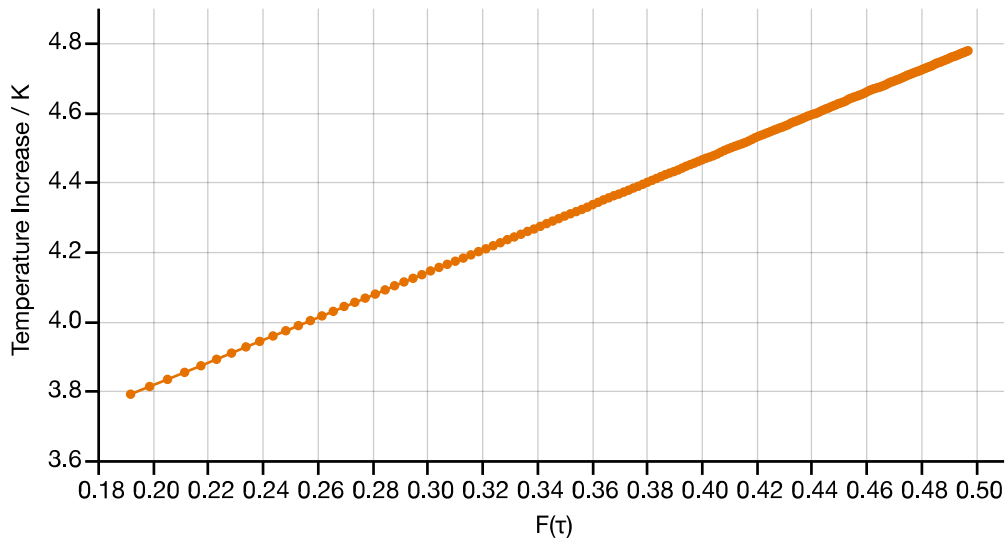
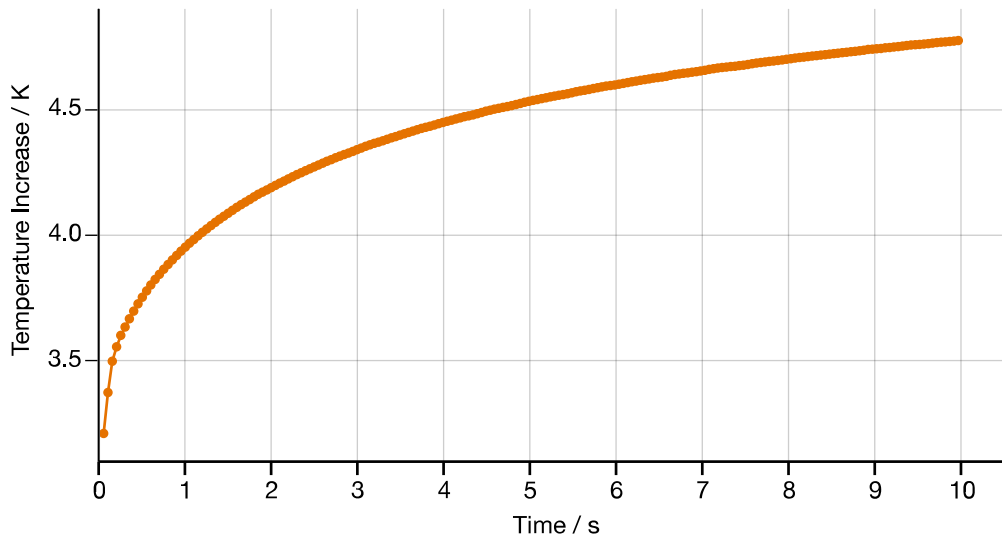
General

| | |
|--|---|
| Meets ISO Standard 22007-2 | Yes, with revised electronics. |
| Measurement Modules | |
| Included | Isotropic, Single-Sided Testing, Slab, One-Dimensional, and Specific Heat Capacity (only measurements without a Hot Cell [®] sensor). |
| Optional | Automation. |
| Sensor Models | |
| Hot Disk[®] sensor – Kapton-insulated | Models 7577, 5465 and 5501. |
| Hot Disk[®] sensor – Teflon-insulated | Models 7577, 5465 and 5501. |
| Hot Strip[®] sensor – Kapton-insulated | All models. |
| Instrument Environment | |
| Operating | 15°C to 30°C. |
| Storage | -20°C to 45°C. |
| Instrument Line Power | |
| Supply Voltage | 100 – 240 VAC, 50 – 60 Hz. |
| Power Consumption | 18 W typical, 190 W maximum. |
| Instrument Warm-Up | 2 hours to rated measurement performance. |
| Instrument Input and Output | |
| Rear Panel | USB type B connector (female) for connectivity. RS232 connector (male) for optional TCU |
| Front Panel | LEMO 8 pin connector (female) for Hot Disk [®] or Hot Strip [®] sensor. LEMO 4 pin connector (female) for optional PT100 temperature sensor. |
| Instrument Dimensions | 190 mm high x 455 mm wide x 485 mm deep. |
| Instrument Weight | 11 kg. |
| Instrument CE Marking | Yes. |

TPS 500S Measurement Demonstration

Stainless Steel

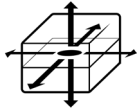
| | |
|--|---|
| Sample | |
| Material | Stainless Steel, AISI 316/316L. |
| Type | Bulk. |
| Temperature | 21°C |
| Measurement Parameters | |
| Measurement Module | Isotropic. |
| Sensor Model | Kapton-insulated Hot Disk® sensor 5501 (radius 6.4 mm). |
| Measurement Time | 10 s. |
| Heating Power | 1.6 mW. |
| Measurement Results | |
| Data Points | 12-200. |
| Thermal Conductivity | 13.68 W/m/K. |
| Thermal Diffusivity | 3.606 mm ² /s. |
| Specific Heat Capacity | 3.795 MJ/m ³ /K. |
| Probing Depth | 12.0 mm. |
| Temperature Increase | 1.0099 K. |
| Standard Deviation in Fitting $\Delta T(\tau)$ | 575 μ K. |



Included with the TPS 500S Instrument

- 5 x Measurement Modules: Isotropic, Single-Sided Testing, Slab, One-Dimensional, and Specific Heat Capacity (Hot Cell[®] sensor optional).
- 3 x Kapton-insulated Hot Disk[®] sensors: Models 7577, 5465 and 5501, with cable.
- Hot Disk[®] Desktop App software (latest version).
- 1 x Stainless Steel verification bulk sample.
- 1 x Single-sided background insulation (single-sided testing).
- 1 x Room temperature sample holder (protective hood optional).
- Instructions manual.
- Instrument test protocol.
- Power supply cord and USB cable.

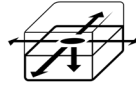
Available measurement modules for the TPS 500S



Isotropic (Standard)



Slab



Single-Sided Testing



One-Dimensional



Specific Heat Capacity



Automation

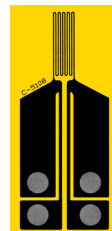
Available sensors for the TPS 500S



Kapton-insulated **Hot Disk**® sensor
Models 7577, 5465, and 5501.



Teflon-insulated **Hot Disk**® sensors
Models 7577, 5465, and 5501.



Kapton-insulated **Hot Strip**® sensor
All models.
(Works only with the One-Dimensional Measurement Module.)

Hot Disk®

Instrument Portfolio

A wide range of Hot Disk® instrument models is available for testing and measuring Thermal Conductivity, Thermal Diffusivity, Thermal Effusivity and Specific Heat Capacity following ISO 22007-2. While typically generous of measurement spectrum, our top-of-the-line instruments are unique in monitoring ultra-short transient temperature readings, thereby tackling sub-millimeter-thick samples and highly-thermal conducting materials, beyond 1800 W/m/K. A further unique feature of our instrumentation is that it requires no external calibration. Our clients can confidently continue its employ, without worrying over the inconvenience of being obliged to return their instruments for re-calibration at regular intervals. Each Hot Disk® instrument includes two LEMO connector ports: one for the relevant Hot Disk® sensor, and one for the optional PT100 ambient temperature sensor.1 Please consult our interactive links below, to help determine which Hot Disk® instrument is best suited to your intended applications and needs.



TPS 3500
For testing the extreme.



TPS 2500S
The benchmark instrument.



TPS 2200
For day-to-day testing.



TPS 1500
For heavy-duty testing.



TPS 500S
For the small-scale lab.



TPS 500
For the economical lab.



M1
Portable and educational.



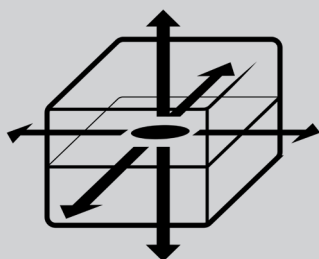
TPS 1000
For cost-effective quality assurance.

Notes

Hot Disk®

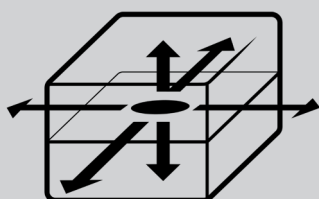
Measurement Modules

Hot Disk® instruments can be tailored to specific testing needs not only by the selection of sensors, but also by the wide range of measurement modules available. These modules allow for the testing of samples of special geometries, thermal conductivity ranges and material types. The Isotropic Module is the standard module for measuring bulk samples, and is included in all instruments. The add-on modules in turn extend the capabilities of your instrument, for example to tackle anisotropic-, slab-, or thin film samples. Based on long client experience, Hot Disk conveniently offers its clients clustered configurations along with many instrument models, via grouping several modules of related interest together, or by providing for the full available range. In effect, this means Hot Disk customers have the option of ordering several add-on modules at a quantity discount. Please contact your local Hot Disk sales representative for available cluster options.



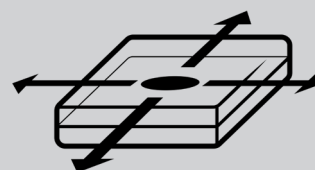
Isotropic (Standard)

All-round testing of bulk samples.



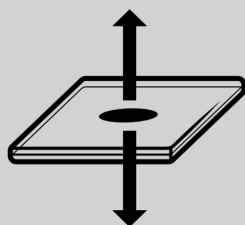
Anisotropic

Testing samples with direction dependent properties.



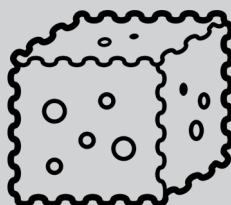
Slab

Testing highly thermal conductive slab or sheet samples.



Thin Film

Testing thermal insulating thin film samples.



Low-Density / Highly-Insulating

Testing the lightest and most insulating samples.

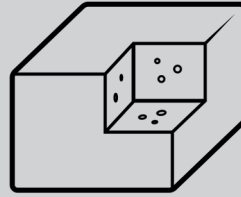


Specific Heat Capacity

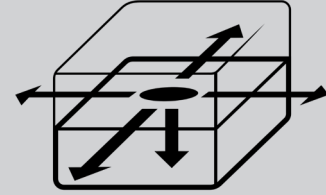
Testing Cp of complex samples and batteries.



One-Dimensional
Testing rod-like samples.



Structural Probe
Identify defects and structural changes inside samples and components.



Single-Sided Testing
Rapid production line QC testing.



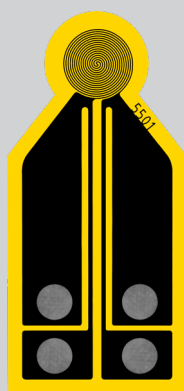
Automation
Remote-controlled testing.

Notes

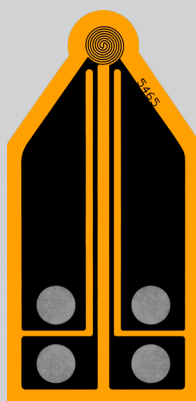
Hot Disk[®] Sensors

We currently supply three different types of sensors to be used with our Hot Disk[®] instruments – configured in tandem with our range of Measurement Modules. All three sensor types make use of a TPS element – a patterned Nickel foil with electrically insulating cladding – that is used for simultaneous transient heating and precise temperature reading.

Our patented Hot Disk[®] sensor is our baseline sensor for measuring Thermal Conductivity and Thermal Diffusivity of isotropic samples. It is also used for testing 2D anisotropic samples, e.g. uniaxial crystals and layered composites with different properties in the in- and through-plane directions. Our patented Hot Strip[®] sensor is used as complement to our Hot Disk[®] sensor, primarily for testing 3D anisotropic samples, e.g. biaxial crystals and fiber composites with different properties along, across, and through the fiber orientation direction. Our Hot Cell[®] sensor is our newest type addition, developed in-house to measure the Specific Heat Capacity of materials or components (with focus on batteries) of arbitrary type, shape, and size.



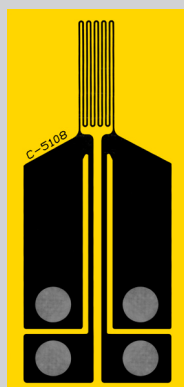
Kapton-insulated
Hot Disk[®] sensor



Teflon-insulated
Hot Disk[®] sensors



Mica-insulated
Hot Disk[®] sensors



Kapton-insulated
Hot Strip[®] sensor



Aluminium & Gold
Hot Cell[®] sensors



Notes

Hot Disk[®]

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