Model 218 Temperature Monitor

Features

- Operates down to 1.4 K with appropriate sensor
- 8 sensor inputs
- Supports diode and RTD sensors
- Continuous 8-input display with readings in K, °C, V, or Ω
- IEEE-488 and RS-232C interfaces, analog outputs, and alarm relays
- Available in two versions: Model 218S and 218E

Product Description

The Model 218 is our most versatile temperature monitor. With eight sensor inputs, it can be used with nearly any diode or resistive temperature sensor. It displays all eight channels continuously in K, °C, V or Ω. The measurement input was designed for the demands of cryogenic temperature measurement, however, the monitor's low noise, high resolution, and wide operating range make it ideal for noncryogenic applications as well.

Sensor Input Reading Capability

The Model 218 has eight constant current sources (one for each input) that can be configured for a variety of sensors. The inputs can be configured from the front panel or via a computer interface, and are grouped in two sets of four. Each set of four inputs is configured for the same sensor type (i.e., all 100 Ω platinum or all silicon diodes).

Two high-resolution A/D converters increase the update rate of the Model 218. It can read sensor inputs more quickly than other scanning monitors because it does not have to wait for current source switching. The result is 16 new readings per second, allowing all inputs to be read twice each second. Inputs can be turned off to obtain a higher reading rate on fewer sensors.

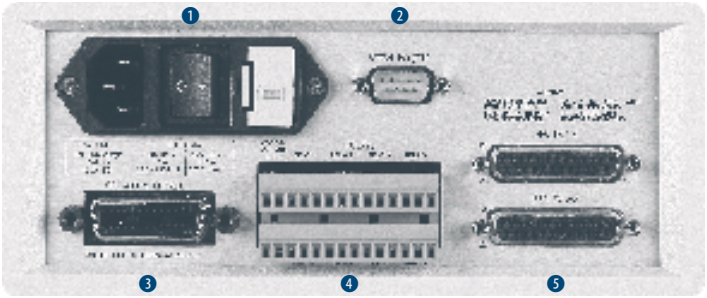
Temperature Response Curves

The Model 218 has standard temperature sensor response curves for silicon diodes and platinum RTDs. It can support a wide variety of temperature sensors because a unique 200-point user curve can be stored for each of the eight inputs. CalCurves™ for Lake Shore calibrated sensors can be stored as user curves. The built in SoftCal™[1] algorithm can also be used to generate improved curves for DT-470 diodes and platinum RTDs that are stored as user curves.

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

Interface Features of Model 218S and Model 218E

Feature	*218S*	*218E*
Numeric keypad	■	■
Front panel curve entry	■	■
Alarms	■	■
RS-232C interface	■	■
IEEE-488 interface	■	
Two analog voltage outputs	■	
Eight relays	■	



1. *Line input assembly*
2. *RS-232C or printer interface*
3. *IEEE-488 interface (218S only)*
4. *Terminal block with relays and analog voltage outputs (218S only)*
5. *Sensor inputs*

Interface

The Model 218 is available with both parallel (IEEE-488, 218S only) and serial (RS-232C) computer interfaces. Each input has a high and low alarm which offer latching and non-latching operation. The eight relays on the Model 218S can be used with the alarms to alert the operator of a fault condition or perform simple on-off control. The Model 218S includes two analog voltage outputs. The user may select the scale and data 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.

Display

The eight display locations on the Model 218 are user configurable. Sources for readout data are temperature units, sensor units, and results of the math function. Input number and data source are always displayed for convenience. The display is updated twice each second.

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[2]	**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[3,6]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1050-HT	4 K to 420 K[3,6]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1070-HT	15 K to 420 K[3]	T > 2 K & B ≤ 19 T
	Cernox™	CX-1080-HT	50 K to 420 K[3]	T > 2 K & B ≤ 19 T
	Germanium	GR-200A/B-1000	2.2 K to 100 K[4]	Not Recommended
	Germanium	GR-200A/B-1500	2.6 K to 100 K[4]	Not Recommended
	Germanium	GR-200A/B-2500	3.1 K to 100 K[4]	Not Recommended
	Carbon-Glass	CGR-1-500	4 K to 325 K[5]	T > 2 K & B ≤ 19 T
	Carbon-Glass	CGR-1-1000	5 K to 325 K[5]	T > 2 K & B ≤ 19 T
	Carbon-Glass	CGR-1-2000	6 K to 325 K[5]	T > 2 K & B ≤ 19 T
	Rox™	RX-102A	1.4 K to 40 K[5]	T > 2 K & B ≤ 10 T

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.

[2] Single excitation current may limit the low temperature range of NTC resistors

[3] Non-HT version maximum temperature: 325 K

[4] Low temperature limited by input resistance range

[5] Low temperature specified with self-heating error: ≤ 5 mK

[6] Low temperature specified with self-heating error: ≤ 12 mK

Typical Sensor Performance – *see Appendix F for sample calculations of typical sensor performance*

	Example Lake Shore Sensor	Temp	Nominal Resistance/ Voltage	Typical Sensor Sensitivity[7]	Measurement Resolution: Temperature Equivalents	Electronic Accuracy: Temperature Equivalents	Temperature Accuracy including Electronic Accuracy, CalCurve™, and Calibrated Sensor
Silicon Diode	DT-670-SD	1.4 K	1.644 V	-12.49 mV/K	1.6 mK	±26 mK	±38 mK
	with 1.4H	77 K	1.028 V	-1.73 mV/K	11.6 mK	±152 mK	±174 mK
	calibration	300 K	0.5597 V	-2.3 mV/K	8.7 mK	±94 mK	±126 mK
		500 K	0.0907 V	-2.12 mV/K	9.4 mK	±80 mK	±130 mK
Silicon Diode	DT-470-SD-13	1.4 K	1.6981 V	-13.1 mV/K	1.5 mK	±26 mK	±38 mK
	with 1.4H	77 K	1.0203 V	-1.92 mV/K	10.5 mK	±137 mK	±159 mK
	calibration	300 K	0.5189 V	-2.4 mV/K	8.4 mK	±88 mK	±120 mK
		475 K	0.0906 V	-2.22 mV/K	9.1 mK	±77 mK	±127 mK
GaAlAs Diode	TG-120-SD	1.4 K	5.391 V	-97.5 mV/K	0.2 mK	±13 mK	±25 mK
	with 1.4H	77 K	1.422 V	-1.24 mV/K	16.2 mK	±359 mK	±381 mK
	calibration	300 K	0.8978 V	-2.85 mV/K	7 mK	±120 mK	±152 mK
		475 K	0.3778 V	-3.15 mV/K	6.4 mK	±75 mK	±125 mK
100 Ω Platinum RTD	PT-103	30 K	3.66 Ω	0.19 Ω/K	10.5 mK	±25 mK	±35 mK
500 Ω Full Scale	with 1.4J	77 K	20.38 Ω	0.42 Ω/K	4.8 mK	±20 mK	±32 mK
	calibration	300 K	110.35 Ω	0.39 Ω/K	5.2 mK	±68 mK	±91 mK
		500 K	185.668 Ω	0.378 Ω/K	5.3 mK	±109 mK	±155 mK
Cernox™	CX-1050-SD-HT[8]	4.2 K	3507.2 Ω	-1120.8 Ω/K	45 μK	±1.4 mK	±6.4 mK
	with 4M	77 K	205.67 Ω	-2.4116 Ω/K	20.8 mK	±75.6 mK	±91.6 mK
	calibration	300 K	59.467 Ω	-0.1727 Ω/K	290 mK	±717 mK	±757 mK
		420 K	45.03 Ω	-0.0829 Ω/K	604 mK	±1.43 K	±1.5 K
Germanium	GR-200A-1000	2 K	6674 Ω	-9930 Ω/K	5 μK	±0.3 mK	±4.3 mK
	with 1.4D	4.2 K	1054 Ω	-526 Ω/K	95 μK	±10 mK	±14 mK
	calibration	10 K	170.9 Ω	-38.4 Ω/K	1.3 mK	±4.4 mK	±9.4 mK
		100 K	2.257 Ω	-0.018 Ω/K	2.78 K	±5.61 K	±5.77 K
Carbon-Glass	CGR-1-2000	4.2 K	2260 Ω	-2060 Ω/K	25 μK	±0.5 mK	±4.5 mK
	with 4L	77 K	21.65 Ω	-0.157 Ω/K	319 mK	±692 mK	±717 mK
	calibration	300 K	11.99 Ω	-0.015 Ω/K	3.33 K	±7 K	±7.1 K

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

Specifications

Input Specifications

	Sensor Temperature Coefficient	Input Range	Excitation Current	Display Resolution	Measurement Resolution	Electronic Accuracy
Diode	negative	0 V to 2.5 V	10 μA ±0.05%[9]	100 μV	20 μV	±160 μV ±0.01% of rdg
	negative	0 V to 7.5 V	10 μA ±0.05%[9]	100 μV	20 μV	±160 μV ±0.02% of rdg
PTC RTD	positive	0 Ω to 250 Ω	1 mA ±0.3%[10]	10 mΩ	2 mΩ	±0.004 Ω ±0.02% of rdg
	positive	0 Ω to 500 Ω	1 mA ±0.3%[10]	10 mΩ	2 mΩ	±0.004 Ω ±0.02% of rdg
	positive	0 Ω to 5000 Ω	1 mA ±0.3%[10]	100 mΩ	20 mΩ	±0.06 Ω ±0.04% of rdg
NTC RTD	negative	0 Ω to 7500 Ω	10 μA ±0.05%[9]	100 mΩ	50 mΩ	±0.1 Ω ±0.04% of rdg

[9] Current source error has negligible effect on measurement accuracy
[10] Current source error is removed during calibration

Thermometry

Number of inputs 8
Input configuration Inputs separated into two groups of four (each group must be the same sensor type) – inputs can be configured from the front panel to accept any of the supported input types
Input accuracy Sensor dependent – refer to Input Specifications table
Measurement resolution Sensor dependent – refer to Input Specifications table
Maximum update rate 16 readings per s total

Thermometry, continued

User curves Room for 8 (1 per input) 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
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-500D, DT-670, CTI-C, PT-100, and PT-1000
Input connector	25-pin D-sub

Front Panel

Display 4 line by 20 character backlit LCD display
Number of reading displays 1 to 8
Display units K, °C, V, and Ω
Reading source Temperature, sensor units, max, min, and linear equation
Display update rate All displayed inputs twice in 1 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 Remote operation, alarm, data logging, max, min, and linear
Keypad Membrane keypad, 20-key, numeric and specific functions
Front panel features Front panel curve entry and keypad lock-out

Interface

IEEE-488.2 interface (218S)
- **Features** SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT0, C0, E1
- **Reading rate** To 16 readings per s
- **Software support** LabVIEW™ driver

Serial interface
- **Electrical format** RS-232C
- **Max baud rate** 9600 baud
- **Connector** 9-pin D-sub
- **Reading rate** To 16 readings per s (at 9600 baud)
- **Printer capability** Support for serial printer through serial interface port used with data log parameters

Alarms
- **Number** 16: 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 (218S)

Relays (218S)
- **Number** 8
- **Contacts** Normally open (NO), normally closed (NC), and common (C)
- **Contact rating** 30 VDC at 5 A
- **Operation** Each input may be configured to activate any or all of the eight relays – relays may be activated on high, low, or both alarms for any input, or manually
- **Connector** Detachable terminal block

Analog voltage output (218S)
- **Number** 2
- **Scale** User selected
- **Update rate** To 16 readings per s
- **Data source** Temperature, sensor units, and linear equation
- **Range** ±10 V
- **Resolution** 1.25 mV
- **Accuracy** ±2.5 mV
- **Min load resistance** 1 kΩ (short-circuit protected)

Data logging
- **Channels** 1 to 8
- **Operation** Data log records can be stored in memory or sent to the printer; stored data may be displayed, printed, or retrieved by computer interface
- **Data memory** Maximum of 1500 single reading records, non-volatile

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, 18 VA
Size 216 mm W × 89 mm H × 318 mm D (8.5 in × 3.5 in × 12.5 in), half rack
Weight 3 kg (6.6 lb)
Approval CE mark

Ordering Information

Part number	Description
218S	Standard Temperature Monitor (8 inputs, IEEE-488 and serial interface, alarms, relays, corrected analog output, data logging)
218E	Economy Temperature Monitor (8 inputs, serial interface, alarms, data logging)

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 Euro line cord and fuses for 220/240 VAC setting
VAC-220	Instrument configured for 220 VAC with universal Euro line cord
VAC-240	Instrument configured for 240 VAC with universal Euro line cord

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

Accessories Included

G-106-253	Two 25-pin D-sub plugs used for sensor input connector
G-106-264	Two 25-pin D-sub shells used for sensor input connector
106-772	Two 14-pin connectors used for relays & analog outputs (218S only)
——	Calibration certificate
MAN-218	Model 218 user manual

Options and accessories

4005	1 m IEEE-488 (GPIB) computer interface cable assembly – includes extender which allows connection of IEEE cable and relay terminal block simultaneously
8000	The CalCurve™ breakpoint table from a calibrated sensor loaded on a CD-ROM for customer uploading
8001-218	The breakpoint table from a calibrated sensor stored in the instrument
8002-05-218	The breakpoint table from a calibrated sensor stored in a NOVRAM for installation at the customer location
CAL-218-CERT	Instrument recalibration with certificate
RM-½	Kit to mount one ½ rack temperature monitor in a 482.6 mm (19 in) rack
RM-2	Kit to mount two ½ rack temperature monitors in a 482.6 mm (19 in) rack