8. Additional Documentation

The following additional documentation is provided for reference. These are separate operators manuals supplied by the manufacturers.

- ✓ Barber Nichols Pump Installation, Operating and Maintenance Manual ON ORDER 3-26-01
- ✓ Lakeshore Model 818/819 Cryopump Monitor User's Manual ON ORDER 3-26-01
- ✓ PoWrMaster AC Motor Controller Model G3U Installation and Service Manual WE HAVE PC3
- ✓ Dwyer Instruments Series 1600 Process Controller Installation and Operating Instructions ON ORDER 3-26-01
- ILM Nitrogen Level Meter Operators Handbook

Data sheets on the following items are included for reference.

- Cryolab CV8 Series Cryogenic Valves
- Cryolab Mini Series Cryogenic Valves
- Cryolab SV3 Vacuum Seal-Off Valves
- Cryolab PR3 Pressure Relief Disc
- Lake Shore DT-470 Silicon Diode Temperature Sensors
- Sensotec 415 Pressure Transmitters

Cryolab TECHNICAL DATA

BULLETIN NUMBER A003A (Rev 3/90)

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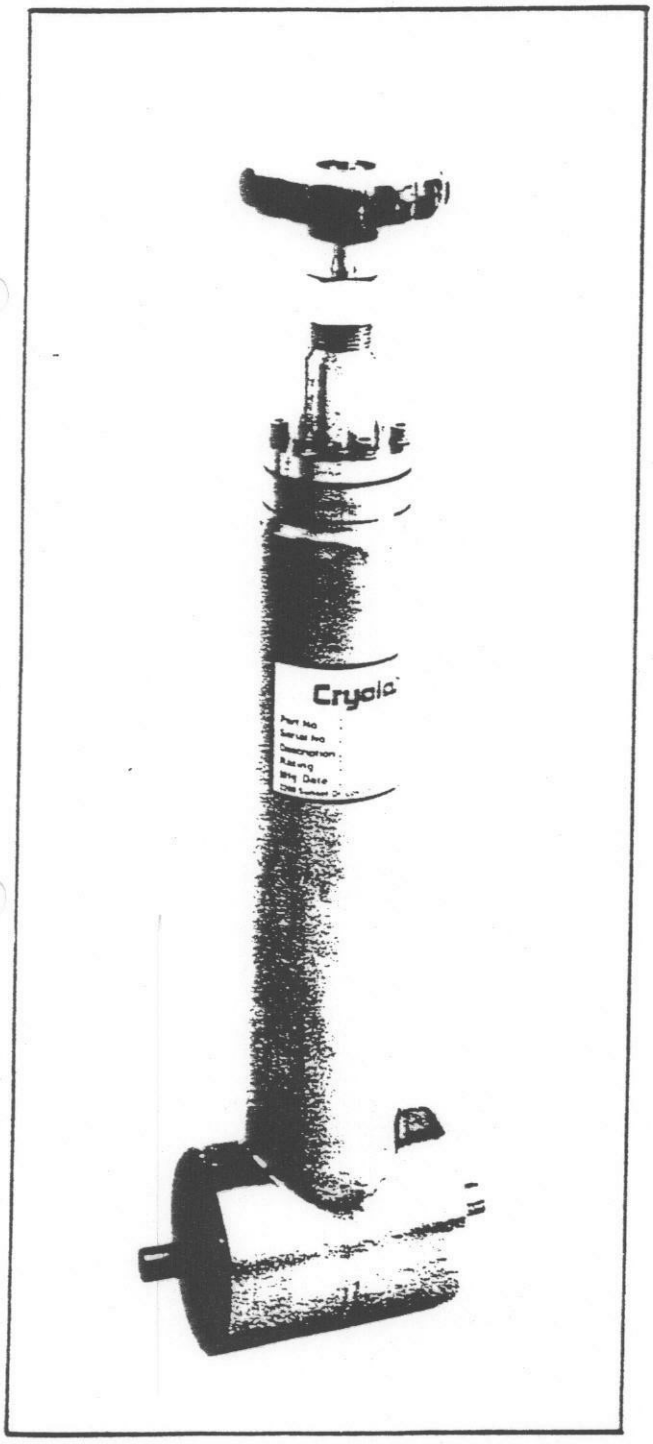
CV8 SERIES VACUUM JACKETED VALVE



CV8 VALVE SERIES

NOW YOU CAN take advantage of precision technology coupled with the reliability of industrial hardware with our CV8 Valve Series.

Years of research and field experience in designing and installing cryogenic and vacuum insulated components are reflected in the versatility and absolute sealing qualities of the CV8 Valves. You have the confidence of knowing the CV8 Series is insensitive to age and will withstand the most severe cryogenic applications.

Our CV8 Valves are equipped with Viton bonnet seals and stem packing backed up with a Teflon seal to insure leak tight performance. The bonnet design is axially bolted for *complete* seal compression while stainless steel Acme stem threads with brass inserts eliminate galling. The body and self-centering Kel-F seat are a *proven* design which will provide years of smooth, maintenance-free operation.

You need the best in cryogenic technology: Contact Cryolab for a full spectrum of options and services for the control valve industry. Any less than the best isn't Cryolab.

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CIRCLE SEAL CONTROLS, INC.
2301 Wardlow Circle · PO Box 3300 · Corona, California 91718 · (909) 270-6200 FAX: (909) 270-6201

CV8 SERIES
VACUUM JACKETED VALVE

Item:
Valve, extended stem, vacuum jacketed, cryogenic uses.

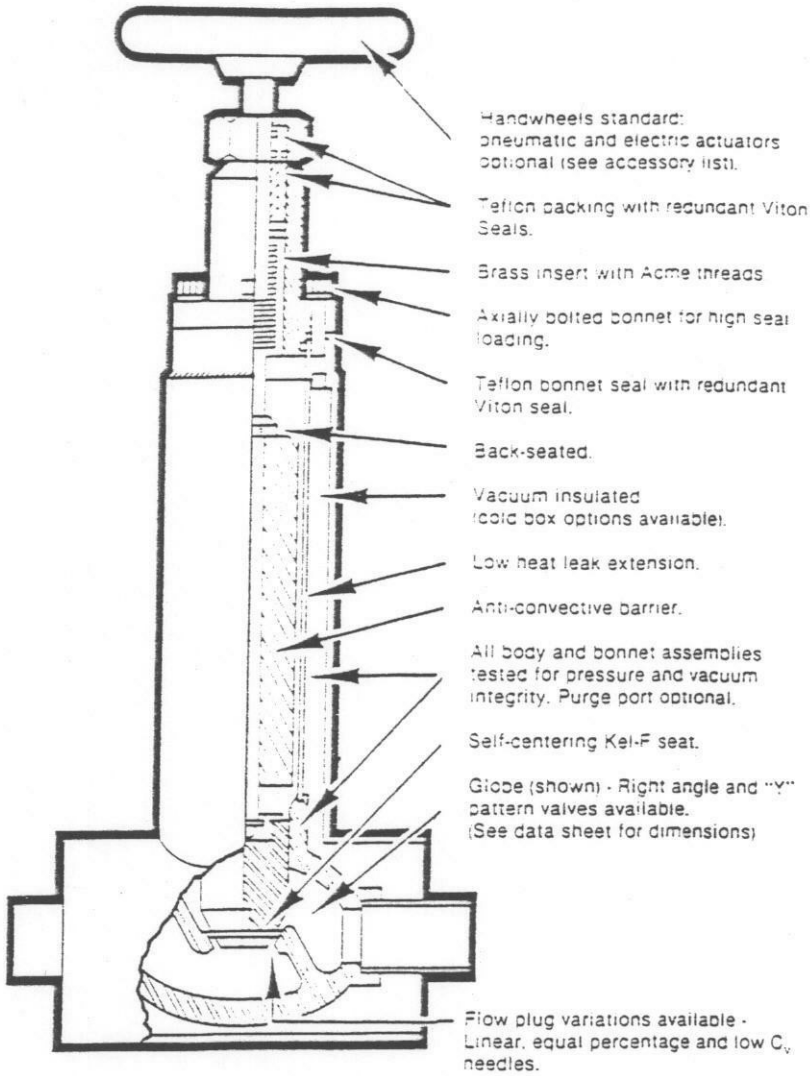
Service:
Cryogenic liquids and gases; helium, hydrogen, nitrogen, natural gas (methane), and oxygen (with special cleaning and packaging).

Operating Ranges:
Temperature: −425°F to +300°F.
Maximum operating pressure: 275 psig (ambient).
Proof pressure: 413 psig (ambient).

Tests:
Valve: Mass spectrometer to 1×10^{-9}cc G He/sec.
Seat: Bubble tight with 100 psig G He across the seat at −320°F. *

Materials:
Metal components are predominantly 300 series stainless steel. All soft goods are Teflon, Kel-F or Viton.

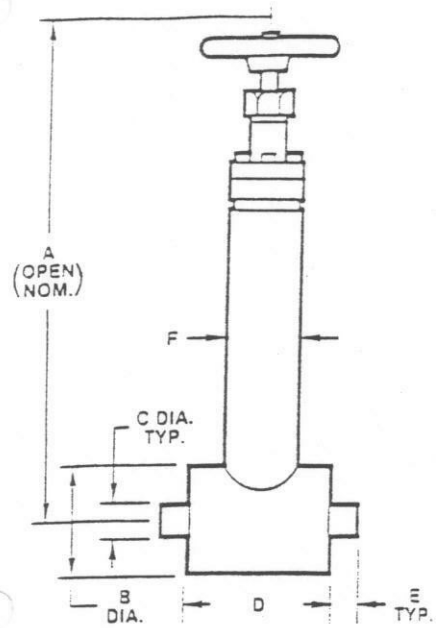
Options:
"Cold box" jacketing, purge ports, pneumatic and electric actuators, positioners, limit switches and position indicators available (please consult factory).



Performance Characteristics

Valve Size	Conductive Heat Leak (BTU/HR to 20°K)	Cooldown Weight (#)	Flow Coefficient (C_v) Globe	Y	Angle
½"	5.9	2.7	6.6	9	8
¾"	6.6	3.3	8	12	10
1"	10.4	3.8	14	22	17
1½"	21.8	7.0	34	47	41
2"	27.3	10.2	50	96	60
3"	68.1	30.8	139	162	145
4"	79.9	51.2	182	288	248

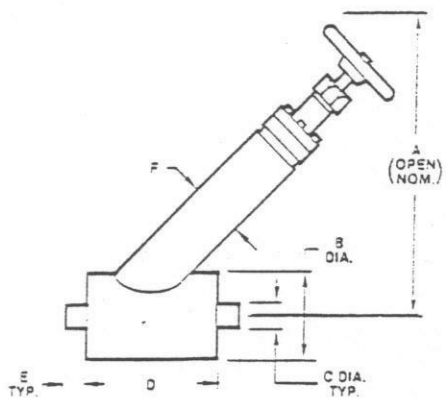
* Please consult factory for larger sizes.



Globe Pattern
Dimensions (Inches)

Size	A	B	C	D	E	F	Assembly Part No.
½" Tube	16.5	2.88	50	3.88	1.0	2.38	CV8-84-5WTG2
½" Pipe	16.5	2.88	84	3.88	1.0	2.38	CV8-84-5WPG2
¾" Tube	16.5	2.88	75	3.88	1.0	2.38	CV8-86-5WTG2
¾" Pipe	16.5	2.88	1.05	3.88	1.0	2.38	CV8-86-5WPG2
1" Tube	16.5	3.50	1.00	5.00	1.0	2.38	CV8-88-5WTG2
1" Pipe	16.5	3.50	1.32	5.00	1.0	2.38	CV8-88-5WPG2
1½" Tube	19.5	4.00	1.50	6.00	1.0	3.5	CV8-812-5WTG1
1½" Pipe	19.5	4.00	1.90	6.00	1.0	3.5	CV8-812-5WPG1
2" Tube	22.5	4.50	2.00	6.00	1.0	4.0	CV8-816-5WTG1
2" Pipe	22.5	4.50	2.38	6.00	1.0	4.0	CV8-816-5WPG1
3" Pipe	28.0	8.62	3.50	12.00	1.0	5.5	CV8-824-5WPG1
4" Pipe	36.0	10.75	4.50	14.00	1.0	8.62	CV8-832-5WPG1

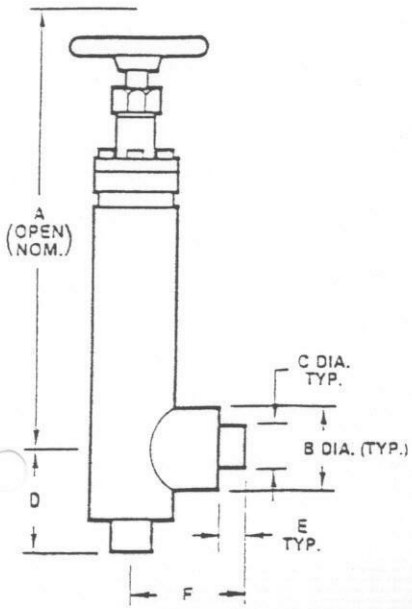
Please consult factory for larger sizes



"Y" Pattern
Dimensions (Inches)

Size	A	B	C	D	E	F	Assembly Part No.
½" Tube	12.6	2.88	50	5.00	1.0	2.38	CV8-84-5WTY2
½" Pipe	12.6	2.88	84	5.00	1.0	2.38	CV8-84-5WPY2
¾" Tube	12.6	2.88	75	5.00	1.0	2.38	CV8-86-5WTY2
¾" Pipe	12.6	2.88	1.05	5.00	1.0	2.38	CV8-86-5WPY2
1" Tube	12.6	2.88	1.00	6.00	1.0	2.38	CV8-88-5WTY2
1" Pipe	14.7	2.88	1.32	6.00	1.0	2.38	CV8-88-5WPY2
1½" Tube	14.7	4.50	1.50	10.00	1.0	3.5	CV8-812-5WTY1
1½" Pipe	14.7	4.50	1.90	10.00	1.0	3.5	CV8-812-5WPY1
2" Tube	14.7	4.50	2.00	10.00	1.0	4.0	CV8-816-5WTY1
2" Pipe	14.7	4.50	2.38	10.00	1.0	4.0	CV8-816-5WPY1
3" Pipe	22.0	8.62	3.50	15.00	1.0	5.5	CV8-824-5WPY1
4" Pipe	34.0	10.75	4.50	18.00	1.0	8.62	CV8-832-5WPY1

Please consult factory for larger sizes



Angle Pattern
Dimensions (Inches)

Size	A	B	C	D	E	F	Assembly Part No.
½" Tube	16.5	2.38	50	3.50	1.0	3.50	CV8-84-5WTR2
½" Pipe	16.5	2.38	84	3.50	1.0	3.50	CV8-84-5WPR2
¾" Tube	16.5	2.88	75	3.50	1.0	3.50	CV8-86-5WTR2
¾" Pipe	16.5	2.88	1.05	3.50	1.0	3.50	CV8-86-5WPR2
1" Tube	16.5	2.88	1.00	3.50	1.0	3.50	CV8-88-5WTR2
1" Pipe	16.5	2.88	1.32	3.50	1.0	3.50	CV8-88-5WPR2
1½" Tube	19.5	3.50	1.50	3.75	1.0	3.75	CV8-812-5WTR1
1½" Pipe	19.5	3.50	1.90	3.75	1.0	3.75	CV8-812-5WPR1
2" Tube	19.5	4.00	2.00	4.00	1.0	4.00	CV8-816-5WTR1
2" Pipe	19.5	4.00	2.38	4.00	1.0	4.00	CV8-816-5WPR1
3" Pipe	28.0	5.56	3.50	5.00	1.0	5.00	CV8-824-5WPR1
4" Pipe	36.0	8.62	4.50	8.00	1.0	8.00	CV8-832-5WPR1

Please consult factory for larger sizes

Cryolab TECHNICAL DATA

BULLETIN NO. A005 4 — Rev. 12/87)

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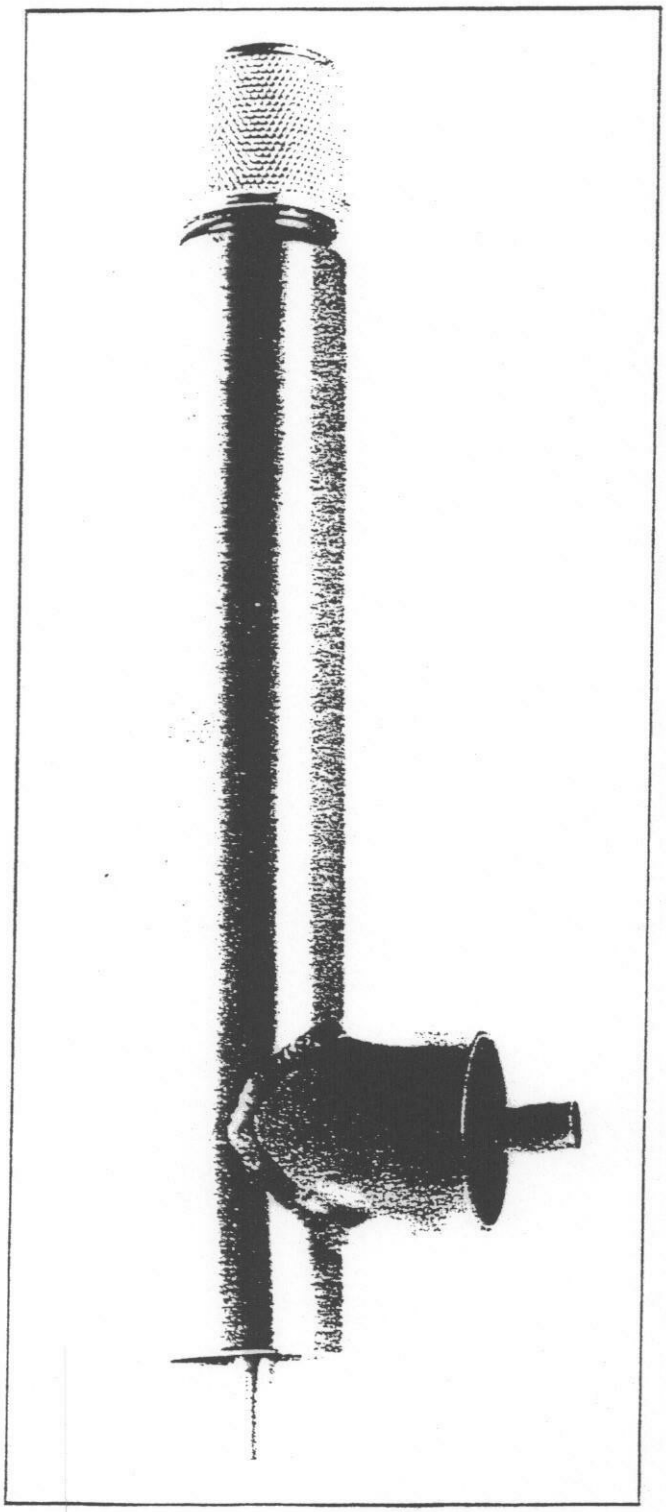
MINI-CRYOGENIC VALVE - STAINLESS STEEL



CV9 Mini-Cryogenic
Vacuum Jacketed Valve

CV9 SERIES MINI-CRYOGENIC VACUUM JACKETED VALVE

The Cryolab CV9 valves offer the lowest heat leak in liquid helium service for the money. The stem is fabricated from a convoluted bellows equaling a 15 inch heat path. The "Kel-F" seat seal on a tapered seat is unsurpassed for tight sealing and reliable service. All metal surfaces exposed to the cryogen or vacuum are 304 stainless steel. The shaft packing is a dual Viton-A o-ring design spring loaded to provide a leak tight, self adjusting seal for years of service.

The valve is specifically designed for liquid helium service but its low cost and large orifice make it an excellent valve for other cryogens (nitrogen, hydrogen, etc.)

Cryolab has many valves for cryogenic applications and the CV9 is the most economically efficient series available.

FEATURE SUMMARY:

- High reliability
- High thermal efficiency
- Compact size
- Low initial cost

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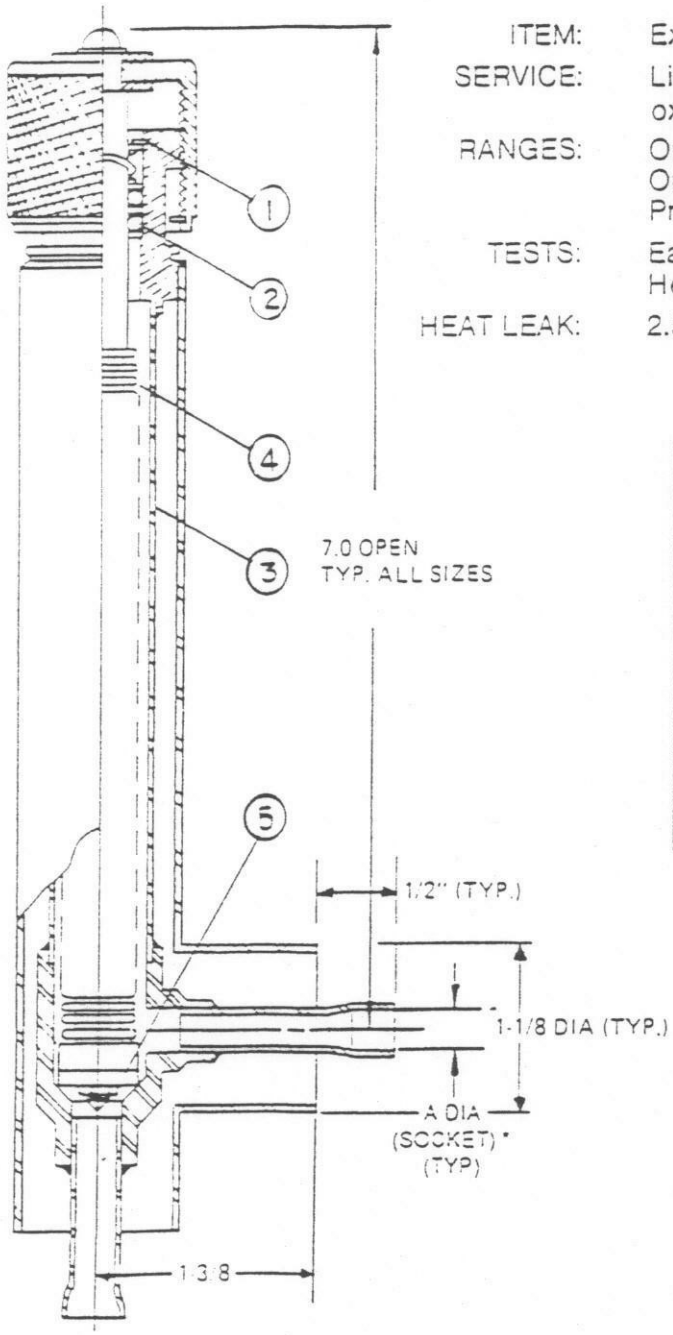
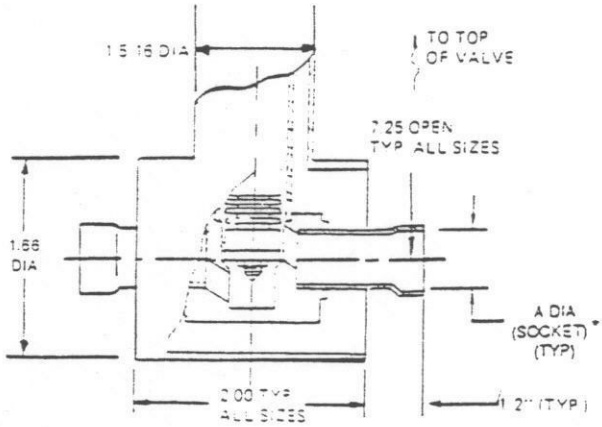


CV9 RIGHT ANGLE VALVE

ITEM:	Extended-stem Cryogenic Valve
SERVICE:	Liquids; helium, hydrogen, nitrogen, natural gas (methane), oxygen (with special cleaning and packaging)
RANGES:	Operating temperature −456 F to −400 F Operating pressure 200 PSIG Proof pressure 400 PSIG
TESTS:	Each valve is mass spectrometer leak tested to 1 x 10^{-9} cc He/second, helium leak tested at 100 PSIG at −320 F.
HEAT LEAK:	2.5 BTU/HR to 20° K (.73 Watts).

MATERIALS

	PART NAME	MATERIAL (specification)
1.	Packing retainer	300 series stainless steel
2.	Packing	Viton-A
3.	Ext. tube	Stainless steel (ASTM A-269)
4.	Ext. stem	Stainless steel (MIL-S-25043)
5.	Seat seal	Kel-F
	Remaining parts	304 stainless steel



CV9 GLOBE VALVE

*ADAPTERS SUPPLIED FOR 1/4 & 3/8 SIZES

ORDERING INFORMATION

TUBE SIZE	A DIA. (SOCKET)	WT.	P/N ANGLE VLV.	C_v	A DIA. (SOCKET)	P/N GLOBE VLV.	C_v
1/4	.255*	12 oz.	CV9-084-5WTR4	.7	.255*	CV9-084-5WTG4	.7
3/8	.380*	12 oz.		1.6	.380*		1.8
1/2	.505	12 oz.		1.6	.505		2.3

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BULLETIN NUMBER A012A (Rev. 1/89)

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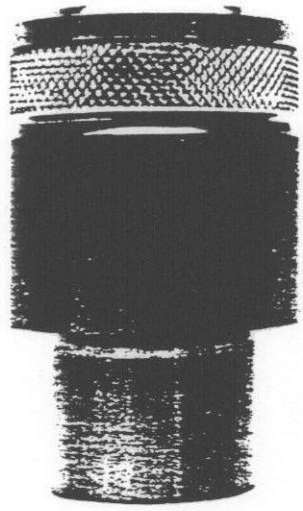
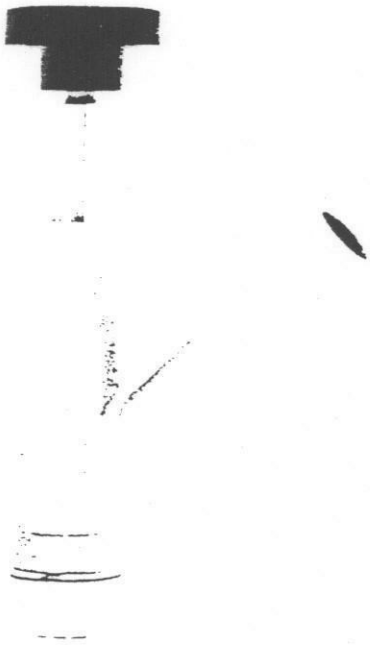
SV1 AND SV3 SEAL-OFF VALVES



SV3 SEAL-OFF VALVE



V03 OPERATOR

SV3 VALVES AND V03 OPERATORS

These compact seal-off valves offer a highly reliable means of evacuating a vacuum space and providing leak-free seal off characteristics when closed. The spring loaded cap gives an additional seal in series with the primary seat seal.

The SV3 series valve offers relief capabilities when a positive pressure upset occurs and the valve automatically reseats when the over-pressure decays.

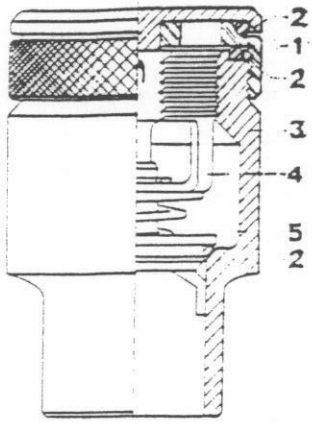
SV1 and SV3 seal-off valves are used in conjunction with a Model V03 valve operator which is mounted on top of the seal-off assembly during evacuation. With the valve operator you actually unscrew and retract the complete inner valve assembly, providing a full capacity conduction path for maximum pumping speeds. Upon completion of the evacuation procedure, the inner valve is again inserted and threaded into place establishing the primary seal. The valve operator is then removed and replaced with the sealed cap.

This valve series provides a wide size range of vacuum seal-off valves that are virtually tamper and accident proof, simple, functional and reliable.

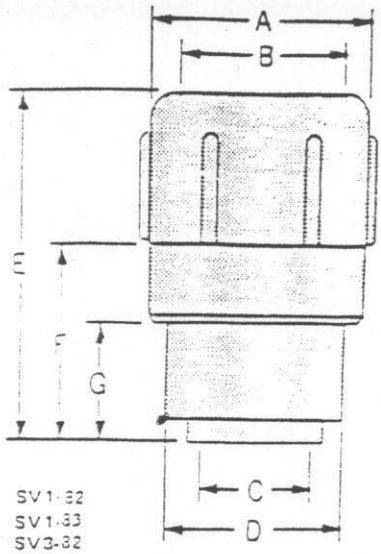
Cryolab has an extensive variety of seal-off valves for every purpose and application. If you have a vacuum to pump it should be through a Cryolab seal-off valve.

FEATURE SUMMARY:

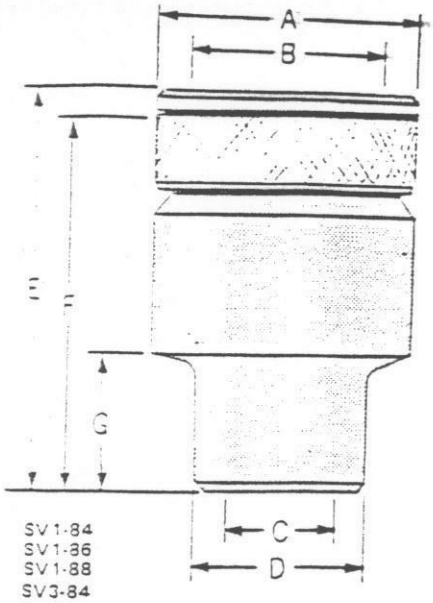
- HIGH CONDUCTIVITY
- COMPACT SIZE
- PRESSURE RELIEVING
- TAMPER RESISTANT
- EASY ACCESS TO VACUUM



SV3 SEAL-OFF VALVE
(SV1 SIMILAR - NO SPRINGS)



SV1-82
SV1-83
SV3-82
SV3-83



SV1-84
SV1-86
SV1-88
SV3-84
SV3-86
SV3-88

MATERIALS

Item	Part Name	Material (Specification)	
1	Cap & Poppet	Black Plastic (ABS) 6061 AL or 304 S.S. (See Valves & Size)	
2	O-Ring	Viton- A (NAS 1593)	
3	Body	5W2	1W1
		304 S.S.	6061 AL
4	Plug	Brass*	Brass*
5	Disc	300 Series Stainless	300 Series Stainless

* 1" VALVE IS 300 SERIES STAINLESS STEEL
STAINLESS OPTIONAL ON OTHER SIZES.

SPECIFICATIONS

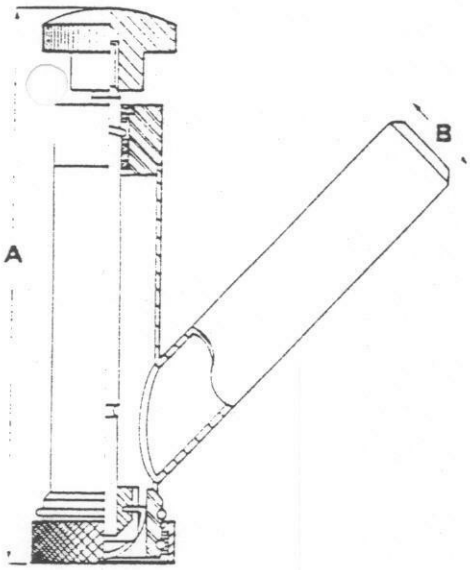
ITEM: Vacuum Seal-Off Valve
SERVICE: High vacuum and/or low pressure with all common gases.
PRESSURE: 1 x 10^{-8} torr up to 2 psig (higher spring setting on special order). Structural integrity: 1,000 psig min.
TEMPERATURE: Plus 150 F. to minus 60 F.
LEAK RATE: Less than 1 x 10^{-9} std. cc. GHe per second. *
CONNECTIONS: Weld standard, others available on special order.

* Exclusive of permeability

SEAL-OFF VALVE ORDERING INFORMATION

	SIZE	304 Cres PART NO.	6061 Al PART NO.	SV1 & SV3 SERIES SEAL-OFF VALVE DIMENSIONS A	B (THRD O.D.)	C	D	E	F	G	VALVE OPERATOR
NON-RELIEVING	1/4	SV1-82-5S2	SV1-82-1W1	3/4	7/16	5/16	5/8	1.30	5/8	3/8	V03-82-5L5
	3/8	SV1-83-5S2	SV1-83-1W3	1	3/4	3/8	5/8	1.75	15/16	5/8	V03-83-5L5
	1/2	SV1-84-5W2	SV1-84-1W3	1 3/16	1 1/16	1/2	3/4	1 13/16	1 11/16	3/4	V03-84-5L5
	3/4	SV1-86-5W2	SV1-86-1W3	1 1/2	1 3/8	3/4	1	1.30	1 15/16	3/4	V03-86-5L5
	1	SV1-88-5W2	SV1-88-1W1	1 3/4	1 5/8	1	1 1/4	2 1/2	2 3/8	15/16	V03-88-5L5
RELIEVING	1/4	SV3-82-5S3	SV3-82-1S2	3/4	9/16	5/16	5/8	1.30	5/8	3/8	V03-82-5L5
	3/8	SV3-83-5S3	SV3-83-1S3	1	3/4	1/2	7/8	1.75	15/16	5/8	V03-83-5L5
	1/2	SV3-84-5W5	SV3-84-1W5	1 3/16	1 1/16	1/2	3/4	2	1 13/16	9/16	V03-84-5L5
	3/4	SV3-86-5W3	SV3-86-1W3	1 1/2	1 3/8	3/4	1	2 1/2	1 15/16	3/4	V03-86-5L5
	1	SV3-88-5W2	SV3-88-1W3	1 3/4	1 5/8	1	1 1/4	2 3/4	2 3/8	15/16	V03-88-5L5

V03 VALVE OPERATOR
(For SV1 & SV3 Series Seal-Off Valves)



V03 Valve Operator Ordering Information

SIZE	PART NUMBER	DIMENSIONS A	B
1/4"	V03-82-5L7	4.38	.625
3/8"	V03-83-5L7	4.38	.625
1/2"	V03-84-5L7	4.38	.625
3/4"	V03-86-5L7	4.63	.875
1"	V03-88-5L7	5.0	1.125

V03 OPERATOR FOR SV1 & SV3 SERIES SEAL-OFF VALVES

The V03 operator features a 45 degree pump-out connection and a proprietary vacuum tight, O-ring sealed quick coupling for seal-off valve connection. Full flow design assures maximum conductance for evacuation of equipment.

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Cryolab TECHNICAL DATA

BULLETIN NUMBER A017A Rev. 7-85

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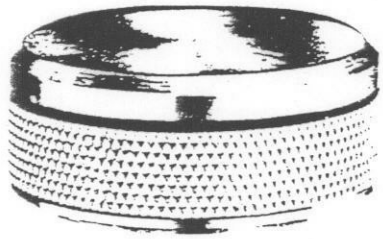
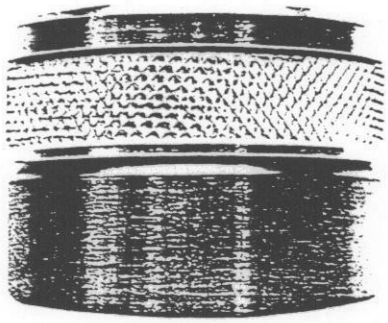
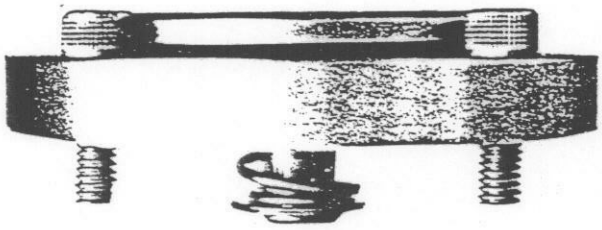
PRESSURE RELIEF, PR3 SERIES



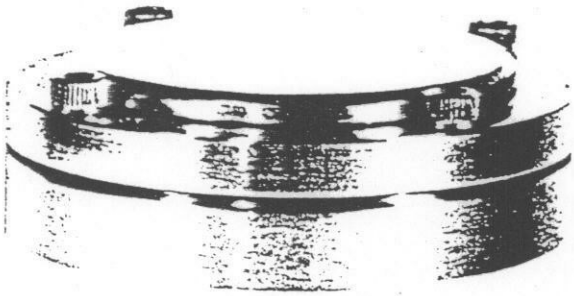
PR3-5T2 CAP ASSEMBLY
(½ and 1 inch)



PR3-5W2 RELIEF VALVE
(½ and 1 inch)



PR3-5F2 CAP ASSEMBLY
(1½ to 3 inch)



PR3-5W3 RELIEF VALVE
(1½ to 3 inch)

PR3 PRESSURE RELIEF DISC

DESCRIPTION

The Cryolab type PR3 Relief Discs are vacuum tight pressure relief discs. A spring loaded disc seats on the o-ring, making a leak tight (to 10-10 std. cc./sec.*) seal. Pressure applied through the body will cause the disc to move away from the body and o-ring allowing gas flow. Reverse pressure assists in sealing the disc.

The discs are compact in design. A typical flanged disc will generally be about one-half inch in height while providing a flow equivalent to a port of one or two inches in diameter. Full 360° pressure outlet provides for maximum flow and the leak tight construction assures no reverse flow. The lightweight of the discs permits convenient handling and the predominately stainless steel construction allows the discs to be used under corrosive environmental conditions.

APPLICATION

Pressure equalization and very low pressure relief can be realized by use of the Cryolab type PR3 disc. These discs are vacuum tight closures in one direction while allowing ample low pressure drop flow in the opposite direction.

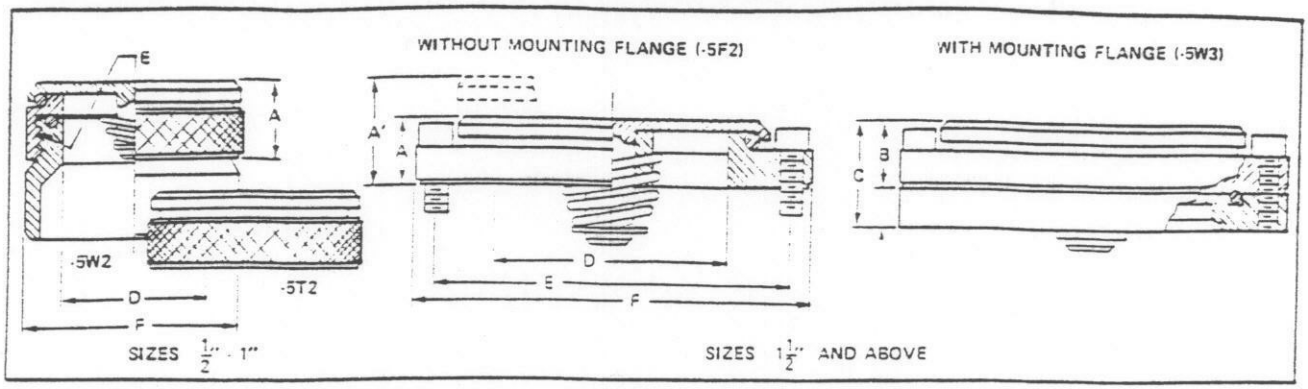
USES OF PR3 RELIEF DISCS

- Protection of the outer wall of vacuum jacketed cryogenic containers.
- Breather valves on storage tank vents and breather caps on fuel tanks.
- Pressure equalization valves on submerged chambers and other volumes which require unidirectional equalization.
- Loss eliminator valves for use in series with safety heads.
- Protection of vacuum systems subjected to pressurized venting and/or unregulated backfill.

*EXCLUSIVE OF PERMEABILITY

DIMENSIONS

PR3 PRESSURE RELIEF DISC



ORDERING INFORMATION

PART NUMBER	MATERIAL	EQUIVALENT PORT SIZE	DIMENSIONS IN INCHES						
			A	A'	B	C	D	E	F
PR3-84-5T2/5W2	304 CRES*	1/2	1/2	3/4	3/4	7/8	11/16	1 1/16-16	1 3/16
PR3-86-5T2/5W2	304 CRES*	3/4	1 1/2	3/4	5/8	1 1/8	15/16	1 3/8-16	1 1/2
PR3-88-5T2/5W2	304 CRES*	1	5/8	15/16	3/4	1 1/8	1 3/16	1 5/8-16	1 3/4
PR3-812-5F2/5W3	304 CRES*	1 1/2	9/16	3/4	5/16	7/8	1 5/8	2 3/8	2 3/4
PR3-816-5F2/5W3	304 CRES*	2	9/16	7/8	5/16	7/8	2 1/8	2 15/16	3 1/4
PR3-820-5F2/5W3	304 CRES*	2 1/2	11/16	1	7/16	1 1/8	2 11/16	3 1/2	4
PR3-824-5F2/5W3	304 CRES*	3**	1 1/8	1 1/4	1/2	1 5/8	3 3/8	4 3/8	5

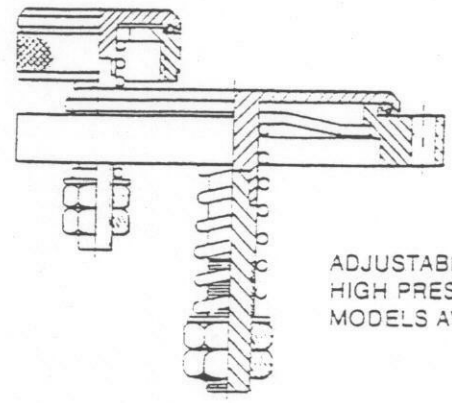
*6061 Aluminum units available on special order

**Larger sizes available on special order

SPECIFICATIONS

*Spec's — Subject to change. Consult Cryolab.

ITEM:	Pressure Relief Disk
SERVICE:	Low pressure & high vacuum
RELIEF PRESSURE:	Under 5 psig (higher pressures available)
SIZE:	As noted in dimensional chart
REVERSE LEAKAGE:	Less than 10^{-7} std. cc/sec. (Exclusive of Permeability)
MATERIALS:	Metal parts predominately 304 Cres O-ring seal Viton-A (77-545)
ENVIRONMENT:	Temperature: -65°F through +150°F Operating Pressure: 0 psig through 50 psig Proof Pressure: 150 psig (disk held closed)
SERVICE LIFE:	Over 10,000 cycles



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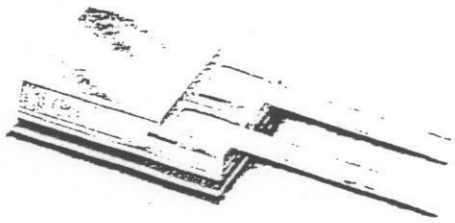
Series DT-470 Silicon Diode Temperature Sensors

Interchangeable, repeatable, accurate, customized for cryogenics — the DT-470 series, wide range, silicon diode temperature sensors



DT-470-SD

Features

- *Monotonic temperature response over its useful range from 1.4K to 475K*
- *All sensors follow a standard temperature response curve (Curve 10)*
- *Available in five bands of tracking accuracy*
- *Repeatability (at 4.2K) typically ±10mK over repeated thermal cycling*
- *High sensitivity at low temperature for critical low temperature measurements*
- *Accommodate a variety of mounting adaptors and probe assemblies*
- *Useful above 60K in magnetic fields up to 5 tesla*

Interchangeable - The DT-470 series silicon diode temperature sensors incorporate remarkably uniform sensing elements that exhibit precise, repeatable, monotonic temperature response over a wide range. The elements are mounted into rugged, hermetically-sealed packages that have been specifically designed for proper thermal behavior in a cryogenic environment. The result is a family of sensors with temperature characteristics so predictable, tightly grouped and stable, that the sensors in many applications can be routinely interchanged with one another.

Repeatable - The small silicon chip in each sensor has a temperature characteristic that is extremely stable and predictable, with excellent conformity from chip to chip. The sensor package is designed to withstand repeated cycling to low temperature without mechanical failure. Repeatability (at 4.2K) over repeated thermal cycling from room temperature to helium temperature is typically ±10mK or better.

Accurate - All DT-470 series diodes follow a standard temperature response curve, Curve 10 (see table page 16). Five tolerance bands are offered to allow sensor selection that will meet both technical and economic considerations. Within these five bands, low temperature accuracies from ±0.25K to ±1K are available. For more demanding requirements, DT-470 sensors can be individually calibrated to accuracies within ±50mK or better.

Customized for Cryogenics - Commercial, component-grade packages are not as useful in more critical cryogenic applications. To produce repeatable, accurate results, two issues must be addressed: the complex thermal link between the sensing element and its entire environment, and the effect of any measurement-induced self-heating of the sensor itself. The DT-470 sensor package solves many of the problems encountered in low temperature thermometry.

The hermetic package incorporates a sapphire substrate for high electrical isolation, but with good thermal conductivity at low temperatures where it is most required. The sensor base is metallized for easy anchoring to a sample or heat sink. Relatively large, robust leads, which are thermally anchored to the substrate, form an integral part of the package. As a result, making connections to the sensor is simplified, and potential measurement error that could be generated by heat conduction along the leads is greatly reduced. The DT-470's low, 10 microampere excitation requirement minimizes the self-heating effects caused by power dissipation in the sensor.

A Variety of Installation Configurations are Available - With its rugged, sapphire/alumina hermetic package and brazed Kovar ribbon leads, DT-470 sensors can effectively accommodate a variety of different mounting adaptors, probes and thermowells (see illustrations on pages 18-19). Choose from a simple cylinder that you merely slide into a mounting hole, metric or SAE-threaded stud mounts, or bolt-on flat mounts. Probes, thermowells and custom mounts are also available. Consult Lake Shore.

DT-470 sensors employed with SoftCal™ see pages 24-25.

Specifications

Temperature reproducibility: DT-470 series sensors are thermally cycled repeatedly from room temperature to liquid helium temperature in Lake Shore's quality assurance facility; Repeatability at 4.2K is typically ±10mK or better

Temperature range: 1.4K to 475K: Note: use with mounting adaptors in most cases reduces upper useful range limit. See ordering information on page 17

Excitation current: 10μA

Maximum reverse voltage: 40 VDC

Maximum forward current: 500μA continuous, or 5 μA in <100 microsecond pulses

Thermal time constants: (Typical) 10 milliseconds at 4.2K; 100 milliseconds at 77K; 200 milliseconds at 305K

Temperature response curve: Standard Curve 10. See table page 16. Nominal output at recommended current: 1.7V at 1.4K 0.1V at 475K.

Accuracy (interchangeability): All DT-470 series sensors track the Standard Curve 10 within five (5) tolerance bands. See ordering information on page 17

Temperature offset, vacuum to liquid at 4.2K: Typically 5 to 35mK depending on configuration. (See application note "Self-Heating Errors in Silicon DiodeTemperature Sensors", page 21)

Maximum recommended storage temperature (long term): 30°C

Materials and construction
Sapphire base with alumina body and lid. Molybdenum/manganese metallization on base and lid top with nickel and gold plating. Gold-tin solder as lid seal. Hermeticity: less than 1×10^{-8} std cc/sec. Cavity size: less than 1mm³

Size: See basic DT-470-SD sensor/mounting adaptor dimensions shown on pages 18-19

Leads: Gold-plated Kovar*, uninsulated, 0.38mm (0.015") by 0.1mm (0.004") cross-section by 12.7mm (0.5") long.
* Typically, 50/50 Ni-Fe composition

Polarity: Positive lead on right with package lid up and leads toward user

Mounting Adaptors: Gold-plated OFHC copper

Radiation conditions: Co-60 gamma: 200 Mrads at 0.1 Mrads/hour: 10K to 80K. Temperature shift, typical: 1.4-10K range, -0.5K. At 20K, -1.5K. At 40K, ±0.25K. At 200K, +4 - 5K. At 300K, +7 - 8K
Cs-137 gamma: 15krads at 1rad/sec.: 300K. Temperature shift, typical: 1.4-70K range, -0.1K. At 100K, -0.5K. At 200K, +2K. At 300K, +4K

Use in magnetic field: Low magnetic field dependence when used in fields up to 5 tesla above 60K. Not recommended for use in magnetic field applications below 60K. (Because Kovar leads are magnetic, sensor could shift in its mounting if not properly anchored) See Mounting Adaptor Section on pages 18-19

Calibrations: DT-470 sensors may be individually calibrated with accuracy to better than ±50 mK. Normally calibration requirements can be satisfied with Band 13 diode sensors. See ordering information on page 17

Installation: Refer to the Installation Application Note on pages 8-13

Typical Magnetic Field-Dependent Temperature Errors
$\Delta T/T$ (%)
at B (magnetic field)

T(K)	B (tesla units) 1	2	3	4	5	Comments
4.2	-200	-300	-350	-400	-500	Strongly orientation dependent.
20	-10	-20	-25	-30	-40	
40	-4	-6	-8	-10	-12	
60	-0.5	-1	-2	-3	-3.5	
80	< 0.1	-0.5	-0.8	-1.1	-1.5	Junction parallel to field.
300	< -0.1	< -0.1	< -0.1	< -0.1	< -0.1	

T(K)	B (tesla units) 1	2	3	4	5	Comments
4.2	-8	-9	-11	-15	-20	Junction perpendicular to field.
20	-4	-5	-5	-0.5	-1.0	
40	-1.5	-3	-4	-5	-5.5	
60	-0.5	-0.7	-0.8	-1	-1.1	
80	-0.1	-0.3	-0.5	-0.6	-0.7	
300	< 0.1	0.2	0.5	0.6	0.6	

Standard Curve #10

Standard Curve #10: Measurement Current = 10 microamperes. ± 0.05%

T (K)	Voltage	dV/dT (mV/K)	T (K)	Voltage	dV/dT (mV/K)	T (K)	Voltage	dV/dT (mV/K)
1.40	1.69812	-13.1	16.0	1.28527	-18.6	95.0	0.98564	-2.02
1.60	1.69521	-15.9	16.5	1.27607	-18.2	100.0	0.97550	-2.04
1.80	1.69177	-18.4	17.0	1.26702	-18.0	110.0	0.95487	-2.08
2.00	1.68786	-20.7	17.5	1.25810	-17.7	120.0	0.93383	-2.12
2.20	1.68352	-22.7	18.0	1.24928	-17.6	130.0	0.91243	-2.16
2.40	1.67880	-24.4	18.5	1.24053	-17.4	140.0	0.89072	-2.19
2.60	1.67376	-25.9	19.0	1.23184	-17.4	150.0	0.86873	-2.21
2.80	1.66845	-27.1	19.5	1.22314	-17.4	160.0	0.84650	-2.24
3.00	1.66292	-28.1	20.0	1.21440	-17.6	170.0	0.82404	-2.26
3.20	1.65721	-29.0	21.0	1.19645	-18.5	180.0	0.80138	-2.28
3.40	1.65134	-29.8	22.0	1.17705	-20.6	190.0	0.77855	-2.29
3.60	1.64529	-30.7	23.0	1.15558	-21.7	200.0	0.75554	-2.31
3.80	1.63905	-31.6	24.0	1.13598	-15.9	210.0	0.73238	-2.32
4.00	1.63263	-32.7	25.0	1.12463	-7.72	220.0	0.70908	-2.34
4.20	1.62602	-33.6	26.0	1.11896	-4.34	230.0	0.68564	-2.35
4.40	1.61920	-34.6	27.0	1.11517	-3.34	240.0	0.66208	-2.36
4.60	1.61220	-35.4	28.0	1.11212	-2.82	250.0	0.63841	-2.37
4.80	1.60506	-36.0	29.0	1.10945	-2.53	260.0	0.61465	-2.38
5.00	1.59782	-36.5	30.0	1.10702	-2.34	270.0	0.59080	-2.39
5.50	1.57928	-37.6	32.0	1.10263	-2.08	280.0	0.56690	-2.39
6.00	1.56027	-38.4	34.0	1.09864	-1.92	290.0	0.54294	-2.40
6.50	1.54097	-38.7	36.0	1.09490	-1.83	300.0	0.51892	-2.40
7.00	1.52166	-38.4	38.0	1.09131	-1.77	310.0	0.49484	-2.41
7.50	1.50272	-37.3	40.0	1.08781	-1.74	320.0	0.47069	-2.42
8.00	1.48443	-35.8	42.0	1.08436	-1.72	330.0	0.44647	-2.42
8.50	1.46700	-34.0	44.0	1.08093	-1.72	340.0	0.42221	-2.43
9.00	1.45048	-32.1	46.0	1.07748	-1.73	350.0	0.39783	-2.44
9.50	1.43488	-30.3	48.0	1.07402	-1.74	360.0	0.37337	-2.45
10.0	1.42013	-28.7	50.0	1.07053	-1.75	370.0	0.34881	-2.46
10.5	1.40615	-27.2	52.0	1.06700	-1.77	380.0	0.32416	-2.47
11.0	1.39287	-25.9	54.0	1.06346	-1.78	390.0	0.29941	-2.48
11.5	1.38021	-24.8	56.0	1.05988	-1.79	400.0	0.27456	-2.49
12.0	1.36809	-23.7	58.0	1.05629	-1.80	410.0	0.24963	-2.50
12.5	1.35647	-22.8	60.0	1.05267	-1.81	420.0	0.22463	-2.50
13.0	1.34530	-21.9	65.0	1.04353	-1.84	430.0	0.19961	-2.50
13.5	1.33453	-21.2	70.0	1.03425	-1.87	440.0	0.17464	-2.49
14.0	1.32412	-20.5	75.0	1.02482	-1.91	450.0	0.14985	-2.46
14.5	1.31403	-19.9	80.0	1.01525	-1.93	460.0	0.12547	-2.41
15.0	1.30422	-19.4	85.0	1.00552	-1.96	470.0	0.10191	-2.30
15.5	1.29464	-18.9	90.0	0.99565	-1.99	475.0	0.09062	-2.22

Shaded portion highlights truncated portion of Standard Curve 10 corresponding to the reduced temperature range of DT-471 diode sensors, described on page 10. The 1.4K to 325K portion of Curve 10 is applicable to the DT-450 miniature silicon diode sensor.

Curve 10

All DT-470, DT-471 and DT-450 series silicon diode temperature sensors follow the same standard temperature response curve, Curve 10. Consequently, all of the sensors from these groups can be routinely interchanged with one another in any operating routine involving this response curve. Curve 10 is programmed into all Lake Shore temperature controllers, digital thermometers and cryopump monitors.

DT-470 series diode sensors are offered in five bands of tracking accuracy, enabling sensors to be selected on the basis of both technical performance and budgetary requirements.

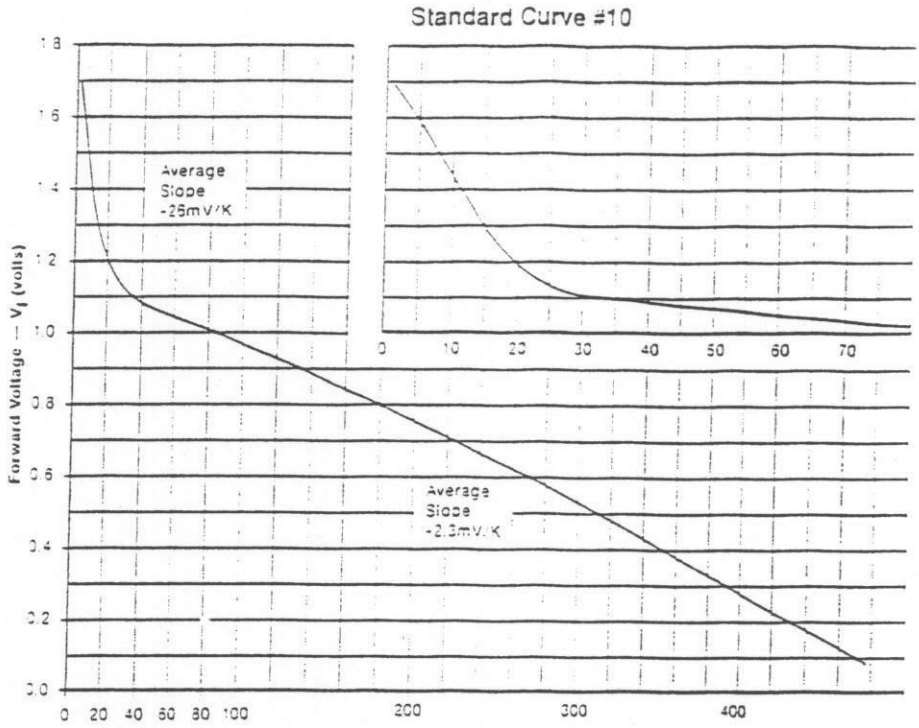


Figure 1.

Ordering Information

Ordering DT-470 series silicon diode temperature sensors:

Example: DT-470-BO-13-1.4LS

- DT-470 refers to the series type (silicon diode) and number.
- -BO refers to the mounting adaptor style selected. See pages 18-19.
- -13 specifies the tolerance (accuracy) band desired. See Curve 10 tolerance (accuracy) bands below.
- -1.4LS designates the type of calibration selected (if desired). See Calibration Options below right.

Standard Curve 10 Tolerance (Accuracy) Bands

Band	2K-100K	100K-305K	305K-475K
11	± 0.25K	± 0.5K	± 1.0K
11A	± 0.25K	± 1% of Temperature	
12	± 0.5K	± 1.0K	± 2.0K
12A	± 0.5K	± 1% of Temperature	
13	± 1.0K	± 1% of Temperature	

Temperature Range: 1.4K to 475K

DT-470-SD-11
DT-470-SD-11A
DT-470-SD-12
DT-470-SD-12A
DT-470-SD-13

Mounting Adaptors

Temperature Range: 1.4 to 325K
Configuring the DT-470/471-SD package with these mounting adaptors (see next page for dimensions):

DT-470-LR	DT-470-MT
DT-470-ET	DT-470-BO/BR
DT-470-CY	DT-470-CU
	DT-470-DI*

* Band 13 only

CO Mounting Adaptor

Temperature Range: 1.4 to 475K
DT-470-SD to DT-470-CO (clamp with spring)
Package of 10 CO clamps with springs (2103-001-10)

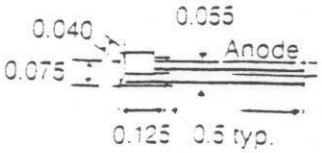
DT-470 Diode Calibration Options

Model	Type	Range(K)
DT-470	1.4DS	1.4 to 100
	1.4LS	1.4 to 325
	1.4HS	1.4 to 475
	4DS	4.0 to 100
	4LS	4.0 to 325
	4HS	4.0 to 475
	77LS	75 to 325
	-2S*	2-point SoftCal™
	-3S*	3-point SoftCal™

* See SoftCal™ application note, pages 24-25.
For detailed information on Calibration Services, see pages 47-48.

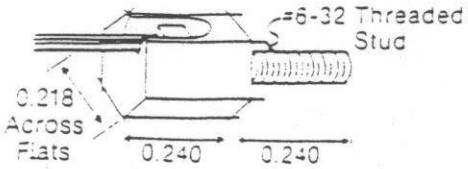
DT-470/471-SD Package Mounting Adaptor Illustrations (Dimensions in inches unless otherwise noted)

DT-470-SD. The SD configuration is the heart of the Lake Shore Cryotronics DT-470 series sensors. It is the smallest package in this series, and is designed primarily for bonding or clamping to a flat surface. Since the sensing element is in the best thermal contact with the base (largest surface) of the package, the package should be mounted with that same surface in good contact with the sample. Mounting materials and methods which will not expose the sensor to temperatures above 200° C are required. Low temperature indium-silver solder or Stycast epoxy is recommended. The SD package style is usable at temperatures up to 475K. Upper limits of temperature ranges shown reflect the type of solder generally used to mount the DT-470-SD package to the adaptor. A solder of indium-silver alloy (M.P. 150° C) is used.



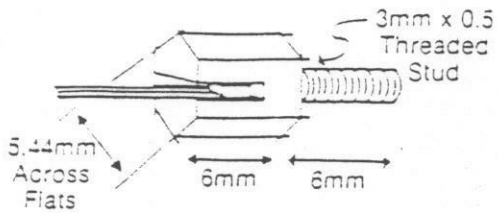
Basic sensor package style.
Temperature Range: 1.4K to 475K
Mass: 0.03g

DT-470-ET. This convenient screw-in package is formed at Lake Shore by soldering a basic SD configuration into a recess in one flat of the hexagonal screwhead. The head terminates in a standard SAE 6-32 threaded stud. Thus, the sensor can be threaded (finger-tight only) into a mounting hole in the sample. A light coating of vacuum grease on the threads further enhances the thermal contact between the sensor package and the sample. The solder used in mounting the SD package to this adaptor constrains the upper useful temperature of this configuration to 325K.



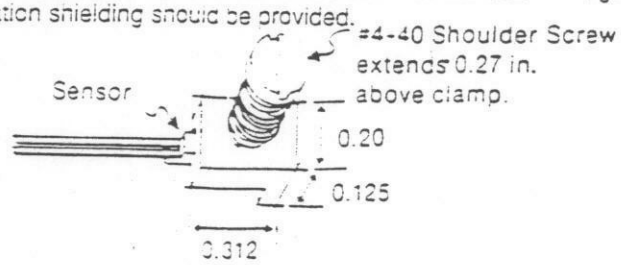
Basic sensor soldered onto SAE-threaded copper adaptor.
Temperature Range: 1.4K to 325K
Mass: 1.4g

DT-470-MT. The MT package is similar to the ET version above except the SD package is mounted in a slot in the center of the hexagonal head and the stud is a 3mm x 0.5 metric thread.



Basic sensor soldered into metric-threaded copper adaptor.
Temperature Range: 1.4K to 325K
Mass: 1.4g

DT-470-CO. A spring-loaded clamp holds a standard SD sensor in contact with the surface of the sample in this configuration. This allows the sensor to be easily changed or replaced. It also enables the sensor to be used over its full operational temperature range of 1.4 to 475K. Extra clamps are available to accommodate applications where frequent relocation of the sensor is desirable. The 4-40 stainless steel screw used with this clamp has a formed shoulder so that, once the screw is properly seated, the spring applies correct pressure to the clamp. A small amount of Apiezon L,N or H grease should be applied between the sample surface and the sensor for better thermal contact. For use below 4K, good radiation shielding should be provided.

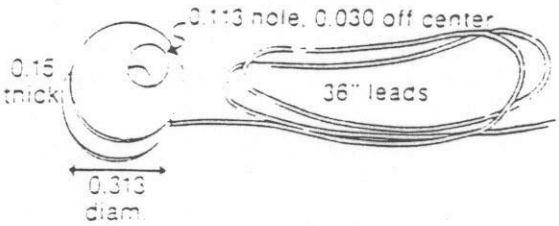


Basic sensor with spring-loaded copper clamp to hold sensor to sample.
Temperature Range: 1.4K to 475K
Mass (w/o Sensor): 1.7g

DT-470-CU. In this configuration, the SD sensor is epoxied into a flat, cylindrical disk and sensor leads are thermally anchored to that same disk. The unit can be mounted to any flat surface with a 4-40 brass screw (not supplied). The CU-style sensor is wired in a four-lead configuration with the leads comprised of a 36-inch length of Lake Shore's highly versatile, 36-gauge, color-coded, QUAD-LEAD™ cryogenic wire. Previous CU package users upgrading to the DT-470 sensors will likely find either the DT-470-CU or the DT-470-BO configuration best suited to mechanically replacing the older sensors with as little system change as possible. Temperature range is 1.4K to 325K.

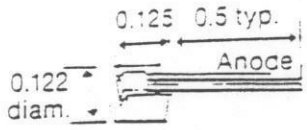
DT-470-DI. This is a two-lead version of the above sensor configuration designed to be the replacement for Lake Shore DT-500DI-8 sensors.

(DT-470-CU/DT-470-DI)



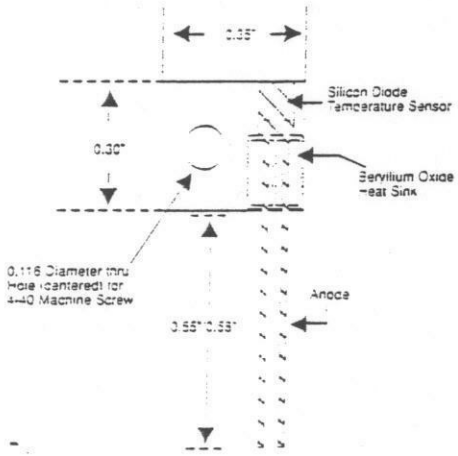
Basic sensor mounted into bolt-on disk with leads thermally anchored to disk with Stycast epoxy.
CU version is 4-leaded, DI is 2-leaded.
Temperature Range: 1.4K to 325K
Mass (excl leads): 1.0g

DT-470-LR. With a DT-470-SD sensor mounted on a slightly-more-than half-rounded cylinder, this package is designed to be inserted into a 1/8 inch (3.2mm) diameter hole. Thermal contact with the surrounding surface is enhanced by applying a coating of vacuum grease to the sensor. Stycast epoxy can also be used to install the sensor, although the mounting is much more permanent in that case. As with other soldered-down sensors, the temperature range of the DT-470-LR extends to 325K.



Basic sensor soldered into cylindrical copper adaptor.
Temperature Range: 1.4K to 325K
Mass 0.15g

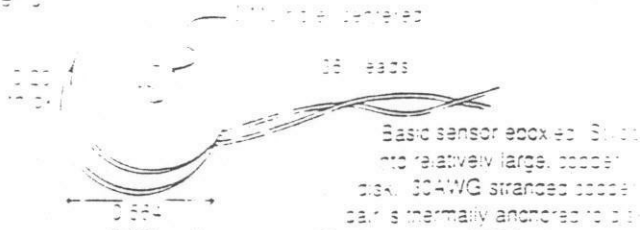
DT-470-BO / DT-470-BR. In addition to being soldered to the mounting block, the SD sensor in this design has its leads thermally anchored (without epoxy) to the block via a beryllium-oxide insert. Since leads can be a significant heat path to the sensing element, and can lead to measurement errors when incorrectly anchored, this configuration helps maintain the leads at the same temperature as the sensor. Mounting of this block is accomplished with a 4-40 screw (not supplied). Usable temperature range of the DT-470-BO sensor is 1.4 to 325K. The -BR version has 36 inch, QL-36 wire attached with epoxy strain relief over the berylium-oxide insert.*



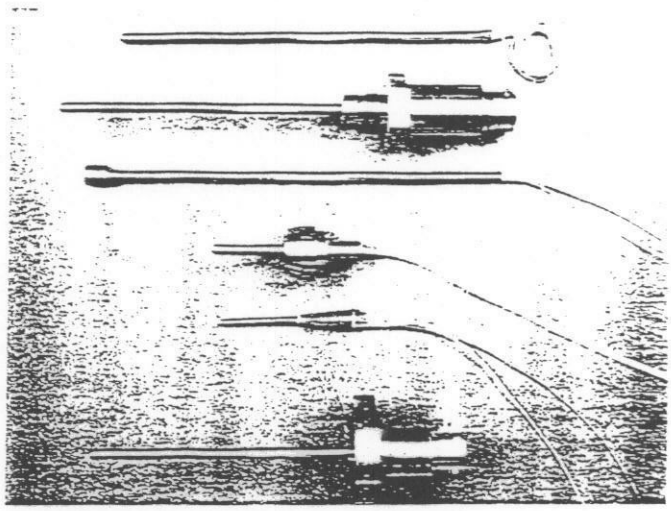
Basic sensor soldered onto bolt-on copper block with leads thermally anchored to block.
Temperature Range: 1.4K to 325K
Mass: 1.5g

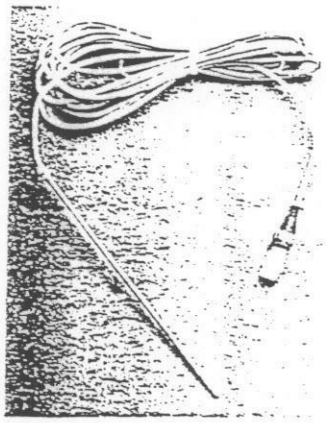
*The customer can provide this strain relief also. Do not get epoxy on the sensor.

DT-470-CY. Some applications are best served by a relatively large-sized, robust sensor and the DT-470-CY fills that role. Very similar to the DU-style above except the disk has a larger diameter with the mounting hole directly in the center. The sensor is a two-lead design with 36-inch heavy duty 30 AWG teflon-coated leads. Special attention must be paid to thermally anchoring the leads to prevent heat leak-induced measurement error.

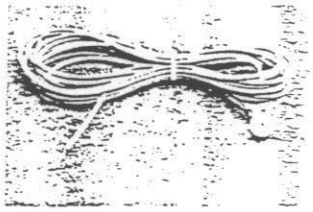


Temperature Range: 1.4K to 325K
Mass (excl. leads): 4.0g



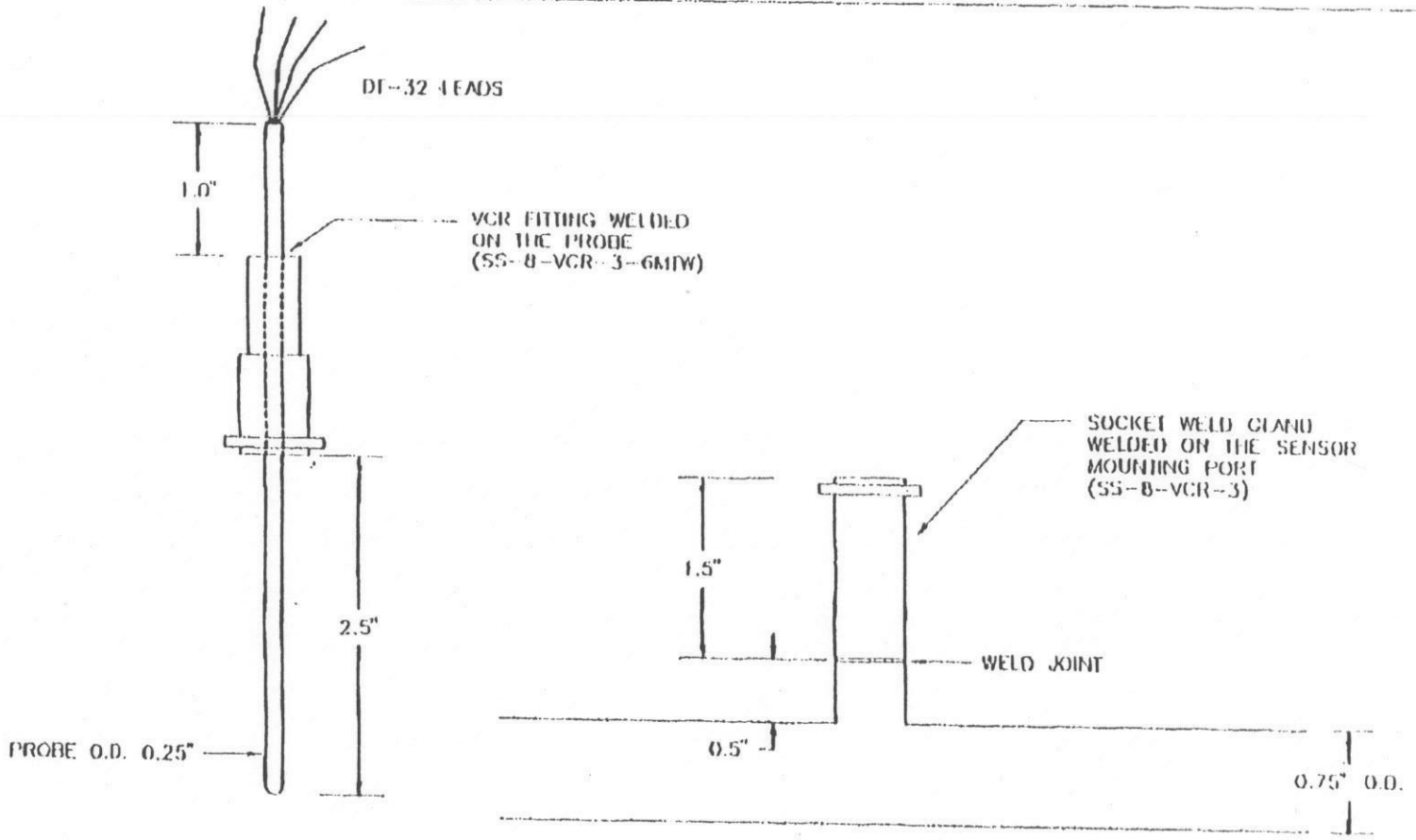


10' 0.66mm cable with DT-470-SD-13 sensor mounted into 6" 16pin long by 1.8" 0.3mm diameter stainless steel probe



6' 1.83mm cable with DT-470 series diode epoxied into DT-470-CY mounting adaptor

PROBES. The flexibility of the Lake Shore DT-470 series sensor makes them ideal candidates for incorporating into various probe and thermowell designs. However, the non-standardized nature of these applications usually demand custom-tailored designs. Lake Shore Cryotronics has a large library of previously-produced probe configurations which can be drawn upon to develop a special probe solution to virtually any cryogenic temperature measurement need. Contact your nearest Lake Shore office or representative and know they can help you.



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: [redacted]	DRAWN BY: MK	Lake Shore Cryotronics, Inc. MEASUREMENT AND CONTROL TECHNOLOGIES
	CHECKED BY: MK	TITLE: DT-470 PROBE
MATERIAL:	CUSTOM X / PROTO / PROD	SIZE: A / DWG NO: PRELIMINARY / REVISION
	FILE NAME: DT470	SCALE: NONE / PART NO: / SHEET 1 OF 1

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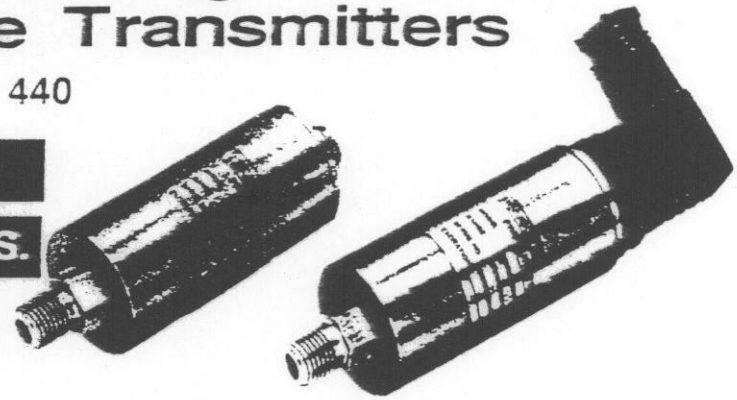
Two Wire Gage/Absolute Pressure Transmitters

Models 415 and 440

4-20ma OUTPUT

ACCURACY 0.1% TO 0.2% F.S.

WELDED STAINLESS



These two-wire transmitter Models 415 and 440 offer rugged, stainless steel construction suitable for even the harshest working environments. These models are available with zero and span adjustments and operate with a supply voltage from 15 to 40 VDC. Two-wire, 4-20ma output is provided. Both models set the accuracy standards for their competitive niches. The Model 415 offers an accuracy of 0.1% while the Model 440 offers an accuracy of .2% F.S.

RDPoffers a wide range of electrical connectors with a Hirschmann type or equivalent as standard on the Model 440. This connector offers many significant advantages to the user, including: flexibility to use any cable size between 4.5 mm and 14 mm or utilize a 1/2" NPT conduit fitting. It has the convenience and advantage of being a solderless and water-resistant connection, as well as allowing the user to turn the vibration-proof mating connector in any of four directions (90° increments) to achieve optimum cable clearance and cable/conduit run paths.

These characteristics and extremely competitive prices make the 415 and 440 units perfect for industrial transmitter applications like bulk liquid inventory control, steam management, and other power plant applications.

Dimensions

Absolute Model 415 (Order Code AP412)
Gage Model 440 (Order Code AP415)
Absolute Model 440 (Order Code AP416)

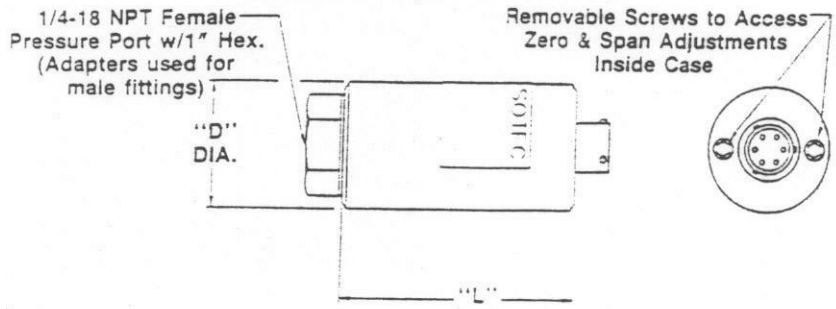
Available Ranges*	D"	L"
2; 5 psi	2.25	4.0
10; 15; 25; **50**; 75; **100**; 150; **200** psi	1.50	3.75
300; **500**; 750; **1000**; 1500 psi	1.50	3.75
2000; **3000**; **5000**; 7500; **10,000** psi	1.50	3.5

*Bold face ranges are the Model 440 and are in stock. These ranges are also available with the Model 415 but are not in stock. **Model 440 ranges** begin at 50 psi.

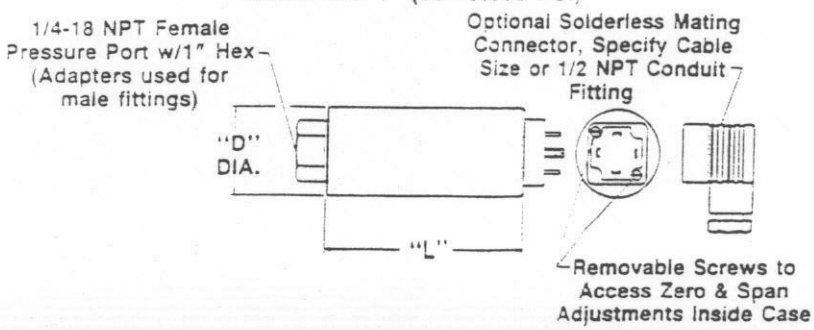
Gage Model 415 (Order Code AP411)

Available Ranges	D"	L"
2; 5 psi	2.25	4.0
10; 15; 25; 50; 75; 100; 150 psi	1.50	4.0
200; 300; 500; 750; 1000; 1500 psi	1.50	3.75
2000; 3000; 5000; 7500; 10,000 psi	1.50	3.5
20,000 psi	1.50	3.75

Model 415 (2 PSI-20,000 PSI)



Model 440 (50-10,000 PSI)



		Model 415 (0.1%) Gage: Order Code AP411 Absolute: Order Code AP412	Model 440 (0.2%)* Gage: Order Code AP415 Absolute: Order Code AP416
PERFORMANCE	Pressure Ranges	2 to 20,000 psi	50* to 10,000 psi
	Accuracy (min)	+/-0.1% F.S.	+/-.2%
	Combined Non-Linearity, Hysteresis, Non-Repeatability	.15% BFSL	.2% BFSL
	Output	4-20ma	4-20ma
	Resolution	Infinite	Infinite
ENVIRONMENTAL	Temperature, Operating	−20° F to 200° F	0 to 185° F
	Temperature, Compensated	60° F to 160° F	30 to 130° F
	Temperature Effect		
	- Zero (max)	.005% F.S./° F	.01 F.S./° F
	- Span (max)	.007% Rdg./° F	.01 Rdg./° F
ELECTRICAL	Strain Gage Type	Bonded foil	Bonded foil
	Supply** (acceptable)	15 to 40 VDC	15 to 40 VDC
	Max. Load Resistance**	500 ohms	500 ohms
	Wiring Code (std)	#23 (See P. 156)	#36 (See P. 156)
	Electrical Termination (std)	PT1H-10-6P or equiv. Hermetic stainless	Hirschman GSA 300N or equiv.*** Water resistant
	Mating Connector (not incl.)	PT06A-10-6S or equiv.	Hirschman GDM or equiv.
	Zero Adjustment	Located Under	Located Under
	Span Adjustment	Top Cover	Top Cover
MECHANICAL	Media	Liquid, Gas	Liquid, Gas
	Overload-Safe	50% over capacity	50% over capacity
	Overload-Burst	200% over capacity	200% over capacity
	Pressure Port 2 to 10,000 psi	1/4-18 NPT female	1/4-18 NPT female
	Wetted Parts Material	17-4 PH Stainless	17-4 PH Stainless
	Type (Gage, Abs.)	Gage or Absolute	Gage or Absolute
	Weight	13 oz.	13 oz.
	Case Material	Stainless steel	Stainless steel

Options

Model 415

Temperature compensated 1b, 1c; Pressure ports 5a, 5b, 5c, 5d; Electrical termination 6e, 6f, 6g, 6h (See P. 168)

Premium Options: 6i, 6j; 9a; 10a (See P. 168)

Accessories: Mating connectors and connector/cable assemblies; Pressure port adapters (See P. 152)

Model 440

Pressure ports 5b, 5d (by use of adaptors only)
Electrical termination 6g (installed in mating connector only)

*Notes:
- * Model 440 50 psi Accuracy is .25% F.S.
- ** For supply voltage under 20VDC, a load resistance of less than 500 ohms is required.
- *** Specify cable dia. can handle 4.5 mm to 14 mm or 1/2", conduit fitting NPT.

RDP GROUP

RDP Electronics Ltd.
Grove Street, Heath Town, Wolverhampton. WV10 0PY. UK.
Tel: 0902-457512 Fax: 0902-452000

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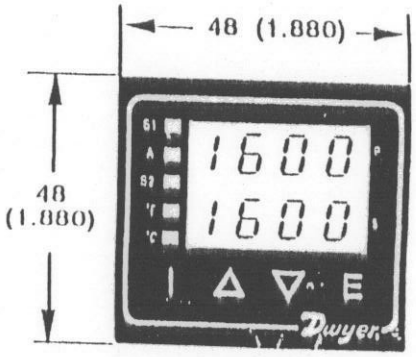
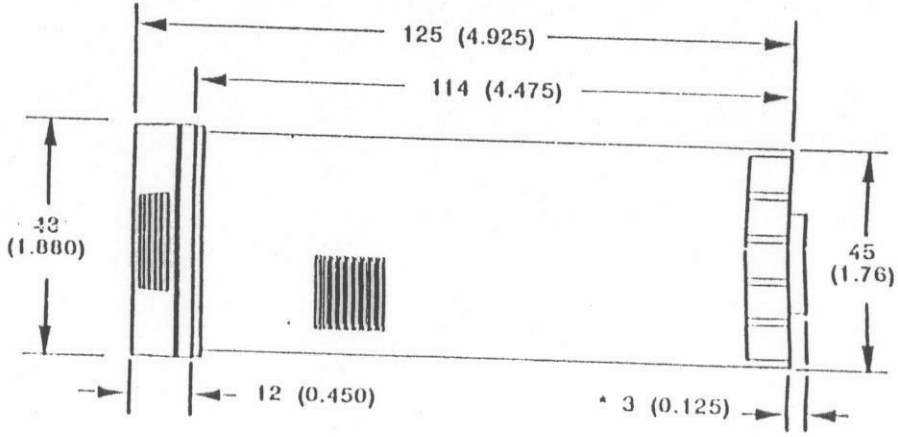
SERIES 1600 TEMPERATURE / PROCESS CONTROL

Specifications - Installation and Operating Instructions

CATHY



MEETS NEMA 3R



PANEL CUTOUT FOR ALL MODELS 45 MM X 45 MM (1.77" X 1.77")
ALLOW FOR 13 MM (0.5") CLEARANCE AT THE REAR OF INSTRUMENT.
* PRESENT FOR ALL OUTPUTS OTHER THAN RELAY.

(ALL DIMENSIONS IN MM WITH INCHES IN PARENTHESIS)

(219) 879-8868

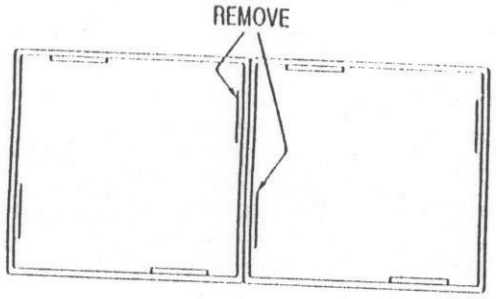
DWYER INSTRUMENTS, INC.
P.O. BOX 373 • MICHIGAN CITY, INDIANA 46360, U.S.A.
Telephone 219/879-8000
Fax 219/872-9057
Telex 25916

Panel Cutout: 45 mm x 45 mm (1.775" x 1.775").
Depth Behind Mounting Surface: 115.3 mm (4.54").
Weight: 227 g (8 oz).
Warranty: 5 years.
Agency Approvals: UL and CSA pending.
Front Panel Rating (non-hazardous locations): Meets NEMA 2, 3R, and 12 ratings.

INSTALLATION

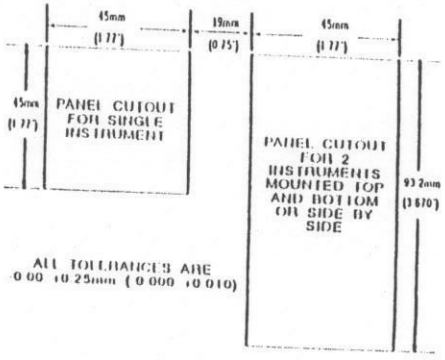
Mount the instrument in a location that will not be subject to excessive temperature, shock, or vibration. All models are designed for mounting in an enclosed panel.

Select the position desired for the instrument on the panel. If more than one instrument is required, only two units can be mounted closely together, either one above the other or side by side. When mounted together, the mounting collar will require modification by removing the inside tab from each collar.

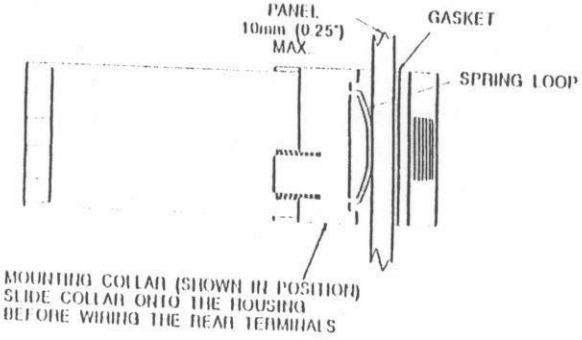


Prepare the panel by cutting and deburring the required opening.

From the front of the panel, slide the housing through the cut out. The housing gasket should be against the housing flange before installing.



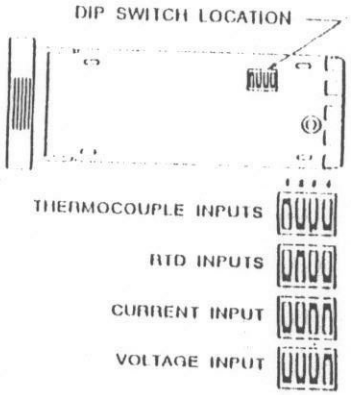
From the rear of the panel slide the mounting collar over the housing. Hold the housing with one hand and using the other hand, push the collar evenly against the panel until the spring loops are slightly compressed. The ratchets will hold the mounting collar and housing in place.



INPUT SELECTION

To change the input type, remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock. Locate the dip switch on the right pcb. Determine the input type desired and change the dip switch setting as shown below.

After changing input selection with the DIP switches, be sure to change the InP menu item (page 13) in the Secure Menu or change the CnF1 menu item in the Configuration Menu (page 20).

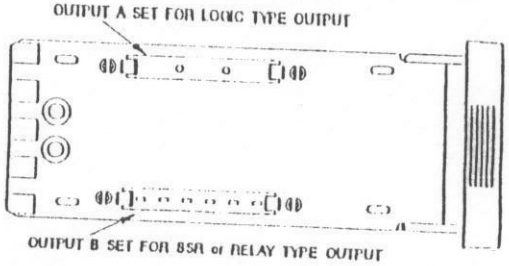


LOGIC JUMPER SELECTION

Instruments with **SSR** or **RELAY** type outputs can be changed to and from a **LOGIC** output in the field.

CAUTION: Damage to the instrument may result from an incorrectly installed jumper strip. Follow the instructions carefully.

1. Remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock.
2. Locate the desired logic jumper strip on the left printed circuit board. The **OUTPUT A** jumper strip is always located near the top edge.

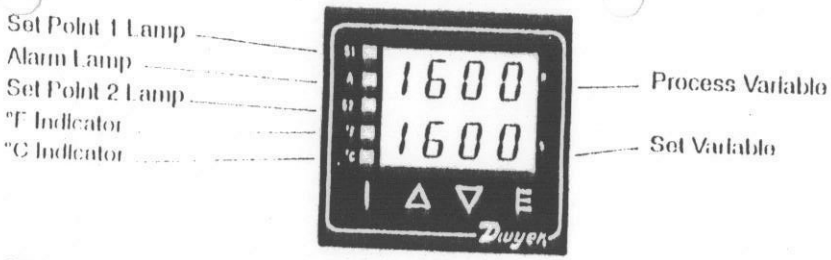


3. To remove the logic jumper strip, carefully insert a small flat blade screwdriver between the retaining clip and the jumper at one end of the jumper strip. Apply slight pressure to move the clip away from the jumper end until it is released, then lift it up and out of the clip.

4. To re-install the jumper strip, hold it with the spring contacts in the desired position. Face springs up for **SSR** or **RELAY** outputs, or face springs down for **LOGIC** outputs. Insert one end of the jumper strip under the retaining clip and press the other end down until the remaining clip engages the jumper.

5. To avoid any damage, recheck the jumper installation and the housing rear terminal panel output wiring.
6. Replace the instrument into its housing.

FRONT PANEL KEY FUNCTIONS



1. **INDEX:** Pressing the INDEX key advances the display to the next menu item. May also be used in conjunction with other keys as noted below.
2. **UP ARROW:** Increments a value, changes a menu item, or selects the item to ON in the upper display
3. **DOWN ARROW:** Decrements a value, changes a menu item, or selects the item to OFF in the upper display.
4. **ENTER:** Pressing ENTER stores the value or the item changed. If not pressed, the previously stored value or item will be retained.
5. **UP ARROW & ENTER:** Pressing these keys simultaneously brings up the **secondary menu** starting at the auto/manual selection. Pressing these keys for 5 seconds will bring up the **secure menu.**
6. **INDEX & DOWN ARROW:** Pressing these keys simultaneously will allow backing up one menu item, or if at the first menu item they will cause the display to return to the **primary menu.** If an alarm condition has occurred, these keys may be used to reset the alarm.
7. **INDEX & ENTER:** Pressing these keys simultaneously and holding them for 5 seconds allows recovery from the various error messages. The following menu items will be reset:

   LPbr: Loop break
   ALIH: Alarm Inhibit
   bAd InP: Bad input error message
   CHEC CAL: Check calibration error message
   SEnC: Sensor rate of change
   OPEn InP: Open input error message
   ArEA: Area error message

Correct the problems associated with the above conditions first before using these reset **keys.** More than one error could be present. Caution is advised since several items are reset at one time.

While in the **Primary or Secondary menu,** if no key is pressed for a period of 30 seconds, the display will return to the HOME position displaying the PV and SV values. The time is increased to 1 minute when in the **Secure menu.**

NOTE: To move to the **primary menu** quickly from any other menu, press the **UP ARROW & ENTER** keys followed by pressing the **INDEX & DOWN ARROW** keys.

METHOD FOR SET UP OF A HEAT / COOL CONTROL WITH SELF TUNE

Determine if the process is predominantly heating or cooling. An extruder, for example, is predominantly cooling when running product. An environmental chamber can be either heating or cooling. (For explanation of terms see pages 14 & 15.)

If the process is predominantly cooling, set S1St to dir and S2St to rE. If the process is predominantly heating, set S1St to rE and S2St to dir. Redirect SP1 to output A or B as required by the hardware (see SP1o). Set S2t to dE. Set SP2 for zero (no overlap of bands, no deadband). Set Pb2 to a desired value (default is 12° F). Set tunE to SELF, Strt to YES, and LEm to End.

Start the process and wait for it to come to stability. Occasionally check that the Self Tune has completed the learning process by INDEXing to Strt in the secondary menu. If the YES value has changed to no, then the process has been learned. Once learning is complete, you may adjust SP2 to either overlap the SP1 band (SP2 value less than zero), or add some separation between them (deadband -- SP2 greater than zero) if required to optimize control.

SECURITY LEVEL SELECTION

Four levels of security are provided. The display shows the current security level. To change security levels change the password value using the **UP & DOWN ARROW** keys and pressing the **ENTER** key. Refer to the password table below for the correct value to enter for the security level desired. The **SECr** menu item security level may be viewed or changed at any time regardless of the present security level. The password values shown in the table cannot be altered, so retain a copy of this page for future reference. This will be the only reference made to password values in this instruction book.

PASSWORD TABLE

SECURITY LEVEL MENU	SECURITY	DISPLAYED VALUE WHEN VIEWED	PASSWORD VALUE TO ENTER
Primary	Locked	1	1110
Secondary	Locked		
Secure	Locked		
Primary	Unlocked	2	1101
Secondary	Locked		
Secure	Locked		
Primary	Unlocked	3	1011
Secondary	Unlocked		
Secure	Locked		
Primary	Unlocked	4	111
Secondary	Unlocked		
Secure	Unlocked		

MENU SELECTIONS

PRIMARY MENU

Press **INDEX** to scan the Lower Display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display.

SP1 Set Point 1, Main Control Point.

SP2 Set Point 2, if equipped.

Set Point Output Type. Ft, Curr, or Volt.

Ft refers to Fast Time Proportioning, for Solid State Relay or 5V Logic Outputs. Timing is fixed at 1 sec.

Curr refers to Proportional Current Output of 0 to 20 mA.

Volt refers to Proportional Voltage Output of 0 to 10 V.

Both Curr & Volt are selected by the Hardware Configuration Code and cannot be changed.

PctO Percent Output Feature: Select **On** or **OFF**.

On When selected **On**, the HOME lower display will indicate the output of the controller in percent. An "o" will appear in the right hand side of the lower display to indicate percent output for SP1. An "ō" will appear on the right hand corner of the lower display to represent percent output for SP2. The display will alternate between these values.

OFF Percent Output display is disabled.

Prog Ramp/Soak Feature: Select **On** or **OFF**

StAt Status Display In the HOME Position: Select **On** or **OFF**. When selected OFF, the HOME display will alternately indicate the normal HOME and the Ramp/Soak partial status in the Lower Display. The partial status display sequences with the set value showing the ramp (S1rA) or soak (S1So) segment being processed at that moment. It will also show the Program output status if at Hold or OoFF.
When selected On, the HOME Display will alternately indicate the normal HOME and the Ramp/Soak full status in both the upper and lower displays. The full status display sequences with the set value; Program run, Hold, or OoFF; and with the time remaining for the ramp S1rA or the soak S1So segments.

1rt Ramp Time In Hours & Minutes: Select **0.00** to **99.59** (HH.MM).

1St Soak Time In Hours & Minutes: Select **0.00** to **99.59** (HH.MM).

PEnd End of Soak action: Select **Hold** or **OoFF**.

Hold Stay at the Present Set Pt.

OoFF Turn Off SP1 and SP2 Outputs at the End of the Soak.

InPC Input Correction: Select **±500 °F (±260 °C)** or **±1000** counts. This feature allows the input value to be changed to agree with an external reference or to compensate for sensor error. When setting values having one or more decimal points, the lowest negative value allowed is -199.9, -19.99, or -1.999. **Note:** InPC is reset to zero when the input type is changed, or when decimal position is changed in T/C or RTD ranges. Changing decimal position in current or voltage ranges will not reset InPC.

FILt Digital Filter: Select OFF, 1 to 99. In some cases the time constant of the sensor, or noise could cause the display to jump enough to be unreadable. A setting of 2 is usually sufficient to provide enough filtering for most cases, (2 represents approximately a 1 second time constant). When the 0.1 degree resolution is selected this should be increased to 4. If this value is set too high, controllability will suffer.

LPbr Loop Break Protection: Select **OFF**, **1** to **9999** seconds. If, during operation, the output is minimum (0%) or maximum (100%), and the Input moves less than 5°F (3°C) or 5 counts over the time set for LPbr, the **LOOP bAd** message will appear. This condition can also be routed to an Alarm Condition if alarms are present and

t... ...ed On (see ALbr in the secure menu). The loop break error can be reset by pressing the **ENTER** key when at the LPbr menu item. The **INDEX & ENTER** keys may also be used.

SECURE MENU

Hold **UP ARROW & ENTER** for 5 Seconds. Press **INDEX** to change the lower display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display.

SECr Security Code: See the Security Level Selection and the Password Table in this manual, in order to enter the correct password.

InP Input Type: Select one of the following. The Inputs are based on four different groups; Thermocouples, RTD's, Current, and Voltage. If changing from one of these groups, the DIP switch on the A/D circuit board will have to be changed to match that particular group. Refer to the Input wiring section for the proper switch settings.

- **J-IC** Type "J" Thermocouple, Iron/Constantan (NIST)
- **CA** Type "K" Thermocouple Chromel/Alumel
- **E-** Type "E" Thermocouple Chromel/Constantan
- **t-** Type "T" Thermocouple Copper/Constantan
- **L-** Type "L" Thermocouple Iron/Constantan (DIN)
- **n-** Type "N" Thermocouple Nicrosil/Nisil
- **r-13** Type "R" Thermocouple Pt 13%Rh/Pt
- **S-10** Type "S" Thermocouple Pt 10%Rh/Pt
- **b-** Type "B" Thermocouple Pt 6%Rh/Pt 30%Rh
- **C-** Type "C" Thermocouple W 5%Re/W 26%Re
- **P392** 100 ohm Platinum (NIST 0.00392 Ω/Ω/°C)
- **n120** 120 ohm Nickel
- **P385** 100 ohm Platinum (DIN 0.00385 Ω/Ω/°C)
- **Curr** DC Current Input 0.0 to 20.0 or 4.0 to 20.0 milliamperes.
- **VoLt** DC Voltage Input 0.0 to 5.0 or 1.0 to 5.0 volts.
- **- - - -** For Access to Calibration and FACt dFLt.

OSUP Zero Suppression: Select **On** or **OFF**. Only with Current and Voltage Input types.

OFF The Input range will start at 0 (zero) Input.

On The Input range will start at 4.00 mA or 1.00 V.

Unit F, C or None

F °F descriptor is On and temperature Inputs will be displayed in actual degrees Fahrenheit.

C °C descriptor is On and temperature Inputs will be displayed in actual degrees Celsius.

nonE °F and °C descriptors will be Off. This is only available with Current and Voltage Inputs.

dPt Decimal Point Positioning: Select **0**, **0.0**, **0.00**, or **0.000**. On temperature type Inputs this will only effect the Process Value, SP1, SP2, ALLo, ALHI, and InPC. For Current and Voltage Inputs all Menu Items related to the Input will be affected.

0 No decimal Point is selected. This is available for all Input Types.

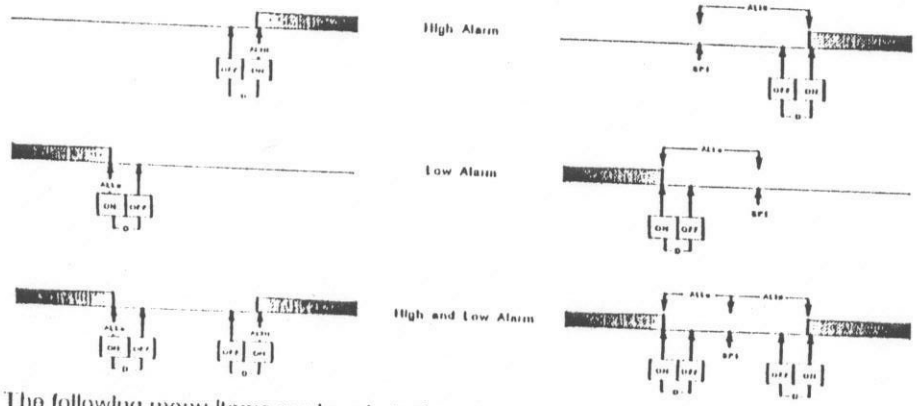
0.0 One decimal place is available for Type J, K, E, T, L, RTD's, Current and Voltage Inputs.

0.00 Two decimal places is only available for Current and Voltage Inputs.

0.000 Three decimal places is only available for Current and Voltage Inputs.

ABSOLUTE ALARMS

DEVIATION ALARMS



The following menu items apply only to the alarm.

AL Alarms: Select **OFF, Lo, HI,** or **HILo.**
- **OFF** Alarms are turned OFF. No Alarm menu items appear in the Secondary and Secure menus.
- **Lo** Low Alarm Only. ALLo appears in the Secondary Menu.
- **HI** High Alarm Only. ALHI appears in the Secondary Menu.
- **HILo** High and Low Alarms. Both share the same Alarm Relay output.

ALt Alarm Type: Select **AbS** or **dE**
- **AbS** Absolute Alarm that may be set anywhere within the values of SPL and SPH and is independent of SP1.
- **dE** Deviation Alarm that may be set as an offset from SP1. As SP1 is changed the Alarm Point will track with SP1.

ALrE Alarm Reset: Select **OnOF** or **Hold.**
- **OnOF** Automatic Reset.
- **Hold** Manual Reset. Acknowledge by simultaneously pressing the **INDEX & DOWN ARROW** keys for 5 sec.

ALPI Alarm Power Interrupt: Select **On** or **OFF.**
- **On** Alarm Power Interrupt is ON.
- **OFF** Alarm Power Interrupt is OFF.

ALIH Alarm Inhibit: Select **On** or **OFF.**
- **On** Alarm Inhibit is ON. Alarm action is suspended until the process value first enters a non-alarm condition.
- **OFF** Alarm Inhibit is OFF.

ALSt Alarm Output State: Select **CLOS** or **OPEn.**
- **CLOS** Closes Contacts at Alarm Set Point.
- **OPEn** Opens Contacts at Alarm Set Point.

ALLP Alarm Lamp: Select **O on** or **OoFF.**
- **O on** Alarm Lamp is ON when alarm contact is closed.
- **OoFF** Alarm Lamp is OFF when alarm contact is closed.

ALbr Alarm Loop Break: Select **On** or **OFF.**
- **On** Loop Break Condition will cause an Alarm Condition.
- **OFF** Loop Break will not affect the Alarm Condition.

DIAGNOSTIC ERROR MESSAGES

DISPLAY	MEANING	SP1, SP2, and ALARM OUTPUTS	ACTION REQUIRED
UFL or **OFL**	Underflow or Overflow: Process value has exceeded input range ends set by SCAL or SCAH.	Set point outputs active Alarms active	Input signals may normally go above or below range ends. If not, check input and correct.
bAd InP **OPEn InP**	**UFL** or **OFL** will sequence to display one of these messages if the **InPt** is set for a time value. For RTD, CURRENT, or VOLTAGE inputs; input error has occurred. For THERMOCOUPLE inputs thermocouple is open.	Set point outputs Inactive Alarms active	To reset use the **INDEX & ENTER** keys. When **InPt** (input fault timer) has been set for a time, the outputs will be turned off after the set time. Setting the time to OFF causes the outputs to remain active, however **UFL** or **OFL** will still be displayed. Correct or replace sensor. To reset use the **INDEX & ENTER** keys.
LOOP bAd	The sensor may be defective, heater fuse open, heater open or the final power output device is bad.	Set point outputs Inactive Alarms active	Correct or replace sensor, or any element in the control loop that may have failed. To reset use the **INDEX & ENTER** keys, or press the **ENTER** key while in the **LPBr** menu item.
SEnC bAd	Sensor rate of change exceeded the programmed limits set for **SEnC.**	Set point outputs Inactive Alarms active	Check the cause. The value setting may be too slow for the process, or the sensor is intermittent. To reset use the **INDEX & ENTER** keys.
#### ArEA	Area appears if the controller's ambient temperature nears specification ends, -5°C (+23°F) or +50°C (+122°F).	Set point outputs active Alarms active	Correct the ambient temperature conditions. Ventilate the area of the cabinet or check for clogged air filters.
(blank) ArEA	Area appears if the controller's ambient temperature exceeds specification ends, -10°C (+14°F) or +55°C (+131°F).	Set point outputs Inactive Alarms active	Correct the ambient temperature conditions. Ventilate the area of the cabinet or check for clogged air filters. To reset use the **INDEX & ENTER** keys.
CHEC CAL	Check calibration appears as an alternating message if the instrument calibration nears tolerance edges.	Set point outputs active Alarms active	
.	Check calibration appears as a flashing message if the instrument calibration exceeds specification.	Set point outputs Inactive Alarms active	Remove the instrument for service and / or recalibration. To reset use the **INDEX & ENTER** keys.

CONFIGURATION CHART

Do not change Hrd1, Hrd2 or Hrd3 to codes different from those on the controller labels. Codes in boldface type indicate factory defaults. See FACt dFLt.

DISPLAY	MENU ITEM	CONFIGURATION CODE
Hrd1	Alarm Hardware	0 = NO 1 = YES
Hrd2	Output A Hardware	1 = SSR/LOGIC 2 = LOGIC/SSR 3 = RELAY/LOGIC 4 = LOGIC/RELAY 5 = CURRENT 6 = VOLTAGE
Hrd3	Output B Hardware	0 = NONE 1 = SSR/LOGIC 2 = LOGIC/SSR 3 = RELAY/LOGIC 4 = LOGIC/RELAY
CnF1	Input Type	**01 = J 1°** 02 = J 0.1° 03 = K 1° 04 = K 0.1° 05 = E 1° 06 = E 0.1° 07 = T 1° 08 = T 0.1° 09 = L 1° 10 = L 0.1° 11 = N 1° 12 = N 0.1° 13 = R 1° 14 = S 1° 15 = B 1° 16 = C 1° 17 = RTD 1° (DIN) 18 = RTD 0.1° (DIN) 19 = RTD 1° (NIST) 20 = RTD 0.1° (NIST) 21 = RTD 1° Ni 22 = RTD 0.1° Ni 23 = 0 to 20 mA 24 = 4 to 20 mA 25 = 0 to 5 VDC 26 = 1 to 5 VDC
CnF2	Temperature Descriptor	0 = No Descriptor 1 = **Degree F** 2 = Degree C
CnF3	SP1 and SP2 Action	**0 = SP1 = Output A, rev. act.** (Single set point Models) 1 = SP1 = Output A, dir. act. (Single set point Models) **2 = SP1 = Output A, rev. act.; SP2 = Output B, dir. act.** 3 = SP1 = Output B, rev. act.; SP2 = Output A, dir. act. 4 = SP1 = Output A, dir. act.; SP2 = Output B, rev. act. 5 = SP1 = Output B, dir. act.; SP2 = Output A, rev. act. 6 = SP1 = Output A, rev. act.; SP2 = Output B, rev. act. 7 = SP1 = Output B, rev. act.; SP2 = Output A, rev. act. 8 = SP1 = Output A, dir. act.; SP2 = Output B, dir. act. 9 = SP1 = Output B, dir. act.; SP2 = Output A, dir. act.
CnF4	Alarm Type	0 = No Alarm **1 = Absolute High Alarm** 2 = Deviation High Alarm 3 = Absolute Low Alarm 4 = Deviation Low Alarm 5 = Absolute High - Low Alarms 6 = Deviation High - Low Alarms
CnF5	Alarm Action	0 = No Alarm **1 = On - Off** 2 = Manual Reset with Power Interrupt 3 = Manual Reset without Power Interrupt 4 = On - Off with Inhibit 5 = Manual Reset with Inhibit

CONFIGURATION CHART, CONT'D.

DISPLAY	MENU ITEM	CONFIGURATION CODE
CnF6	Alarm State	0 = No Alarm **1 = Close at SP, LED flashing** 2 = Open at SP, LED flashing 3 = Close at SP, LED off 4 = Open at SP, LED off
AcPt	Accept Configuration	no = Retain old Configuration. Press ENTER to exit. YES = Accept Configuration. Press ENTER to exit.
Id ##		Factory Identification. Not for customer use.
FACt dFLt		Factory default. Defaults Configuration to factory codes shown in boldface type in the chart above. **Warning:** The Hardware Configuration will be cleared and must be re-entered using the Hardware Configuration code found on the Model / Serial label located on the top of the instrument housing. The configuration menu cannot be exited until valid Hardware codes are entered. If factory default is desired, simultaneously press the **ENTER & DOWN ARROW** keys.

QUICK REFERENCE MENU CHART

The following MENU ITEMS are briefly described in the order that they will appear on the displays.

PRIMARY Menu.
Press **INDEX** to Scan the Lower Display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display

LOWER DISPLAY	UPPER DISPLAY	FUNCTION
####	####	"HOME" display. Upper display shows Process Variable, lower display shows Set Variable (SP1).
SP1	####	Set Point 1, Adjustable within the values of SPL and SPH.
SP2	####	Set Point 2, Adjustable within the values of SPL and SPH.

S[illegible]URE Menu. Hold **UP ARROW & ENTER** for 5 Sec. Pr[illegible]DEX to change the lower display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display.

LOWER DISPLAY	UPPER DISPLAY	FUNCTION
SECr	1	No Menu Items May be Altered, (Full Security).
	2	Only Primary Menu Items may be Altered.
	3	Only Primary and Secondary Menu Items may be Altered.
	4	All Menus may be Altered, (No Security).
InP	J IC	Input Type "J" Thermocouple, Iron/Constantan (NIST).
	CA	Input Type "K" Thermocouple, Chromel/Alumel.
	E-	Input Type "E" Thermocouple, Chromel/Constantan.
	t-	Input Type "T" Thermocouple, Copper/Constantan.
	L-	Input Type "L" Thermocouple, Iron/Constantan (DIN).
	n	Input Type "N" Thermocouple, Nicrosil/Nisil.
	r 13	Input Type "R" Thermocouple, Pt 13%Rh/Pt.
	S-10	Input Type "S" Thermocouple, Pt 10%Rh/Pt.
	b-	Input Type "B" Thermocouple, Pt 6%Rh/Pt 30%Rh.
	C-	Input Type "C" Thermocouple, W 5%Re/W 26%Re.
	P392	100 Ω Platinum (NIST 0.00392 Ω/Ω/°C)
	n120	120 Ω Nickel
	P385	100 Ω Platinum (DIN 0.00385 Ω/Ω/°C)
	Curr	Current Input, 0 to 20 Milliamps.
	VoLt	Voltage Input, 0 to 5 Volts.
	- - - -	Access to calibration and FACt dFLt
OSUP	On/OFF	0% or 20% Suppression for Current or Voltage Inputs. OFF = 0 to 20 mA or 0 to 5 V, On = 4 to 20 mA or 1 to 5 V.
Unit	F	Turn On °F Light, Available for All Inputs.
	C	Turn On °C Light. Available for All Inputs.
	nonE	No Light Is On, Only Available with Voltage and Current Input

LOWER DISPLAY	UPPER DISPLAY	FUNCTION
dPt	0	Decimal Point Position, Available for all Input Types
	0.0	Available Only for J, K, E, T, L, RTD's, Current, or Voltage.
	0.00	Available Only for Current or Voltage Inputs.
	0.000	Available Only for Current or Voltage Inputs.
InPt	###.#	Input Fault Timer, Select OFF, 0.1 to 540.0 min.
SEnC	#####	Sensor Rate of Change, OFF, 1 to 4000 °F, °C , or counts.
SCAL	#####	Minimum Scale Low. Viewable only for Thermocouple and RTD Inputs. Adjustable for Current and Voltage Inputs.
SCAH	#####	Maximum Scale High. Viewable only for Thermocouple and RTD Inputs. Adjustable for Current and Voltage Inputs.
SPL	####	Minimum Adjustment for SP1, SP2, ALLo, ALHi, SP1d, & SP2d.
SPH	####	Maximum Adjustment for SP1, SP2, ALLo, ALHi, SP1d, & SP2d.
SP1o	OutA	Change SP1 and SP2 hardware outputs. OutA = SP1 to 7 & 8, SP2 to 9 & 10.
	OutB	OutB = SP1 to 9 & 10, SP2 = 7 & 8.
S1Ot	Cy	Adjustable Time Proportioning (Cycle Rate). Press **ENTER** to Adjust CY1 Value for 2 to 80 sec.
	OnOF	On/Off Differential. Press **ENTER** to Adjust SP1d Value for 2 to full scale degrees or counts.
	PUL	Pulsed Time proportioning. Press **ENTER** to adjust PUL1 for 1 to 7. 1 = Linear, 7 = Most non-linear
	Ft	Fast Time Proportioning, Fixed at 1 sec.
	Curr	Proportional Current, Viewable only, cannot be changed.
	Volt	Proportional Voltage, Viewable only, cannot be changed.
S1St	dir	Direct Action, Usually for Cooling Applications.
	rE	Reverse Action, Usually for Heating Applications.
S1OL	##	SP1 Output Low Limit, 0 to 90%, but less than S1OH.
S1OH	###	SP1 Output High Limit, 10 to 102%, but greater than S1OL .