Model 224 12-channel
Cryogenic temperature monitor

Quantum Design

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Lake Shore CRYOTRONICS

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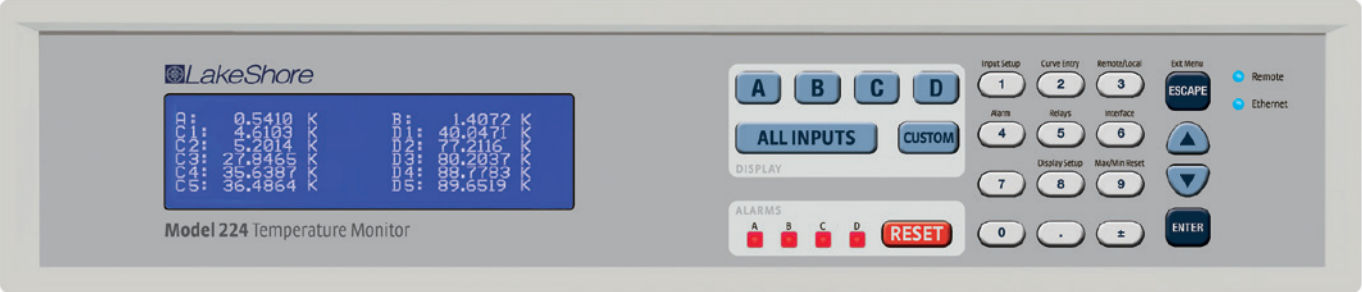

- Lake Shore's most capable cryogenic temperature monitor
- Equipped with 12 sensor channels for maximum monitoring capabilities
- Precisely measures in both higher temperature and cryogenic applications—down to 300 mK
- Ideal for multi-sensor lab uses, particularly for monitoring Cernox™ sensors
- Ethernet, USB and IEEE-488 computer interfaces
- Proven, intuitive user interface
- Customizable display enables you to label individual input channels

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.

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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.

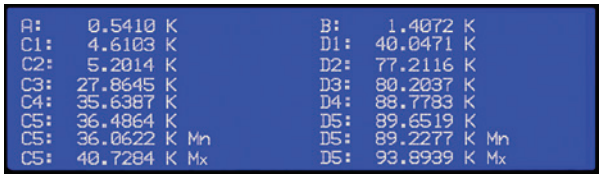
Plus, monitoring can be done over a network. Using the Ethernet port on the Model 224, you can keep an eye on temperatures and log measurement data remotely via a networked local PC or even remotely over a TCP/IP Internet connection from anywhere. A chart recorder utility embedded in the Ethernet module 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



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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[1,3]	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
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 limited by input resistance range*
[3] *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

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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.

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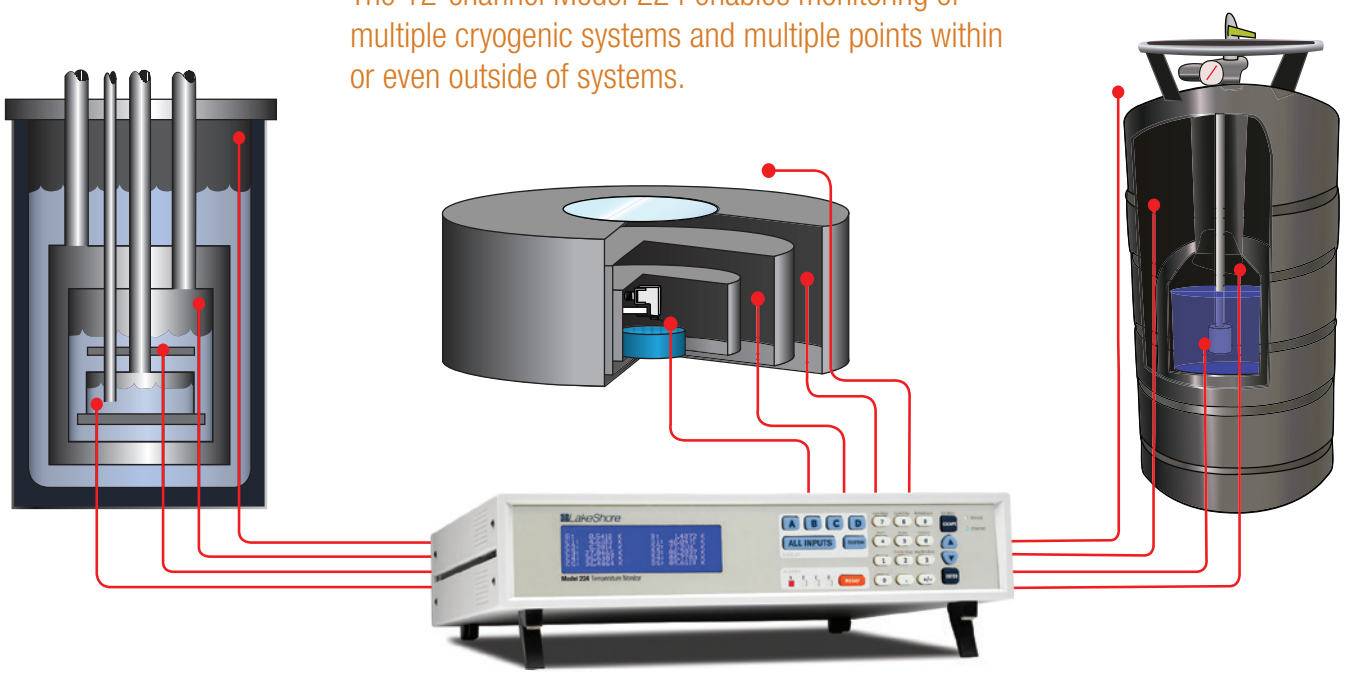
Model 224 Specifications

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	Negative	0 Ω to 10 Ω	1 mA[6]	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[6]	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[6]	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[6]	1 mΩ	4.5 mΩ	±0.01 Ω ±0.04% of rdg	(0.3 mΩ + 0.0015% of rdg/°C
		0 Ω to 1 kΩ	10 µA[6]	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[6]	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[6]	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[6]	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[6]	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	Positive	0 Ω to 10 Ω	1 mA[6]	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[6]	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[6]	1 mΩ	2 mΩ	±0.004 Ω ±0.01% of rdg	(0.1 mΩ + 0.001% of rdg/°C
		0 Ω to 300 Ω	1 mA[6]	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[6]	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[6]	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[6]	100 mΩ	200 mΩ	±0.4 Ω ±0.02% of rdg	(10 mΩ + 0.001% of rdg/°C

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

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



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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 12
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, alarms A – D
Keypad 23-key silicone elastomer keypad
Front panel features Front-panel curve entry, display contrast control, and keypad lockout

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 (contact Lake Shore for availability)

USB
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 (contact Lake Shore for availability)

Ethernet
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 (contact Lake Shore for availability)

Alarms
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

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

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Please specify your power cord choice:

Instruments are configured for your country's supply voltage and ship with the appropriate power cord. Please specify from the following choices. If your required cord type is not offered, please select based on the required voltage so that the instrument can be configured correctly and make arrangements to supply your own 3-pin IEC cord.

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)

Ordering Information

Part number	Description
224-12	Temperature monitor with 12 diode/RTD inputs—includes 12 6-pin DIN plug sensor input mating connectors (G-106-233), one 6-pin terminal block (106-737), a calibration certificate, and user manual (MAN-224)
RM-1	Rack mount kit for mounting one full rack instrument
CAL-224-CERT	Model 224 recalibration with certificate
CAL-224-DATA	Model 224 recalibration with certificate and data
G-106-233	Sensor input mating connector (6-pin DIN plug)
106-737	Terminal block (6-pin)
MAN-224	Model 224 user's manual

The technical and pricing information contained herein is subject to change at any time. 112913

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