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

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 ≥ 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[1]	Cernox™	CX-1010	2 K to 325 K[4]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1030-HT	3.5 K to 420 K[2, 5]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1050-HT	4 K to 420 K[2, 5]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1070-HT	15 K to 420 K[2]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1080-HT	50 K to 420 K[2]	T > 2 K & B ≤ 19 T
	Germanium	GR-300-AA	1.2 K to 100 K[3]	Not recommended
	Germanium	GR-1400-AA	4 K to 100 K[3]	Not recommended
	Rox™	RX-102A	1.4 K to 40 K[4]	T > 2 K & B ≤ 10 T

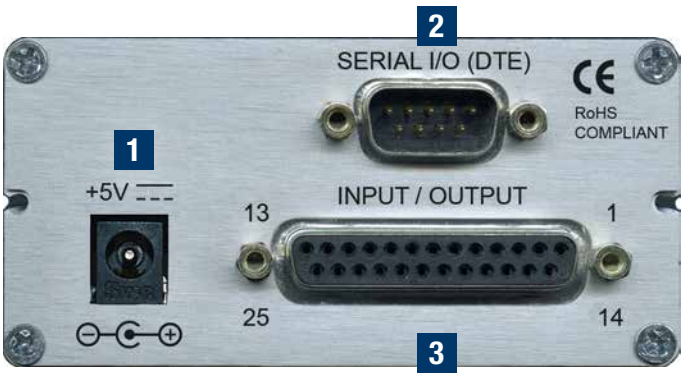
1 Single excitation current may limit the low temperature range of NTC resistors
2 Non-HT version maximum temperature: 325 K
3 Low temperature limited by input resistance range
4 Low temperature specified with self-heating error: ≤ 5 mK
5 Low temperature specified with self-heating error: ≤ 12 mK

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

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[6]	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[7] 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

[6] Typical sensor sensitivities were taken from representative calibrations for the sensor listed
[7] Non-HT version maximum temperature: 325 K

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 µA ±0.05%[8]	100 µV	20 µV	±200 µV ±0.01% of rdg	±10 µV ±5 PPM of rdg/°C
GaAlAs diode	negative	0 V to 7.5 V	10 µA ±0.05%[8]	100 µV	20 µV	±350 µV ±0.02% of rdg	±20 µV ±5 PPM of rdg/°C
100 Ω platinum RTD, 250 Ω full scale	positive	0 Ω to 250 Ω	1 mA ±0.3%[9]	10 mΩ	2 mΩ	±0.06 Ω ±0.02% of rdg	±0.2 mΩ ±5 PPM of rdg/°C
100 Ω platinum RTD, 500 Ω full scale	positive	0 Ω to 500 Ω	1 mA ±0.3%[9]	10 mΩ	2 mΩ	±0.06 Ω ±0.02% of rdg	±0.2 mΩ ±5 PPM of rdg/°C
1000 Ω platinum RTD	positive	0 Ω to 5000 Ω	1 mA ±0.3%[9]	100 mΩ	20 mΩ	±0.4 Ω ±0.04% of rdg	±2.0 mΩ ±5 PPM of rdg/°C
Cernox™ RTD	negative	0 Ω to 7500 Ω	10 µA ±0.05%[8]	100 mΩ	50 mΩ	±0.8 Ω ±0.04% of rdg	±20 mΩ ±15 PPM of rdg/°C

[8] Current source error has negligible effect on measurement accuracy
[9] 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	±1.25 mV	±5.0 µA
Resolution	0.3 mV	0.6 µA
Min load resistance	500 Ω	NA
Compliance voltage	NA	10 V
Load regulation	NA	±0.02% of reading 0 to 500 Ω

	Temperature	Sensor units (fixed by type)
Scales:	0 K to 20 K	Diodes: 1 V = 1 V
	0 K to 100 K	100 Ω platinum: 1 V = 100 Ω
	0 K to 200 K	1000 Ω platinum: 1 V = 1000 Ω
	0 K to 325 K	NTC resistor: 1 V = 1000 Ω
	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 °C to 35 °C at rated accuracy, 10 °C to 40 °C at reduced accuracy
Power requirements Regulated +5 VDC at 400 mA
Size 96 mm W × 48 mm H × 166 mm D (3.8 in × 1.9 in × 6.5 in)
Mounting Panel mount into 91 mm W × 44 mm H (3.6 in × 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 × 132 mm H (4.1 in × 5.2 in)

2112 Dual 1/4 DIN panel-mount adapter, 105 mm W × 132 mm H (4.1 in × 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 × 30 mm H × 64 mm D (1.6 in × 1.2 in × 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
211N	Model 211S with all accessories except the power supply

Accessories

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

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