USER'S MANUAL

Model 1015
Warm-Up Power Supply

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LIMITED WARRANTY

Lake Shore Cryotronics, Inc. (henceforth Lake Shore), the manufacturer, warrants this product for a period of 12 months from the date of shipment. During the warranty period, under authorized return of instruments or component parts to Lake Shore freight prepaid, the company will repair, or at its option replace, any part found to be defective in material or workmanship, without charge to the Owner for parts, service labor or associated customary shipping cost. Replacement or repaired parts will be warranted for only the unexpired portion of the original warranty.

All products are thoroughly tested and calibrated to published specifications prior to shipment. Calibration Certifications are offered for 6 month periods only. Where such documentation must be updated, a re-certification service is offered by Lake Shore at a reasonable cost.

LIMITATION OF WARRANTY

This warranty is limited to Lake Shore products purchased and installed in the United States. This same protection will extend to any subsequent owner during the warranty period. It does not apply to damage caused by accident, misuse, fire, flood, or acts of God, from failure to properly install, operate, or maintain the product in accordance with the printed instructions provided. This warranty does not apply to defects resulting from improper or inadequate maintenance, unauthorized modification or misuse, operation outside of the environmental specifications for any product or part or buyer-supplied software interfacing.

THIS WARRANTY IS IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE EXPRESSLY EXCLUDED. THE OWNER AGREES THAT LAKE SHORE'S LIABILITY WITH RESPECT TO THIS PRODUCT SHALL BE SET FORTH IN THIS WARRANTY, AND INCIDENTAL OR CONSEQUENTIAL DAMAGES ARE EXPRESSLY EXCLUDED.

CERTIFICATION

Lake Shore certifies that this product has been inspected and tested in accordance with its published specifications and that this product met its published specifications at the time of shipment. The accuracy and calibration of this product at the time of shipment are traceable to the United States National Institute of Standards and Technology (NIST); formerly known as the National Bureau of Standards (NBS), or to a recognized natural standard.

TRADEMARK ACKNOWLEDGEMENT

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Cryo-Gloves® is a trademark of Tempshield.
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Teflon® is a trademark of DuPont De Nemours.

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CHAPTER 1

INTRODUCTION

1.0 GENERAL

The Model 1015 was designed and manufactured in the United States of America by Lake Shore Cryotronics, Inc. This chapter provides a general description in Paragraph 1.1, Electrostatic Discharge in Paragraph 1.2, safety summary in Paragraph 1.3, and safety symbols in Paragraph 1.4.

1.1 MODEL 1015 GENERAL DESCRIPTION

The Model 1015 is designed specifically for use with Series 100 Cryogenic Test Stations. It provides up to 80 watts of heater power on each of two channels to warm both the first and second stage of the test station to room temperature for rapid sample turn around.

The Model 1015 contains two temperature monitoring circuits to control each heater channel. The Model 1015 monitors the temperature of each stage via the diode temperature sensors mounted on each, and automatically shuts down when each of the stages reaches room temperature.

There are two different power levels available for each channel to accommodate different test set-ups or heating requirements; a low range (LO) of 25 watts and a high range (HI) of 80 watts into a 25 Ω load.

Front panel controls and indicators allow users to select power levels and monitor unit status. Monitor power applied to the heaters (POWER ON HI or POWER ON LO), stage status (READY or WAIT), as well as operational status (START or STOP) from the front panel.

The rear panel contains the sensor input and heater output for each stage as well as the selection of continuous or one-shot operation and cycle timing.

Table 1-1. Model 1015 Specifications

Sensor Inputs: Dual two-lead silicon diode inputs through 5-pin socket connectors, with sensor open and short circuit heater power shut-off protection, and heater open circuit shut-off protection.

Sensor Excitation: Nominal 10 µA constant current.

Configuration DIP Switches: Bank of four DIP switches selects SINGLE or CONTINUOUS cycle; and 10, 5, and 1 minute cycle delay times (timeouts).

HEATER HI and LO Outputs: Binding posts for HEATER HI (+) and LO (-) outputs for each stage.

Output Power: LO – Up to 25 W (1 A, 25 V) into a 25 Ω load.
HI – Up to 80 W (1.75 A, 45 V) into a 25 Ω load.

Operating Temperature: 15-35 °C

Dimensions: 21.6 × 10.2 × 33 cm (8.5 × 4 × 15 inches)
Style L, half-rack

Net Weight: 7 kilograms (15.4 pounds)

Power: Rear panel selectable 110/120/220/240 VAC, +5% –10%; 50-60 Hz; 350 VA.

NOTE: Product Specifications subject to change without notice.

1.2 ELECTROSTATIC DISCHARGE

Electrostatic Discharge (ESD) is a transfer of electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field. It may damage electronic parts, assemblies, and equipment. The low-energy source that most commonly destroys Electrostatic Discharge Sensitive (ESDS) devices is the human body, which generates and retains static electricity. Simply walking across a carpet in low humidity may generate up to 35,000 volts of static electricity.

Current technology trends toward greater complexity, increased packaging density, and thinner dielectrics between active elements, which results in electronic devices with even more ESD sensitivity. Some electronic parts are more ESDS than others. ESD levels of only a few hundred volts may damage electronic components such as semiconductors, thick and thin film resistors, and piezoelectric crystals during testing, handling, repair, or assembly. Discharge voltages below 4000 volts cannot be seen, felt, or heard.

1.2.1 Identifying ESDS Components

Below are industry symbols used to label ESDS components:

1.2.2 Handling ESDS Components

Observe all precautions to prevent damage to ESDS components before installation. Bring the device and everything that contacts it to ground potential by providing a conductive surface and discharge paths. At a minimum, observe these precautions:

1. De-energize or disconnect all power and signal sources and loads used with unit.
2. Place unit on a grounded conductive work surface.
3. Ground technician through a conductive wrist strap (or other device) using 1 MΩ series resistor to protect operator.
4. Ground any tools, such as soldering equipment, that contact unit. Contact with operator's hands provides a sufficient ground for tools that are otherwise electrically isolated.
5. Place ESDS devices and assemblies removed from a unit on a conductive work surface or in a conductive container. An operator inserting or removing a device or assembly from a container must maintain contact with a conductive portion of the container. Use only plastic bags approved for storage of ESD material.
6. Do not handle ESDS devices unnecessarily or remove from the packages until actually used or tested.

1.3 SAFETY SUMMARY

Observe these general safety precautions during all phases of instrument operation, service, and repair. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended instrument use. Lake Shore Cryotronics, Inc. assumes no liability for Customer failure to comply with these requirements.

Ground The Instrument

To minimize shock hazard, connect instrument chassis and cabinet to an electrical ground. The instrument comes with a 3-conductor AC power cable. Plug it into an approved three-contact electrical outlet or use a three-contact adapter with the green ground wire firmly secured to an electrical ground (safety ground) at the power outlet. The power cable jack and mating plug meet Underwriters Laboratories (UL) and International Electrotechnical Commission (IEC) safety standards.

Do Not Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away From Live Circuits

Operating personnel must not remove instrument covers. Refer component replacement and internal adjustments to qualified maintenance personnel. Do not replace components with power cable connected. To avoid injuries, always disconnect power and discharge circuits before touching them.

Do Not Substitute Parts Or Modify Instrument

Do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an authorized Lake Shore Cryotronics, Inc. representative for service and repair to ensure that safety features are maintained.

1.4 SAFETY SYMBOLS


Direct current (power line).


Alternating current (power line).


Alternating or direct current (power line).


Three-phase alternating current (power line).


Earth (ground) terminal.


Protective conductor terminal.


Frame or chassis terminal.

On (supply)


Off (supply)


Equipment protected throughout by double insulation or reinforced insulation (equivalent to Class II of IEC 536, Annex H).


Caution: High voltages or temperatures. Background color: Yellow; Symbol and outline: Black.


Caution or Warning - See instrument documentation. Background color: Yellow; Symbol and outline: Black.

CHAPTER 2
INSTALLATION

2.0 GENERAL

This chapter details inspection and unpacking in Paragraph 2.1, repackaging for shipment in Paragraph 2.2, sensor installation in Paragraph 2.3, power and ground requirements in Paragraph 2.4, load connection in Paragraph 2.5, sensor installation recommendations in Paragraph 2.6, and rack mounting in Paragraph 2.7.

2.1 INSPECTION AND UNPACKING

Inspect shipping containers for external damage. Make all claims for damage (apparent or concealed) or partial loss of shipment in writing to Lake Shore within 5 days from receipt of goods. If damage or loss is apparent, please notify the shipping agent immediately.

Open the shipping containers. Use the packing list included with the system to verify receipt of the instrument, sensor, accessories, and manual. Inspect for damage. Inventory all components supplied before discarding any shipping materials. If there is freight damage to the instrument, file proper claims promptly with the carrier and insurance company and notify Lake Shore. Notify Lake Shore immediately of any missing parts. Lake Shore cannot be responsible for any missing parts unless notified within 60 days of shipment.

2.2 REPACKAGING FOR SHIPMENT

To return the Model 1015 or accessories for repair or replacement, obtain a Return Goods Authorization (RGA) number from Technical Service in the United States, or from the authorized sales/service representative from which the product was purchased. Instruments may not be accepted without a RGA number. When returning an instrument for service, Lake Shore must have the following information before attempting any repair.

1. Instrument model and serial number.
2. User name, company, address, and phone number.
3. Malfunction symptoms.
4. Description of system.
5. Returned Goods Authorization (RGA) number.

Repack the system in its original container (if available). Affix shipping labels and FRAGILE warnings. Write RGA number on the outside of the container or on the packing slip. If not available, consult Lake Shore for shipping and packing instructions.

2.3 POWER AND GROUND REQUIREMENTS

The Model 1015 requires a power source of 100, 120, 220 or 240 VAC (+5%, –10%), 50 to 60 Hz single phase. The instrument includes a three-prong detachable power cord for 120 VAC operation which mates with the rear panel UL/IEC/ICEE Standard plug.

CAUTION: Verify that the rear panel AC Line Voltage Selection Wheel (Figure 3-2, Key 1) is set to the AC voltage source to be used (Table 2-1) and that the proper fuse is installed before inserting the power cord and turning on the instrument.

To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends, and some local codes require, instrument panels and cabinets be gounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument.

Table 2-1. Line Voltage Selection

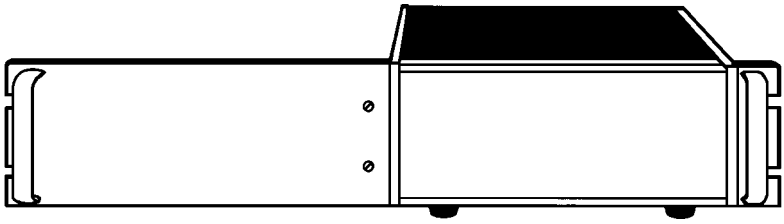
Line Voltage (Volts)	Operating Range (Volts)	Slow Blow Fuse (Amps)
100	90 – 105	5.0
120	108 – 126	5.0
220	198 – 231	2.5
240	216 – 252	2.5

2.4 BENCH USE

The Model 1015 ships with feet and a tilt stand installed and is ready to use as a bench instrument. Extend the tilt stand to elevate the front of the instrument for operating and viewing convenience. Do not subject the Model 1015 to excessive shock and vibrations like those that usually accompany high vacuum pumping systems.

2.5 RACK MOUNTING

Purchase a PM-3H1 or PM-3H2 rack mounting kit to install the Model 1015 in a standard 19-inch instrument rack.



P-1015-2-1.bmp

Figure 2-1. Typical Rack Configuration

2.6 SENSOR INPUT CONNECTIONS

The sensor input connectors J1 and J2 on the Model 1015 rear panel provide connections for the First and Second Stage inputs. The connector definitions are listed in Table 2-2.

Use a four-wire connection (Figure 2-1A) to avoid introducing IR drops in the voltage sensing pair which causes temperature measurement error. Use the alternate two-wire connection (Figure 2-1B) in less critical applications where lead resistance is small and small readout errors can be tolerated.

Lake Shore 36-Gauge Cryogenic wire is ideal for sensor connections. The four Phosphor Bronze leads with Formvar insulation are bonded together and color-coded red, green, clear and blue for easy wire identification.

2.7 ENVIRONMENTAL REQUIREMENTS

WARNING: To prevent electrical fire or shock hazards, do not expose this instrument to rain or excess moisture.

To meet and maintain specifications in Table 1-1, operate the Model 1015 at an ambient temperature range of 23 ±5 °C. Operate within the range of 15 – 35 °C with reduced accuracy.

The Model 1015 is for laboratory use. No humidity or altitude specifications have been determined for this unit.

Table 2-2. Sensor Connections for the J1 and J2 Inputs

Terminal	Description
A	+ Current Out
B	– Current Out
D	– Voltage Sense
E	+ Voltage Sense

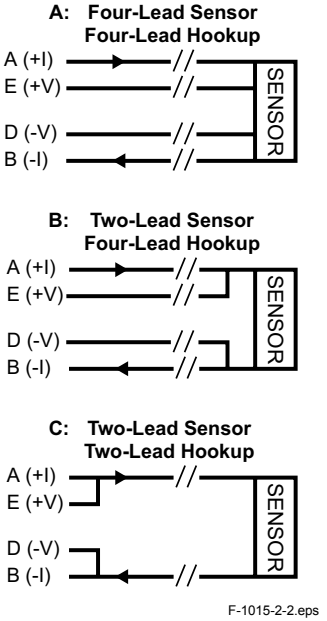


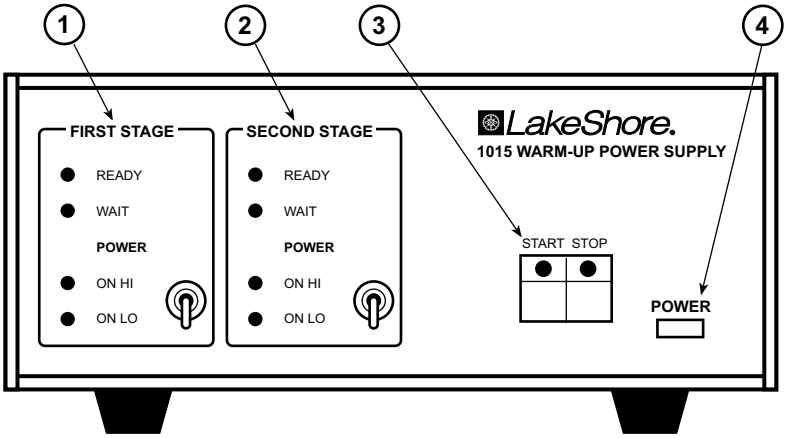
Figure 2-2. Sensor Connections

CHAPTER 3

OPERATION

3.1 CONTROLS AND INDICATORS

Figures 3-1 and 3-2 identify the various Model 1015 front and rear panel annunciators, controls, and connectors.



F-1015-3-1.eps

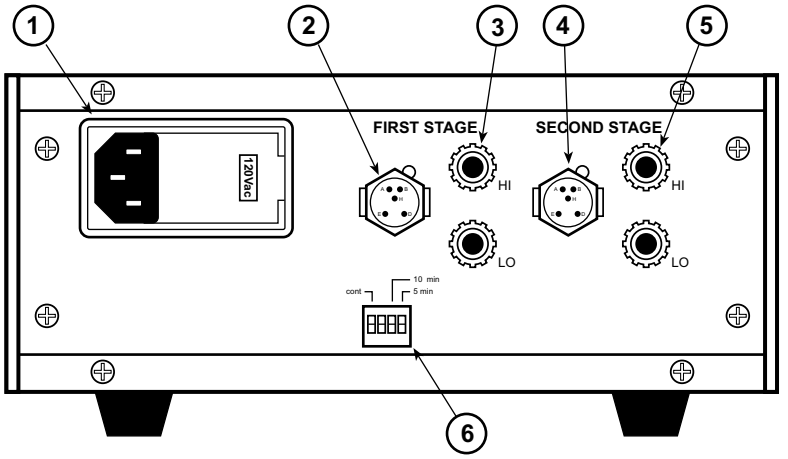
① First Stage Block – Annunciated POWER, READY, and WAIT indicators and power setting selection for the First Stage.

② Second Stage Block – Annunciated POWER, READY, and WAIT indicators and power setting selection for the Second Stage.

③ START/STOP – Annunciated START/STOP warm-up cycle operation.

④ Power ON/OFF Switch.

Figure 3-1. Model 1015 Front Panel



① AC Receptacle – AC power input, line voltage selection, and fuse.

② J1 – Input connector for the First Stage sensor.

③ J2 – Input connector for the Second Stage sensor.

④ J3 and J4 – Heater Output for the First Stage.

⑤ J5 and J6 – Heater Output for the Second Stage.

⑥ Configuration Switch – DIP switch selection of SINGLE or CONTINUOUS cycle operation; 10, 5, and 1 minute cycle delay times (timeouts).

Figure 3-2. Model 1015 Rear Panel

3.2 OPERATION

3.2.1 HI / LO Power Selection

Prior to turning on the unit, select the HI (80 watt) or LO (25 watt) power setting for each stage.

3.2.2 Power ON/OFF

Before connecting AC power to the Model 1015, verify rear panel line voltage selector corresponds to the available power line voltage. Verify correct fuse installation.

Immediately after power ON, the Model 1015 enters the STOP condition: STOP annunciator on, all others off. In the STOP condition, the unit applies no power to the heaters.

3.2.3 SINGLE Cycle Operation

In **SINGLE** cycle operation, the Model 1015 warms the first and second stages to room temperature. Upon reaching room temperature, the Model 1015 shuts off heater output to that stage and does not allow it to go back on.

To select the **SINGLE** cycle operation, switch the rear panel **CONT** switch to the down position. To initiate the warm-up cycle, press the front panel **START** button. The **START** LED lights and the unit monitors the First and Second stage sensor inputs to determine if they are already at room temperature. If they are, the stage enters the **READY** state. If not, the unit turns on the power to the stage and indicates it by lighting the red **POWER** LED.

If the **POWER** LED does not light and the stage is not **READY**, there is a fault in either the sensor or heater connections. The unit applies power to the stages until they are both at room temperature, or **READY**. Terminate the warm-up cycle at any point by pressing the **STOP** button. The **STOP** button returns the unit to the power-up state.

3.2.4 CONTINUOUS Cycle Operation

In **CONTINUOUS** (**CONT**) mode, the Model 1015 continues to apply heater power to a stage until the stage remains at room temperature for the cycle delay time (timeout).

To select the CONT mode, switch the rear panel **CONT** switch to the up position and select a timeout. To select a 10 minute timeout place the **10 min** switch in the up position, and the **5 min** switch in the down position. To select a 5 minute timeout, place the **5 min** switch in the up position, and the **10 min** switch in the down position. To select a 1 minute timeout put both the **10 min** and **5 min** switches in the down position (both the **10 min** and **5 min** switches in the up position selects a 10 minute timeout).

To initiate the warm-up cycle, press the front panel **START** button. The **START** LED lights and the unit monitors the First and Second stage temperatures to determine if they are at room temperature. If they are, the yellow **WAIT** LED lights and the unit monitors the stage temperature for the timeout period. If the stage is still at room temperature after the timeout period, the **WAIT** LED turns off and the **READY** LED lights.

If the stage is not at room temperature, the unit turns on power to the stage, monitors it until it reaches room temperature, turns off the stage power, and starts the timeout sequence. In the **READY** state, if stage temperature falls below room temperature, the unit turns stage power back on and repeats the cycle. The unit checks inputs for proper operation as in **SINGLE** mode and the **STOP** button resets the warm-up cycle at any time.

CHAPTER 4

MAINTENANCE

4.1 FUSE REPLACEMENT

WARNING: To prevent shock hazard, turn off instrument and disconnect it from AC line power and all test equipment before replacing fuse.

1. Turn POWER switch Off and disconnect power cord from unit. The fuse compartment is to the right of the power connector.
2. Pry open the fuse compartment door with a small screwdriver.
3. Remove upper fuse holder by sliding it out of its position with the screwdriver.

CAUTION: Replace fuse with the same type and rating as specified by the line voltage selected.

4. Replace with a 5.0 A fuse for 110 V (115 VAC) operation or a 2.5 A fuse for 220 V (230 VAC) operation. Use slow blow fuses.
5. Replace fuse holder and compartment cover and connect the power cord.

4.2 Line Voltage Configuration

The rear-panel, 3-pronged line power connector permits Model 1015 operation at either 115 or 230 VAC. The configuration is indicated on rear panel in the Line Voltage Selection Block. Use the procedure below to change line voltage.

WARNING: To prevent shock hazard, turn off instrument and disconnect it from AC line power and all test equipment before changing line voltage configuration.

1. Turn power switch OFF and disconnect the power cord from the unit. The line voltage slection switch is to the right of the power connector
2. Slide the switch to the 115 or 230 VAC position with a small screwdriver.

4.3 CALIBRATION AND TROUBLESHOOTING

Return the Model 1015 to Lake Shore or a factory representative for calibration or repair. See Paragraph 2.2.

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APPENDIX A

GLOSSARY OF TERMINOLOGY

absolute zero. The temperature of –273.15 °C, or –459.67 °F, or 0 K, thought to be the temperature at which molecular motion vanishes and a body would have no heat energy.[1]

active length. Defined as the electrically active length of the helium level sensor. As opposed to actual physical length, which, due to sensor mounting provisions, will be somewhat larger.

alarm setpoints. Low and high alarm setpoints are defined by the user. The low alarm is always active and will sound whenever the LHe level drops below the setpoint. The high alarm is only active in Continuous Mode (used during filling) and will sound when the LHe level rises above the setpoint.

ambient temperature. The temperature of the surrounding medium, such as gas or liquid, which comes into contact with the apparatus.[1]

American Standard Code for Information Exchange (ACSII). A standard code used in data transmission, in which 128 numerals, letters, symbols, and special control codes are represented by a 7-bit binary number as follows:

Bits b_7 b_6 b_5					000	001	010	011	100	101	110	111
b_4	b_3	b_2	b_1	Row ↓ Col. →	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENG	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SS	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	~	l	|
1	1	0	1	13	CR	GS	–	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

asphyxiant gas. A gas which has little or no positive toxic effect but which can bring about unconsciousness and death by displacing air and thus depriving an organism of oxygen.

baud. A unit of signaling speed equal to the number of discrete conditions or signal events per second, or the reciprocal of the time of the shortest signal element in a character.[2]

boiling point. The temperature at which a substance in the liquid phase transforms to the gaseous phase; commonly refers to the boiling point at sea level and standard atmospheric pressure.

Celsius (°C) Scale. A temperature scale that registers the freezing point of water as 0 °C and the boiling point as 100 °C under normal atmospheric pressure. Celsius degrees are purely derived units, calculated from the Kelvin Thermodynamic Scale. Formerly known as "centigrade." *See* Temperature for conversions.

cgs system of units. A system in which the basic units are the centimeter, gram, and second.[2]

cryogen. *See* cryogenic fluid.[1]

cryogenic. Refers to the field of low temperatures, usually –130 °F or below, as defined by 173.300(f) of Title 49 of the Code of Federal Regulations.

cryogenic fluid. A liquid that boils at temperatures of less than about 110 K at atmospheric pressure, such as hydrogen, helium, nitrogen, oxygen, air, or methane. Also known as cryogen.[1]

cryostat. An apparatus used to provide low-temperature environments in which operations may be carried out under controlled conditions.[1]

degree. An incremental value in the temperature scale, i.e., there are 100 degrees between the ice point and the boiling point of water in the Celsius scale and 180 degrees between the same two points in the Fahrenheit scale.

electrostatic discharge (ESD). A transfer of electrostatic charge between bodies at different electrostatic potentials caused by direct contact or induced by an electrostatic field.

excitation. Either an AC or DC input to a sensor used to produce an output signal. Common excitations include: constant current, constant voltage, or constant power.

Fahrenheit (°F) Scale. A temperature scale that registers the freezing point of water as 32 °F and the boiling point as 212 °F under normal atmospheric pressure. *See* Temperature for conversions.

international system of units (SI). A universal coherent system of units in which the following seven units are considered basic: meter, kilogram, second, ampere, kelvin, mole, and candela. The International System of Units, or Système International d'Unités (SI), was promulgated in 1960 by the Eleventh General Conference on Weights and Measures. For definition, spelling, and protocols, *see* Reference 3 for a short, convenient guide.

IPTS-68. International Practical Temperature Scale of 1968. Also abbreviated as T_{68}.

ITS-90. International Temperature Scale of 1990. Also abbreviated as T_{90}. This scale was designed to bring into as close a coincidence with thermodynamic temperatures as the best estimates in 1989 allowed.

Kelvin (K). The unit of temperature on the Kelvin Scale. It is one of the base units of SI. The word "degree" and its symbol (°) are omitted from this unit. *See* Temperature Scale for conversions.

Kelvin Scale. The Kelvin Thermodynamic Temperature Scale is the basis for all international scales, including the ITS-90. It is fixed at two points: the absolute zero of temperature (0 K), and the triple point of water (273.16 K), the equilibrium temperature that pure water reaches in the presence of ice and its own vapor.

liquid helium (LHe). Used for low temperature and superconductivity research: minimum purity 99.998%. Boiling point at 1 atm = 4.2 K. Latent heat of vaporization = 2.6 kilojoules per liter. Liquid density = 0.125 kilograms per liter.

EPA Hazard Categories: Immediate (Acute) Health and Sudden Release of Pressure Hazards
DOT Label: Nonflammable Gas
DOT Class: Nonflammable Gas
DOT Name: Helium, Refrigerated Liquid
DOT ID No: UN 1963

liquid nitrogen (LN_2). Also used for low temperature and superconductivity research and for its refrigeration properties such as in freezing tissue cultures: minimum purity 99.998%, O_2 8 ppm max. Boiling point at 1 atm = 77.4 K. Latent heat of vaporization = 160 kilojoules per liter. Liquid density = 0.81 kilograms per liter.

EPA Hazard Categories: Immediate (Acute) Health and Sudden Release of Pressure Hazards
DOT Label: Nonflammable Gas
DOT Class: Nonflammable Gas
DOT Name: Nitrogen, Refrigerated Liquid
DOT ID No: UN 1977

LSCI. Lake Shore Cryotronics, Inc.

material safety data sheet (MSDS). OSHA Form 20 contains descriptive information on hazardous chemicals under the OSHA Hazard Communication Standard (HCS). These data sheets also provide precautionary information on the safe handling of the gas as well as emergency and first aid procedures.

MKSA System of Units. A system in which the basic units are the meter, kilogram, and second, and the ampere is a derived unit defined by assigning the magnitude $4\pi \times 10^{-7}$ to the rationalized magnetic constant (sometimes called the permeability of space).

NBS. National Bureau of Standards. Now referred to as NIST.

NbTi. Niobium-titanium. A superconductive alloy with a transition temperature typically near 9 K in zero magnetic field.

National Institute of Standards and Technology (NIST). Government agency located in Gaithersburg, Maryland and Boulder, Colorado, that defines measurement standards in the United States.

parts per million (ppm). 4×10^{-6} is four parts per million.

pounds per square inch (psi). A unit of pressure. 1 psi = 6.89473 kPa. Variations include psi absolute (psia) measured relative to vacuum (zero pressure) where one atmosphere pressure equals 14.696 psia and psi gauge (psig) where gauge measured relative to atmospheric or some other reference pressure.

prefixes. SI prefixes used throughout this manual are as follows:

Factor	Prefix	Symbol	Factor	Prefix	Symbol
10^{24}	yotta	Y	10^{-1}	deci	d
10^{21}	zetta	Z	10^{-2}	centi	c
10^{18}	exa	E	10^{-3}	milli	m
10^{15}	peta	P	10^{-6}	micro	μ
10^{12}	tera	T	10^{-9}	nano	n
10^{9}	giga	G	10^{-12}	pico	p
10^{6}	mega	M	10^{-15}	femto	f
10^{3}	kilo	k	10^{-18}	atto	a
10^{2}	hecto	h	10^{-21}	zepto	z
10^{1}	deka	da	10^{-24}	yocto	y

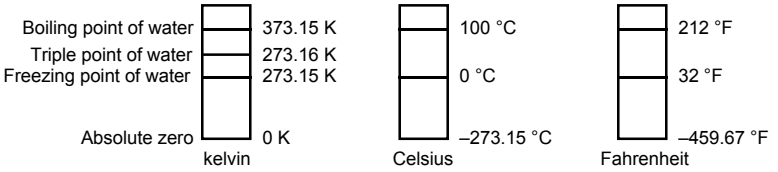
RS-232C. Bi-directional computer serial interface standard defined by the Electronic Industries Association (EIA). The interface is single-ended and non-addressable.

setpoint. The value selected to be maintained by an automatic controller.[1]

serial interface. A computer interface where information is transferred one bit at a time rather than one byte (character) at a time as in a parallel interface. RS-232C is the most common serial interface.

SI. Système International d'Unités. *See* International System of Units.

temperature scales. *See* Kelvin Scale, Celsius Scale, and ITS-90. Proper metric usage requires that only kelvin and degrees Celsius be used. However, since degrees Fahrenheit is in such common use, all three scales are delineated as follows:



To convert kelvin to Celsius, subtract 273.15.
To convert Celsius to Fahrenheit: multiply °C by 1.8 then add 32, or:
°F = (1.8 x °C) + 32.
To convert Fahrenheit to Celsius: subtract 32 from °F then divide by 1.8, or:
°C = (°F. 32)/ 1.8.

References:

1 Sybil P. Parker, Editor. *Dictionary of Scientific and Technical Terms: Third Edition*. New York: McGraw Hill, 1969 (IBSN 0-395-20360-0)

2 Christopher J. Booth, Editor. *The New IEEE Standard Dictionary of Electrical and Electronic Terms: IEEE Std 100-1992, Fifth Edition.* New York: Institute of Electrical and Electronics Engineers, 1993 (IBSN 1-55937-240-0). Definitions printed with permission of the IEEE.

3 Nelson, Robert A. *Guide For Metric Practice,* Page BG7 - 8, Physics Today, Eleventh Annual Buyer's Guide, August 1994 (ISSN 0031-9228 coden PHTOAD)

APPENDIX B

HANDLING OF LIQUID HELIUM AND NITROGEN

B1.0 GENERAL

Liquid Helium (LHe) and liquid nitrogen (LN_2) are often used in association with the Model 201/208 Digital Thermometer. Although not explosive, the following are safety considerations in the handling of LHe and LN_2.

B2.0 PROPERTIES

LHe and LN_2 are colorless, odorless, and tasteless gases. Gaseous nitrogen makes up about 78% of the Earth's atmosphere, while helium comprises only about 5 ppm. Most helium is recovered from natural gas deposits. Once collected and isolated, gases will liquefy when properly cooled. Refer to Table B-1.

Table B-1. Comparison of Liquid Helium to Liquid Nitrogen

Property	LHe	LN_2
Boiling Point @1 atm, in °K	4.2	77
Thermal Conductivity (Gas), w/cm–°K	0.083	0.013
Latent Heat of Vaporization, Btu/liter	2.4	152
Liquid Density, pounds/liter	0.275	0.78

B3.0 HANDLING CRYOGENIC STORAGE DEWARS

All cryogenic containers (dewars) must be operated in accordance with the manufacturer's instructions. Safety instructions will also be posted on the side of each dewar. Cryogenic dewars must be kept in a well-ventilated place where they are protected from the weather and away from any sources of heat.

B4.0 LIQUID HELIUM AND NITROGEN SAFETY PRECAUTIONS

Transferring LHe and LN_2 should be in accordance with the manufacturer/supplier's instructions. During the transfer, all safety precautions written on the storage dewar and recommended by the manufacturer must be followed.

WARNING: Liquid helium and liquid nitrogen are potential asphyxiants and can cause rapid suffocation without warning. Store and use in area with adequate ventilation. DO NOT vent container in confined spaces. DO NOT enter confined spaces where gas may be present unless area has been well ventilated. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical help.

WARNING: Liquid helium and liquid nitrogen can cause severe frostbite to the eyes or skin. DO NOT touch frosted pipes or valves. In case of frostbite, consult a physician at once. If a physician is not readily available, warm the affected areas with water that is near body temperature.

The two most important safety aspects to consider when handling LHe and LN_2 are adequate ventilation and eye and skin protection. Although helium and nitrogen gases are non-toxic, they are dangerous in that they replace the air in a normal breathing atmosphere. Liquid products are of an even greater threat since a small amount of liquid evaporates to create a large amount of gas. Therefore, it is imperative that cryogenic dewars be stored and operated in open and well ventilated areas.

Persons transferring LHe and LN_2 should make every effort to protect eyes and skin from accidental contact with liquid or the cold gas issuing from it. Protect your eyes with full face shield or chemical splash goggles. Safety glasses (even with side shields) are not adequate. Always wear special cryogenic gloves (Tempshield Cryo-Gloves® or equivalent) when handling anything that is, or may have been, in contact with the liquid or cold gas, or with cold pipes or equipment. Long sleeve shirts and cuffless trousers that are of sufficient length to prevent liquid from entering the shoes are recommended.

B5.0 RECOMMENDED FIRST AID

Every site that stores and uses LHe and LN_2 should have an appropriate Material Safety Data Sheet (MSDS) present. The MSDS may be obtained from the manufacturer/distributor. The MSDS will specify the symptoms of overexposure and the first aid to be used. A typical summary of these instructions is provided as follows.

If symptoms of asphyxia such as headache, drowsiness, dizziness, excitation, excess salivation, vomiting, or unconsciousness are observed, remove the victim to fresh air. If breathing is difficult, give oxygen. If breathing has stopped, give artificial respiration. Call a physician immediately.

If exposure to cryogenic liquids or cold gases occurs, restore tissue to normal body temperature (98.6 °F) as rapidly as possible, then protect the injured tissue from further damage and infection. Call a physician immediately. Rapid warming of the affected parts is best achieved by bathing it in warm water. The water temperature should not exceed 105 °F (40 °C), and under no circumstances should the frozen part be rubbed, either before or after rewarming. If the eyes are involved, flush them thoroughly with warm water for at least 15 minutes. In case of massive exposure, remove clothing while showering with warm water. The patient should not drink alcohol or smoke. Keep warm and rest. Call a physician immediately.

∞ NOTES ∞

Lake Shore

is a technology leader in the development of cryogenic temperature sensors, precision low temperature measurement and control instrumentation, and magnetic measurement and test systems. Since 1968, Lake Shore physicists, material scientists, and engineers have dedicated themselves to the development of tomorrow's technology today. Lake Shore serves a worldwide network of Customers including university and national laboratories, aerospace and other industries, as well as many of the premier companies in the world.