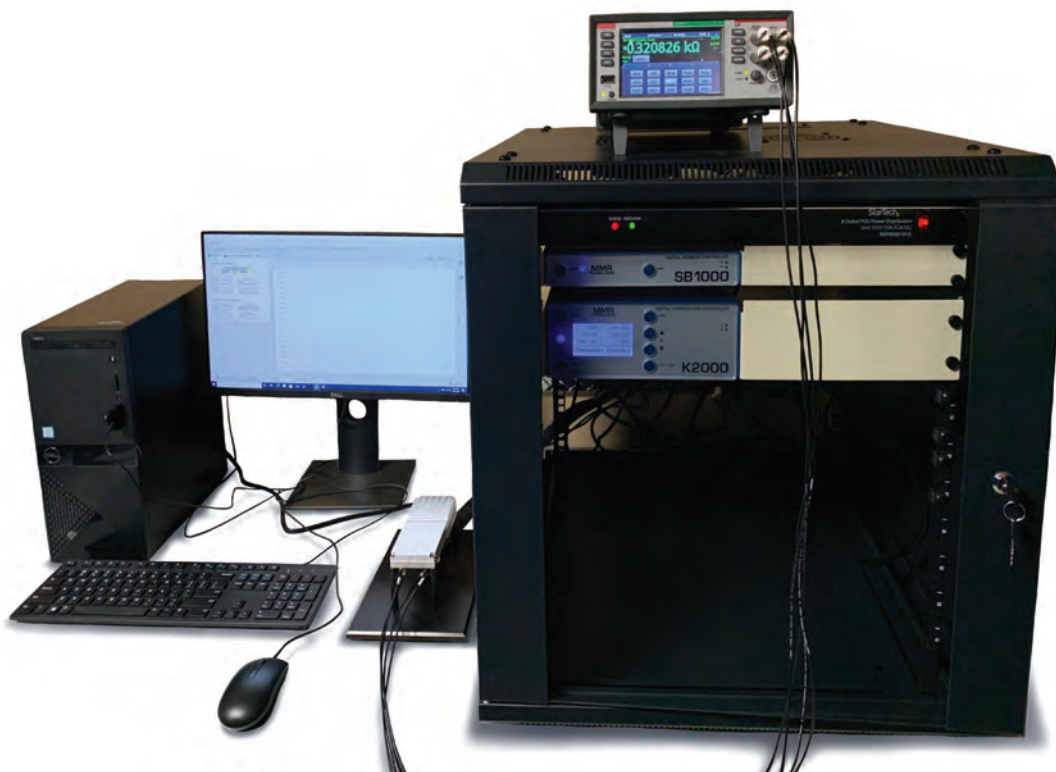


# TRANSIENT SIGNAL TECHNOLOGIES

ADVANCED SOLUTIONS IN MATERIALS SCIENCE

## SEEBECK EFFECT MEASUREMENT SYSTEMS



### FEATURES

- High precision of Seebeck coefficient measurements
- High signal-to-noise ratio and fast data acquisition
- Differential measurements algorithm
- Wide temperature range (80 K - 700 K)
- Statistical data analysis
- Real-time thermal voltage transient measurements
- User-friendly, automated measurement setup

### APPLICATIONS

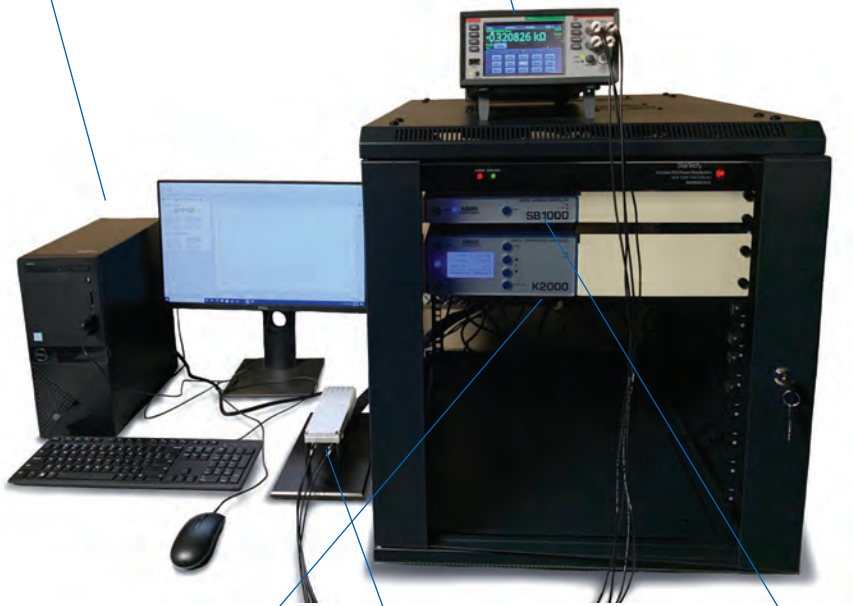
Temperature dependent thermopower measurements on electrically conductive specimens provide information about the sign of the majority carriers, the mechanism of charge conduction in conjunction with appropriate theoretical models, information on the band structure of the material. The knowledge of Seebeck coefficient is a key factor in optimization of thermoelectric materials and finding right applications for it. A high sensitivity to structural change makes thermopower measurements an excellent technique for the study of structural phase conditions on the charge transport properties of a given material.

# TYPICAL VARIABLE TEMPERATURE SEEBECK SYSTEM SETUP

DELL DESKTOP COMPUTER

ELECTRICAL CONDUCTIVITY/  
THERMAL VOLTAGE TRANSIENT  
MODULE

VARIABLE  
TEMPERATURE  
(80 K - 700 K)  
CRYOSTAT



TEMPERATURE  
CONTROLLER

HOT STAGE  
CHAMBER

SEEBECK  
CONTROLLER



VACUUM ACCESSORIES



VACUUM ROTARY PUMP



# SB1000 DIGITAL SEEBECK CONTROLLER

## INTRODUCTION

Designed with the user and ease of use in mind, the SB1000 Digital Seebeck Effect Controller offers a reliable platform for Seebeck coefficient measurements in wide temperature range of 80 K - 700 K using the cryogenic systems (liquid nitrogen cryostats) or hot thermal stage systems from Transient Signal Technologies, integrated into vacuum environment.



The SB1000 Seebeck controller provides:

- Highly accurate and highly reproducible Seebeck coefficient measurements
- Differential measurement technique of Seebeck coefficient with high signal-to-noise ratio
- Special amplification circuitry integrated into vacuum environment that allows high SNR
- High data acquisition speed allowing statistical measurements and analysis
- Variation of the temperature gradient across the sample by applying selected power to Seebeck heater
- Easy measurement of samples ranging from metals to semiinsulators
- Single step operation against an internal reference material
- Small, compact size
- Fully automated control with built in Reference
- Low temperature (80 K - 400 K) and high temperature (200 K - 700 K) sample mounting stages

## FEATURES AND BENEFITS

Several unique features of the SB1000 Digital Seebeck Controller provide significant user benefits:

- Improved CMR ADC stability - Enabling high-precision measurements
- Improved hardware communications - Ensure experiment accuracy
- Faster operation - Improved speed for data collection and reduced experiment runtime
- Real-time voltage monitoring - Displaying real-time sample stage voltages
- Stand-alone Seebeck experiments at ambient temperature - No requirement to connect with a temperature controller if only room temperature experiments are required
- Computer interface - For integrated software control through RS-232C or USB connections
- Small footprint - The SB1000 Digital Seebeck controller
- Integrated software suite - Provides a single package that works with different temperature controllers K2000, DC600 and SB1000 Seebeck controller
- Several new features are added including electrical conductivity and thermal voltage transient signal measurements by integration of Keithley DMM6500.

## THE VARIABLE TEMPERATURE SEEBECK EFFECT MEASUREMENT SYSTEMS (SMS)

The variable temperature Seebeck Effect Measurement System is designed to provide complete automatic measurements of the Seebeck coefficient of various materials: metals, semiconductors, semiinsulators. The system uses special differential measurements algorithm when specimen under the test is compared to reference sample.

### A TYPICAL VARIABLE TEMPERATURE SEEBECK EFFECT MEASUREMENT SYSTEM

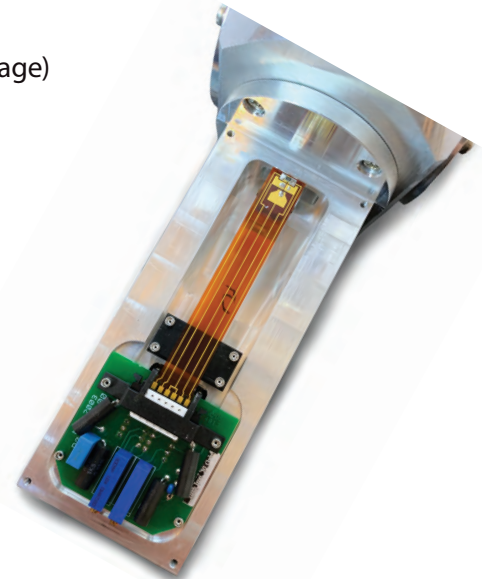
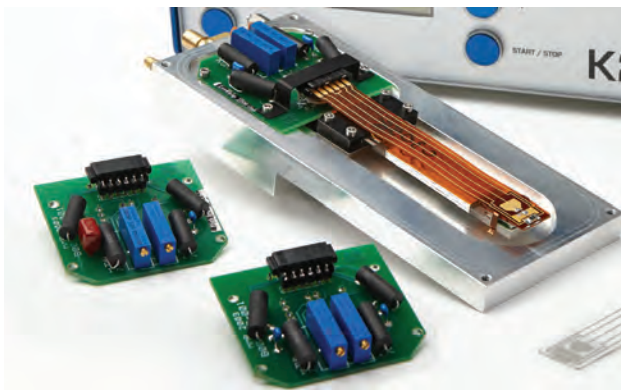
A typical variable temperature Seebeck Effect Measurement system includes:

- DC600 Programmable Temperature Controller and SB1000 Seebeck Effect Measurement Controller
- Liquid nitrogen cryostat with integrated amplification circuitry into the vacuum environment
- Kapton (80 K - 400 K) or ceramic (200 K - 700 K) sample mounting stages
- Vacuum pump and vacuum accessories
- Four soldering pins for electrical conductivity measurements by two probe or by four probe measurement technique
- Dell Optiplex 3000 Tower desktop computer and 22" LCD monitor
- All electronics mounted in 19" electronic rack

### AVAILABLE TEMPERATURE RANGES

Depending on vacuum variable temperature cryostat the SMS systems can operate in different temperature ranges:

- Room Temperature only (Seebeck effect chamber with room temperature stage)
- 80 K to 500 K (LN2 VPF cryostat, can be upgraded up to 700 K with hot stage integration)
- 80 K to 700 K (LN2 VPF cryostat with integrated hot stage)
- Room Temperature to 700 K (Seebeck effect chamber with hot stage)



Transient Signal Technologies offers programmable temperature controller that is designed for use with variable temperature systems. This controller provides accurate temperature measurements, precise temperature control, and easy-to-use data acquisition functions over the temperature range from 80 K to 700 K. DC600 temperature controller is designed to operate with Pt RTD temperature sensors and supports 50 Watt heaters. This controller is supplied with VPF cryostats and hot stages for operation in 80 K - 700 K temperature range.

## K2000 TEMPERATURE CONTROLLER

For SMS operating in 300 K - 700 K temperature range we offer low-wattage K2000 programmable temperature controller that is intentionally designed for operation with miniature ceramic hot stages. This controller provides accurate temperature measurements, precise temperature control, and easy-to-use data acquisition functions over the temperature range from 300 K to 700 K. K2000 temperature controller is designed for operation with Pt RTD temperature sensors and supports 10 Watt heaters. This controller is supplied with Seebeck effect vacuum chambers.



## SAMPLE MOUNTING STAGES

Each system is supplied with sample mounting stages for low temperature operation and high temperature operation. The Kapton sample stages are designed and calibrated for 80 K - 400 K temperature range. Ceramic stages are designed and calibrated for operation in 200 K - 700 K temperature range. Each stage has installed Seebeck heater for accurate temperature gradient control across the sample under test. The Seebeck heater may vary power in the range of 10 mWatt - 1 Watt.



## ELECTRICAL CONDUCTIVITY MEASUREMENTS AND THERMAL VOLTAGE TRANSIENT MEASUREMENTS

Electrical conductivity measurements can be done by:

- Adding to the Seebeck systems electrical conductivity module that consists of Keithley DMM6500 with all necessary accessories and integrated PCB boards into vacuum cryostats
- Adding van der Pauw controller, model H5000. H5000 controller allows future upgrade to Hall effect



Added Keithley DMM6500 controller allows thermal voltage transient signal measurements in real time after applying the heat pulses. This is a very desired feature for setting up Seebeck experiments properly and for optimization of Seebeck coefficient measurements in different temperature ranges. All add-on modules that utilize DMM6500 are supplied with LabView software package for hardware control and data acquisition.

## SPECIFICATIONS

### SB1000 Seebeck Controller:

Stand Alone Operation:	Room temperature only
Resolution for Measurements:	70nV (1000G, 300G, 100G and 30G Amplifiers available)
Power to Heat Sample:	Generates a temperature difference across sample; power available min: 0.01W, max: 1W
Software Control:	Transient Signal Technologies Integrated Software Suite/LabView
Data Output Options:	Reports can be generated directly through the software suite exporting data to PNG, JPG, TXT and CSV options available
Computer Requirements:	Windows® based computer
Operating System:	Windows® 7, Windows® 8, Windows® 10
Computer Connections:	USB or available serial port
Hardware:	32-bit or 64-bit
Dimensions:	Width: 8.75 inches (22.23 cm)
Length:	14.25 inches (36.20 cm)
Length with cables connected:	18 inches (45.72 cm)
Height:	1.5 inches (3.81 cm)
Weight:	5 pounds (2.3 kg)
Rack Mount:	This controller is the size of a half-wide, full-length, standard rack mount and can be integrated into a rack mounted cabinet with a shelf
Electrical Requirements:	Switching power supply (dual voltage) 100V - 240V (50/60Hz)
Power Consumption:	< 300 Watts

### Temperature Ranges:

No Temperature Controller:	Room temperature only
DC600 Temperature Controller:	80 K - 500 K (LN2 cryostat)
DC600 Temperature Controller:	80 K - 700 K (LN2 cryostat with hot stage added)
DC600 or K2000 Temperature Controller:	300 K - 700 K (hot stage system)

### Cryostat Specifications:

Vacuum Range:	10 mTorr or better
Vacuum Accessory Package:	10E-4 Torr to Atm
Vacuum Oil Rotary Pump:	120 L/min or better

### Sample Specifications:

Sample Width:	2.5 mm or less
Sample Length:	2mm - 8 mm
Type of Sample:	bulk material, thin film, nanomaterials

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