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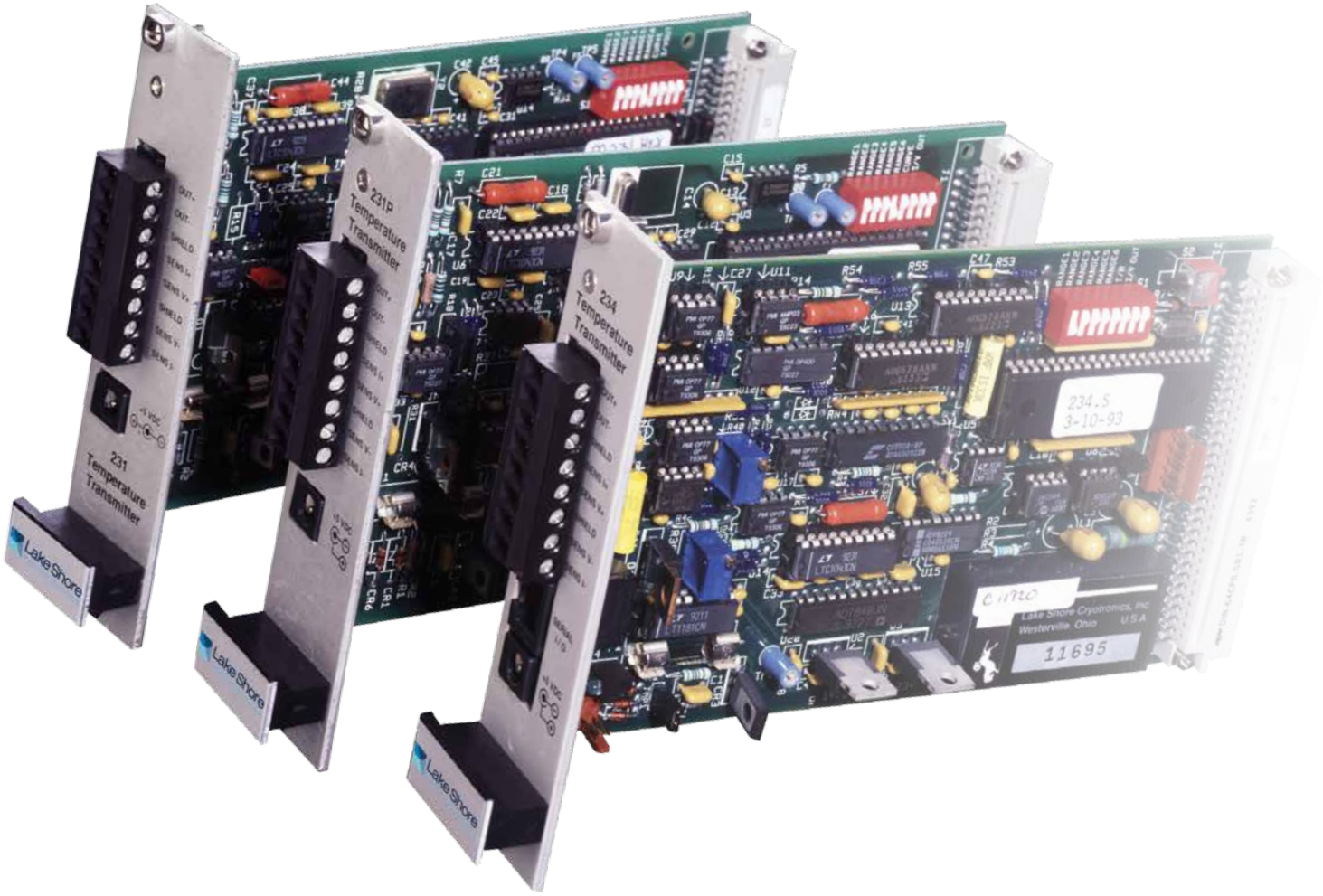
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230 Series Temperature Transmitters/Monitors

The Model 231, Model 231P, and Model 234 each support a different sensor type



230 Series features

- Sensor input fully isolated from power supply potential
- Different models support various sensor types
- 4-lead differential measurement
- Output range of 4 mA to 20 mA or 0 mA to 20 mA (0 V to 10 V)
- Available rack-mount case holds up to 12 units
- Full 3 year standard warranty

Model 231 features

- Operates from 1.4 K to 500 K with appropriate diode

Model 231P features

- Operates from 1.4 K to 800 K with appropriate PTC RTD

Model 234 features

- Operates from 100 mK to 420 K with appropriate NTC RTD
- Includes serial interface

Model 231

The Model 231 operates with either silicon diode or gallium-aluminum-arsenide (GaAlAs) diode sensors.

Excited with a 10 µA current source from the Model 231, the sensors produce a voltage that depends on temperature. A microcontroller reads the voltage through an A/D converter and translates it into temperature using a temperature response curve. The Model 231 includes two standard curves for DT-470 and DT-670 diode sensors. It also supports a single CalCurve™ option for calibrated sensors (TG-120 diodes require a CalCurve™).

Model 231P

The Model 231P uses a PT-100 Series platinum sensor. The Model 231P excites the sensor with a 500 µA current to produce a measurable signal. Either the standard platinum curve (IEC 751) or a CalCurve™ is used for temperature conversion.

Model 234

The Model 234 operates with Cernox™, carbon-glass, germanium, or other negative temperature coefficient (NTC) resistance temperature sensors. The Model 234 excites the sensor with a constant voltage of 10 mV or less to minimize the effects of sensor self-heating at low temperatures.

The Model 234 employs an analog control circuit to maintain a constant voltage signal across the sensor. A series of reference resistors convert the resulting sensor current to a voltage. A microcontroller reads the voltage with an A/D converter, calculates sensor resistance, and converts the resistance to temperature by table interpolation (requires a CalCurve™ for temperature conversion). The sensor excitation voltage is reversed each reading to compensate for thermal voltages and offsets.

Once one of the 230 Series obtains temperature data, it transmits a current of 4 mA to 20 mA. The current output changes linearly with sensor temperature. Output scale depends on the selected temperature range. Several switch-selected ranges are available. Highest accuracy and sensitivity are achieved when the output is set for a narrow temperature band. A 0 mA to 20 mA output is also available to convert output to a voltage scaled from zero. A 500 Ω, ±0.02% output load resistor produces the maximum full-scale output of 10 V.

Circuitry for the Model 230 Series is powered by a single +5 VDC supply applied either from the front panel connector or the power pins on the VME bus connector. The outputs are isolated so several transmitters can be run off the same supply without interference.

Mechanical mounting is easy because the 230 Series is built on a standard size VME card. It fits directly into a single height (3U) VME card holder. The transmitter does not use the electrical bus format, only its physical shape and power supply.

The Model 234 includes a RJ11 serial interface.

Model 234 measurement scales, excitation, resolution, and accuracy

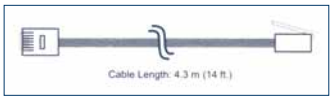
	Sensor resistance	Sensor excitation voltage	Resolution	Accuracy ±(% rdg + Ω)
0	1 Ω to 6 Ω	5 mV	0.0003 Ω	0.5 + 0.0006
1	4.5 Ω to 12.5 Ω	5 mV	0.0001 Ω	0.1 + 0.0013
2	9 Ω to 60 Ω	10 mV	0.001 Ω	0.1 + 0.006
3	45 Ω to 125 Ω	5 mV	0.001 Ω	0.1 + 0.013
4	90 Ω to 360 Ω	10 mV	0.003 Ω	0.1 + 0.036
5	290 kΩ to 1.25 kΩ	10 mV	0.01 Ω	0.1 + 0.13
6	900 kΩ to 3.6 kΩ	10 mV	0.03 Ω	0.1 + 0.36
7	2.9 kΩ to 12.5 kΩ	10 mV	0.1 Ω	0.1 + 1.3
8	9 kΩ to 36 kΩ	10 mV	0.3 Ω	0.1 + 3.6
9	29 kΩ to 300 kΩ	10 mV	6.8 Ω	0.5 + 30

Thermometry	231	231P	234
Number of inputs	1	1	1
Measurement type	4-lead differential	4-lead differential	4-lead differential
Sensor type	Silicon diode, GaAlAs diode	Platinum	Carbon-glass, germanium, Cernox™
Sensor temperature coefficient	Negative	Positive	Negative
Sensor units	Volts (V)	Ohms (Ω)	Ohms (Ω)
Input range	0 V to 5 V	0 Ω to 312 Ω	1 Ω to 300 kΩ
Sensor excitation	10 µA ±0.1% DC current	500 µA ±0.02% DC current	Constant voltage pinned at 5 mV or 10 mV dependent on resistance range
Update rate	5 rdg/s	5 rdg/s	4 rdg/s (2 rdg/s on Scale 0 only)
Precision curve storage	One curve loaded at Lake Shore	One curve loaded at Lake Shore	One curve, loaded at Lake Shore or in the field via serial interface
Example Lake Shore sensor	DT-470-CO	PT-103	CGR-1-1000 with 1.4L calibration
Sensor temperature range	1.4 K to 475 K	30 K to 800 K	1.4 K to 325 K
Standard curve	Lake Shore Curve 10	IEC 751	Requires calibrated sensor and CalCurve™
Typical sensor sensitivity[1]	-30 mV/K at 4.2 K 40 mK at 77 K 32 mK at 300 K	0.19 Ω/K at 30 K 11 mK at 77 K 13 mK at 300 K 14 mK up to 800 K	-700 Ω/K at 4.2 K ±0.12 mK at 30 K ±6.6 mK at 77 K ±67 mK at 300 K
Measurement resolution[1]			
Sensor units	76.3 µV	4.8 mΩ	Range dependent
Temperature equivalence	2.5 mK at 4.2 K 40 mK at 77 K 32 mK at 300 K	22 mK at 30 K 11 mK at 77 K 13 mK at 300 K 14 mK up to 800 K	±0.04 mK at 4.2 K ±0.12 mK at 30 K ±6.6 mK at 77 K ±67 mK at 300 K
Electronic measurement accuracy[1]			
Sensor units	±75 µV ±0.01% of reading	±0.05 Ω ±0.05% of reading	Range dependent (see table on 126)
Temperature accuracy	±0.07 K at 4.2 K ±0.16 K at 77 K ±0.12 K at 300 K	±0.2 K at 30 K ±0.15 K at 77 K ±0.3 K at 300 K ±0.7 K up to 800 K	±2 mK at 4.2 K ±8 mK at 10 K ±18 mK at 77 K ±1.2 K at 300 K
Measurement temperature coefficient			
Sensor units (% of reading/°C ambient)	0.0006% of resistance rdg /°C	0.002% of resistance rdg /°C	0.0125% of resistance rdg /°C
Temperature equivalence	3 mK/°C at 4.2 K 3 mK/°C at 77 K 1.2 mK/°C at 300 K	0.4 mK/°C at 30 K 1 mK/°C at 77 K 6 mK/°C at 300 K 18 mK/°C at 800 K	±0.18 mK/°C at 4.2 K ±0.8 mK/°C at 10 K ±18 mK/°C at 77 K ±100 mK/°C at 300 K
Magnetic field use			
Silicon diode	Recommended for T ≥ 60 K and B ≤ 3 T	NA	NA
GaAlAs diode	Recommended for T ≥ 4.2 K and B ≤ 5 T	NA	NA
Platinum	NA	Recommended for T > 40 K and B ≤ 2.5 T	NA
Carbon-glass	NA	NA	Recommended for T ≥ 2 K and B ≤ 19 T

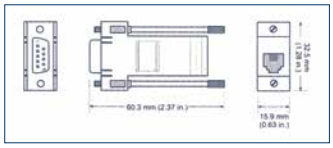
	231	231P	234
General			
Ambient temperature range	15 °C to 35 °C	15 °C to 35 °C	15 °C to 35 °C
Power requirements	±5 (±0.25) VDC, 500 mA, 2.5 W	±5 (±0.25) VDC, 500 mA, 2.5 W	234: ±5 (±0.25) VDC, 500 mA, 2.5 W
Enclosure type	See diagrams	See diagrams	See diagrams
Mounting	VME end panel and back plane: transmitters do not use electrical bus format, only its physical shape and power	VME end panel and back plane: transmitters do not use electrical bus format, only its physical shape and power	VME end panel and back plane: transmitters do not use electrical bus format, only its physical shape and power
Size	100 mm H × 160 mm D × 30.5 mm W	100 mm H × 160 mm D × 30.5 mm W	234: 100 mm H × 160 mm D × 30.5 mm W
Weight	0.25 kg (0.5 lb)	0.25 kg (0.5 lb)	0.25 kg (0.5 lb)

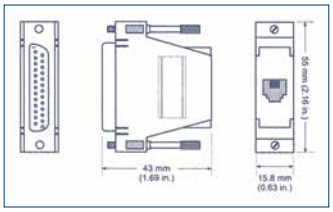
[1] *See Appendix F for sample calculations of typical sensor performance*

Output	231	231P	234
Number of outputs	1	1	1
Output type	Current source, isolated from power source—output or sensor can be grounded, but not both (all models)		
Output range	4 mA to 20 mA or 0 mA to 20 mA (for 0 V to 10 V with provided 500 Ω 0.02%, 25 ppm resistor) (all models)		
Output compliance	10 V (500 Ω max load)	10 V (500 Ω max load)	10 V (500 Ω max load)
Output temperature ranges			
Range 1	0 K to 20 K	0 K to 20 K	0 K to 10 K
Range 2	0 K to 100 K	0 K to 100 K	0 K to 20 K
Range 3	0 K to 200 K	0 K to 200 K	0 K to 100 K
Range 4	0 K to 325 K	0 K to 325 K	0 K to 200 K
Range 5	0 K to 475 K	0 K to 475 K	0 K to 300 K
Range 6	0 K to 1000 K	0 K to 1000 K	75 K to 325 K
4 mA to 20 mA output Output resolution			
Current	1.22 µA (0.006% of full scale)	1.22 µA (0.006% of full scale)	1.22 µA (0.006% of full scale)
Temperature equivalence			
Range 1	1.5 mK	Not used	0.8 mK
Range 2	7.6 mK	7.6 mK	1.5 mK
Range 3	15.3 mK	15.3 mK	7.6 mK
Range 4	24.8 mK	24.8 mK	15.3 mK
Range 5	36.2 mK	36.2 mK	22.9 mK
Range 6	76.3 mK	76.3 mK	19.1 mK
Output accuracy			
Current	±2 µA (±0.01% of full scale)	±2 µA (±0.01% of full scale)	±5 µA (±0.025% of full scale)
Temperature equivalence			
Range 1	2.5 mK	Not used	3.1 mK
Range 2	12.5 mK	12.5 mK	6.2 mK
Range 3	25 mK	25 mK	31.2 mK
Range 4	41 mK	41 mK	62.5 mK
Range 5	59 mK	59 mK	93.7 mK
Range 6	125 mK	125 mK	78.1 mK
Output temperature coefficient			
Current (%/°C ambient)	±0.0055% of output current per °C	±0.0055% of output current per °C	±2 µA/°C (±0.01%/°C)
Temperature equivalence			
Range 1	1 mK/°C	Not used	±1 mK/°C
Range 2	6 mK/°C	6 mK/°C	±2 mK/°C
Range 3	12 mK/°C	12 mK/°C	±10 mK/°C
Range 4	18 mK/°C	18 mK/°C	±20 mK/°C
Range 5	26 mK/°C	26 mK/°C	±30 mK/°C
Range 6	55 mK/°C	55 mK/°C	±25 mK/°C
0 mA to 20 mA output (0 V to 10 V with 500 Ω, 0.02% load resistor) Output resolution			
Voltage	0.6 mV	0.6 mV	0.61 mV
Temperature equivalence			
Range 1	1.2 mK	Not used	0.6 mK
Range 2	6.1 mK	6.1 mK	1.2 mK
Range 3	12.2 mK	12.2 mK	6.1 mK
Range 4	19.8 mK	19.8 mK	12.2 mK
Range 5	29 mK	29 mK	18.3 mK
Range 6	61 mK	61 mK	15.2 mK
Output accuracy			
Voltage	3 mV (0.03% of full scale)	3 mV (0.03% of full scale)	±4.5 mV (±0.025% of full scale ±0.02% resistor accuracy)
Temperature equivalence			
Range 1	6 mK	Not used	4.5 mK
Range 2	30 mK	30 mK	9.0 mK
Range 3	60 mK	60 mK	45.0 mK
Range 4	98 mK	98 mK	90.0 mK
Range 5	143 mK	143 mK	135.0 mK
Range 6	300 mK	300 mK	112.5 mK
Output temperature coefficient			
Voltage (% output/°C ambient)	±0.008%/°C	±0.008%/°C	±1.25 mV/° C (±0.01%/°C ±0.0025%/°C of load resistor)
Temperature equivalence			
Range 1	2 mK/°C	Not used	±1.2 mK/°C
Range 2	8 mK/°C	8 mK/°C	±2.5 mK/°C
Range 3	16 mK/°C	16 mK/°C	±12 mK/°C
Range 4	26 mK/°C	26 mK/°C	±25 mK/°C
Range 5	38 mK/°C	38 mK/°C	±36 mK/°C
Range 6	80 mK/°C	80 mK/°C	±30 mK/°C



2001


2003



2002


2308-12

Multiple card enclosure (2308-12)

The 2308-12 VME card case holds up to 12 temperature transmitters. A +5 VDC power supply with universal input is provided with the case. Wall mount power supplies are not necessary with a 2308-12.

Card slots	12
Output voltage	+5 VDC, 100 mV peak to peak ripple
Output current	6 A (max)
Input power	Universal 85 to 265 VAC, 47 to 440 Hz, 60 W
Ambient temp range	15 °C to 35 °C (59 °F to 95 °F)
Enclosure mounting	Bench or full (19 in) rack
Size	450 mm W × 178 mm H × 260 mm D (17.7 in × 7 in × 10.25 in)
Weight	5.5 kg (12 lb)

Power connections

Lake Shore temperature transmitters are powered by a +5 VDC supply if the transmitter card is ordered without a rack or plug-in supply. The voltage must be regulated to within ±0.25 VDC. Each transmitter draws up to 500 mA from the supply.

Ordering information

Part number	Description
231	Transmitter card for use with silicon diode—includes sensor/output mating connector (106-739), 500 ohm, 0.02% PPM output resistor (103-626), calibration certificate and user's manual
231-115	231 transmitter with a 115 VAC (50/60 Hz) wall plug-in power supply
231-230	231 transmitter with 230 VAC wall plug-in power supply
231P	Transmitter for use with platinum resistor—includes sensor/output mating connector (106-739), 500 ohm, 0.02% PPM output resistor (103-626), calibration certificate and user's manual
231P-115	231P transmitter with 115 VAC (50/60 Hz) wall plug-in power supply
231P-230	231P transmitter with 230 VAC wall plug-in power supply
234	Transmitter for use with carbon-glass, germanium, and Cernox™—includes sensor/output mating connector (106-739), 500 ohm, 0.02% PPM output resistor (103-626), calibration certificate and user's manual
234-115	234 transmitter with 115 VAC (50/60 Hz) wall plug-in power supply
234-230	234 transmitter with 230 VAC wall plug-in power supply

Accessories

2001	RJ11 4 m (14 ft) modular serial cable
2002	RJ11 to DB25 adapter—connects RJ11 cable to a 25-pin RS-232C serial port on rear of computer
2003	RJ11 to DB9 adapter—connects RJ11 cable to a 9-pin RS-232C serial port on rear of computer
2308-12	VME rack and power supply (holds up to 12 transmitters)
2308-BP	VME rack blank panel
8002-231	231 CalCurve™ data, field installed
8002-231P	231P CalCurve™ data, field installed
8002-234	234/234D CalCurve™ data, field installed
CAL-231-CERT	Instrument recalibration with certificate
CAL-231P-CERT	Instrument recalibration with certificate
CAL-234-CERT	Instrument recalibration with certificate

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