

# Model 211

## Temperature controller



### Model 211 features

- Operates down to 1.2 K with appropriate sensor
- One sensor input
- Supports diode and RTD sensors
- 0 V to 10 V or 4 mA to 20 mA output
- Large 5-digit LED display
- RS-232C serial interface and alarm relays
- CE certification
- Full 3 year standard warranty



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### Introduction

The Lake Shore single-channel Model 211 temperature monitor provides the accuracy, resolution, and interface features of a benchtop temperature monitor in an easy to use, easily integrated, compact instrument. With appropriate sensors, it measures from 1.2 K to 873 K, including temperatures in high vacuum and magnetic fields. Alarms, relays, user-configurable analog voltage or current output, and a serial interface are standard features on the Model 211. It is a good choice for liquefied gas storage and monitoring, cryopump control, cryo-cooler, and materials science applications, and when you need greater accuracy than thermocouples allow.

### Sensor input reading capability

The Model 211 temperature monitor supports diode temperature sensors and resistance temperature detectors (RTDs). It can be configured for the type of sensor in use from the instrument front panel. Ensuring high accuracy and 5-digit measurement resolution are 4-lead differential measurement and 24-bit analog-to-digital conversion.

The Model 211 converts voltage or resistance to temperature units based on temperature response curve data for the sensor in use. Standard temperature response curves for silicon diodes and platinum RTDs are included in instrument firmware. It also provides non-volatile memory for one 200-point temperature response curve, which can be entered via the serial interface.

### Interface

With an RS-232C serial interface and other interface features, the Model 211 is valuable as a stand-alone monitor and is easily integrated into other systems. Setup and every instrument function can be performed via serial interface or the front panel. Temperature data can be read up to seven times per second over computer interface; the display is updated twice each second. High and low alarms can be used in latching mode for error limit detection and in non-latching mode in conjunction with relays to perform simple on-off control functions. The analog output can be configured for either 0 to 10 V or 4 to 20 mA output.

### 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	$T \geq 60 \text{ K} \ \& \ B \leq 3 \text{ T}$
	Silicon diode	DT-670E-BR	30 K to 500 K	$T \geq 60 \text{ K} \ \& \ B \leq 3 \text{ T}$
	Silicon diode	DT-414	1.4 K to 375 K	$T \geq 60 \text{ K} \ \& \ B \leq 3 \text{ T}$
	Silicon diode	DT-421	1.4 K to 325 K	$T \geq 60 \text{ K} \ \& \ B \leq 3 \text{ T}$
	Silicon diode	DT-470-SD	1.4 K to 500 K	$T \geq 60 \text{ K} \ \& \ B \leq 3 \text{ T}$
	Silicon diode	DT-471-SD	10 K to 500 K	$T \geq 60 \text{ K} \ \& \ B \leq 3 \text{ T}$
	GaAlAs diode	TG-120-P	1.4 K to 325 K	$T > 4.2 \text{ K} \ \& \ B \leq 5 \text{ T}$
	GaAlAs diode	TG-120-PL	1.4 K to 325 K	$T > 4.2 \text{ K} \ \& \ B \leq 5 \text{ T}$
	GaAlAs diode	TG-120-SD	1.4 K to 500 K	$T > 4.2 \text{ K} \ \& \ B \leq 5 \text{ T}$
Positive temperature coefficient RTDs	100 $\Omega$ platinum	PT-102/3	14 K to 873 K	$T > 40 \text{ K} \ \& \ B \leq 2.5 \text{ T}$
	100 $\Omega$ platinum	PT-111	14 K to 673 K	$T > 40 \text{ K} \ \& \ B \leq 2.5 \text{ T}$
	Rhodium-iron	RF-800-4	1.4 K to 500 K	$T > 77 \text{ K} \ \& \ B \leq 8 \text{ T}$
	Rhodium-iron	RF-100T/U	1.4 K to 325 K	$T > 77 \text{ K} \ \& \ B \leq 8 \text{ T}$
Negative temperature coefficient RTDs <sup>1</sup>	Cernox™	CX-1010	2 K to 325 K <sup>4</sup>	$T > 2 \text{ K} \ \& \ B \leq 19 \text{ T}$
	Cernox™	CX-1030-HT	3.5 K to 420 K <sup>2,5</sup>	$T > 2 \text{ K} \ \& \ B \leq 19 \text{ T}$
	Cernox™	CX-1050-HT	4 K to 420 K <sup>2,5</sup>	$T > 2 \text{ K} \ \& \ B \leq 19 \text{ T}$
	Cernox™	CX-1070-HT	15 K to 420 K <sup>2</sup>	$T > 2 \text{ K} \ \& \ B \leq 19 \text{ T}$
	Cernox™	CX-1080-HT	50 K to 420 K <sup>2</sup>	$T > 2 \text{ K} \ \& \ B \leq 19 \text{ T}$
	Germanium	GR-300-AA	1.2 K to 100 K <sup>3</sup>	Not recommended
	Germanium	GR-1400-AA	4 K to 100 K <sup>3</sup>	Not recommended
	Rox™	RX-102A	1.4 K to 40 K <sup>4</sup>	$T > 2 \text{ K} \ \& \ B \leq 10 \text{ T}$

<sup>1</sup> Single excitation current may limit the low temperature range of NTC resistors

<sup>2</sup> Non-HT version maximum temperature: 325 K

<sup>3</sup> Low temperature limited by input resistance range

<sup>4</sup> Low temperature specified with self-heating error:  $\leq 5 \text{ mK}$

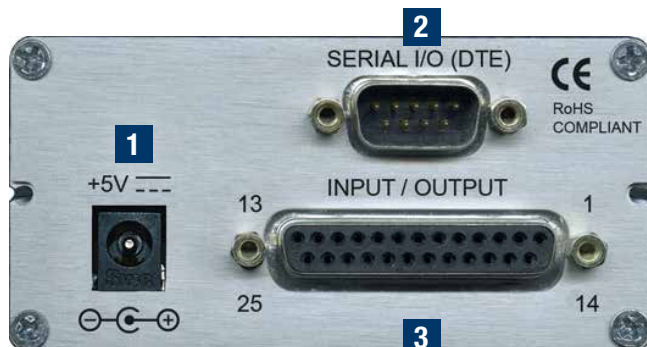
<sup>5</sup> Low temperature specified with self-heating error:  $\leq 12 \text{ mK}$

**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 2 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.

### Model 211 rear panel



1 Power input connector

2 Serial (RS-232C) I/O (DTE)

3 Analog output

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### Display

The Model 211 has a 6-digit LED display with measurements available in temperature units K, °C, °F, or sensor units V or Ω.

### Specifications

#### Sensor input configuration

Diode/RTD	
Measurement type	4-lead differential
Excitation	8 constant current sources
Supported sensors	Diodes: silicon, GaAlAs RTDs: 100 Ω platinum, 1000 Ω platinum, germanium, carbon-glass, Cernox™, and Rox™
Standard curves	DT-470, DT-670, CTI-C, PT-100, and PT-1000
Input connector	Shared 25-pin D-sub

### Thermometry

**Number of inputs** 1

**Input configuration** Input can be configured from the front panel to accept any of the supported input types

**Isolation** Measurement is not isolated from chassis ground

**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** 7 rdg/s

**User curve** One 200-point CalCurve™ or user curve in non-volatile memory

### Front panel

**Display** 5-digit LED

**Number of reading displays** 1

**Display units** K, °C, °F, V, and Ω

**Reading source** Temperature and sensor units

**Display update rate** 2 rdg/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

**Display annunciators** K, °C, °F, and V/Ω

**Keypad** 4 full travel keys, numeric and specific functions

**Front panel features** Display brightness control, keypad lock-out

### Typical sensor performance—see Appendix F for sample calculations of typical sensor performance

	Example Lake Shore sensor	Temperature	Nominal resistance/voltage	Typical sensor sensitivity <sup>6</sup>	Measurement resolution: temperature equivalents	Electronic accuracy: temperature equivalents	Temperature accuracy including electronic accuracy, CalCurve™, and calibrated sensor
Silicon diode	DT-670-SD with 1.4H calibration	1.4 K	1.644 V	-12.49 mV/K	1.6 mK	±29 mK	±41 mK
		77 K	1.028 V	-1.73 mV/K	11.6 mK	±175 mK	±197 mK
		300 K	0.5597 V	-2.3 mV/K	8.7 mK	±111 mK	±143 mK
		500 K	0.0907 V	-2.12 mV/K	9.4 mK	±99 mK	±149 mK
Silicon diode	DT-470-SD-13 with 1.4H calibration	1.4 K	1.6981 V	-13.1 mV/K	1.5 mK	±28 mK	±40 mK
		77 K	1.0203 V	-1.92 mV/K	10.5 mK	±157 mK	±179 mK
		300 K	0.5189 V	-2.4 mV/K	8.4 mK	±105 mK	±137 mK
		475 K	0.0906 V	-2.22 mV/K	9.1 mK	±94 mK	±144 mK
GaAlAs diode	TG-120-SD with 1.4H calibration	1.4 K	5.391 V	-97.5 mV/K	0.2 mK	±15 mK	±27 mK
		77 K	1.422 V	-1.24 mV/K	16.2 mK	±512 mK	±534 mK
		300 K	0.8978 V	-2.85 mV/K	7 mK	±186 mK	±218 mK
		475 K	0.3778 V	-3.15 mV/K	6.4 mK	±135 mK	±185 mK
100 Ω platinum RTD 500 Ω full scale	PT-103 with 1.4J calibration	30 K	3.66 Ω	0.19 Ω/K	10.5 mK	±320 mK	±330 mK
		77 K	20.38 Ω	0.42 Ω/K	4.8 mK	±153 mK	±165 mK
		300 K	110.35 Ω	0.39 Ω/K	5.2 mK	±210 mK	±232 mK
		500 K	185.668 Ω	0.378 Ω/K	5.3 mK	±257 mK	±303 mK
Cernox™	CX-1050-SD-HT <sup>7</sup> with 4M calibration	4.2 K	3507.2 Ω	-1120.8 Ω/K	45 μK	±2.0 mK	±7.0 mK
		77 K	205.67 Ω	-2.4116 Ω/K	20.8 mK	±366 mK	±382 mK
		300 K	59.467 Ω	-0.1727 Ω/K	290 mK	±4.8 K	±4.8 K
		420 K	45.03 Ω	-0.0829 Ω/K	604 mK	±9.9 K	±9.9 K
Germanium	GR-300-AA with 0.3D calibration	1.2 K	600 Ω	-987 Ω/K	51 μK	±0.6 mK	±5.3 mK
		1.4 K	449 Ω	-581 Ω/K	86 μK	±1 mK	±5 mK
		4.2 K	94 Ω	-27 Ω/K	1.9 mK	±16 mK	±20 mK
		100 K	3 Ω	-0.024 Ω/K	2.10 K	±2.5 K	±2.5 K
Germanium	GR-1400-AA with 1.4D calibration	4 K	1873 Ω	-1008 Ω/K	50 μK	±1.1 mK	±5.1 mK
		4.2 K	1689 Ω	-862 Ω/K	58 μK	±1.2 mK	±5.2 mK
		10 K	253 Ω	-62 Ω/K	807 μK	±1.8 mK	±6.3 mK
		100 K	3 Ω	-0.021 Ω/K	2.40 K	±2.9 K	±2.9 K
Carbon-glass (no longer available)	CGR-1-2000 with 4L calibration	4.2 K	2260 Ω	-2060 Ω/K	25 μK	±0.6 mK	±4.6 mK
		77 K	21.65 Ω	-0.157 Ω/K	319 mK	±410 mK	±435 mK
		300 K	11.99 Ω	-0.015 Ω/K	3.33 K	±4.2 K	±4.2 K

<sup>6</sup> Typical sensor sensitivities were taken from representative calibrations for the sensor listed

<sup>7</sup> Non-HT version maximum temperature: 325 K

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### Input specifications

Sensor type	Sensor temperature coefficient	Input range	Excitation current	Display resolution	Measurement resolution	Electronic accuracy	Instrument temperature coefficient
Silicon diode	negative	0 V to 2.5 V	10 $\mu$ A $\pm$ 0.05% <sup>8</sup>	100 $\mu$ V	20 $\mu$ V	$\pm$ 200 $\mu$ V $\pm$ 0.01% of rdg	$\pm$ 10 $\mu$ V $\pm$ 5 PPM of rdg/ $^{\circ}$ C
GaAlAs diode	negative	0 V to 7.5 V	10 $\mu$ A $\pm$ 0.05% <sup>8</sup>	100 $\mu$ V	20 $\mu$ V	$\pm$ 350 $\mu$ V $\pm$ 0.02% of rdg	$\pm$ 20 $\mu$ V $\pm$ 5 PPM of rdg/ $^{\circ}$ C
100 $\Omega$ platinum RTD, 250 $\Omega$ full scale	positive	0 $\Omega$ to 250 $\Omega$	1 mA $\pm$ 0.3% <sup>9</sup>	10 m $\Omega$	2 m $\Omega$	$\pm$ 0.004 $\Omega$ $\pm$ 0.02% of rdg	$\pm$ 0.2 m $\Omega$ $\pm$ 5 PPM of rdg/ $^{\circ}$ C
100 $\Omega$ platinum RTD, 500 $\Omega$ full scale	positive	0 $\Omega$ to 500 $\Omega$	1 mA $\pm$ 0.3% <sup>9</sup>	10 m $\Omega$	2 m $\Omega$	$\pm$ 0.004 $\Omega$ $\pm$ 0.02% of rdg	$\pm$ 0.2 m $\Omega$ $\pm$ 5 PPM of rdg/ $^{\circ}$ C
1000 $\Omega$ platinum RTD	positive	0 $\Omega$ to 5000 $\Omega$	1 mA $\pm$ 0.3% <sup>9</sup>	100 m $\Omega$	20 m $\Omega$	$\pm$ 0.06 $\Omega$ $\pm$ 0.04% of rdg	$\pm$ 2.0 m $\Omega$ $\pm$ 5 PPM of rdg/ $^{\circ}$ C
Cernox™ RTD	negative	0 $\Omega$ to 7500 $\Omega$	10 $\mu$ A $\pm$ 0.05% <sup>8</sup>	100 m $\Omega$	50 m $\Omega$	$\pm$ 0.8 $\Omega$ $\pm$ 0.04% of rdg	$\pm$ 20 m $\Omega$ $\pm$ 15 PPM of rdg/ $^{\circ}$ C

<sup>8</sup> Current source error has negligible effect on measurement accuracy

<sup>9</sup> Current source error is removed during calibration

### Interface

#### Serial interface

Electrical format	RS-232C
Max baud rate	9600 baud
Connector	9-pin D-sub
Reading rate	Up to 7 rdg/s

#### Alarms

Number	2, high and low
Data source	Temperature
Settings	High setpoint, Low setpoint, Dead band, Latching or Non-latching
Actuators	Display message, relays

#### Relays

Number	2
Contacts	Normally Open (NO), Normally Closed (NC), and Common (C)
Contact rating	30 VDC at 1 A
Operation	Activate relays on high or low input alarm or manual
Connector	Shared 25-pin D-sub

#### Analog output

Isolation Output is not isolated from chassis ground

Update rate	7 readings per s
Data source	Temperature

	Voltage	Current
Range	0 V to 10 V	4 mA to 20 mA
Accuracy	$\pm$ 1.25 mV	$\pm$ 5.0 $\mu$ A
Resolution	0.3 mV	0.6 $\mu$ A
Min load resistance	500 $\Omega$	NA
Compliance voltage	NA	10 V
Load regulation	NA	$\pm$ 0.02% of reading 0 to 500 $\Omega$

	Temperature	Sensor units (fixed by type)
Scales:	0 K to 20 K	Diodes: 1 V = 1 V
	0 K to 100 K	100 $\Omega$ platinum: 1 V = 100 $\Omega$
	0 K to 200 K	1000 $\Omega$ platinum: 1 V = 1000 $\Omega$
	0 K to 325 K	NTC resistor: 1 V = 1000 $\Omega$
	0 K to 475 K	
	0 K to 1000 K	

**Settings** Voltage or current, scale

**Connector** Shared 25-pin D-sub

### General

**Ambient temperature** 15  $^{\circ}$ C to 35  $^{\circ}$ C at rated accuracy, 10  $^{\circ}$ C to 40  $^{\circ}$ C at reduced accuracy

**Power requirements** Regulated +5 VDC at 400 mA

**Size** 96 mm W  $\times$  48 mm H  $\times$  166 mm D (3.8 in  $\times$  1.9 in  $\times$  6.5 in)

**Mounting** Panel mount into 91 mm W  $\times$  44 mm H (3.6 in  $\times$  1.7 in) cutout

**Weight** 0.45 kg (1 lb)

**Approvals** CE mark, RoHS



2111 Single 1/4 DIN panel-mount adapter, 105 mm W  $\times$  132 mm H (4.1 in  $\times$  5.2 in)



2112 Dual 1/4 DIN panel-mount adapter, 105 mm W  $\times$  132 mm H (4.1 in  $\times$  5.2 in)

### Power supply (109-132)

**Comes standard with interchangeable input plugs**

**Power requirements** 100 to 240 VAC, 50 or 60 Hz, 0.3 A max

**Output** +5 V at 1.2 A

**Size** 40.5 mm W  $\times$  30 mm H  $\times$  64 mm D (1.6 in  $\times$  1.2 in  $\times$  2.5 in)

**Weight** 0.15 kg (0.33 lb)



### Ordering information

Part number	Description
211S	Model 211 single channel temperature monitor—includes 100 to 240 V, 6 W universal power supply with interchangeable input plugs (109-132), one DB-25 sensor input mating connector (G-106-253), one sensor input mating connector shell (G-106-264), a calibration certificate and a user's manual Model 211S with all accessories except the power supply
211N	
<b>Accessories</b>	
109-132	100-240 VAC power supply with interchangeable plugs for US, UK, Europe, Australia, and China application
2111	Single 1/4 DIN panel-mount adapter
2112	Dual 1/4 DIN panel-mount adapter
8000	CalCurve™, CD-ROM (included with calibrated sensor)
G-106-253	DB-25 plug, qty 1
G-106-264	DB-25 hood, qty 1
CAL-211-CERT	Instrument recalibration with certificate
CAL-211-DATA	Instrument recalibration with certificate and data
119-043	Model 211 temperature monitor manual

All specifications are subject to change without notice