

# BUILD YOUR OWN THERMAL CONDUCTIVITY INSTRUMENT

## Thermal Conductivity Kit

Developed by the experts at C-Therm Technologies Ltd., the Tckit offers thermal conductivity analysis at an affordable price.

An economical “do-it-yourself” solution, the Tckit is targeted primarily towards academic researchers. Employing the Transient Plane Source (TPS) method, the Tckit includes the tools & software needed to build and customize a thermal conductivity analyzer at a fraction of the price.

Paired with a standard Source Measure Unit (sold separately), the Tckit is a great way to start testing thermal conductivity, now!



## What's In The Box:

- FLEX Transient Plane Source (TPS) Thermal Conductivity Sensor with 4-Prong Source Measure Unit Connector
- Stainless Steel 304 Reference Samples
- TECAS™ Control Software on USB Key
- Serial-to-USB Communication Cable
- Step-by-Step User Guide



## TECAS™ Control Software

C-Therm's proprietary measurement and analysis software TECAS™ enables users to intuitively setup analysis, with post processing of data via an easy and visual platform. Running on Windows 10, direct export to CSV file allows for simple indexing of results.

## Source Measure Unit Requirements

The Tckit can be powered by a wide range of off-the-shelf SMU instruments. C-Therm recommends the Keithley SMU 2400 series.

## Principles of Operation

The C-Therm Tckit, configured with the Transient Plane Source (TPS) technique, enables the characterization of thermal conductivity and diffusivity of materials. It employs a two-sided sensor, and the user iteratively develops the timing and power parameters. Intended for rough and heterogeneous materials that are not well-suited to a single-sided test method, this configuration allows researchers the maximum versatility in test parameters and experimental design. Variations of this technique, with a bridge circuit, are offered in accordance to ISO 22007.



APPLICATION NOTE

# LIGHTWEIGHT CONCRETE



## Experimental Set Up

The thermal conductivity of a lightweight concrete was measured utilizing the C-Therm TCkit FLEX Transient Plane Source (TPS) sensor at ambient conditions (23.2 °C).

The flexible, 13 mm Kapton-based sensor was placed between a sliced lightweight concrete cylinder. The FLEX sensor was paired to a Keithley model 2400 source measure unit and controlled via laptop running C-Therm's TECAS™ software.

Referencing ISO standard "ceramic material" recommendations and through initial sample testing experimentation, the applied power was chosen to be 0.5 watts with the measured test time to be 40 seconds. Experiments were carried out in 10 locations to understand variations in thermal conductivity throughout the heterogeneous sample.

## Testing Results

Following ten measurements with removal of the sensor between each reading, the average thermal conductivity of the lightweight concrete was reported at 0.52 W/mK with a reproducibility relative standard deviation (RSD) better than 3%.

Figure 1 illustrates the variability of test results between different locations, with the average thermal conductivity of the ten tests represented by the solid blue line. Above and below the average line are +/- 5% lines. The observed variation between tests can be attributed to the sample's heterogeneity.

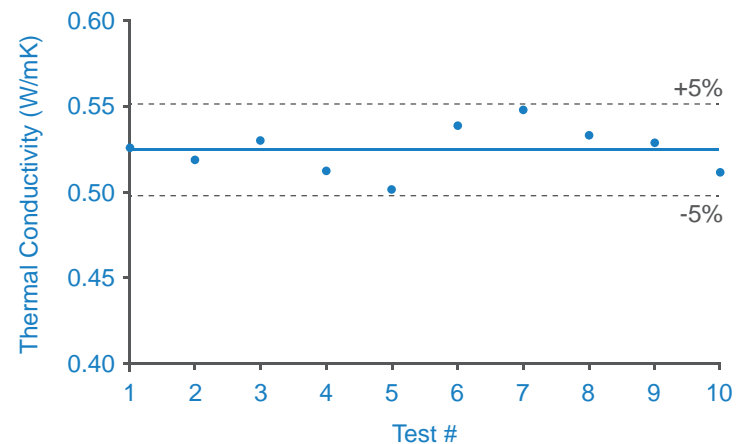
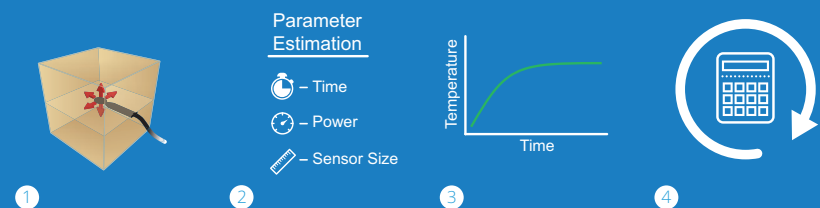


Fig. 1: Thermal conductivity results with +/- 5% lines.

## Principles of Operation



1. Power is applied to the sensor's spiral heating element, providing a small amount of heat. The resulting rise in temperature induces a voltage change across the sensor element.
2. The results from the initial scouting run are used to estimate test time, power level, and ideal sensor size.
3. The test result is a plot of temperature vs time.
4. The results are analyzed with an iterative solving procedure.

## Sensor Specifications

TEST METHOD	Transient Plane Source
THERMAL CONDUCTIVITY RANGE	0.03 to 60 W/mK
TEMPERATURE RANGE	10 to 80 °C
ACCURACY	Better than 5%
PRECISION	Better than 2%
REPRODUCIBILITY	Better than 3%
SENSOR SIZE	13 mm diameter
TESTING TIME	10 s to 180 s
POWER RANGE	0.01 W to 10 W
SMALLEST SAMPLE SIZE	10 mm X 30 mm diameter
LARGEST SAMPLE SIZE	Unlimited