Model 224 Temperature Monitor

Model 224 features

- Lake Shore's most capable cryogenic temperature monitor

- Equipped with 12 sensor channels for maximum monitoring capabilities

- Precisely measures in both higher temperature and cryogenic applications—down to 300 mK

- Ideal for multi-sensor lab uses, particularly for monitoring Cernox™ sensors

- Ethernet, USB and IEEE-488 computer interfaces

- Proven, intuitive user interface

- Customizable display enables you to label individual input channels

- CE certification

- Full 3 year standard warranty

Introduction

The Lake Shore Model 224 temperature monitor offers precision measurement in a wide range of cryogenic and higher-temperature applications with the ability to easily monitor up to 12 sensor channels. It provides better measurement performance in applications where researchers need to ensure accuracy and precision in their low cryogenic temperature monitoring. Used with Lake Shore's Cernox™ sensors, the Model 224 enables reliable and repeatable temperature measurement over a broad range and as low as 300 mK.

Cernox thin-film RTD sensors offer high sensitivity and low magnetic field-induced errors at cryogenic temperatures. The Model 224 has been optimized for use with these well-respected temperature sensors, and features many of the same advanced capabilities of Lake Shore Model 336 temperature controller, including its proven high-precision input circuitry.

In addition to Cernox, the Model 224 supports other NTC RTDs, PTC RTDs such as platinum sensors, and diodes such as the Lake Shore DT-670 Series. In cryogenic applications, the monitor is an ideal addition to any university or commercial low-temperature research lab requiring measurement flexibility using multiple sensors and sensor types. Used with silicon diodes, it provides accurate measurements in cryo-cooler and cryo-gas production applications from 1.4 K to above room temperature. Connected to PTC RTDs (platinum and rhodium-iron sensors), the Model 224 works well in cryogenic applications at liquid nitrogen temperatures.

You can set up different sensor types and responses on each input to support simultaneous measurement of various critical points in a system. Examples include monitoring multiple cryogenic refrigeration systems (e.g., liquid nitrogen Dewars, He-4 cryostats, and closed-cycle refrigerators), multiple stages within systems operating at different temperature levels, thermal gradient profiling, redundant measurements of critical values, leak detection, and other cryogenic applications where you need accurate readings at multiple points. Alarm thresholds can be configured independently for each input, and alarm events can activate the unit's relay outputs for hard-wired triggering of other systems or audible annunciators. Relays can be activated on high, low, or both alarms for any input.

Configure each input independently

Because the Model 224 features 12 independently configurable 6-pin DIN inputs, you can set it up for a different sensor on each input and run a number of different measurements simultaneously for various critical points in a system. Two inputs (A and B) are dedicated and non-scanned, updated at 10 rdg/s. The remaining 10 are scanned channels—inputs C and D can have up to five input devices each. These scanned channels are read anywhere from 1 to 10 rdg/s, depending on how many are being used at once.

Press any of the 4 input buttons (A, B, C or D) to view or change the parameters for each channel in the input display mode

The Model 224 features four high-resolution, 24-bit analog-to-digital converters for fast measurements. Optical isolation of input circuitry reduces line noise—interference that can skew low-level measurements—while providing repeatable sensor measurements.

Current reversal eliminates thermal electromotive force (EMF) errors when using resistance sensors. Also, nine excitation currents enable temperature measurements down to 300 mK when you use the appropriate NTC RTDs. When autoranging is enabled, the range will be automatically selected so that the excitation voltage is below 10 mV. This keeps the power dissipated in the sensor at a minimum, yet still at enough of a level to provide accurate measurements.

Monitor locally or remotely—from anywhere

For local monitoring, the front panel of the Model 224 features a bright liquid crystal display with an LED backlight that shows up to 12 readings simultaneously, or, you can even display a single sensor input to see greater detail at a glance.
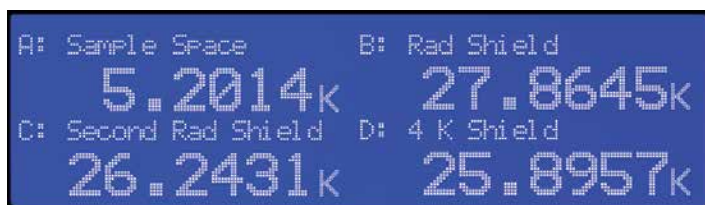
Plus, monitoring can be done over a network. Using the Ethernet port on the Model 224, you can keep an eye on temperatures and log measurement data remotely via a networked local PC or even remotely over a TCP/IP Internet connection from anywhere. A chart recorder utility embedded in the Ethernet module enables real-time charting of temperatures using a convenient graphical interface. You can also interface with the temperature monitor or link it to a data acquisition system via its serial USB or parallel IEEE-488 ports.
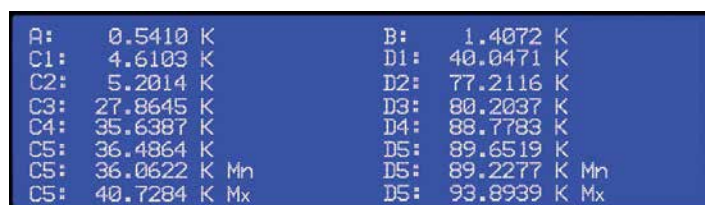
Intuitive, configurable display

The Model 224 front panel features a 23-key keypad and intuitive user interface for easy navigation of the temperature monitor's functions.

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.

Custom display modes can show multiple configurations of channels. The display above shows the 4 main inputs with their custom labels, while the one below shows all 12 channels plus 4 additional settings

Stores response curves

Like the Lake Shore Model 336, the Model 224 includes standard temperature sensor calibration curves for silicon diodes, platinum RTDs, and Rox™ (ruthenium oxide) RTDs.

The monitor's non-volatile memory enables users to store up to 39 200-point CalCurves for Lake Shore calibrated sensors or user curves. Lake Shore also offers curve handler software, which allows you to upload and manipulate temperature sensor calibration data.

And for applications requiring more accuracy than what's available using the built-in sensor curves, the Model 224 includes the Lake Shore SoftCal™ algorithm. It generates curves for silicon diodes and platinum RTDs for storage as user curves.

Sensor Selection

Sensor temperature range (sensors sold separately)

		Model	Useful range	Magnetic field use
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[1,2]	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[2]	Not recommended
	Germanium	GR-1400-AA	1.8 K to 100 K[2]	Not recommended
	Rox™	RX-102	0.3 K to 40 K[2]	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[2]	T > 2 K & B ≤ 10 T
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

[1] Non-HT version maximum temperature: 325 K
[2] Low temperature specified with self-heating error: ≤5 mK

Model 224 rear panel

1 Sensor input connectors
2 Line input assembly
3 Terminal block
4 Ethernet interface
5 USB interface
6 IEEE-488 interface

Ideal applications

■ Labs with multiple temperature sensors

■ Applications where both cryogenic and higher temperature readings are required

■ Monitoring of simple Dewars and LN cryostats (>4.2 K)

■ Closed-cycle refrigerators (CCRs) at 3 K to 4 K

■ Pumped He-4 (1.4 K) and He-3 (300 mK) systems

■ Temperature monitoring where superconducting magnets are used, such as in mass spectrometer and particle accelerator equipment

See our high-performance, highly flexible Cernox™ sensors

■ Low magnetic field-induced errors

■ A temperature range of 100 mK to 420 K (model dependent)

■ High sensitivity at low temperatures and good sensitivity over a broad range

■ Excellent resistance to ionizing radiation

■ Bare die cryogenic temperature sensor with fast characteristic thermal response times: 1.5 ms at 4.2 K, 50 ms at 77 K

■ Broad selection of models to meet your thermometry needs

■ Excellent stability

■ A variety of packaging options

These thin-film resistance cryogenic sensors offer significant advantages over diodes and conventional RTD sensors. The smaller package size makes them useful in a wide range of experimental mounting schemes, and they are also available in a chip form.
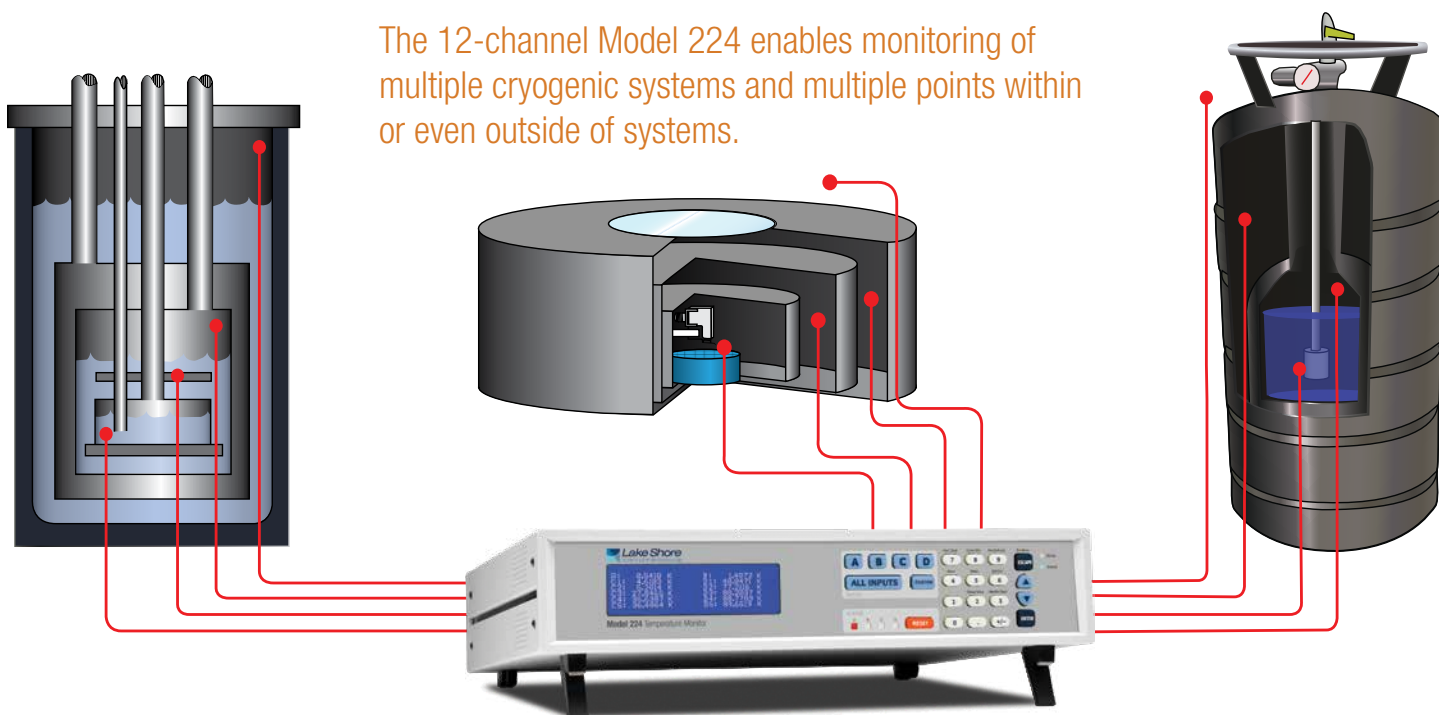
Model 224 Specifications

Input specifications

	Sensor temperature coefficient	Input Range	Excitation current	Display resolution	Measurement resolution	Electronic accuracy (at 25 °C)	Measurement temperature coefficient
NTC RTD 10 mV		0 Ω to 10 Ω	1 mA[3]	0.1 mΩ	0.15 mΩ	±0.002 Ω ±0.06% of rdg	(0.01 mΩ + 0.001% of rdg)/°C
		0 Ω to 30 Ω	300 µA[3]	0.1 mΩ	0.45 mΩ	±0.002 Ω ±0.06% of rdg	(0.03 mΩ + 0.0015% of rdg)/°C
		0 Ω to 100 Ω	100 µA[3]	1 mΩ	1.5 mΩ	±0.01 Ω ±0.04% of rdg	(0.1 mΩ + 0.001% of rdg)/°C
		0 Ω to 300 Ω	30 µA[3]	1 mΩ	4.5 mΩ	±0.01 Ω ±0.04% of rdg	(0.3 mΩ + 0.0015% of rdg)/°C
	Negative	0 Ω to 1 kΩ	10 µA[3]	10 mΩ	15 mΩ +0.002% of rdg	±0.1 Ω ±0.04% of rdg	(1 mΩ + 0.001% of rdg)/°C
		0 Ω to 3 kΩ	3 µA[3]	10 mΩ	45 mΩ +0.002% of rdg	±0.1 Ω ±0.04% of rdg	(3 mΩ + 0.0015% of rdg)/°C
		0 Ω to 10 kΩ	1 µA[3]	100 mΩ	150 mΩ +0.002% of rdg	±1.0 Ω ±0.04% of rdg	(10 mΩ + 0.001% of rdg)/°C
		0 Ω to 30 kΩ	300 nA[3]	100 mΩ	450 mΩ +0.002% of rdg	±2.0 Ω ±0.04% of rdg	(30 mΩ + 0.001% of rdg)/°C
		0 Ω to 100 kΩ	100 nA[3]	1 Ω	1.5 Ω +0.005% of rdg	±10.0 Ω ±0.04% of rdg	(100 mΩ + 0.002% of rdg)/°C
Diode	Negative	0 V to 2.5 V	10 µA ±0.05%[4,5]	10 µV	10 µV	±80 µV ±0.005% of rdg	(10 µV + 0.0005% of rdg)/°C
		0 V to 10 V	10 µA ±0.05%[4,5]	100 µV	20 µV	±320 µV ±0.01% of rdg	(20 µV + 0.0005% of rdg)/°C
PTC RTD		0 Ω to 10 Ω	1 mA[3]	0.1 mΩ	0.2 mΩ	±0.002 Ω ±0.01% of rdg	(0.01 mΩ + 0.001% of rdg)/°C
		0 Ω to 30 Ω	1 mA[3]	0.1 mΩ	0.2 mΩ	±0.002 Ω ±0.01% of rdg	(0.03 mΩ + 0.001% of rdg)/°C
		0 Ω to 100 Ω	1 mA[3]	1 mΩ	2 mΩ	±0.004 Ω ±0.01% of rdg	(0.1 mΩ + 0.001% of rdg)/°C
	Positive	0 Ω to 300 Ω	1 mA[3]	1 mΩ	2 mΩ	±0.004 Ω ±0.01% of rdg	(0.3 mΩ + 0.001% of rdg)/°C
		0 Ω to 1 kΩ	1 mA[3]	10 mΩ	20 mΩ	±0.04 Ω ±0.02% of rdg	(1 mΩ + 0.001% of rdg)/°C
		0 Ω to 3 kΩ	1 mA[3]	10 mΩ	20 mΩ	±0.04 Ω ±0.02% of rdg	(3 mΩ + 0.001% of rdg)/°C
		0 Ω to 10 kΩ	1 mA[3]	100 mΩ	200 mΩ	±0.4 Ω ±0.02% of rdg	(10 mΩ + 0.001% of rdg)/°C

[3]   Current source error is removed during calibration
[4]   Current source error has negligible effect on measurement accuracy
[5]   Diode input excitation can be set to 1 mA

The 12-channel Model 224 enables monitoring of multiple cryogenic systems and multiple points within or even outside of systems.

Sensor input configuration

Diode/RTD	
Measurement type	4-lead differential
Excitation	Constant current with current reversal for RTDs
Supported sensors	RTDs: Cernox™,100 Ω platinum,1000 Ω platinum, germanium, carbon-glass, and Rox™ Diodes: silicon, GaAlAs
Standard curves	DT-470, DT-670, DT-500-D, DT-500-E1, PT-100, PT-1000, RX-102A, RX-202A
Input connector	6-pin DIN

Thermometry

Number of inputs 12 (2 dedicated; 10 scanned)

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

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 rdg/s on each non-scanned input; 5 rdg/s when configured as 100 kΩ NTC RTD with reversal on; 2 rdg/s on each scanned input; update rate is dependent on the number of channels enabled (typically from 10 rdg/s for 1 channel to 2 rdg/s for all 10 scanned channels)

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

Front panel

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

Number of reading displays 1 to 16

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

Display annunciators Alarm

LED annunciators Remote, Ethernet status, alarm

Keypad 23-key silicone elastomer keypad

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

Interface

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)
Function	Emulates a standard RS-232 serial port
Baud rate	57,600
Connector	B-type USB
Reading rate	To 10 rdg/s on each input
Software support	LabVIEW™ driver (see www.lakeshore.com)
Function	TCP/IP, web interface with built-in utilities
Connector	RJ-45
Reading rate	To 10 rdg/s on each input
Software support	LabVIEW™ driver (see www.lakeshore.com)
Number	12, 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
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, 35 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
224-12	Temperature monitor with 12 diode/RTD inputs—includes twelve 6-pin DIN plug sensor input mating connectors (G-106-233), one 6-pin terminal block (106-737), a calibration certificate and a user's manual

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

RM-1	Kit for mounting one full rack instrument
G-106-233	Sensor input mating connector (6-pin DIN plug)
106-737	Terminal block (6-pin)
CAL-224-CERT	Instrument calibration with certificate
CAL-224-DATA	Instrument recalibration with certificate and data
119-062	Model 224 temperature monitor user manual

All specifications are subject to change without notice