Model 336
Temperature Controller

Lake Shore
CRYOTRONICS

Model 336 Temperature Controller

- Operates down to 300 mK with appropriate NTC RTD sensors
- Four sensor inputs and four independent control outputs
- Four PID-controlled outputs: 100 W and 50 W into a 50 or 25 Ω load and two low-power voltage outputs
- Autotuning automatically collects PID parameters
- Automatically switch sensor inputs using zones to allow continuous measurement and control from 300 mK to 1 505 K
- Custom display setup allows you to label each sensor input
- Ethernet, USB, and IEEE-488 interfaces
- Supports diode, RTD, and thermocouple temperature sensors
- Sensor excitation current reversal eliminates thermal EMF errors for resistance sensors
- ±10 V analog voltage outputs, alarms, and relays

Introduction

The first of a new generation of innovative temperature measurement and control solutions by Lake Shore, the Model 336 temperature controller comes standard equipped with many advanced features promised to deliver the functionality and reliable service you've come to expect from the world leader in cryogenic thermometry. The Model 336 is the only temperature controller available with four sensor inputs, four control outputs and 150 W of low noise heater power. Two independent heater outputs providing 100 W and 50 W can be associated with any of the four sensor inputs and programmed for closed loop temperature control in proportional-integral-derivative (PID) mode. The improved autotuning feature of the Model 336 can be used to automatically collect PID parameters, so you spend less time tuning your controller and more time conducting experiments.

The Model 336 supports the industry's most advanced line of cryogenic temperature sensors as manufactured by Lake Shore, including diodes, resistance temperature detectors (RTDs), and thermocouples. The controller's zone tuning feature allows you to measure and control temperatures seamlessly from 300 mK to over 1,500 K by automatically switching temperature sensor inputs when your temperature range goes beyond the usable range of a given sensor. You'll never again have to be concerned with temperature sensor over or under errors and measurement continuity issues. Alarms, relays, and ±10 V analog voltage outputs are available to help automate secondary control functions.

Another innovative first from Lake Shore, the ability to custom label sensor inputs eliminates the guesswork in remembering or determining the location to which a sensor input is associated. As we strive to maintain increasingly demanding workloads, ease of use and the ability to stay connected from anywhere in the world are critical attributes. With standard Ethernet, USB, and IEEE-488 interfaces and an intuitive menu structure and logic, the Model 336 was designed with efficiency, reliable connectivity, and ease of use in mind. While you may need to leave your lab, Ethernet ensures you'll always be connected to your experiments. The new intuitive front panel layout and keypad logic, bright graphic display, and LED indicators enhance the user friendly front panel interface of the Model 336.

In many applications, the unparalleled feature set of the Model 336 allows you to replace several instruments with one, saving time, money, and valuable laboratory space. Delivering more feedback, tighter control, and faster cycle times, the Model 336 keeps up with increasingly complex temperature measurement and control applications. It is the ideal solution for general purpose to advanced laboratory applications. Put the Model 336 temperature controller to use in your lab and let it take control of your measurement environment.

Sensor inputs

The Model 336 offers four standard sensor inputs that are compatible with diode and RTD temperature sensors. The field-installable Model 3060 thermocouple input option provides support for up to two thermocouple inputs by adding thermocouple functionality to inputs C and D.

Sensor inputs feature a high-resolution 24-bit analog-to-digital converter; each input has its own current source, providing fast settling times. All four sensor inputs are optically isolated from other circuits to reduce noise and to provide repeatable sensor measurements. Current reversal eliminates thermal electromotive force (EMF) errors in resistance sensors. Nine excitation currents facilitate temperature measurement and control down to 300 mK using appropriate negative temperature coefficient (NTC) RTDs. Autorange mode automatically scales excitation current in NTC RTDs to reduce self heating at low temperatures as sensor resistance changes by many orders of magnitude. Temperatures down to 1.4 K can be measured and controlled using silicon or GaAlAs diodes. Software selects the appropriate excitation current and signal gain levels when the sensor type is entered via the instrument front panel. The unique zone setting feature automatically switches sensor inputs, enabling you to measure temperatures from 300 mK to over 1 500 K without interrupting your experiment.

The Model 336 includes standard temperature sensor response curves for silicon diodes, platinum RTDs, ruthenium oxide RTDs, and thermocouples. Non-volatile memory can also store up to 39 200-point CalCurves for Lake Shore calibrated temperature sensors or user curves. A built-in SoftCal algorithm can be used to generate curves for silicon diodes and platinum RTDs that can be stored as user curves. Temperature sensor calibration data can be easily uploaded and manipulated using the Lake Shore curve handler software.

Temperature control

Providing a total of 150 W of heater power, the Model 336 is the most powerful temperature controller available. Delivering very clean heater power, it precisely controls temperature throughout the full scale temperature range for excellent measurement reliability, efficiency, and throughput. Two independent PID control outputs supplying 100 W and 50 W of heater power can be associated with any of the four standard sensor inputs. Precise control output is calculated based on your temperature setpoint and feedback from the control sensor. Wide tuning parameters accommodate most cryogenic cooling systems and many high-temperature ovens commonly used in laboratories. PID values can be manually set for fine control, or the improved autotuning feature can automate the tuning process. Autotune collects PID parameters and provides information to help build zone tables. The setpoint ramp feature provides smooth, continuous setpoint changes and predictable setpoint approaches without the worry of overshoot or excessive settling times. When combined with the zone setting feature, which enables automatic switching of sensor inputs and scales current excitation through ten different preloaded temperature zones, the Model 336 provides continuous measurement and control from 300 mK to 1505 K.

Control outputs 1 and 2 are variable DC current sources referenced to chassis ground. Output 1 can provide 100 W of continuous power to a 25 Ω load or 50 W to a 50 Ω or 25 Ω load. Output 2 provides 50 W to 25 Ω or 50 Ω heater loads. Outputs 3 and 4 are variable DC voltage source outputs providing two ±10 V analog outputs. When not in use to extend the temperature controller heater power, these outputs can function as manually controlled voltage sources.

Temperature limit settings for inputs are provided as a safeguard against system damage. Each input is assigned a temperature limit, and if any input exceeds that limit, all control channels are automatically disabled.

Interface

The Model 336 is standard equipped with Ethernet, universal serial bus (USB) and parallel (IEEE-488) interfaces. In addition to gathering data, nearly every function of the instrument can be controlled through a computer interface. You can download the Lake Shore curve handler software to your computer to easily enter and manipulate sensor calibration curves for storage in the instruments non-volatile memory.

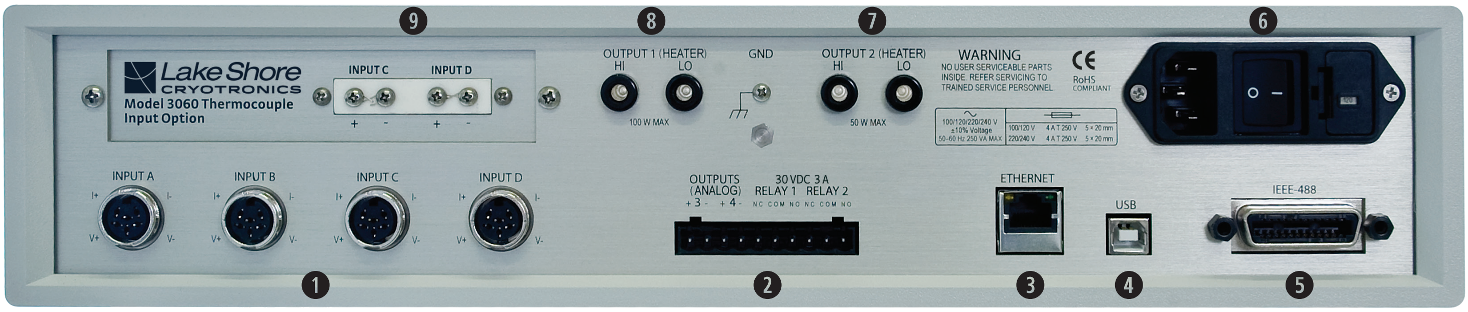
Ethernet provides the ability to access and monitor instrument activities via the internet from anywhere in the world. The USB interface emulates an RS-232C serial port at a fixed 57,600 baud rate, but with the physical connections of a USB. It also allows you to download firmware upgrades, ensuring the most current firmware version is loaded into your instrument without having to physically change anything.

Each sensor input has a high and low alarm that offer latching and non-latching operation. The two relays can be used in conjunction with the alarms to alert you of a fault condition and perform simple on/off control. Relays can be assigned to any alarm or operated manually.

The ±10 V analog voltage outputs on outputs 3 and 4 can be configured to send a voltage proportional to temperature to a strip chart recorder or data acquisition system. You may select the scale and data sent to the output, including temperature or sensor units.

1. Sensor input connectors
2. Terminal block (analog outputs and relays)
3. Ethernet interface
4. USB interface
5. IEEE-488 interface
6. Line input assembly
7. Output 2 heater
8. Output 1 heater
9. Thermocouple option inputs

Model 336 rear panel connections



Configurable display

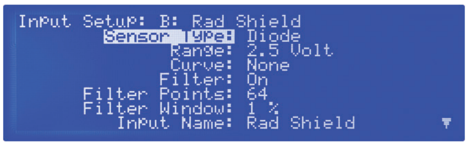
The Model 336 offers a bright, graphic liquid crystal display with an LED backlight that simultaneously displays up to eight readings. You can show all four loops, or If you need to monitor one input, you can display just that one in greater detail. Or you can custom configure each display location to suit your experiment. Data from any input can be assigned to any of the locations, and your choice of temperature or sensor units can be displayed. For added convenience, you can also custom label each sensor input, eliminating the guesswork in remembering or determining the location to which a sensor input is associated.

Four input/output display with labels

Standard display option featuring all four inputs and associated outputs.

Two input/output display with labels

Reading locations can be user configured to meet application needs. Here, the input name is shown above each measurement reading along with the designated input letter.



Intuitive menu structure

Logical navigation allows you to spend more time on research and less time on setup.

Use additional input types with option cards

The field-installable input option cards add additional input types. The Model 3060 adds thermocouple capability. The Model 3061 adds capacitance sensor inputs. The Model 3062 adds four Cernox®/diode inputs. While the option cards can be easily removed, it is not necessary as the standard inputs remain functional when the options are not being used.

Sensor selection

Sensor temperature range (sensors sold separately)

		Model	Useful range	Magnetic field use
Diodes	Silicon diode	DT-670-SD	1.4 K to 500 K	T ≥ 60 K & B ≤ 3 T
	Silicon diode	DT-670E-BR	30 K to 500 K	T ≥ 60 K & B ≤ 3 T
	Silicon diode	DT-414	1.4 K to 375 K	T ≥ 60 K & B ≤ 3 T
	Silicon diode	DT-421	1.4 K to 325 K	T ≥ 60 K & B ≤ 3 T
	Silicon diode	DT-470-SD	1.4 K to 500 K	T ≥ 60 K & B ≤ 3 T
	Silicon diode	DT-471-SD	10 K to 500 K	T ≥ 60 K & B ≤ 3 T
	GaAlAs diode	TG-120-P	1.4 K to 325 K	T > 4.2 K & B ≤ 5 T
	GaAlAs diode	TG-120-PL	1.4 K to 325 K	T > 4.2 K & B ≤ 5 T
	GaAlAs diode	TG-120-SD	1.4 K to 500 K	T > 4.2 K & B ≤ 5 T
Positive temperature coefficient RTDs	100 Ω platinum	PT-102/3	14 K to 873 K	T > 40 K & B ≤ 2.5 T
	100 Ω platinum	PT-111	14 K to 673 K	T > 40 K & B ≤ 2.5 T
	Rhodium-iron	RF-800-4	1.4 K to 500 K	T > 77 K & B ≤ 8 T
	Rhodium-iron	RF-100T/U	1.4 K to 325 K	T > 77 K & B ≤ 8 T
Negative temperature coefficient RTDs	Cernox®	CX-1010	0.3 K to 325 K[1]	T > 2 K & B ≤ 19 T
	Cernox®	CX-1030-HT	0.3 K to 420 K[1,3]	T > 2 K & B ≤ 19 T
	Cernox®	CX-1050-HT	1.4 K to 420 K[1]	T > 2 K & B ≤ 19 T
	Cernox®	CX-1070-HT	4 K to 420 K[1]	T > 2 K & B ≤ 19 T
	Cernox®	CX-1080-HT	20 K to 420 K[1]	T > 2 K & B ≤ 19 T
	Germanium	GR-300-AA	0.35 K to 100 K[3]	Not recommended
	Germanium	GR-1400-AA	1.8 K to 100 K[3]	Not recommended
	Carbon-glass	CGR-1-500	1.4 K to 325 K	T > 2 K & B ≤ 19 T
	Carbon-glass	CGR-1-1000	1.7 K to 325 K[2]	T > 2 K & B ≤ 19 T
	Carbon-glass	CGR-1-2000	2 K to 325 K[2]	T > 2 K & B ≤ 19 T
	Rox™	RX-102	0.3 K to 40 K[3]	T > 2 K & B ≤ 10 T
	Rox™	RX-103	1.4 K to 40 K	T > 2 K & B ≤ 10 T
	Rox™	RX-202	0.3 K to 40 K[3]	T > 2 K & B ≤ 10 T
Thermocouples *Option—3060*	Type K	9006-006	3.2 K to 1505 K	Not recommended
	Type E	9006-004	3.2 K to 934 K	Not recommended
	Chromel-AuFe 0.07%	9006-002	1.2 K to 610 K	Not recommended

[1] Non-HT version maximum temperature: 325 K
[2] Low temperature limited by input resistance range
[3] Low temperature specified with self-heating error: ≤ 5 mK

Silicon diodes are the best choice for general cryogenic use from 1.4 K to above room temperature. Silicon diodes are economical to use because they follow a standard curve and are interchangeable in many applications. They are not suitable for use in ionizing radiation or magnetic fields.

Cernox® thin-film RTDs offer high sensitivity and low magnetic field-induced errors over the 0.3 K to 420 K temperature range. Cernox sensors require calibration.

Platinum RTDs offer high uniform sensitivity from 30 K to over 800 K. With excellent reproducibility, they are useful as thermometry standards. They follow a standard curve above 70 K and are interchangeable in many applications.

Typical sensor performance

	Example Lake Shore sensor	Temperature	Nominal resistance/ voltage	Typical sensor sensitivity[4]	Measurement resolution: temperature equivalents	Electronic accuracy: temperature equivalents	Temperature accuracy including electronic accuracy, Calcurve™, and calibrated sensor	Electronic control stability[5]: temperature equivalents
Silicon diode	DT-670-CO-13 with 1.4H calibration	1.4 K	1.664 V	-12.49 mV/K	0.8 mK	±13 mK	±25 mK	±1.6 mK
		77 K	1.028 V	-1.73 mV/K	5.8 mK	±76 mK	±98 mK	±11.6 mK
		300 K	0.5596 V	-2.3 mV/K	4.3 mK	±47 mK	±79 mK	±8.7 mK
		500 K	0.0907 V	-2.12 mV/K	4.7 mK	±40 mK	±90 mK	±9.4 mK
Silicon diode	DT-470-SD-13 with 1.4H calibration	1.4 K	1.6981 V	-13.1 mV/K	0.8 mK	±13 mK	±25 mK	±1.6 mK
		77 K	1.0203 V	-1.92 mV/K	5.2 mK	±68 mK	±90 mK	±10.4 mK
		300 K	0.5189 V	-2.4 mV/K	4.2 mK	±44 mK	±76 mK	±8.4 mK
		475 K	0.0906 V	-2.22 mV/K	4.5 mK	±38 mK	±88 mK	±9 mK
GaAlAs diode	TG-120-SD with 1.4H calibration	1.4 K	5.391 V	-97.5 mV/K	0.2 mK	±8.8 mK	±21 mK	±0.4 mK
		77 K	1.422 V	-1.24 mV/K	16 mK	±373 mK	±395 mK	±32 mK
		300 K	0.8978 V	-2.85 mV/K	7 mK	±144 mK	±176 mK	±14 mK
		475 K	0.3778 V	-3.15 mV/K	6.4 mK	±114 mK	±164 mK	±12.6 mK
100 Ω platinum RTD 500 Ω full scale	PT-103 with 14J calibration	30 K	3.660 Ω	0.191 Ω/K	1.1 mK	±13 mK	±23 mK	±2.2 mK
		77 K	20.38 Ω	0.423 Ω/K	0.5 mK	±10 mK	±22 mK	±1.0 mK
		300 K	110.35 Ω	0.387 Ω/K	5.2 mK	±39 mK	±62 mK	±10.4 mK
		500 K	185.668 Ω	0.378 Ω/K	5.3 mK	±60 mK	±106 mK	±10.6 mK
Cernox®	CX-1010-SD with 0.3L calibration	0.3 K	2322.4 Ω	-10785 Ω/K	8.5 µK	±0.1 mK	±3.6 mK	±17 µK
		0.5 K	1248.2 Ω	-2665.2 Ω/K	26 µK	±0.2 mK	±4.7 mK	±52 µK
		4.2 K	277.32 Ω	-32.209 Ω/K	140 µK	±3.8 mK	±8.8 mK	±280 µK
		300 K	30.392 Ω	-0.0654 Ω/K	23 mK	±339 mK	±414 mK	±46 mK
Cernox®	CX-1050-SD-HT[6] with 1.4M calibration	1.4 K	26566 Ω	-48449 Ω/K	20 µK	±0.3 mK	±5.3 mK	±40 µK
		4.2 K	3507.2 Ω	-1120.8 Ω/K	196 µK	±2.1 mK	±7.1 mK	±392 µK
		77 K	205.67 Ω	-2.4116 Ω/K	1.9 mK	±38 mK	±54 mK	±3.8 mK
		420 K	45.03 Ω	-0.0829 Ω/K	18 mK	±338 mK	±403 mK	±36 mK
Germanium	GR-300-AA with 0.3D calibration	0.35 K	18225 Ω	-193453 Ω/K	4 µK	±48 µK	±4.2 mK	±8 µK
		1.4 K	449 Ω	-581 Ω/K	41 µK	±481 µK	±4.7 mK	±82 µK
		4.2 K	94 Ω	-26.6 Ω/K	56 µK	±1.8 mK	±6.8 mK	±112 µK
		100 K	2.7 Ω	-0.024 Ω/K	6.3 mK	±152 mK	±175 mK	±12.6 mK
Germanium	GR-1400-AA with 1.4D calibration	1.8 K	15288 Ω	-26868 Ω/K	28 µK	±302 µK	±4.5 mK	±56 µK
		4.2 K	1689 Ω	-862 Ω/K	91 µK	±900 µK	±5.1 mK	±182 µK
		10 K	253 Ω	-62.0 Ω/K	73 µK	±1.8 mK	±6.8 mK	±146 µK
		100 K	2.8 Ω	-0.021 Ω/K	7.1 mK	±177 mK	±200 mK	±14.2 mK
Carbon-glass	CGR-1-500 with 1.4L calibration	1.4 K	103900 Ω	-520000 Ω/K	13 µK	±0.1 mK	±4.1 mK	±26 µK
		4.2 K	584.6 Ω	-422.3 Ω/K	63 µK	±0.8 mK	±4.8 mK	±126 µK
		77 K	14.33 Ω	-0.098 Ω/K	4.6 mK	±108 mK	±133 mK	±9.2 mK
		300 K	8.55 Ω	-0.0094 Ω/K	16 mK	±760 mK	±865 mK	±32 mK
Rox™	RX-102A-AA with 0.3B calibration	0.5 K	3701 Ω	-5478 Ω/K	41 µK	±0.5 mK	±5 mK	±82 µK
		1.4 K	2005 Ω	-667 Ω/K	128 µK	±1.4 mK	±6.4 mK	±256 µK
		4.2 K	1370 Ω	-80.3 Ω/K	902 µK	±8 mK	±24 mK	±1.8 mK
		40 K	1049 Ω	-1.06 Ω/K	62 mK	±500 mK	±537 mK	±124 mK
Thermocouple 50 mV *Option—3060*	Type K	75 K	-5862.9 µV	15.6 µV/K	26 mK	±0.25 K[7]	Calibration not available from Lake Shore	±52 mK
		300 K	1075.3 µV	40.6 µV/K	10 mK	±0.038 K[7]		±19.6 mK
		600 K	13325 µV	41.7 µV/K	10 mK	±0.184 K[7]		±20 mK
		1505 K	49998.3 µV	36.0 µV/K	11 mK	±0.73 K[7]		±22 mK
Capacitance *Option—3061*	CS-501	4.2 K	6.0 nF	27 pF/K	1.9 mK	NA	Calibration not available from Lake Shore	±3.8 mK
		77 K	9.1 nF	52 pF/K	1.0 mK			±2.0 mK
		200 K	19.2 nF	174 pF/K	2.9 mK			±5.8 mK

[4] Typical sensor sensitivities were taken from representative calibrations for the sensor listed
[5] Control stability of the electronics only, in an ideal thermal system
[6] Non-HT version maximum temperature: 325 K
[7] Accuracy specification does not include errors from room temperature compensation

Model 336 Specifications

Input specifications

Standard inputs and scanner option *Model 3062*	Sensor temperature coefficient	Input range	Excitation current	Display resolution	Measurement resolution	Electronic accuracy at 25 °C[8] [for the 3062 scanner option card]	Measurement temperature coefficient	Electronic control stability[8]
Diode	Negative	0 V to 2.5 V	10 μA ±0.05%[10,11]	10 μV	10 μV	±80 μV ±0.005% of rdg [±250 μV ±0.025% of rdg]	(10 μV + 0.0005% of rdg)/°C	±20 μV
		0 V to 10 V	10 μA ±0.05%[10,11]	100 μV	20 μV	±160 μV ±0.01% of rdg [±1 mV ±0.03% of rdg]	(20 μV + 0.0005% of rdg)/°C	±40 μV
PTC RTD	Positive	0 Ω to 10 Ω	1 mA[12]	0.1 mΩ	0.2 mΩ	±0.002 Ω ±0.01% of rdg [±0.002 Ω ±0.03% of rdg]	(0.01 mΩ + 0.001% of rdg)/°C	±0.4 mΩ
		0 Ω to 30 Ω	1 mA[12]	0.1 mΩ	0.2 mΩ	±0.002 Ω ±0.01% of rdg [±0.002 Ω ±0.03% of rdg]	(0.03 mΩ + 0.001% of rdg)/°C	±0.4 mΩ
		0 Ω to 100 Ω	1 mA[12]	1 mΩ	2 mΩ	±0.004 Ω ±0.01% of rdg [±0.004 Ω ±0.03% of rdg]	(0.1 mΩ + 0.001% of rdg)/°C	±4 mΩ
		0 Ω to 300 Ω	1 mA[12]	1 mΩ	2 mΩ	±0.004 Ω ±0.01% of rdg [±0.004 Ω ±0.03% of rdg]	(0.3 mΩ + 0.001% of rdg)/°C	±4 mΩ
		0 Ω to 1 kΩ	1 mA[12]	10 mΩ	20 mΩ	±0.04 Ω ±0.02% of rdg [±0.04 Ω ±0.04% of rdg]	(1 mΩ + 0.001% of rdg)/°C	±40 mΩ
		0 Ω to 3 kΩ	1 mA[12]	10 mΩ	20 mΩ	±0.04 Ω ±0.02% of rdg [±0.04 Ω ±0.04% of rdg]	(3 mΩ + 0.001% of rdg)/°C	±40 mΩ
		0 Ω to 10 kΩ	1 mA[12]	100 mΩ	200 mΩ	±0.4 Ω ±0.02% of rdg [±0.04 Ω ±0.04% of rdg]	(10 mΩ + 0.001% of rdg)/°C	±40 mΩ
NTC RTD 10 mV	Negative	0 Ω to 10 Ω	1 mA[12]	0.1 mΩ	0.15 mΩ	±0.002 Ω ±0.06% of rdg [±0.002 Ω ±0.08% of rdg]	(0.01 mΩ + 0.001% of rdg)/°C	±0.3 mΩ
		0 Ω to 30 Ω	300 μA[12]	0.1 mΩ	0.45 mΩ	±0.002 Ω ±0.06% of rdg [±0.002 Ω ±0.08% of rdg]	(0.03 mΩ + 0.0015% of rdg)/°C	±0.9 mΩ
		0 Ω to 100 Ω	100 μA[12]	1 mΩ	1.5 mΩ	±0.01 Ω ±0.04% of rdg [±0.01 Ω ±0.06% of rdg]	(0.1 mΩ + 0.001% of rdg)/°C	±3 mΩ
		0 Ω to 300 Ω	30 μA[12]	1 mΩ	4.5 mΩ	±0.01 Ω ±0.04% of rdg [±0.01 Ω ±0.06% of rdg]	(0.3 mΩ + 0.0015% of rdg)/°C	±9 mΩ
		0 Ω to 1 kΩ	10 μA[12]	10 mΩ	15 mΩ +0.002% of rdg	±0.1 Ω ±0.04% of rdg [±0.1 Ω ±0.06% of rdg]	(1 mΩ + 0.001% of rdg)/°C	±30 mΩ ±0.004% of rdg
		0 Ω to 3 kΩ	3 μA[12]	10 mΩ	45 mΩ +0.002% of rdg	±0.1 Ω ±0.04% of rdg [±0.1 Ω ±0.06% of rdg]	(3 mΩ + 0.0015% of rdg)/°C	±90 mΩ ±0.004% of rdg
		0 Ω to 10 kΩ	1 μA[12]	100 mΩ	150 mΩ +0.002% of rdg	±1.0 Ω ±0.04% of rdg [±1.0 Ω ±0.06% of rdg]	(10 mΩ + 0.001% of rdg)/°C	±300 mΩ ±0.004% of rdg
		0 Ω to 30 kΩ	300 nA[12]	100 mΩ	450 mΩ +0.002% of rdg	±2.0 Ω ±0.04% of rdg [±2.0 Ω ±0.06% of rdg]	(30 mΩ + 0.001% of rdg)/°C	±900 mΩ ±0.004% of rdg
		0 Ω to 100 kΩ	100 nA[12]	1 Ω	1.5 Ω +0.005% of rdg	±10.0 Ω ±0.04% of rdg [±10.0 Ω ±0.06% of rdg]	(100 mΩ + 0.002% of rdg)/°C	±3 Ω ±0.01% of rdg

Thermocouple option *Model 3060*	Sensor temperature coefficient	Input range	Excitation current	Display resolution	Measurement resolution	Electronic accuracy (at 25 °C)[8]	Measurement temperature coefficient	Electronic control stability[9]
Thermocouple *3060*	Positive	±50 mV	NA	0.1 μV	0.4 μV	±4.5 μV ±0.07% of rdg[13]	(0.1 μV + 0.001% of rdg)/°C	±0.8 μV

Capacitance option *Model 3061*	Sensor temperature coefficient	Input range	Excitation current	Display resolution	Measurement resolution	Electronic accuracy (at 25 °C)[8]	Measurement temperature coefficient	Electronic control stability[9]
Capacitance *3061*	Positive or negative	0.1 nF to 15 nF	3.496 kHz 1 mA square wave	0.1 pF	0.05 pF	±50 pF ±0.1% of rdg	2.5 pF/°C	0.1 pF
		1 nF to 150 nF	3.496 kHz 10 mA square wave	1 pF	0.5 pF	±50 pF ±0.1% of rdg	5 pF/°C	1 pF

[8] With current reversal enabled for RTD measurements
[9] Control stability of the electronics only, in ideal thermal system
[10] Current source error has negligible effect on measurement accuracy
[11] Diode input excitation can be set to 1 mA
[12] Current source error is removed during calibration
[13] Accuracy specification does not include errors from room temperature compensation

Sensor input configuration

	Diode/RTD	Thermocouple
Measurement type	4-lead differential	2-lead differential, room temperature compensated
Excitation	Constant current with current reversal for RTDs	NA
Supported sensors	**Diodes:** Silicon, GaAlAs **RTDs:** 100 Ω Platinum, 1000 Ω Platinum, Germanium, Carbon-Glass, Cernox®, and Rox™	Most thermocouple types
Standard curves	DT-470, DT-670, DT-500-D, DT-500-E1, PT-100, PT-1000, RX-102A, RX-202A	Type E, Type K, Type T, AuFe 0.07% vs. Cr, AuFe 0.03% vs. Cr
Input connector	6-pin DIN	Screw terminals in a ceramic isothermal block

Thermometry

Number of inputs 4 (8 with scanner option)

Input configuration Inputs can be configured from the front panel to accept any of the supported input types. Thermocouple and capacitance inputs require an optional input card that can be installed in the field.

Supported option cards Thermocouple (3060), capacitance (3061), or scanner (3062)

Option slots 1

Isolation Sensor inputs optically isolated from other circuits but not each other

A/D resolution 24-bit

Input accuracy Sensor dependent, refer to Input Specifications table

Measurement resolution Sensor dependent, refer to Input Specifications table

Maximum update rate 10 rdg/s on each input, 5 rdg/s when configured as 100 kΩ NTC RTD with reversal on, 2 rdg/s on each scanned input (scanner option only)

Autorange Automatically selects appropriate NTC RTD or PTC RTD range

User curves Room for 39 200-point CalCurves™ or user curves

SoftCal™ Improves accuracy of DT-470 diode to ±0.25 K from 30 K to 375 K; improves accuracy of platinum RTDs to ±0.25 K from 70 K to 325 K; stored as user curves

Math Maximum and minimum

Filter Averages 2 to 64 input readings

Control

Control outputs 4

Heater outputs (Outputs 1 & 2)

Control type Closed loop digital PID with manual heater output or open loop

Update rate 10/s

Tuning Autotune (one loop at a time), PID, PID zones

Control stability Sensor dependent, see Input Specifications table

PID control settings

- **Proportional (gain)** 0 to 1000 with 0.1 setting resolution
- **Integral (reset)** 1 to 1000 (1000/s) with 0.1 setting resolution
- **Derivative (rate)** 1 to 200% with 1% resolution
- **Manual output** 0 to 100% with 0.01% setting resolution

Zone control 10 temperature zones with P, I, D, manual heater out, heater range, control channel, ramp rate

Setpoint ramping 0.1 K/min to 100 K/min

Output 1

	25 Ω setting	50 Ω setting
Type	Variable DC current source	
D/A resolution	16-bit	
Max power	100 W	50 W
Max current	2 A	1 A
Voltage compliance	50 V	50 V
Heater load for max power	25 Ω	50 Ω
Heater load range	10 Ω to 100 Ω	
Ranges	3 (decade steps in power)	
Heater noise	0.12 µA RMS (dominated by line frequency and its harmonics)	
Grounding	Output referenced to chassis ground	
Heater connector	Dual banana	
Safety limits	Curve temperature, power up heater off, short circuit protection	

Output 2

	25 Ω setting	50 Ω setting
Type	Variable DC current source	
D/A resolution	16-bit	
Max power	50 W	50 W
Max current	1.41 A	1 A
Voltage compliance	35.4 V	50 V
Heater load for max power	25 Ω	50 Ω
Heater load range	10 Ω to 100 Ω	
Ranges	3 (decade steps in power)	
Heater noise	0.12 µA RMS (dominated by line frequency and its harmonics)	
Grounding	Output referenced to chassis ground	
Heater connector	Dual banana	
Safety limits	Curve temperature, power up heater off, short circuit protection	

Unpowered analog outputs (Outputs 3 & 4)

Control type Closed loop PID, PID zones, warm up heater mode, manual output, or monitor output

Tuning Autotune (one loop at a time), PID, PID zones

Control stability Sensor dependent, see Input Specifications table

PID control settings

- **Proportional (gain)** 0 to 1000 with 0.1 setting resolution
- **Integral (reset)** 1 to 1000 (1000/s) with 0.1 setting resolution
- **Derivative (rate)** 1 to 200% with 1% resolution
- **Manual output** 0 to 100% with 0.01% setting resolution

Zone control 10 temperature zones with P, I, D, manual heater out, heater range, control channel, ramp rate

Setpoint ramping 0.1 K/min to 100 K/min

Warm up heater mode settings

- **Warm up percentage** 0 to 100% with 1% resolution
- **Warm up mode** Continuous control or auto-off

Monitor output settings

- **Scale** User selected
- **Data source** Temperature or sensor units
- **Settings** Input, source, top of scale, bottom of scale, or manual

Type Variable DC voltage source

Update rate 10/s

Range ±10 V

Resolution 16-bit, 0.3 mV

Accuracy ±2.5 mV

Noise 0.3 mV RMS

Minimum load resistance 1 kΩ (short-circuit protected)

Connector Detachable terminal block

Front panel

Display 8-line by 40-character (240 × 64 pixel) graphic LCD display module with LED backlight

Number of reading displays 1 to 8

Display units K, °C, V, mV, Ω

Reading source Temperature, sensor units, max, and min

Display update rate 2 rdg/s

Temperature display resolution 0.0001° from 0° to 99.9999°, 0.001° from 100° to 999.999°, 0.01° above 1000°

Sensor units display resolution Sensor dependent, to 6 digits

Other displays Input name, setpoint, heater range, heater output, and PID

Setpoint setting resolution Same as display resolution (actual resolution is sensor dependent)

Heater output display Numeric display in percent of full scale for power or current

Heater output resolution 0.01%

Display annunciators Control input, alarm, tuning

LED annunciators Remote, Ethernet status, alarm, control outputs

Keypad 27-key silicone elastomer keypad

Front panel features Front panel curve entry, display contrast control, and keypad lock-out

Interface

IEEE-488.2

Capabilities	SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT0, C0, E1
Reading rate	To 10 rdg/s on each input
Software support	LabVIEW™ driver (see www.lakeshore.com)

USB

Function	Emulates a standard RS-232 serial port
Baud rate	57,600
Connector	B-type USB connector
Reading rate	To 10 rdg/s on each input
Software support	LabVIEW™ driver (see www.lakeshore.com)

Ethernet

Function	TCP/IP command and control, web interface, curve handler, configuration backup, chart recorder
IPv6 compatibility	TCP/IP command and control, web interface only
Connector	RJ-45
Reading rate	To 10 rdg/s on each input
Software support	LabVIEW™ driver (contact Lake Shore for availability)

Alarms

Number	4, high and low for each input
Data source	Temperature or sensor units
Settings	Source, high setpoint, low setpoint, deadband, latching or non-latching, audible on/off, and visible on/off
Actuators	Display annunciator, beeper, and relays

Relays

Number	2
Contacts	Normally open (NO), normally closed (NC), and common (C)
Contact rating	30 VDC at 3 A
Operation	Activate relays on high, low, or both alarms for any input, or manual mode
Connector	Detachable terminal block

General

Ambient temperature 15 °C to 35 °C at rated accuracy; 5 °C to 40 °C at reduced accuracy

Power requirement 100, 120, 220, 240 VAC, ±10%, 50 or 60 Hz, 250 VA

Size 435 mm W × 89 mm H × 368 mm D (17 in × 3.5 in × 14.5 in), full rack

Weight 7.6 kg (16.8 lb)

Approval CE mark, RoHS

Ordering information

Part number	Description
336	4 diode/RTD inputs and 4 control outputs, including one dual banana jack heater input connector (106-009), four 6-pin DIN plug sensor input mating connectors (G-106-233), one 10-pin terminal block (G-106-750), a calibration certificate and a user's manual
336-3060	Model 336 with a 3060 option card installed
336-3061	Model 336 with a 3061 option card installed
336-3062	Model 336 with a 3062 option card installed
3060	2-thermocouple input option, uninstalled
3061	Capacitance input option for 350/336, uninstalled
3062	4-channel scanner option for diodes and RTD sensors for 350/336, uninstalled

Please indicate your power/cord configuration:

1 100 V—U.S. cord (NEMA 5-15)
2 120 V—U.S. cord (NEMA 5-15)
3 220 V—Euro cord (CEE 7/7)
4 240 V—Euro cord (CEE 7/7)
5 240 V—U.K. cord (BS 1363)
6 240 V—Swiss cord (SEV 1011)
7 220 V—China cord (GB 1002)

Accessories

6201	1 m (3.3 ft long) IEEE-488 (GPIB) computer interface cable assembly
8001-336	CalCurve™, factory installed—the breakpoint table from a calibrated sensor stored in the instrument (extra charge for additional sensor curves)
CAL-336-CERT	Instrument recalibration with certificate
CAL-336-DATA	Instrument recalibration with certificate and data

All specifications are subject to change without notice

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