SPECIAL FUNCTION TEST & MEASUREMENT PRODUCTS

DC205 Low-noise high-resolution DC voltage source

SR540 Optical chopper

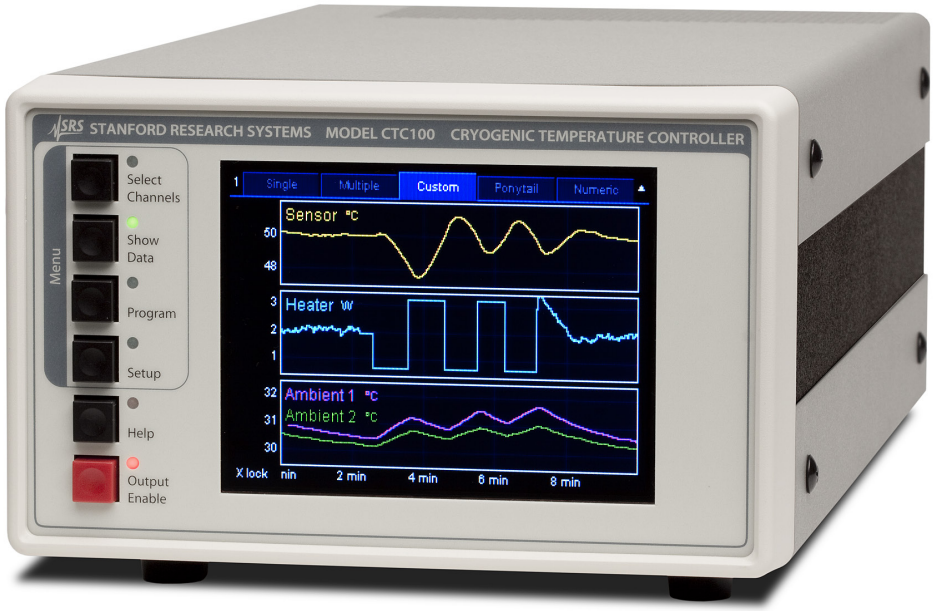
PS300 High voltage power supplies

PTC10 Programmable temperature controller

CTC100 Cryogenic temperature controller

Temperature Controllers

CTC100 — Cryogenic temperature controller



CTC100 Temperature Controller

- ***4 temperature sensor inputs***
- ***2 powered & 4 analog voltage outputs***
- ***Up to 6 feedback control loops***
- ***4 analog & 8 digital I/O channels***
- ***Graphical touchscreen display***
- ***Data logging on removable flash media***
- ***User programs (macros)***
- ***USB, Ethernet, RS-232 & GPIB (opt.)***

- ***CTC100 ... $2895*** *(U.S. list)*

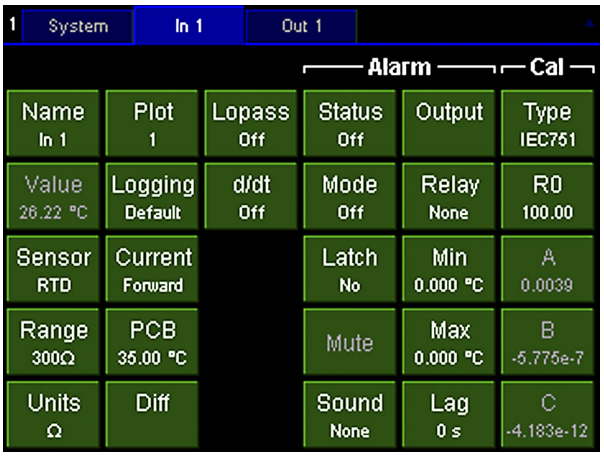
Introducing the new CTC100 Cryogenic Temperature Controller — a high performance instrument that can monitor and control temperatures with millikelvin resolution.

The CTC100 Cryogenic Temperature Controller is configured to suit a wide range of research and industrial applications. The system consists of four sensor inputs, two powered and four analog voltage outputs, and up to six feedback control loops. Four general purpose analog and eight digital I/Os are available, along with autotuning functions for setting PID parameters automatically.

Sensor Inputs

The CTC100 offers four temperature inputs that can read RTDs, thermistors, and diodes. Each temperature input channel has its own 24-bit ADC with eleven input ranges, and is equipped with its own independent excitation current source.

Standard calibration curves for a variety of sensors are included, and custom calibration curves of up to 200 points each can be entered. Each sensor input has high and low level or rate-of-change alarms. Sensor inputs can be lowpass-filtered to reduce noise, and/or differenced with another channel.



Channel setup menu

Powered and Unpowered Outputs

The CTC100 has two heater outputs that can each deliver up to 100 W of power to a 25 Ω heater. In addition, four analog voltage I/O channels can be used to drive heaters with the help of an external amplifier.

PID Feedback Control

With up to six feedback control loops available, the CTC100 can provide precise temperature control of each of its heater outputs by continually adjusting the heater power. Any of the CTC100's channels can be selected as the input for each feedback loop. Feedback time constants can be adjusted between 200 ms and 10 hrs.

Up to ten sets of PID parameters can be stored for each channel. Setpoints can be ramped at a fixed rate (or with a user program), set from an analog input.

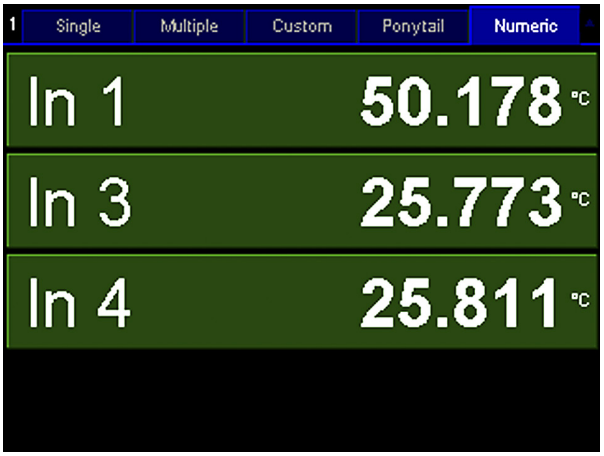
Analog and Digital I/Os

The CTC100 comes with four general-purpose ±10 V voltage I/O channels read by a 24-bit ADC. It also has eight digital I/O channels that can interact with user programs.

Four 5 A relays can be used for process control. Three virtual channels, not connected to any physical input, allow calculated values (such as the difference between two channels, or a value calculated by a user program) to be displayed, graphed, and logged.

Numeric and Graphical Display

The CTC100's color LCD display can show any combination of temperature measurements and heater outputs on graphs or numeric displays. Up to eight channels can be plotted either on a single graph with a common Y axis, or on separate graphs with independent Y axes. Touchscreen operation makes the instrument versatile and easy to use.

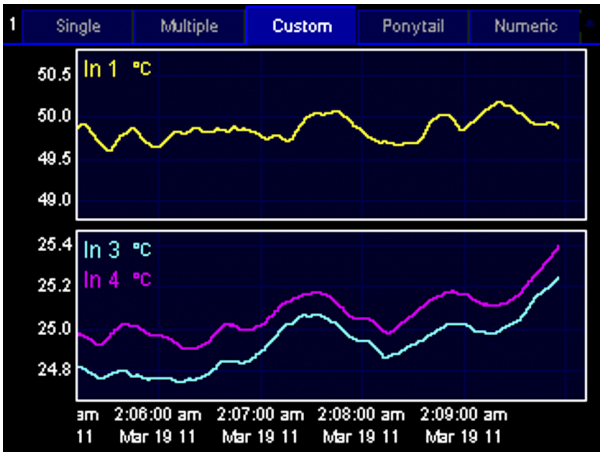


Numeric display

Data Logging

Up to 4096 readings per channel can be logged to the CTC100's internal memory. For longer-term storage, data can be logged to standard USB memory sticks or hard drives.

Data logged to USB devices can be transferred to a computer by plugging the USB device into a PC. Windows applications are included to graph CTC100 log files and to convert them to various ASCII text formats.

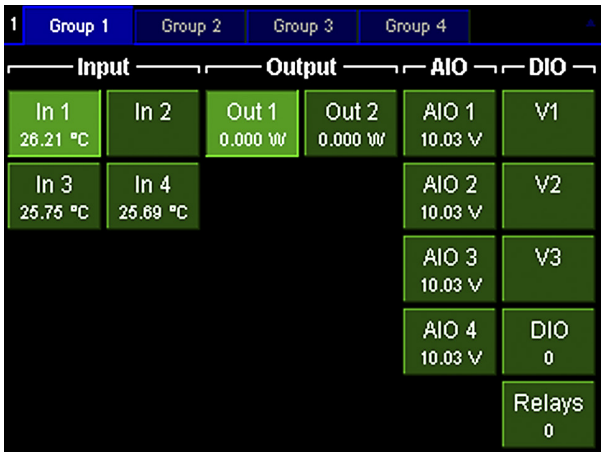


Graphical display

Computer Communications

Each of the CTC100's front-panel controls has a corresponding text command that can be sent over USB, Ethernet, and either RS-232 or an optional GPIB interface.

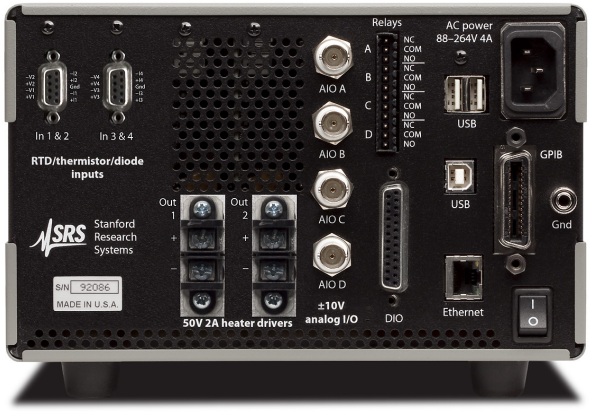
When the USB interface is used, the CTC100 appears on the computer as a standard COM port and can be controlled by any software that is compatible with an RS-232 port.



Select menu

User Programs

User programs (macros), consisting of one or more remote commands, can be uploaded to the CTC100. This is done by either sending them through one of the communications ports or by saving them as text files on a USB memory device and then plugging the device into the CTC100. Program macros can also be entered and edited from the front panel.



CTC100 rear panel

Specifications

Temperature Controller

Min. sampling rate	1 Hz
Max. sampling rate	50 or 60 Hz (depending on AC line frequency)
Data logging rate	10 samples/second/channel to 1 sample/hour/channel (can be set independently for each channel or globally for all channels)
Display resolution	0.001 °C, °F, K, V, A, W, etc. if –1000 < displayed value < 1000; 6 significant figures otherwise
PID autotuning	Single step response or relay tuning with conservative, moderate, and aggressive response targets
Display	320 × 240 pixel color touchscreen; numeric and graphical data displays.
Alarms	Upper and lower temperature limits or rate-of-change limits can be set on each channel.
Computer interface	USB, Ethernet, and RS-232; GPIB (IEEE488.2) optional
Power	10 A, 88 to 132 VAC or 176 to 264 VAC, 47 to 63 Hz or DC
Dimensions	8.5" × 5" × 16" (WHL)
Weight	13 lbs.
Warranty	One years parts and labor on defects in material and workmanship

Analog I/O

Inputs/outputs	4 voltage I/O channels, independently configurable as inputs or outputs
Connector	4 BNC jacks
Range	±10 V
Resolution	24-bit input, 16-bit output
ADC noise	30 µVrms (at 10 samples/s)

Digital I/O

Inputs/outputs	8 optoisolated TTL lines, configurable as either 8 inputs or 8 outputs
Connector	One DB-25F

Relays

Outputs	4 independent SPDT relays

100 W DC outputs

Output	Two unipolar DC current sources
Connector	#6 screw terminals
Range	50 V 2 A, 50 V 0.6 A, 50 V 0.2 A, 20 V 2 A, 20 V 0.6 A, 20 V 0.2 A

CTC100 Specifications

Output resolution	16 bit
Accuracy	±1 mA (2 A range) ±0.5 mA (0.6 A range) ±0.2 mA (0.2 A range)
Noise (rms)	(25 Ω load, DC to 10 Hz) 5 µA (2 A range) 1.5 µA (0.6 A range) 0.5 µA (0.2 A range)

Diodes, Thermistors and RTD inputs

Inputs	Four inputs for 2-wire or 4-wire thermistor, diode, or RTD
Socket	Two DB9 (female)

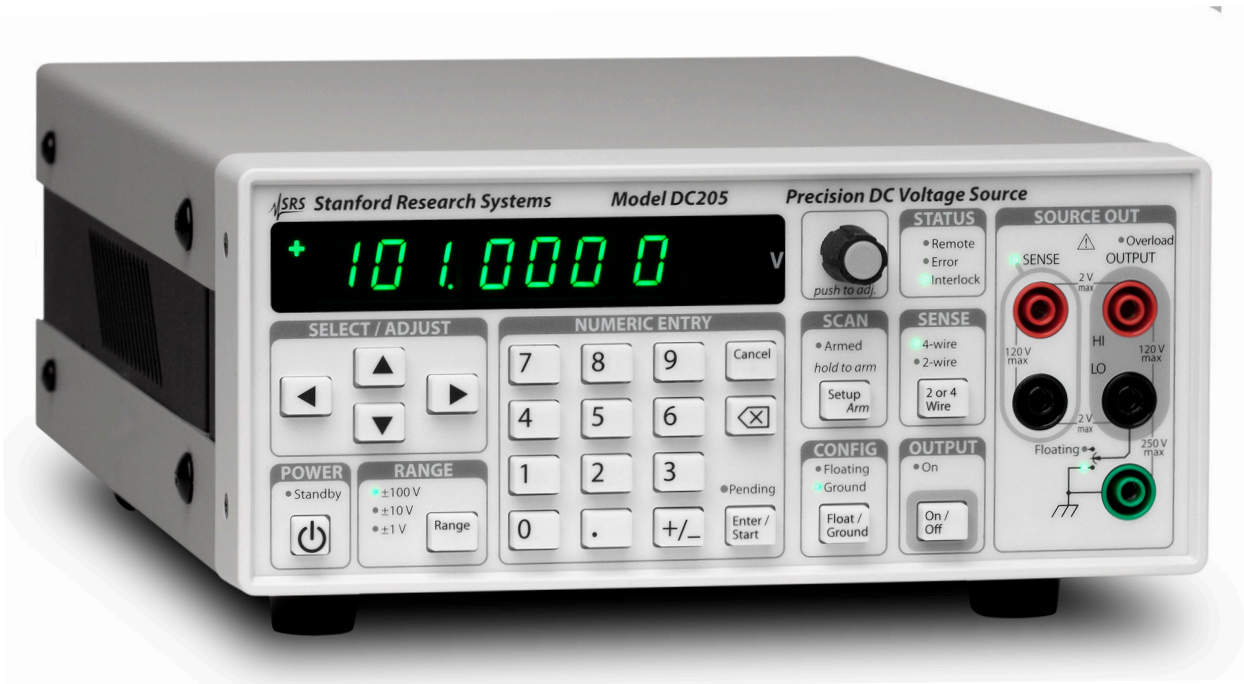
	Input Range	*Excitation Current*	*Initial Accuracy*	*Temp. Drift (typ.)* (at midrange)	*Noise (rms)* (at midrange)
Diodes	0 to 2.5 V	10 µA	10 µV + 0.01 % of rdg	±5 ppm/°C	3 µV
RTDs	0 to 10 Ω	3 mA	±0.005 Ω	±0.0001 Ω/°C	0.0001 Ω
	0 to 30 Ω	3 mA	±0.005 Ω	±0.0001 Ω/°C	0.0001 Ω
	0 to 100 Ω	2 mA	±0.008 Ω	±0.0002 Ω/°C	0.0002 Ω
	0 to 300 Ω	1 mA	±0.015 Ω	±0.0004 Ω/°C	0.0003 Ω
	0 to 1 kΩ	500 µA	±0.05 Ω	±0.001 Ω/°C	0.0007 Ω
	0 to 3 kΩ	200 µA	±0.1 Ω	±0.003 Ω/°C	0.002 Ω
	0 to 10 kΩ	50 µA	±0.25 Ω	±0.01 Ω/°C	0.007 Ω
	0 to 30 kΩ	50 µA	±1 Ω	±0.02 Ω/°C	0.008 Ω
	0 to 100 kΩ	5 µA	±4 Ω	±1 Ω/°C	0.12 Ω
	0 to 300 kΩ	5 µA	±13 Ω	±2 Ω/°C	0.2 Ω
	0 to 2.5 MΩ	1 µA	±1 kΩ	±50 Ω/°C	10 Ω
Thermistors	0 to 10 Ω	1 mA	±0.007 Ω	±0.0002 Ω/°C	0.0003 Ω
	0 to 30 Ω	300 µA	±0.03 Ω	±0.0004 Ω/°C	0.001 Ω
	0 to 100 Ω	100 µA	±0.07 Ω	±0.002 Ω/°C	0.002 Ω
	0 to 300 Ω	30 µA	±0.25 Ω	±0.004 Ω/°C	0.006 Ω
	0 to 1 kΩ	10 µA	±0.6 Ω	±0.01 Ω/°C	0.02 Ω
	0 to 3 kΩ	3 µA	±2 Ω	±0.06 Ω/°C	0.06 Ω
	0 to 10 kΩ	1 µA	±6 Ω	±0.2 Ω/°C	0.2 Ω
	0 to 30 kΩ	300 nA	±25 Ω	±1 Ω/°C	1.0 Ω
	0 to 100 kΩ	100 nA	±150 Ω	±3 Ω/°C	6 Ω
	0 to 300 kΩ	30 nA	±1 kΩ	±20 Ω/°C	40 Ω
	0 to 2.5 MΩ	1 µA	±1 kΩ	±30 Ω/°C	10 Ω

Ordering Information

CTC100	Cryogenic temperature controller	$2895
Option 01	GPIB interface (replaces RS-232)	$495
O100CTRM	Rack mount tray	$150

Precision DC Source

DC205 — ±100 VDC source



DC205 Precision DC Source

- **±100 VDC range**
- **True 6-digit resolution**
- **1 ppm/°C stability**
- **0.0025 % accuracy (1 yr.)**
- **Triggerable voltage scans**
- **Low-noise design**
- **Linear power supply**
- **RS-232, USB and fiber optic interfaces**

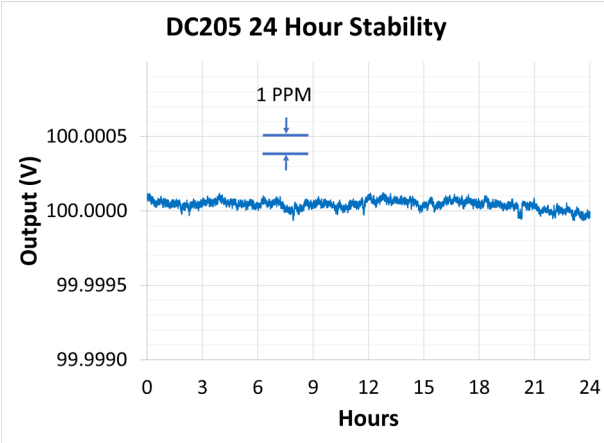
The DC205 low-noise, high-resolution DC voltage source is the right tool when a precision bias source is needed. Its bipolar, four-quadrant output delivers up to 100 V with 1 µV resolution and up to 50 mA of current. In 4-wire mode (remote sense), the instrument corrects for lead resistance delivering accurate potential to your load. The DC205's output stability is a remarkable ±1 ppm over 24 hours. With its linear power supply, there is no need to worry about high-frequency noise.

True 6-Digit Resolution

The front-panel display of the DC205 lets you set voltage with true 6-digit resolution. There are three voltage ranges to choose from: ±1 V, ±10 V and ±100 V which allows voltage settings from 1 µV to 100 V — eight orders of magnitude!

Low-Noise Design

The DC205 has outstanding noise characteristics — on the 1 V range, the rms noise is less than 1 µV (0.1 Hz to 10 Hz). It is also accurate to 0.0025 % over a one year period, and it has excellent temperature stability with a specification of less than 1 ppm/°C. The design even features linear power supplies rather than switching power supplies, so switching frequency interference can never be a problem.



DC205 Stability

Bipolar, Four-Quadrant Output

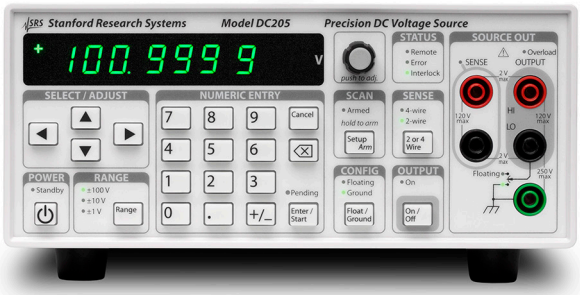
The DC205 can output either positive or negative voltages, and it operates in either grounded or floating mode. In floating mode, the output can float up to 250 V relative to chassis ground. You can also select either 2-wire or 4-wire operation. In 4-wire mode (remote sense), the instrument maintains its preset voltage directly at your load eliminating the effect of lead resistance.

Computer Interfaces

The DC205 has both RS-232 and USB computer interfaces on its rear panel. All functions of the instrument can be set or read via the interfaces. For remote interfacing with complete electrical isolation, the DC205 also has a rear-panel fiber optic interface. When connected to the SX199 Remote Computer Interface Unit, a path for controlling the DC205 via GPIB, Ethernet, and RS-232 is provided.

Voltage Scanning

The instrument's triggerable voltage scanning feature can be useful in a number of experimental applications. The start and stop voltage, and scan speed can all be controlled. Scan speeds can be set from 100 ms to 10,000 s, and the scan function can either be a ramp or a triangle wave. Single scans and continuous scans are both supported, and the instrument can be triggered from the front panel, remotely over one of the interfaces, or from an external trigger signal.



DC205 front panel

DC205 rear panel

DC205 Specifications

Signal Output

Output configuration	2-wire or 4-wire (remote sense) Output can be set to Ground or Float (250 V max.) mode
±1 VDC range	
Full scale	±1.010000 V
Resolution	1 µV
Max. current	50 mA
Accuracy	24 hour: ±(7 ppm of setting + 2 µV) 90 day*: ±(12 ppm of setting + 6 µV) 1 year*: ±(25 ppm of setting + 10 µV)
Stability	24 hour: ±(1 ppm of setting + 1 µV)
Temp. coefficient	±(1 ppm of setting + 1 µV)/°C (0 °C to 40 °C)
Noise (typ.)	0.5 µVrms (0.1 Hz to 10 Hz) 9 µVrms (10 Hz to 100 kHz)
±10 VDC range	
Full scale	±10.10000 V
Resolution	10 µV
Max. current	50 mA
Accuracy	24 hour: ±(7 ppm of setting + 12 µV) 90 day*: ±(12 ppm of setting + 20 µV) 1 year*: ±(25 ppm of setting + 20 µV)
Stability	24 hour: ±(1 ppm of setting + 3 µV)
Temp. coefficient	±(1 ppm of setting + 2 µV)/°C (0 °C to 40 °C)
Noise (typ.)	1.5 µVrms (0.1 Hz to 10 Hz) 12 µVrms (10 Hz to 100 kHz)
±100 VDC range	
Full scale	±101.0000 V
Resolution	100 µV
Max. current	25 mA
Accuracy	24 hour: ±(8 ppm of setting + 120 µV) 90 day*: ±(12 ppm of setting + 200 µV) 1 year*: ±(25 ppm of setting + 200 µV)
Stability	24 hour: ±(1 ppm of setting + 20 µV)
Temp. coefficient	±(1 ppm of setting + 15 µV)/°C (0 °C to 40 °C)
Noise (typ.)	12 µVrms (0.1 Hz to 10 Hz) 50 µVrms (10 Hz to 100 kHz)

Voltage Scanning

Scan speed	0.1 s to 9999.9 s
Scan type	Ramp or triangle wave, continuous or single shot
Triggered scans	Scans can be triggered using the rear-panel trigger input

Remote Interfaces

USB	Virtual COM port with FTDI drivers, 115.2k baud, 8 bits, no parity, 1 stop bit, RTS/CTS flow
RS-232	DB-9 connector, 9600 baud
Optical fiber	Connection to SX199 Optical Interface Controller. Provides connectivity to GPIB, RS-232 and Ethernet

General

Operating temperature	0 °C to 40 °C, non-condensing
Power	<30 W, 100/120/220/240 VAC, 50 Hz or 60 Hz
Dimensions	8.3" × 3.55" × 13.0" (WHD)
Weight	10 lbs.
Warranty	One year parts and labor on defects in materials and workmanship

* *Preliminary specifications*

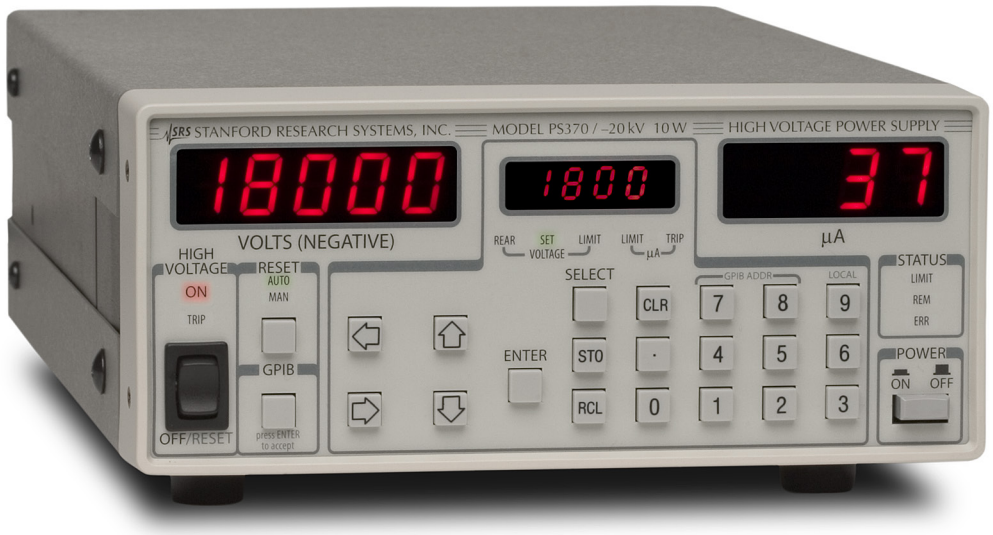
All performance specifications after 2 hours warm-up at 23 °C ± 1 °C ambient, unless otherwise stated

Ordering Information

DC205	Precision voltage source
O205RMS	Single rack mount kit
O205RMD	Dual rack mount kit

High Voltage Power Supplies

PS300 Series — DC high voltage power supplies to 20 kV



PS300 Series High Voltage Supplies

- **Up to 20 kV (PS375)**
- **1 V resolution**
- **0.05 % accuracy**
- **Programmable limits and trips**
- **0.0015 % ripple**
- **0.001 % regulation**
- **GPIB interface**
- **RS-232 interface (10 W models)**

- **PS310**
- **PS325**
- **PS350**
- **PS355, PS365, PS370, PS375**

The PS300 Series High Voltage Power Supplies — rugged, compact, reliable instruments for just about any high voltage application.

With up to 20 kV output capability, a GPIB computer interface, and 0.001 % voltage regulation, these high voltage power supplies have become the industry standard.

There are several models to choose from, with outputs ranging from 1.25 kV to 20 kV.

Model	Output Voltage	Current
PS310	±12 V to ±1.25 kV	20 mA
PS325	±25 V to ±2.5 kV	10 mA
PS350	±100 V to ±5 kV	5 mA
PS355	–100 V to –10 kV	1 mA
PS365	+100 V to +10 kV	1 mA
PS370	–100 V to –20 kV	0.5 mA
PS375	+100 V to +20 kV	0.5 mA

The PS310, PS325 and PS350 are dual-polarity, 25 W supplies, while the PS355, PS365, PS370 and PS375 are single-polarity, 10 W supplies. All of the instruments are arc and short-circuit protected with separate programmable hard and soft current limits, making it possible to use them as constant current sources.

The Right Features

Whichever model you choose, you'll appreciate the convenience and versatility of the PS300 Series. Two large LED displays monitor the output voltage and current being delivered to your load. Overload reset, limit and trip status, local/remote state, and high voltage enable are also displayed, so you can monitor the instrument status at a glance. A highly visible red LED always indicates when the high voltage is on.

Easy to Use

Operation is simple. The parameter being adjusted or set is displayed separately and can be entered without affecting the actual output voltage. Up to nine instrument configurations can be stored and recalled at any time, making it easy to run multiple tests.

High voltage cables

Remote Programming

Both GPIB and RS-232 computer interfaces are standard on all 10 W supplies. GPIB is available as an option on the 25 W instruments. All parameters can be set and read via the computer interfaces.

PS370 rear panel

Analog Monitoring and Control

A rear-panel analog input allows the high voltage output to be programmed by a 0 to 10 VDC signal. Two rear-panel analog outputs provide output voltage and current monitoring capabilities. These outputs drive up to 10 mA of current and have 1 Ω output impedance.

Performance and Value

The PS300 Series High Voltage Power Supplies are as useful in the R&D lab as they are in automated test applications. Wherever you are using them, the PS300 Series provide proven reliability and performance at a very affordable price.

PS310, PS325 & PS350 Specifications

Model	Output Voltage	Max. Current
PS310	±12 V to ±1.25 kV	20 mA
PS325	± 25 V to ±2.5 kV	10 mA
PS350	± 100 V to ±5.0 kV	5 mA

Output

Voltage set accuracy	0.01 % + 0.05 % of full scale, typ
Volt. display accuracy	Vset accuracy ± 1 V, typ. (± 2 V, max.)
Voltage resolution	1 V (set and display)
Voltage resettability	1 V
Voltage limit range	0 to 100 % of full scale
Voltage regulation(*)	0.001 % for ±10 % line change 0.005 % for 100 % load change
Output ripple (rms)	<0.002 % of full scale
Current limit range	0 to 105 % of full scale
Trip current range	10 µA to 105 % of full scale
Trip response time	<10 µs (excluding stored output charge)
Current set accuracy	0.01 % + 0.05 % of full scale
Current resolution	10 µA (PS310 and PS325) 1 µA (PS350)
Current display accuracy	±10 µA (typ.), ±20 µA (max.) (PS310 and PS325) ±1 µA (typ.), ±2 µA (max.) (PS350)

General

Stability	0.01 % per hr., <0.03 % per 8 hrs.
Temperature drift	50 ppm/°C, 10 to 40 °C (typ.)
Protection	Arc and short circuit protected (Programmable voltage limit, current limit, and current trip)
Recovery time	12 ms for 40 % step change in load current (typ.)
Discharge time	<6 s (to <1 % of full-scale voltage with no load, typ.)

Monitor Outputs

Output scale	0 to +10 V for 0 to full-scale output regardless of polarity
Current rating	10 mA (max.)
Output impedance	<1 Ω
Accuracy	±0.2 % of full scale
Update rate	8 Hz

External Voltage Set

Input scale	0 to +10 V for 0 to full-scale output regardless of polarity
Input impedance	1 MΩ
Accuracy	±0.2 % of full scale
Update rate	16 Hz
Output slew rate	<0.3 s for 0 to full scale (full load)

Mechanical

HV connector PS310/325/350	 Kings type 1704-1
Mating connector PS310/325/350	 Kings type 1705-1
Dimensions, weight	8.1" × 3.5" × 16" (WHD), 8 lbs.
Power	50 W, 100/120/220/240 VAC, 50 Hz/60 Hz
Warranty	One year parts and labor on defects in materials or workmanship

(*) Regulation specification applies for Vout >0.5% full scale (typ.) for full load & Vout >1% full scale (typ.) for no load. Below these values the unit may not regulate correctly.

All performance specifications apply after a one hour warm-up period, and are restricted to the specified voltage range for each model.

PS355, PS365, PS370 & PS375 Specifications

Model	Output Voltage	Max. Current
PS355	–100 V to –10 kV	1 mA
PS365	+100 V to +10 kV	1 mA
PS370	–100 V to –20 kV	500 µA
PS375	+100 V to +20 kV	500 µA

Output

Voltage set accuracy	0.06 % of full scale
Volt. display accuracy	Vset accuracy ± 1 V, typ. (± 2 V, max.)
Voltage resolution	1 V (set and display)
Voltage limit range	0 to 100 % of full scale
Voltage regulation	0.001 % for ±10 % line change 0.04 % for 100 % load change
Output ripple (rms)	<0.01 % of full scale (300 Hz to 300 kHz)
Current limit range	0 to 105 % of full scale
Current trip range	10 µA to 105 % of full scale
Trip response time	<10 ms (excluding stored output charge)
Output stored charge	<20 µC max (PS355 and PS365) <40 µC max (PS370 and PS375)
Current set accuracy	0.5 % of full scale
Current resolution	±1 µA
Current display acc.	±1 µA (typ.), ±2 µA (max.)

General

Temperature drift	50 ppm/°C, 10 to 40 °C (typ.)
Protection	Arc and short circuit protected (Programmable voltage limit, current limit, and current trip)
HV output slew rate	7,000 V/s typ (PS355 and PS365) 14,000 V/s typ (PS370 and PS375)
Recovery time	12 ms for 40 % step change in load current (typ.)
Discharge time	<6 s (to <1 % of full-scale voltage with no load, typ.)

Monitor Outputs

Output scale	0 to +10 V for 0 to full-scale output regardless of polarity
Current rating	10 mA (max.)
Output impedance	<100 Ω
Accuracy	±0.2 % of full scale
Update rate	87.5 Hz

External Voltage Set

Input scale	0 to +10 V for 0 to full-scale output regardless of polarity
Input impedance	1 MΩ
Accuracy	±0.2 % of full scale
Update rate	87.5 Hz

Mechanical

HV connector	
PS355/365	Kings type 1064-1
PS370/375	Kings type 1764-1
Mating connector	
PS355/365	Kings type 1065-1
PS370/375	Kings type 1765-1
Dimensions, weight	8.1" × 3.5" × 14" (WHD), 8 lbs.
Power	75 W, 100-240 VAC, 50 Hz to 60 Hz
Warranty	One year parts and labor on defects in materials or workmanship

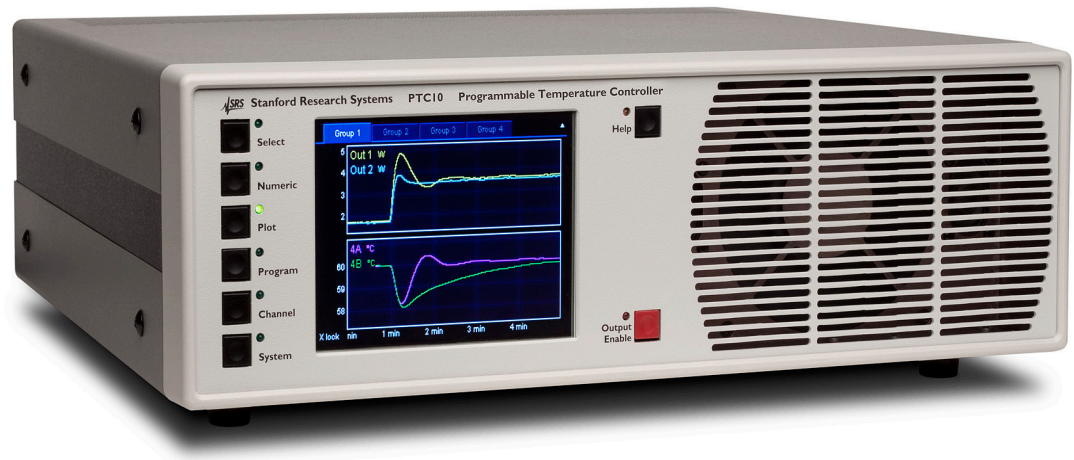
All performance specifications apply after a one hour warm-up period, and are restricted to the specified voltage range for each model.

Ordering Information

PS310	±1.25 kV DC power supply
PS325	±2.5 kV DC power supply
PS350	±5.0 kV DC power supply
Option 01	GPIB interface
/2D	Double rack mount kit
/2S	Single rack mount kit
/3A	SHV to SHV cable, 10 ft.
/3B	SHV to MHV cable, 10 ft.
PS355	–10 kV supply w/ GPIB & RS-232
PS365	+10 kV supply w/ GPIB & RS-232
/3C	10 kV-SHV to open cable, 10 ft.
/3D	10 kV-SHV to 10 kV-SHV cable, 10 ft.
O300RMS	Single rack mount kit
O300RMD	Double rack mount kit
PS370	–20 kV supply w/ GPIB & RS-232
PS375	+20 kV supply w/ GPIB & RS-232
/3E	20 kV-SHV to open cable, 10 ft.
/3F	20 kV-SHV to 20 kV-SHV cable, 10 ft.
O300RMS	Single rack mount kit
O300RMD	Double rack mount kit

Temperature Controllers

PTC10 — Programmable temperature controller



PTC10 Temperature Controller

- **Up to 16 input channels**
- **Up to 6 PID feedback control channels**
- **50 Hz PID sampling**
- **1 mK resolution**
- **Data logging on removable flash media**
- **USB, Ethernet, RS-232 interfaces (std.)**
- **GPIB interface (opt.)**

- **PTC10 ... $1750** *(U.S. list)*

Introducing the PTC10 Programmable Temperature Controller from SRS — the ideal instrument for measuring temperature, controlling heaters, and logging temperature data.

The PTC10 Programmable Temperature Controller is a modular system that can be configured to suit a wide range of applications. The system consists of the PTC10 Controller and up to four I/O cards — two types of input cards for RTDs and thermocouples, and two types of output cards for driving heaters. The I/O cards are ordered separately, and you can mix and match them in any way you wish.

Input Cards

The PTC320 Thermistor/Diode/RTD reader has a single input that can read a variety of resistive and diode temperature sensors including thermistors, RTDs, cryogenic diodes, and ruthenium oxide sensors.

The PTC321 RTD reader has four inputs for 100 Ω platinum RTD sensors. Each channel has a four-wire input with its own 1 mA current source for sensor excitation. The current can be reversed with each reading to cancel out stray thermocouple EFMs.

The PTC330 four-channel thermocouple input card is factory configured to read either E, J, K, N or T type thermocouples. Each channel is electrically isolated allowing thermocouples to be attached to electrically-live equipment. An internal

PTC330 Thermocouple Card

PTC430 DC Output Card

isothermal block, with its own RTD temperature sensor, provides highly accurate cold junction measurements.

Output Cards

The PTC420 AC output card is a heater driver that switches up to 5 A of 100 VAC to 240 VAC line current with a solid-state relay. The output power is controlled by switching the current on for some fraction of a 10 s cycle period and off for the remainder of the period. The PTC420 is intended to drive large heaters with response times of more than about 10 s. A PTC chassis can run up to two PTC420s at full power simultaneously.

The PTC430 DC output card delivers up to 1 A of current at 50 VDC, or up to 2 A at 20 VDC. Its unipolar output provides finer control for driving smaller, faster responding heaters.

The PTC440 TEC driver delivers ±5 A of current at ±12 VDC. This bipolar output card is optimized for driving thermoelectric coolers. It also includes a temperature sensor input that can read thermistors, RTDs, LM135, and AD590 sensors.

A PTC chassis can run up to three PTC430s and/or PTC440s at full power simultaneously.

PID Feedback

In a proportional-integral-differential (PID) feedback loop, the power supplied to a heater (the feedback output) is continually adjusted to keep a temperature reading (the input) at a predetermined value (the setpoint). The PTC10 offers up to six independent PID feedback outputs: one on each of up to two output cards, plus the four analog I/O channels. Any of the data channels can be used as the feedback input. PID feedback loops can be auto-tuned using either a single step response or a relay tuning method in which multiple steps create a temperature oscillation.

Data Acquisition and Display

All input channels are read simultaneously at rates between 1 Hz and the line frequency (50 or 60 Hz). Each input channel can be lowpass-filtered to reduce noise. Input channels can also be differenced with any other channel. Three "virtual channels", which are not connected to any physical input, can display the results of more complex calculations.

Standard calibration curves are included for popular sensor types. Custom calibration curves with up to 200 points each can also be applied to any input; the curves are stored on a removable USB memory device and are loaded by simply plugging the device into the PTC10. Sensor calibration can also be adjusted by entering an offset and gain from the front panel.

The PTC10 has an internal data log that stores up to 4096 points per channel. Data can be written to the log at intervals between 0.1 s and 1 hr. The log rate can be set independently for each channel, or a global rate can be used. Data can also be logged to removable USB memory devices like flash keys, flash card readers, and USB hard drives. In this case, the maximum number of points that can be logged is determined by the size of the memory device.

Input and output data can be displayed numerically or plotted on the LCD screen. Up to eight plots, each with up to eight data channels, can be displayed. You can zoom or pan the plots by touching or dragging your finger across the screen.

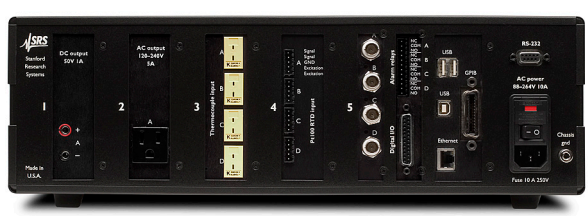
Upper/lower alarm levels or rate-of-change limits can be assigned to each input. If these limits are exceeded, an audible alarm sounds, a specified relay trips, and a specified output channel can be shut off. Alarms can be latching or non-latching.

Programmability

Remote operation is supported with USB, GPIB (opt.), RS-232, and Ethernet interfaces. All instrument functions can be controlled and read over any of the interfaces. When the USB interface is used, the PTC appears as a COM port on your PC.

The PTC10 supports user-defined macros that consist of one or more remote commands. Macros can be controlled from the front panel, and up to ten macros can run simultaneously. Macros can call other macros, and conditional statements, variables, and loops are supported. Using the PTC10's three virtual channels, macro variables can be plotted on-screen, saved to logs, and/or used as inputs for feedback loops.

Macros are a powerful tool that can be used to tailor the behavior of the PTC10 for your experiment. For example, infinite-loop macros running as background tasks can take steps to address alarm conditions, automatically switch between sensor inputs (or heater outputs) depending on the current temperature or other factors, or implement cascade feedback schemes.



PTC10 rear panel

Multi-Purpose Ports

The PTC10 has four configurable general-purpose analog I/O channels, each of which can be used either as a 24-bit, ±10V input or a 16-bit, ±10V output. The PTC10 also has eight bidirectional digital I/O lines that can interact with macros, and four relays that can be tripped by alarms, remote commands, macros, or from the front panel.

The PTC10's analog I/O channels can be used as feedback inputs, and custom calibration curves can be applied to convert their voltage readings into temperature, pressure, etc. values. If configured as an output, each analog I/O channel has its own PID feedback loop and can be interfaced with external equipment to control a heater or valve. The analog I/O channels can also be made to follow any other input or output, with scale and offset factors applied.

Flexibility

The PTC10 Programmable Temperature Controller has the flexibility to handle virtually any temperature application. It's as useful in the research lab as it is in industry. The PTC10 is the right choice for all your temperature control experiments.

Specifications

PTC10 Temperature Controller

Data acquisition rate	1 to 50 Hz
Temperature resolution	<0.001 °C
PID feedback	Both manual and auto-tuning modes are available.
Data display	320 × 240 pixel touchscreen. Both numeric and graphical data displays.
Alarms	Upper and lower temperature limits, and rate-of-change limits can be set on each channel. If exceeded, an audio alarm and a relay closure will occur.
Analog ports	
# of ports	4 configurable DAC or ADC ports
Range	±10 VDC
Resolution	24-bit input, 16-bit output
Update rate	50 Hz
Connector	BNC
Computer interface	USB, Ethernet, and RS-232. GPIB (IEEE488.2) is optional.
Power	10 A 88 to 132 VAC or 176 to 264 VAC, 47 to 63 Hz or DC
Dimensions, weight	17" × 5" × 18" (WHL), 25 lbs.
Warranty	One years parts and labor on defects in material and workmanship.

PTC320 Thermistor/Diode/RTD Reader Card

Inputs	One input for 2-wire or 4-wire thermistor, diode or RTD
Connector	6-pin 240° push-pull DIN socket

Thermistors

Range	*Excitation current*	*Initial accuracy*	*Drift*	*Noise (rms)*
30 Ω	200 µA	±0.025 Ω	±0.002 Ω/°C	0.003 Ω
100 Ω	100 µA	±0.06 Ω	±0.006 Ω/°C	0.006 Ω
300 Ω	50 µA	±0.1 Ω	±0.006 Ω/°C	0.012 Ω
1 kΩ	30 µA	±0.2 Ω	±0.01 Ω/°C	0.02 Ω
3 kΩ	20 µA	±0.6 Ω	±0.03 Ω/°C	0.03 Ω
10 kΩ	10 µA	±1.3 Ω	±0.1 Ω/°C	0.6 Ω
30 kΩ	5 µA	±4 Ω	±0.15 Ω/°C	0.1 Ω
100 kΩ	3 µA	±10 Ω	±0.5 Ω/°C	0.3 Ω
300 kΩ	2 µA	±250 Ω	±3 Ω/°C	3 Ω
2.5 MΩ	1 µA	±30 kΩ	±2000 Ω/°C	25 Ω

Diodes

Excitation current	10 µA
Initial accuracy	±100 ppm
Drift	±5 ppm/°C
Voltage input	0 to 2.5 V
Initial accuracy	10 µV + 0.01 % of reading
Drift	±5 ppm/°C
RMS noise	1.5 µV

RTDs

Range	*Excitation current*	*Initial accuracy*	*Drift*	*Noise (rms)*
30 Ω	5 mA	±0.004 Ω	±0.0006 Ω/°C	0.00012 Ω
100 Ω	2 mA	±0.008 Ω	±0.001 Ω/°C	0.0003 Ω
300 Ω	1 mA	±0.02 Ω	±0.0015 Ω/°C	0.0006 Ω
1 kΩ	500 µA	±0.04 Ω	±0.005 Ω/°C	0.0013 Ω
3 kΩ	200 µA	±0.1 Ω	±0.01 Ω/°C	0.003 Ω
10 kΩ	100 µA	±0.2 Ω	±0.03 Ω/°C	0.006 Ω
30 kΩ	50 µA	±1 Ω	±0.06 Ω/°C	0.012 Ω
100 kΩ	10 µA	±2.5 Ω	±0.2 Ω/°C	0.07 Ω
300 kΩ	5 µA	±16 Ω	±3 Ω/°C	0.25 Ω
2.5 MΩ	1 µA	±30 kΩ	±2000 Ω/°C	25 Ω

PTC321 Pt RTD Card

Temperature range	–200 °C to 850 °C
Inputs	Four 100 Ω Pt RTD 4-wire inputs
Excitation	1 mA
Accuracy	±30 mK
Noise	2 mKrms (10 samples/s)
Temp. coefficient	1.4 mK/°C
Signal conditioning	Selectable 1 and 10 second time constant digital LPFs are provided.
Signal detection	Detects open and short circuit conditions.

PTC330 Thermocouple Card

Thermocouple types	E, J, K, N or T
Temperature range	(range of calibration table with cold junction at 25 °C)
E-type	–245 °C to 1025 °C
J-type	–185 °C to 1225 °C
K-type	–245 °C to 1395 °C
N-type	–245 °C to 1325 °C
T-type	–245 °C to 425 °C
Inputs	Four thermocouple inputs
Input capacitance	<1 pF
Connector type	Omega mini thermocouple jacks
Accuracy	±500 mK (over 12 months)
Noise	20 mKrms (10 samples/s)
Temp. coefficient	20 mK/°C (type K thermocouple at 164.0 K)
CMRR	100 dB
CM isolation	250 VAC

PTC420 AC Output Card

Output voltage	120/240 VAC
Max. output current	5 A
Cycle time	Adjustable between 1 and 240 s
Max. line voltage	250 VAC
Surge current	100 A max. (non-repetitive)
Output resolution	0.1 % at 10 s cycle time
Heater resistance (min.)	24 Ω (110 VAC), 46 Ω (230 VAC)

PTC430 DC Output Card

Max. output voltage	50 VDC
Voltage ranges	20 V and 50 V
Max. output current	1 A
Current ranges	0.1 A, 0.5 A, 1 A (50 V) or 2 A (20 V)
Output resolution	16-bit (24-bit with dithering)
Accuracy	±1 mA (1 A range) ±0.1 mA (0.5 A range) ±0.01 mA (0.1 A range)
Noise (rms), 50 Ω load, DC to 10 Hz	6 µV (50 V 1 A and 20 V 2 A ranges) 1.5 µA (0.5 A range) 0.2 µA (0.1 A range)

PTC431 100 W DC Output Card

Output	One unipolar DC current sources
Connector	#6 screw terminals
Range	50 V 2 A, 50 V 0.2 A, 50 V 0.02 A, 20 V 2 A, 20 V 0.2 A, 20 V 0.02 A
Output resolution	16 bit
Accuracy	±1 mA (2 A range) ±0.02 mA (0.2 A range) ±0.002 mA (0.02 A range)
Noise (rms)	(25 Ω load, DC to 10 Hz) 5 µA (2 A range) 0.5 µA (0.2 A range) 0.05 µA (0.02 A range)

PTC440 TEC Driver Card

Output	One linear, bipolar DC current source
Input	One 2- or 4-wire thermistor, RTD, IC temperature sensor input
Connector	One 15-pin DB15-F

TEC Driver

Output current	–5 A to +5 A
Maximum power	60 W
Compliance volt.	12 V
Output resolution	0.15 mA
Accuracy	±5 mA

Temperature Sensor Input

Compatible sensors	
Thermistors	2- or 4-wire NTC thermistors
RTDs	4-wire platinum RTDs, 100 Ω to 1000 Ω at 0 °C
IC sensors	LM335, AD590 or equivalent
Excitation current	10 µA, 100 µA or 1 mA
Input range	
Resistance	1 Ω to 250 kΩ
Voltage	0 to 2.5 V
Current	0 to 1 mA
Electronic noise	
100 Ω Pt RTD	0.003 Ω rms = 10 mK rms (at 25 °C and 1 mA excitation)
1 kΩ thermistor	0.03 Ω rms = 0.7 mK rms (at 25 °C and 1 mA excitation) 0.2 Ω rms = 5 mK rms (at 25 °C and 100 µA excitation)
10 kΩ thermistor	0.4 Ω rms = 0.8 mK rms (at 25 °C and 100 µA excitation) 3 Ω rms = 7 mK rms (at 25 °C and 10 µA excitation)
LM135/235/335	4 mK rms
AD590/592	9 mK rms

PTC323 Diode/Thermistor/RTD Reader Card

Inputs	Two inputs for 2-wire or 4-wire thermistor, diode, or RTD
Socket	One DB9 (female)

	Input Range	*Excitation Current*	*Initial Accuracy*	*Temp. Drift (typ.)* (at midrange)	*Noise (rms)* (at midrange)
Diodes	0 to 2.5 V	10 µA	10 µV + 0.01 % of rdg	±5 ppm/°C	3 µV
RTDs	0 to 10 Ω	3 mA	±0.005 Ω	±0.0001 Ω/°C	0.0001 Ω
	0 to 30 Ω	3 mA	±0.005 Ω	±0.0001 Ω/°C	0.0001 Ω
	0 to 100 Ω	2 mA	±0.008 Ω	±0.0002 Ω/°C	0.0002 Ω
	0 to 300 Ω	1 mA	±0.015 Ω	±0.0004 Ω/°C	0.0003 Ω
	0 to 1 kΩ	500 µA	±0.05 Ω	±0.001 Ω/°C	0.0007 Ω
	0 to 3 kΩ	200 µA	±0.1 Ω	±0.003 Ω/°C	0.002 Ω
	0 to 10 kΩ	50 µA	±0.25 Ω	±0.01 Ω/°C	0.007 Ω
	0 to 30 kΩ	50 µA	±1 Ω	±0.02 Ω/°C	0.008 Ω
	0 to 100 kΩ	5 µA	±4 Ω	±1 Ω/°C	0.12 Ω
	0 to 300 kΩ	5 µA	±13 Ω	±2 Ω/°C	0.2 Ω
	0 to 2.5 MΩ	1 µA	±1 kΩ	±50 Ω/°C	10 Ω
Thermistors	0 to 10 Ω	1 mA	±0.007 Ω	±0.0002 Ω/°C	0.0003 Ω
	0 to 30 Ω	300 µA	±0.03 Ω	±0.0004 Ω/°C	0.001 Ω
	0 to 100 Ω	100 µA	±0.07 Ω	±0.002 Ω/°C	0.002 Ω
	0 to 300 Ω	30 µA	±0.25 Ω	±0.004 Ω/°C	0.006 Ω
	0 to 1 kΩ	10 µA	±0.6 Ω	±0.01 Ω/°C	0.02 Ω
	0 to 3 kΩ	3 µA	±2 Ω	±0.06 Ω/°C	0.06 Ω
	0 to 10 kΩ	1 µA	±6 Ω	±0.2 Ω/°C	0.2 Ω
	0 to 30 kΩ	300 nA	±25 Ω	±1 Ω/°C	1.0 Ω
	0 to 100 kΩ	100 nA	±150 Ω	±3 Ω/°C	6 Ω
	0 to 300 kΩ	30 nA	±1 kΩ	±20 Ω/°C	40 Ω
	0 to 2.5 MΩ	1 µA	±1 kΩ	±30 Ω/°C	10 Ω

Ordering Information

PTC10	Programmable temperature controller	$1750
Opt.01	GPIB interface	$595
PTC320	Thermistor/Diode/RTD reader	$695
PTC321	4-ch. Pt RTD card	$695
PTC322	4-ch. Pt RTD card (single slot only)	$695
PTC323	Thermistor/Diode/RTD reader	$950
PTC330E	4-ch. E-type thermocouple card	$695
PTC330J	4-ch. J-type thermocouple card	$695
PTC330K	4-ch. K-type thermocouple card	$695
PTC330T	4-ch. T-type thermocouple card	$695
PTC330N	4-ch. N-type thermocouple card	$695
PTC420	600 W AC output card	$495
PTC430	50 W DC output card	$595
PTC431	100 W DC output card	$750
PTC440	TEC driver	$595
O10RM	Rack mount kit	$100

Optical Chopper

SR540 — Optical chopper system

- **4 Hz to 3.7 kHz chopping frequencies**
- **Low phase jitter**
- **Single and dual beam experiments**
- **Sum & difference reference outputs**

SR540 Specifications

The SR540 chopper will handle all your optical chopping requirements — from simple measurements to dual-beam and intermodulation experiments. The SR540 has a 4-digit frequency display, front-panel frequency control, analog voltage frequency control, and two reference outputs with selectable operating modes. Two anodized aluminum blades are provided: a 5/6 slot blade for frequencies up to 400 Hz, and a 25/30 slot blade for frequencies up to 3.7 kHz. Reference outputs are provided for frequencies corresponding to each row of slots, as well as the sum and difference frequencies.

Chop frequency	4 Hz to 400 Hz (5/6 slot blade) 400 Hz to 3.7 kHz (25/30 slot blade)
Frequency stability	250 ppm/°C (typ.)
Frequency drift	<2 %, 100 Hz < f < 3700 Hz
Phase jitter (rms)	0.2° (50 Hz to 400 Hz) 0.5° (400 Hz to 3.7 kHz)
Frequency display	4-digit, 1 Hz resolution and accuracy
Frequency control	10-turn pot with 3 ranges: 4 Hz to 40 Hz 40 Hz to 400 Hz 400 Hz to 3.7 kHz
Input control voltage	0 to 10 VDC for 0 to 100 % of full scale. Control voltage overrides frequency dial.
Reference modes	f_{inner}, f_{outer}, $5 \times f_{outer}$, $f_{inner} + f_{outer}$, $f_{outer} - f_{inner}$
Dimensions	Controller: 7.7" × 1.8" × 5.1" (WHD) Head: 2.8" × 2.1" × 1.0" (WHD)
Blade diameter	4.04" ± 0.002"
Cable length	6 ft.
Power	12 W, 100/120/220/240 VAC, 50/60 Hz
Warranty	One year parts and labor on materials and workmanship, 90 days on motor

Ordering Information

SR540	Optical chopper
O5402530	25/30 dual-slot replacement blade
O54056	5/6 dual-slot replacement blade
O5405	5-slot replacement blade
O54030	30-slot replacement blade
O540RCH	Replacement chopper head