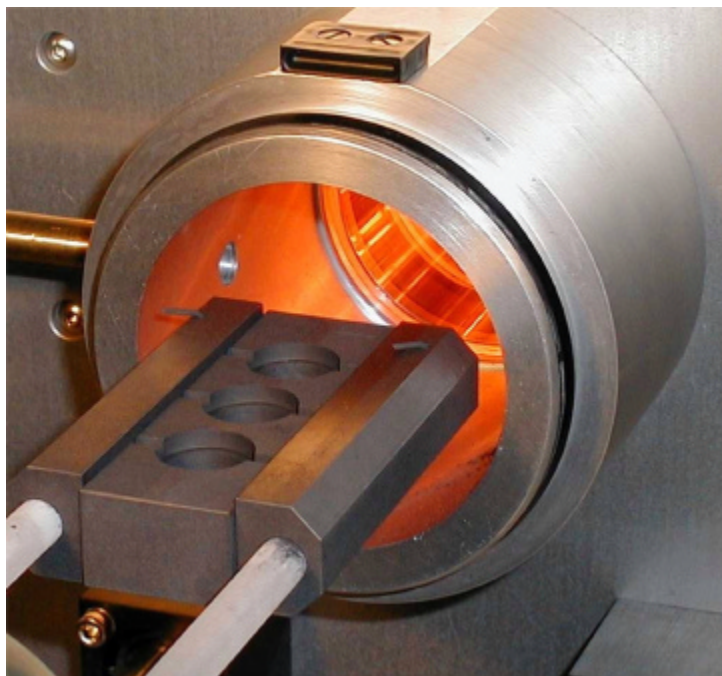


# FlashLine™ 3000 THERMAL PROPERTIES TESTER



- ◆  $-180^{\circ}$  to  $200^{\circ}$  &  $50^{\circ}$  to  $1200^{\circ}\text{C}$  range
- ◆ Large and small sample sizes
- ◆ High sample throughput
- ◆  $\alpha$ ,  $C_p$ , and  $\lambda$  measurement
- ◆ In-plane testing of thin plates
- ◆ Table top system

**MODULAR ARCHITECTURE**, a hallmark of all FlashLine instruments, makes this perhaps the most flexible system of its kind presently offered on the commercial market anywhere in the world. It allows the selection of subsystems and options to assemble a configuration that best suits any application. Many of these elements are interchangeable or selectable as an addition at a later date to grow with changing needs. Noteworthy among these are the **multiple sample** testing option and the **large sample** option, both of which were pioneered by Anter. These features not only increase productivity, but also make the optional specific heat capacity measurement reliable.

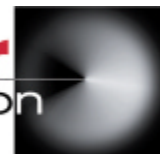
**PRICED MODERATELY** and simple to operate, the FL-3000 device covers the most commonly needed cryogenic to  $1200^{\circ}\text{C}$  temperature range with six models, producing very good quality data. It is suitable for research and development programs as well as production control. This system uses a High Speed Xenon Discharge (HSXD) pulse source and a fixed basic configuration with optionally selectable internal modules. The compact bench-top unit is easy to maintain and very economical to operate in terms of consumables.

**HSXD SYSTEM**, developed and patented by Anter has successfully addressed the problem of producing a pulse that is short (shorter than many laser-based commercial systems), while uniformly concentrating sufficient power from the flash source directly on the entire face of the sample. Due to this optimized energy gathering scheme, even samples as large as 30 mm in diameter can be illuminated with sufficient energy.

A unique capability of the FL-3000 system is to accommodate a variety of sample sizes, starting with standard small samples to large diameter thick samples. This allows testing of coarse-grain materials (such as refractories, carbons, rocks, etc.) and composites. Also, using special sample fixtures, pastes, films, liquids, and samples through melting can be tested. For radioactive or hazardous materials, special sample capsules are available that allow keeping the system in a clean area while the capsules are loaded inside a glove box. The modular design naturally allows the separation of the instrument section from the control electronics for glove box or hot cell installation.

**TESTING TIME** is only minutes at ambient. Reaching other temperatures is also highly accelerated as compared to conventional systems due to the use of an Infrared furnace. A test sequence to  $1000^{\circ}\text{C}$  in  $100^{\circ}\text{C}$  intervals can be completed in a few hours for three samples concurrently. Using the thermal conductivity testing mode, the device offers a nearly tenfold time reduction when compared to the much more difficult to perform steady state measurement procedures (comparative cut-bar, etc.).

**WINDOWS™** operating and data analysis software combine ease of use by non-technical operators with additional powerful analysis tools for advanced research.



The model number of a complete system consists of the basic designation FL-3000 followed by the other selected attributes [ ] in any order, such as FL-3000[XS][SXX][XV][P02].

## CONFIGURATION

The system, in its lowest cost form, is a single sample, conventional device. Alternately, it may be configured as a two or three sample instrument. (A single sample device can also be upgraded any time for multi-sample operation.) A multisample instrument automatically indexes the sample holder and precisely brings into alignment one sample at a time.

The rear surface temperature rise is detected with either a high quality InSb detector for above ambient measurements or a solid state detector for lower temperatures. Sample temperature is measured with thermocouples adjacent to the sample being measured. Due to the high thermal uniformity of the proprietary high speed IR furnace, the sample temperature is known to be within  $\pm 1^\circ\text{C}$ . Extensive temperature programming is provided directly from software with very tight ( $\pm 0.5^\circ\text{C}$ ) resolution. The high speed IR furnace is capable of controlled heating rates up to  $100^\circ\text{C}/\text{minute}$  to go from one test temperature to the next one.

## BASE INSTRUMENT

FlashLine™-3000 Thermal Properties Tester, equipped with furnace, complete temperature control and data acquisition subsystems, HSXD pulse source and power supply, control electronics, safety interlocks, optical pulse delivery components, IR optics, and LN<sub>2</sub> cooled IR detector or solid state detector for rear face thermogram determination.

FL-3000 [R]	ambient only (furnace omitted)
FL-3000 [K]	ambient to $200^\circ\text{C}$ operation
FL-3000 [S]	$-180$ to $+200^\circ\text{C}$ operation
FL-3000 [A]	$50$ to $500^\circ\text{C}$ operation
FL-3000 [B]	$50$ to $1000^\circ\text{C}$ operation
FL-3000 [C]	$50$ to $1200^\circ\text{C}$ operation

For service above  $1200^\circ\text{C}$  (up to  $3000^\circ\text{C}$ ), the FL-5000™ System should be considered.

## OPERATING MODE

[SS]	Single sample operation
[M2]	Two sample operation (30mm dia.)
[M3]	Three sample operation (12.7mm dia.)

## SAMPLE HOLDERS

One appropriate sample holder is necessary to complete the system. When considering the material of construction must be taken into consideration to avoid compatibility problems with samples. All sample holders are interchangeable. Accessory adapters are available to test 20, 12.7 mm diameter, and a variety of square or rectangular samples.

[S10]	Sample holder, Alumina	(up to $1200^\circ\text{C}$ )
[S11]	Sample holder, Graphite	(up to $1200^\circ\text{C}$ )
[S12]	Sample holder, Ceramic	(up to $1000^\circ\text{C}$ )
[S13]	Sample holder, Stainless Steel	(up to $700^\circ\text{C}$ )
[S14]	Sample holder, Aluminum	(up to $500^\circ\text{C}$ )

## ATMOSPHERE

The instrument in its basic form is gas-tight and ready for air or inert gas purging. Operation with vacuum is optional.

[LV] Low Vacuum Service	(to $10^{-3}$ torr range)
[HV] High Vacuum Service	(to $10^{-5}$ torr range)

## SPECIFIC HEAT CAPACITY DETERMINATION

The use of the flash technique to determine heat capacity is based on alternately measuring a known (reference) and an unknown (sample) in a quantitative way, and obtaining the results from their differential behavior. To do this, the flash source must remain stable during the period that separates the "reference" shot from the "unknown" shot. Using the multi sample, indexed operating mode, this requirement is fully met as the system will test the "unknown" immediately after the "reference", with minimal time differential, and in the exact same thermal environment. Under these conditions, results as good or better than those produced by conventional means, such as Differential Scanning Calorimeter, can be obtained. (A detailed discussion of limitations and comparison to competitive instruments can be found in a Technical Note, supplied on request.)

[P01] Specific Heat Capacity Testing Software

Usable only with multi-sample system, except for ambient operation.

## THERMAL CONDUCTIVITY DETERMINATION

Thermal conductivity can be computed from measured values of thermal diffusivity and specific heat capacity, with the additional knowledge of density. Thus, a system can automatically determine thermal conductivity using the measured (or separately entered) heat capacity and thermal diffusivity, with separately entered density data.

[P03] Thermal Conductivity Testing Software

## REFERENCES

Although the flash method is absolute in nature (it requires no transfer standard for calibration), it is advisable to periodically run verification tests to ascertain proper system operation. For specific heat capacity testing, the use of one reference is a necessity. All references are supplied with appropriate certificate and installable data file.

## PERFORMANCE

Thermal Diffusivity Determination

Reproducibility:  $\pm 2\%$  or better

Accuracy:  $\pm 4\%$  or better

*Determined with NIST Certified Standard graphite*

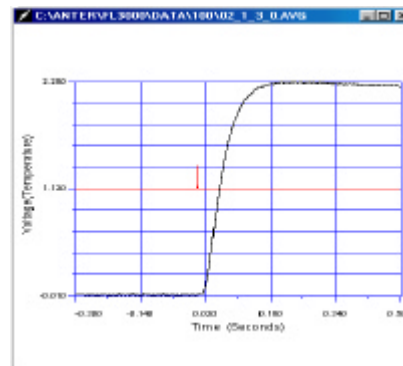
Range: 3 to  $0.001\text{ cm}^2/\text{s}$

*With proper sample thickness*

Specific Heat Capacity

Accuracy:  $\pm 3\%$  or better

*Determined with OFHC copper*



Easy to use Windows™ 95/98 based software for automatic operation and data analysis.

INSTRUMENTS FOR THE NEW MILLENNIUM®