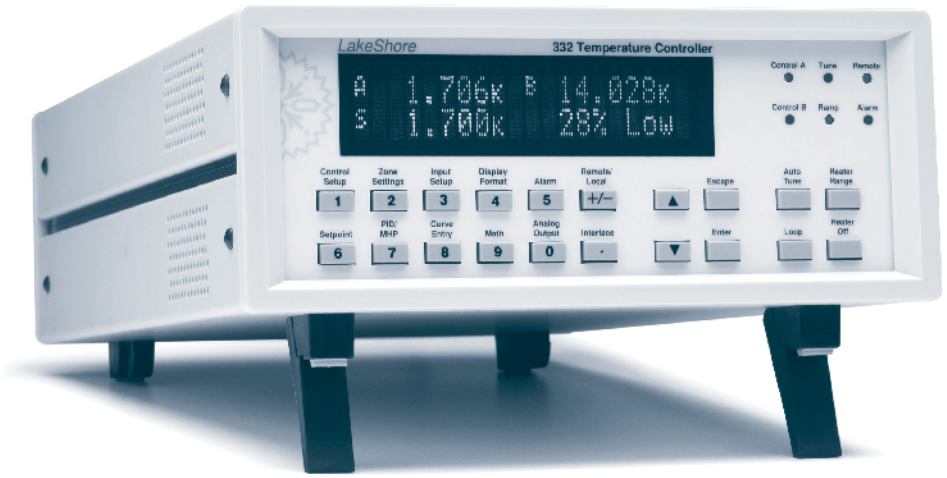
Model 332 Temperature Controller

Features

- Operates down to 500 mK with appropriate NTC RTD sensors
- Two sensor inputs
- Supports diode, RTD, and thermocouple sensors
- Sensor excitation current reversal eliminates thermal EMF errors for resistance sensors
- Two autotuning control loops: 50 W and 10 W
- IEEE-488 and RS-232C interfaces, analog outputs, and alarm relays



Product Description

Building on the best selling Model 331 temperature controller platform, the Model 332 incorporates advanced electronics for high resolution temperature measurement and control. The Model 332 automatically scales excitation current to support Cernox™ and other negative temperature coefficient (NTC) resistors to as low as 500 mK. The Model 332 also includes 50 W and 10 W heater outputs for greater flexibility in cryocooler applications requiring a second heater for fine and coarse control.

Sensor Inputs

The Model 332 temperature controller features two inputs, with a high-resolution 24-bit analog-to-digital converter and separate current source for each input. Sensors are optically isolated from other instrument functions for quiet and repeatable sensor measurements.
The two sensor inputs included in the Model 332 can be configured to measure and control nearly any diode, RTD, and thermocouple temperature sensor.

Sensor inputs for both versions of the Model 332 are preconfigured and compatible with either diode/RTDs or thermocouple sensors. The purchaser's choice of two diode/RTD inputs, one diode/RTD input and one thermocouple input, or two thermocouple inputs must be specified at time of order and cannot be reconfigured in the field. Software selects appropriate excitation current and signal gain levels when sensor type is entered via the instrument front panel.

With NTC RTD sensors at temperatures as low as 500 mK, and with resistance being as high as 75 kΩ, the Model 332 automatically provides an excitation current down to 1 µA. This minimizes sensor self-heating induced errors.
At higher temperatures, when resistance is low and concern for sensor self-heating is minimal, the Model 332 provides an excitation current up to 1 mA for a better signal to noise ratio and high measurement resolution. The Model 332 also uses current reversal to eliminate thermal electromotive force (EMF) errors for all resistive sensors.

Standard temperature response curves for silicon diodes, platinum RTDs, and many thermocouples are included. Up to twenty 200-point CalCurves™ for Lake Shore calibrated sensors or user curves can be loaded into non-volatile memory via a computer interface or the instrument front panel. A built-in SoftCal™[1] algorithm can also be used to generate curves for silicon diodes and platinum RTDs, for storage as user curves.

Temperature Control

For the greatest flexibility in temperature control, the Model 332 has two independent, proportional-integral-derivative (PID) control loops that drive two heater outputs of 50 W and 10 W.

A PID control algorithm calculates control output based on temperature setpoint and feedback from the control sensor. Wide tuning parameters accommodate most cryogenic cooling systems and many small high-temperature ovens. Control output is generated by a high resolution digital-to-analog converter for smooth, continuous control. The user can set the PID values manually or the Autotuning feature of the Model 332 can automate the tuning process.

The Loop 1 heater output is a well-regulated variable DC current source. The output is optically isolated from other circuits to reduce interference and ground loops. The output can provide up to 50 W of continuous power to a resistive heater load, and includes two lower ranges for systems with less cooling power. The second control loop heater output is a single-range, variable DC voltage source that can vary from 0 V to 10 V. The output can source up to 1 A of current providing a maximum of 10 W of heater power.

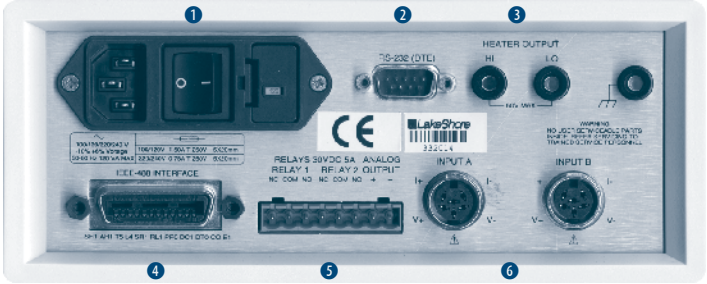
The setpoint ramp feature allows smooth continuous changes in setpoint and also makes the approach to a setpoint temperature more predictable. The zone feature can automatically change control parameter values for operation over a large temperature range. Values for ten different temperature zones can be loaded into the instrument, which will select the next appropriate zone value on setpoint change.

Interface

The Model 332 includes both parallel (IEEE-488) and serial (RS-232C) computer interfaces. In addition to data gathering, nearly every function of the instrument can be controlled via computer interface. Also included is a Model 330 command emulation mode that makes the Model 332 interchangeable with the older Model 330 in software-controlled systems.

Each input has a high and low alarm which offer latching and non-latching operation. The two relays on the Model 332 can be used in conjunction with the alarms to alert the operator of a fault condition or perform simple on-off control. Relays can be assigned independently to any alarm or be operated manually.

When not being used for temperature control, the loop 2 control output can be used as an analog voltage output. It can be configured to send a voltage, proportional to temperature, to a data acquisition system. The user may select the scale and data to be sent to the output, including temperature, sensor units, or linear equation results. Under manual control, the analog voltage output can also serve as a voltage source for other applications.



Model 332 Rear Panel Connections

❶ *Line input assembly*
❷ *Serial (RS-232C) I/O (DTE)*
❸ *Heater output*
❹ *IEEE-488 interface*
❺ *Terminal block (for relays and loop 2/analog output)*
❻ *Sensor input connectors*

[1] *The Lake Shore SoftCal™ algorithm for silicon diode and platinum RTD sensors is a good solution for applications that need more accuracy than a standard sensor curve but not traditional calibration. SoftCal™ uses the predictability of a standard curve to improve the accuracy of an individual sensor around known temperature reference points.*

Configurable Display

The Model 332 includes a bright vacuum fluorescent display that simultaneously displays up to four readings. Frequently used functions can be controlled with one or two keystrokes on the front panel. Display data includes input and source annunciators for each reading. All four display locations can be configured by the user. Data from either input may be assigned to any of the four locations. The user's choice of temperature, sensor units, maximum, minimum, or linear equation results can be displayed. Heater range and control output as current or power can also be continuously displayed numerically or as a bar graph for immediate feedback on control operation.

Normal (Default) Display Configuration

The display provides four reading locations. Readings from each input and the control setpoint can be expressed in any combination of temperature or sensor units, with heater output expressed as a percent of full scale current or power.

Flexible Configuration

Reading locations can be configured by the user to meet application needs. The character preceding the reading indicates input A or B or setpoint S. The character following the reading indicates measurement units or the math function in use.

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	0.6 K to 325 K[4]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1030-HT	1 K to 420 K[2,4]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1050-HT	1.4 K to 420 K[2]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1070-HT	4 K to 420 K[2]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1080-HT	20 K to 420 K[2]	T > 2 K & B ≤ 19 T
	Germanium	GR-300-AA	0.5 K to 100 K[3]	Not Recommended
	Germanium	GR-1400-AA	1.4 K to 100 K[3]	Not Recommended
	Carbon-Glass	CGR-1-500	1.9 K to 325 K[4]	T > 2 K & B ≤ 19 T
	Carbon-Glass	CGR-1-1000	2.2 K to 325 K[4]	T > 2 K & B ≤ 19 T
	Carbon-Glass	CGR-1-2000	2.5 K to 325 K[4]	T > 2 K & B ≤ 19 T
	Rox™	RX-102A	0.5 K to 40 K[4]	T > 2 K & B ≤ 10 T
	Rox™	RX-103A	1.4 K to 40 K	T > 2 K & B ≤ 10 T
	Rox™	RX-202A	0.5 K to 40 K[4]	T > 2 K & B ≤ 10 T
Thermocouples	**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

[2] Non-HT version maximum temperature: 325 K
[3] Low temperature limited by input resistance range
[4] 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. 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 0.6 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 – *see Appendix F for sample calculations of typical sensor performance*

	Example Lake Shore sensor	Temp	Nominal resistance/ voltage	Typical sensor sensitivity[5]	Measurement resolution: temperature equivalents	Electronic accuracy: temperature equivalents	Temperature accuracy including electronic accuracy, CalCurve™, and calibrated sensor	Electronic control stability[6]: temperature equivalents
Silicon Diode	DT-670-SD-13 with 1.4H calibration	1.4 K	1.644 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	0.5597 V	-2.3 mV/K	4.4 mK	±47 mK	±79 mK	±8.8 mK
		500 K	0.0907 V	-2.12 mV/K	4.8 mK	±40 mK	±90 mK	±9.6 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	±69 mK	±91 mK	±10.4 mK
		300 K	0.5189 V	-2.4 mV/K	4.2 mK	±45 mK	±77 mK	±8.4 mK
		475 K	0.0906 V	-2.22 mV/K	4.6 mK	±38 mK	±88 mK	±9.2 mK
GaAlAs Diode	TG-120-SD with 1.4H calibration	1.4 K	5.391 V	-97.5 mV/K	0.2 mK	±4 mK	±16 mK	±0.4 mK
		77 K	1.422 V	-1.24 mV/K	16.2 mK	±122 mK	±144 mK	±32.4 mK
		300 K	0.8978 V	-2.85 mV/K	7 mK	±44 mK	±76 mK	±14 mK
		475 K	0.3778 V	-3.15 mV/K	6.4 mK	±32 mK	±82 mK	±12.8 mK
100 Ω Platinum RTD 500 Ω Full Scale	PT-103 with 14J calibration	30 K	3.660 Ω	0.191 Ω/K	10.5 mK	±23 mK	±33 mK	±21 mK
		77 K	20.38 Ω	0.423 Ω/K	4.8 mK	±15 mK	±27 mK	±9.6 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-1050	CX-1050-SD-HT[7] with 1.4M calibration	2 K	11844 Ω	-11916 Ω/K	43 μK	±0.5 mK[11]	±5.5 mK[11]	±86 μK
		4.2 K	3507 Ω	-1120.8 Ω/K	50 μK	±1.4 mK[10]	±6.4 mK[10]	±100 μK
		77 K	205.67 Ω	-2.411 Ω/K	2 mK	±39 mK[9]	±55 mK[9]	±4 mK
		420 K	45.03 Ω	-0.0829 Ω/K	3.7 mK	±230 mK[8]	±295 mK[8]	±7.4 mK
Cernox™ CX-1070	CX-1070-SD-HT[7] with 4.2M calibration	4.2 K	5979.4 Ω	-2225.3 Ω/K	36 μK	±1.1 mK[10]	±6.1 mK[10]	±72 μK
		77 K	248.66 Ω	-3.1498 Ω/K	1.8 mK	±35 mK[9]	±51 mK[9]	±3.6 mK
		300 K	66.441 Ω	-0.2013 Ω/K	1.5 mK	±137 mK[8]	±177 mK[8]	±3 mK
		420 K	49.819 Ω	-0.0944 Ω/K	3.2 mK	±222 mK[8]	±287 mK[8]	±6.4 mK
Germanium	GR-300-AA with 0.3D calibration	0.5 K	5443 Ω	-34800 Ω/K	2 μK	±0.1 mK[11]	±4.3 mK[11]	±4 μK
		1.4 K	449 Ω	-581 Ω/K	13 μK	±0.3 mK[10]	±4.5 mK[10]	±26 μK
		4.2 K	94 Ω	-26.6 Ω/K	149 μK	±1.8 mK[9]	±7.1 mK[9]	±0.3 mK
		100 K	2.7 Ω	-0.024 Ω/K	12.6 mK	±88 mK[8]	±6.8 mK[8]	±25 mK
Germanium	GR-1400-AA with 1.4D calibration	2 K	11038 Ω	-16700 Ω/K	29 μK	±0.3 mK[11]	±4.5 mK[11]	±58 μK
		4.2 K	1689 Ω	-862 Ω/K	43 μK	±0.9 mK[10]	±5.1 mK[10]	±86 μK
		10 K	253 Ω	-62.0 Ω/K	89 μK	±1.8 mK[9]	±6.8 mK[9]	±178 μK
		100 K	2.8 Ω	-0.021 Ω/K	14.4 mK	±102 mK[8]	±125 mK[8]	±29 mK
Rox™	RX-102A-AA with 1.4B calibration	1.4 K	2005 Ω	-667 Ω/K	60 μK	±1.4 mK[10]	±17.4 mK[10]	±120 μK
		4.2 K	1370 Ω	-80.3 Ω/K	0.5 mK	±8.1 mK[10]	±24.1 mK[10]	±1 mK
		10 K	1167 Ω	-15.3 Ω/K	2.1 mK	±37 mK[10]	±55 mK[10]	±4.2 mK
		40 K	1049 Ω	-1.06 Ω/K	29 mK	±490 mK[10]	±527 mK[10]	±58 mK
Thermocouple 50 mV	Type K	75 K	-5862.9 μV	15.6 μV/K	26 mK	±0.25 K[12]	Calibration not available from Lake Shore	±52 mK
		300 K	1075.3 μV	40.6 μV/K	10 mK	±0.038 K[12]		±20 mK
		600 K	13325 μV	41.7 μV/K	10 mK	±0.184 K[12]		±20 mK
		1505 K	49998.3 μV	36.006 μV/K	12 mK	±0.73 K[12]		±24 mK

[5] Typical sensor sensitivities were taken from representative calibrations for the sensor listed
[6] Control stability of the electronics only, in an ideal thermal system
[7] Non-HT version maximum temperature: 325 K

[8] NTC RTD range 75 Ω *[10] NTC RTD range 7500 Ω*
[9] NTC RTD range 750 Ω *[11] NTC RTD range 75000 Ω*

[12] Accuracy specification does not include errors from room temperature compensation

Specifications

Input Specifications

	Sensor temperature coefficient	Input range	Excitation current	Display resolution	Measurement resolution	Electronic accuracy	Electronic control stability[13]
Diode	negative	0 V to 2.5 V	10 μA ±0.05%[14,15]	100 μV	10 μV	±80 μV ±0.005% of rdg	±20 μV
	negative	0 V to 7.5 V	10 μA ±0.05% [14,15]	100 μV	20 μV	±80 μV ±0.01% of rdg	±40 μV
PTC RTD	positive	0 Ω to 250 Ω	1 mA[16]	10 mΩ	2 mΩ	±0.004 Ω ±0.01% of rdg	±4 mΩ
	positive	0 Ω to 500 Ω	1 mA[16]	10 mΩ	2 mΩ	±0.004 Ω ±0.01% of rdg	±4 mΩ
	positive	0 Ω to 5000 Ω	1 mA[16]	100 mΩ	20 mΩ	±0.04 Ω ±0.02% of rdg	±40 mΩ
NTC RTD	negative	0 Ω to 75 Ω	1 mA[16]	1 mΩ	0.3 mΩ +0.000% of rdg	±0.001 Ω ±0.04% of rdg	±0.6 mΩ
	negative	0 Ω to 750 Ω	100 μA[16]	10 mΩ	3 mΩ +0.001% of rdg	±0.01 Ω ±0.04% of rdg	±6 mΩ ±0.002% of rdg
	negative	0 Ω to 7500 Ω	10 μA[16]	100 mΩ	20 mΩ + 0.001% of rdg	±0.1 Ω ±0.04% of rdg	±40 mΩ ±0.002% of rdg
	negative	0 Ω to 75000 Ω	1 μA[16]	1 Ω	0.15 Ω +0.003% of rdg	±1.0 Ω ±0.04% of rdg	±0.3 Ω ±0.006% of rdg
Thermocouple	positive	±25 mV	NA	1 μV	0.4 μV	±1 μV ±0.05% of rdg[17]	±0.8 μV
	positive	±50 mV	NA	1 μV	0.4 μV	±1 μV ±0.05% of rdg[17]	±0.8 μV

[13] Control stability of the electronics only, in an ideal thermal system
[14] Current source error has negligible effect on measurement accuracy
[15] Diode input excitation current can be set to 1 mA – refer to the Model 331 user manual for details
[16] Current source error is removed during calibration
[17] Accuracy specification does not include errors from room temperature compensation

Thermometry

Number of inputs 2
Input configuration Each input is factory configured as either diode/RTD or thermocouple
Isolation Sensor inputs optically isolated from other circuits but not from 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 readings per s on each input with the following exceptions: 5 readings per s when configured as 75 kΩ NTC RTD with reversal on, 5 readings per s on input A when configured as thermocouple
Autorange Automatically selects appropriate NTC RTD range
User curves Room for 20 200-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, minimum, and linear equation (Mx + B) or M(x + B)
Filter Averages 2 to 64 input readings

Sensor Input Configuration

	Diode/RTD	Thermocouple
Measurement type	4-lead differential	2-lead, 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-500D, DT-670, 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	Ceramic isothermal block

Control

Control loops 2
Control type Closed loop digital PID with manual heater output or open loop
Tuning Autotune (one loop at a time), manual PID, zones
Control stability Sensor dependent – to 2× measurement resolution (in an ideal thermal system)

PID control settings
- **Proportional (gain)** 0 to 1000 with 0.1 setting resolution
- **Integral (reset)** 1 to 1000 (1000 per s) with 0.1 setting resolution
- **Derivative (rate)** 1% to 200% with 1% setting resolution
- **Manual output** 0% to 100% with 0.001% setting resolution

Zone control 10 temperature zones with P, I, D, manual heater out, and heater range
Setpoint ramping 0.1 K per min to 100 K per min
Safety limits Curve temperature, power up heater off, and short-circuit protection

Heater Output

	Loop 1	Loop 2
Heater output type	Variable DC current source	Variable DC voltage source
Heater output D/A resolution	18-bit	16-bit
Max heater power	50 W	10 W
Max heater output current	1 A	1 A
Heater output compliance	50 V	10 V
Heater source impedance	N/A	0.1 Ω maximum
Heater output ranges	3 decade steps in power	1
Heater load type	Resistive	Resistive
Heater load range	10 Ω to 100 Ω recommended	10 Ω minimum
Heater load for max power	50 Ω	10 Ω
Heater noise (<1 kHz) RMS	50 μV + 0.017% of output voltage	<0.3 mV
Isolation	Optical isolation between output and other circuits	None
Heater connector	Dual banana	Detachable terminal block

Loop 1 Full Scale Heater Power at Typical Resistance

Heater resistance	Heater range	Heater power
10 Ω	Low	100 mW
	Med	1 W
	High	10 W
25 Ω	Low	250 mW
	Med	2.5 W
	High	25 W
50 Ω	Low	500 mW
	Med	5 W
	High	50 W

Front Panel

Display 2 line by 20 character, 9 mm character height, vacuum fluorescent display
Number of reading displays 1 to 4
Display units K, °C, V, mV, and Ω
Reading source Temperature, sensor units, max, min, and linear equation
Display update rate All readings twice per s
Temp display resolution 0.001° from 0° to 99.999°, 0.01° from 100° to 999.99°, 0.1° above 1000°
Sensor units display resolution Sensor dependent to 5 digits
Other displays Setpoint, heater range, and heater output (user selected)
Setpoint setting resolution Same as display resolution (actual resolution is sensor dependent)
Heater output display Numeric or graphical display in percent of full scale for power or current
Heater output resolution 1% numeric or 2% graphical
Display annunciators Control input, remote, alarm, tuning, ramp, max, min, and linear
Keypad 20 full-travel keys, numeric and specific functions
Front panel features Front panel curve entry, display brightness control, and keypad lock-out

Interface

IEEE-488.2 interface
- **Features** SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT0, C0, E1
- **Reading rate** To 10 readings per s on each input
- **Software support** LabVIEW™ driver

Serial interface
- **Electrical format** RS-232C
- **Max baud rate** 9600 baud
- **Connector** 9-pin D-sub
- **Reading rate** To 10 readings per s on each input (at 9600 baud)

Special interface features Model 330 command emulation mode

Alarms
- **Number** 4: high and low for each input
- **Data source** Temperature, sensor units, and linear equation
- **Settings** Source, high setpoint, low setpoint, deadband, latching or non-latching, and audible 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 5 A
- **Operation** Activate relays on high, low, or both alarms for either input or manual
- **Connector** Detachable terminal block

Analog voltage output ***(when not used as control loop 2 output)***
- **Scale** User selected
- **Update rate** 10 readings per s
- **Data source** Temperature, sensor units, linear equation
- **Settings** Input, source, top of scale, bottom of scale, or manual
- **Range** ±10 V
- **Resolution** 0.3 mV
- **Accuracy** ±2.5 mV
- **Max output power** 1 W (jumper selected)
- **Min load resistance** 100 Ω (short-circuit protected)
- **Source impedance** 0.01 Ω

General

Ambient temperature 15 °C to 35 °C at rated accuracy, 10 °C to 40 °C at reduced accuracy
Power requirement 100, 120, 220, 240 VAC, (+6%, -10%), 50 or 60 Hz, 150 VA
Size 216 mm W × 89 mm H × 368 mm D (8.5 in × 3.5 in × 14.5 in), half rack
Weight 4.8 kg (10.5 lb)
Approval CE mark

Ordering Information

Part number	Description
332S	Two diode/resistor inputs
332S-T1	One diode/resistor, one thermocouple input
332S-T2	Two thermocouple inputs

Select a power configuration*:

VAC-100	Instrument configured for 100 VAC with U.S. power cord
VAC-120	Instrument configured for 120 VAC with U.S. power cord
VAC-120-ALL	Instrument configured for 120 VAC with U.S. power cord and universal European power cord and fuses for 220/240 VAC setting
VAC-220	Instrument configured for 220 VAC with European power cord
VAC-240	instrument configured for 240 VAC with European power cord

**Other country line cords available, consult Lake Shore*

Accessories included

106-009	Heater output connector (dual banana jack)
G-106-233	Sensor input mating connector (6-pin DIN plug); 2 included
106-739	Terminal block, 8-pin
——	Calibration certificate
MAN-332	User manual

Options and accessories

4005	1 m (3.3 ft long) IEEE-488 (GPIB) computer interface cable assembly – includes extender required for simultaneous use of IEEE cable and relay terminal block
8001-332	CalCurve™, factory-installed – calibrated sensor breakpoint table factory-installed into nonvolatile memory
8002-05-332	CalCurve™, field-installed – calibrated sensor breakpoint table loaded into nonvolatile memory
CAL-332-CERT	Instrument recalibration with certificate
CAL-332-DATA	Instrument recalibration with certificate and data
RM-½	Kit for mounting one ½ rack temperature controller in a 482.6 mm (19 in) rack, 90 mm (3.5 in) high
RM-2	Kit for mounting two ½ rack temperature controllers in a 482.6 mm (19 in) rack, 135 mm (5.25 in) high

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