Rev 1.1

TEMP2 **800-220-00**

REDSTAR3 Dual Array Temperature Controller

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7.0 TEMP2 800-220-00 REDSTAR3 Dual Array Temperature Controller

7.1 Overview

The TEMP2 is a dual array temperature control and monitoring subsystem based on Lakeshore Cryotonics Model 331/2 temperature controllers plus a Model 218 Temperature monitor.

7.1.1 NICI Requirements

7.1.1.1 Independently control the temperature of each array to a user settable temperature approximately 30-35 degrees Kelvin +/- 0.1 degrees Kelvin.

7.1.1.2 The temperature not vary by more than 0.1 degrees over periods of 10 minutes. Gradual drifts of not more than 1 degree are allowed as long as the change in temperature does not exceed 0.1 degrees K/10 minute period..

7.1.1.3 The temperature controller shall be serially controlled and allow for readout of the temperature and modification of the set point, the servo loop PID parameters and the heater output power.

7.1.1.4 Temperature sensors positions will be in the following locations:

1. Array #1 mount
2. Array #2 mount
3. Cold Structure Closed Cycle Cooler first stage
4. Cold Structure Closed Cycle Cooler second stage
5. Camera cold structure (farthest point from closed cycle cooler attachment)
6. Radiation shield (farthest point from closed cycle cooler attachment)
7. Radiation Shield cooler first stage
8. APD temperature

7.2 Technical Specifications 800-220-00 TEMP2

- Lakeshore Model 331/2 Controller (see attached vendor documentation for detailed specs)
- 2 channel temperature monitor
- with Si Diode (DT-470) sensors, ~± 0.5mK accuracy (30K-375K)
- 24 bit ADC resolution at 10 sample/sec rate
- 2 channel PID (with manual mode) controller
- Control stability better than ± 0.6mK at 1.4K, ± 11mK at 77K
- Heater #1 50W (1Amp), 18 bit DAC, 50uV isolated output
- Heater #2 10W (1Amp), 16 bit DAC, < 0.3mV non-isolated output
- RS-232 interface

Environmental Specifications

- 15-35 °C rated accuracy, 10-40 °C reduced

Mechanical Specifications

Each Model 331/2 Temperature Controller and the Model 218 Temperature Monitor have the following dimensions

- Width: 217 mm (8.5 in)
- Height: 90 mm (3.5 in)
- Depth: 317 mm (14.5 in) plus clearance for rear connections
- Weight: 4.8 kilograms (10.5 pounds

Model 331/2

- Weight: 4.8 kilograms (10.5 pounds)

Model 218

- Weight: 3 kilograms (6.6 pounds)

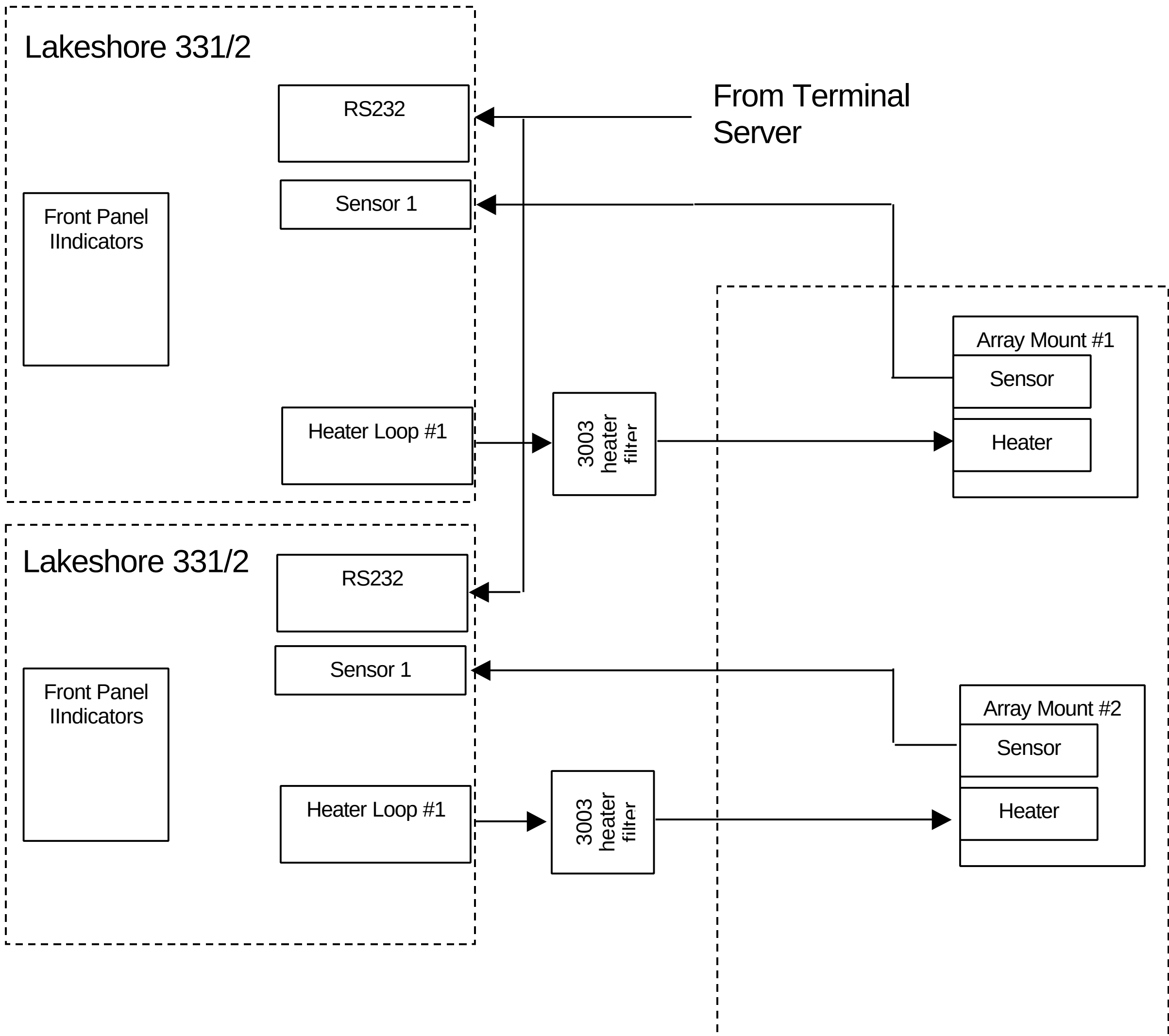
3303 Output Filter

- Width: 217 mm (8.5 in)
- Height: 90 mm (3.5 in)
- Depth: 317 mm (14.5 in) plus clearance for rear connections
- Weight: 1 kilograms (2.2) pounds

7.3 Front Panel photo

Note

7.4 Block Diagram



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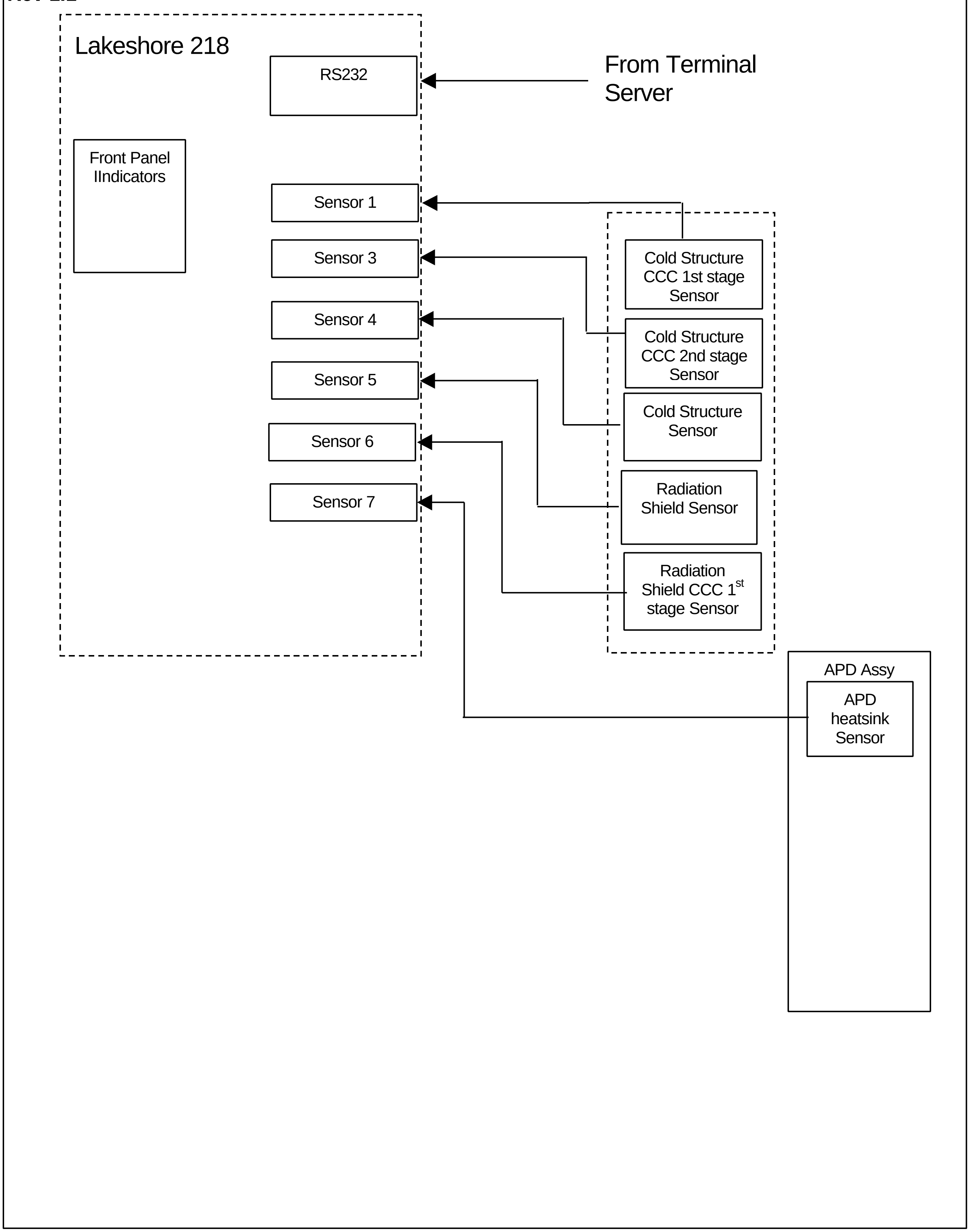


Lakeshore 218
RS232
From Terminal Server
Front Panel IIndicators
Sensor 1
Sensor 3
Sensor 4
Sensor 5
Sensor 6
Sensor 7
Cold Structure CCC 1st stage Sensor
Cold Structure CCC 2nd stage Sensor
Cold Structure Sensor
Radiation Shield Sensor
Radiation Shield CCC 1st stage Sensor
APD Assy
APD heatsink Sensor

7.5 Functional Description 800-200-00 TEMP

7.5.1 Overview

Although the TEMP2 subsystem is basically a standard installation of two Lakeshore Model 331/2 controllers and Model 218 monitor, application specific information is presented here.
Two individual controllers are used to control the two infrared arrays. Each controller has 2 control loops and heater outputs. The following description details the configuration for a single array.

7.5.2 Lakeshore 331/2

The Lakeshore 331/2 controls each heater output based on PID control loop that monitors the sampled temperature derived from a 4 wire measurement of a Si diode (DT-470).

7.5.2.1 Temperature Sensor Measurement

Temperature is sensed using a 4 wire connection to a Lakeshore DT-470 Si diode . The diodes from the “standard” series (explained in the following Lakeshore diagram). The sensor is fed with a 10 µA ±0.01% excitation current. A 24 bit ADC is used to sample the resulting voltage at a 10 sample/sec rate (331/2).

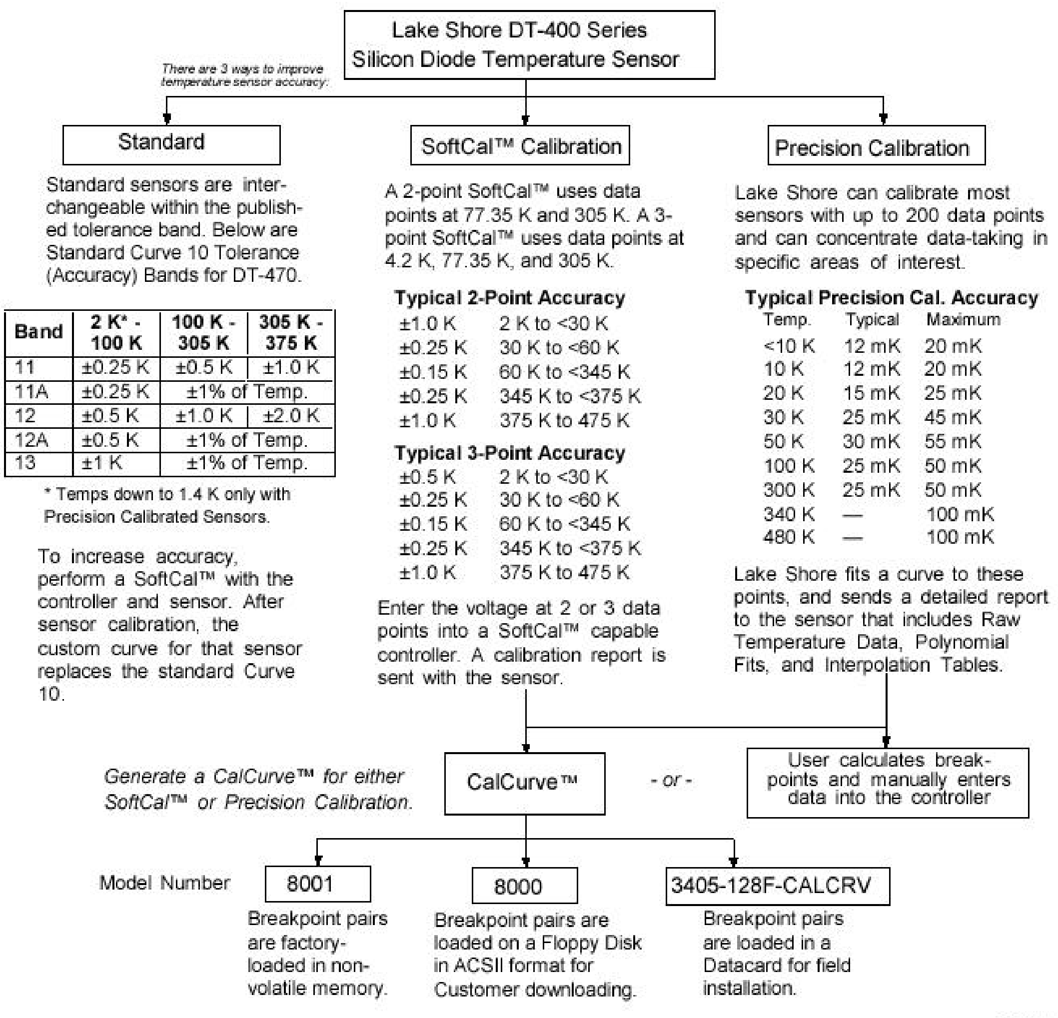


Figure 2-1. Silicon Diode Sensor Calibrations and CalCurve

7.5.2.2 PID control

Each heater output is controlled using a Proportional (P) , Integral (I) and Derivative (D) term control loop. The controller compares the set point temperature to the measured sensor temperature (at a 10 times/sec rate), computes an error, applies the PID terms and outputs a correction 18 bit (16 bit in the heater#2 case) DAC number to the heater output.
For optimal array operation it is necessary to manually tune these terms ONCE THE CRYOSTAT HAS REACHED THERMAL OPERATIONAL EQUILIBIUM. The AUTOTUNE feature can produce adequate settings (again only after the cryostat has reach equilibrium), but experience has shown that manual settings produce the best results. Consequently, it is best to start with the “default” settings obtained during system integration and make minor adjustments around these number on the telescope. The default settings are:

DEFAULT SETTINGS as of xx/xx/xx

ARRAY#1
P = ###
I = ###
D = ###
ARRAY#2
P = ###
I = ###
D = ###

Refer to page ## of the attached Lakeshore manual to repeat the tuning procedure and detailed explanation.
It should not be necessary (nor recommended) to repeat the Lakeshore manual tuning procedure, but for quick reference, the following section has been copied from the Lakeshore manual.

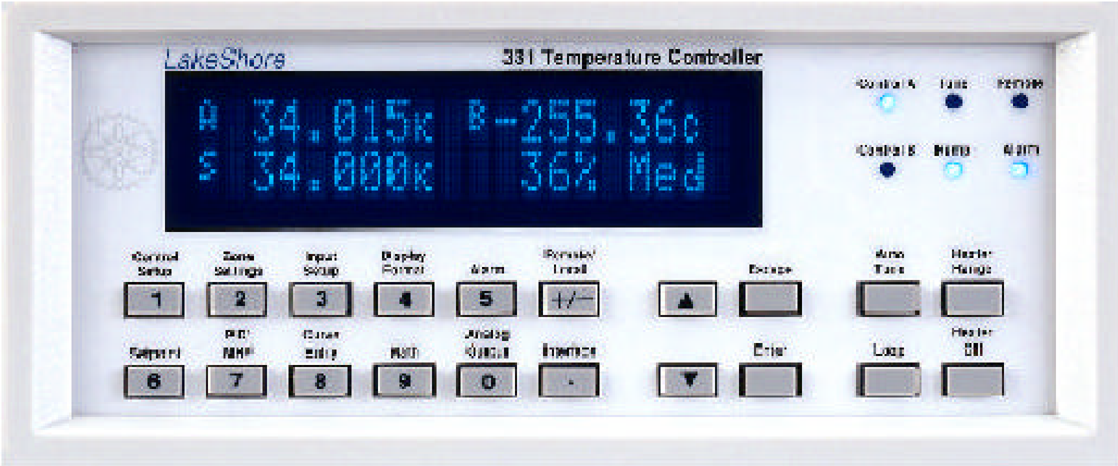
> *2.7.2 Tuning Proportional*
> *The proportional setting is so closely tied to heater range that it can be thought of as fine and course adjustments of the same setting. An appropriate heater range must be known before moving on to the proportional setting.*
> *Begin this part of the tuning process by letting the cooling system cool and stabilize with the heater off. Place the Model 332 in Manual PID control mode, then turn integral, derivative and manual output settings off. Enter a setpoint several degrees above the cooling systems lowest temperature. Enter a low proportional setting of approximately 5 or 10 and then enter the appropriate heater range as described above. The heater display should show a value greater than zero and less than 100%. The load temperature should stabilize at a temperature below the setpoint. If the load temperature and heater meter swing rapidly, the heater range may be set too high and should be reduced. Very slow changes in load temperature that could be described as drifting are an indication of a proportional setting that is too low (which is addressed in the next step). Gradually increase the proportional setting by doubling it each time. At each new setting, allow time for the temperature of the load to stabilize. As the proportional setting is increased, there should be a setting in which the load temperature begins a sustained and predictable oscillation rising and falling in a consistent period of time. The goal is to find the proportional value in which the oscillation begins, do not turn the setting so high that temperature and heater output changes become violent. Record the proportional setting and the amount of time it takes for the load change from one temperature peak to the next. The time is called the oscillation period of the load and it helps describe the dominant time constant of the load which is used in setting integral. If all has gone well, the appropriate proportional setting is one half of the value required for sustained oscillation. If the load does not oscillate in a controlled manner, the heater range could be set too low. A constant heater reading of 100% on the display would be an indication of a low range setting. The heater range could also be too high, indicated by rapid changes in the load temperature or heater output with a proportional setting of less than 5. There are a few systems that will stabilize and not oscillate with a very high proportional setting and a proper heater range setting. For these systems, setting a proportional setting of one half of the highest setting is the best choice.*

7.5.2.3 Heater Resistors

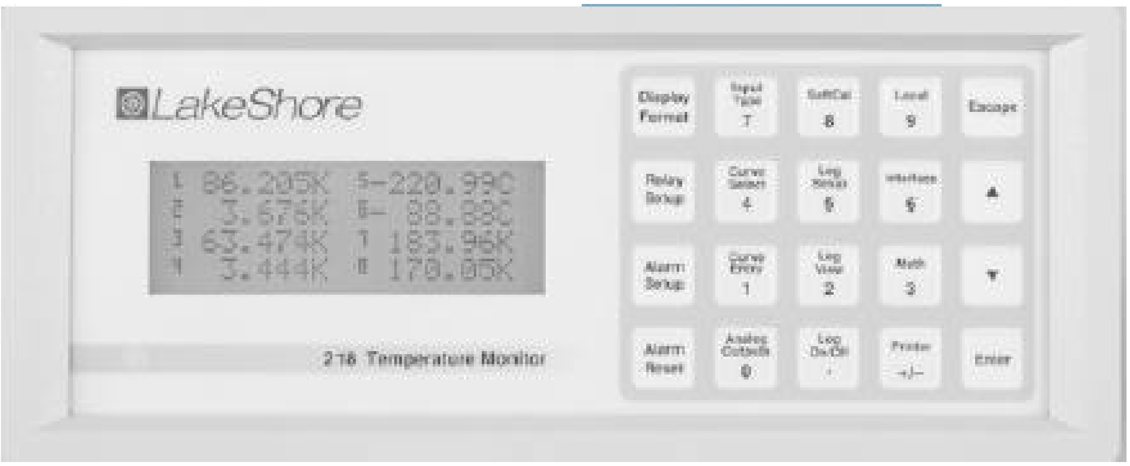
The array mounts have integral (epoxied) heater resistors embedded in a channel in on the backside of the front cold plate. There are four 100Ohm resistors arranged in a parallel pairs and brought out of the cryostat on four conductors. The 50Ohm loads are then tied in series at the heater filter into a 100 Ohm equivalent load.

7.5.2.4 Front Panel Information

The front panel displays the measured temperature, set point and percentage heater output for each control



loop. Although it is possible for set points to be entered via the front panel, array controller software will program the values via the RS232 interface. Consequently, the front panel buttons should only be used in a engineering capacity.



7.6 Configuration and Connections

7.6.2 Configuration

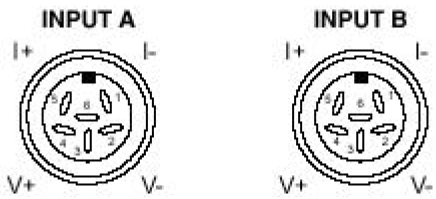
All operational configuration issues should be configured by the instrument control software via the RS232 interface. Refer to the Software Operation Manual for details.

7.6.3 RS232 Connection

The TempCont (#1 or #2) cable connects to the DE-9 RS232 connectors on the rear panel of the controllers and monitor. The interface does not use hardware handshaking.

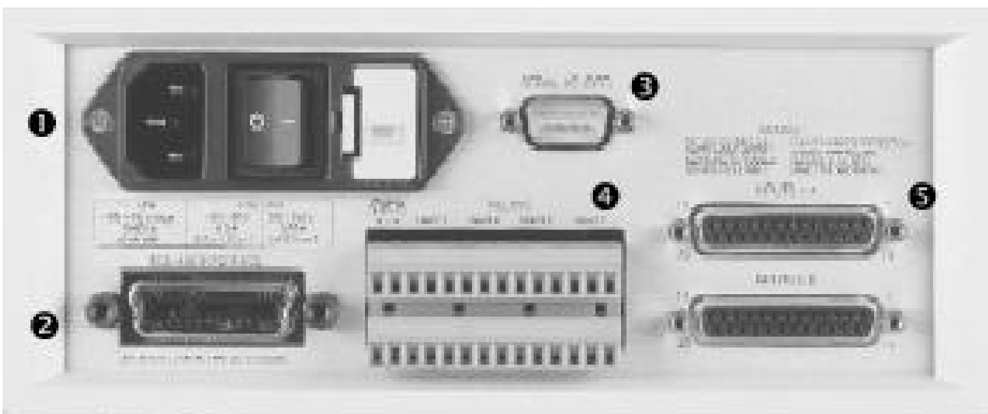
7.6.4 Si Diode Connections

The Si Diodes connect to the Model 331/2 controller INPUT A and INPUT B rear panel connectors with the DIN6 cables.



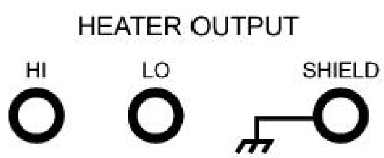
PIN	SYMBOL	DESCRIPTION
1	I–	– Current
2	V–	– Voltage
3	*none*	Driven Shield or Guard
4	+V	+ Voltage
5	+I	+ Current
6	*none*	No Connection

The Si diodes connect to the Model 218 monitor via the rear panel DB25 connector (figure #5).



7.6.5 Heater Connections

The array mount heater resistors connect to the controller via prewired 3003 filter assemblies.



PIN	DESCRIPTION
1	HI
2	LO
3	SHIELD

7.6.6 AC power Connection

A standard 3 pronged 120VAC connector should be cabled to the appropriate Baytech power control unit.

TEMPERATURE SENSORS AND HEATERS

FUNCTION LAKESHORE DT471-BR	CRYO NUM/ NAME	WIRE COLOR CODE	LOCAL SIGNAL NAME	.1X1X10 TEMP 10PIN CGRID CONN	.1X1X10 TEMP 10CON CGRID CONN	? INCH MANGANIN CABLE	NON-STD .1X2X5 16PIN HDR FEED-	.1X2X5 16PIN CON FEED-	? INCH MANGANIN	.1X1X8 8PIN CGRID	.1X1X8 8CON CGRID	? INCH MANGANIN	JH1 30 PIN IDC
RED	RED_I+	BLK/BLU	I+	3	3		1	2		1	1	1	1
ARRAY	RED_V+	YEL/CLR	V+	4	4		2	1		2	2	2	2
TEMP	RED_I-	RED	I-	5	5		3	4		3	3	3	3
SENSOR	RED_V-	GRN	V-	6	6		4	3		4	4	4	4
RED	RED+HTR1		R3||R4+	7	7		5	6		5	5	5	5
ARRAY	RED_HTR2		R3||R4-	8	8		6	5		6	6	6	6
HEATER	RED_HTR3		R1||R2+	9	9		7	8		7	7	7	7
RESISTORS	RED_HTR4		R1||R2-	10	10		8	7		8	8	8	8
				10PIN CGRID	10PIN CGRID		16PIN FD THRU	16 PIN FD THRU					
BLUE	BLU_I+	BLK/BLU	I+	3	3		1	2		1	1	9	9
ARRAY	BLU_V+	YEL/CLR	V+	4	4		2	1		2	2	10	10
TEMP	BLU_I-	RED	I-	5	5		3	4		3	3	11	11
SENSOR	BLU_V-	GRN	V-	6	6		4	3		4	4	12	12
BLUE	GUID_HTR		R3||R4+	7	7		5	6		5	5	13	13
ARRAY	GUID_HTR		R3||R4-	8	8		6	5		6	6	14	14
HEATER	GUID_HTR		R1||R2+	9	9		7	8		7	7	15	15
RESISTORS	GUID_HTR		R1||R2-	10	10		8	7		8	8	16	16
				4PIN CGRID	4PIN CGRID								
	STG1_TMP	BLK/BLU	I+	1	1							17	17
CCC 1ST STG	STG1_TMP	YEL/CLR	V+	2	2							18	18
TEMP	STG1_TMP	RED	I-	3	3							19	19
SENSOR	STG1_TMP	GRN	V-	4	4							20	20
				4PIN CGRID	4PIN CGRID								
	STG2_TMP	BLK/BLU	I+	1	1							21	21
CCC 2ND STG	STG2_TMP	YEL/CLR	V+	2	2							22	22
TEMP	STG2_TMP	RED	I-	3	3							23	23
SENSOR	STG2_TMP	GRN	V-	4	4							24	24
				4PIN CGRID	4PIN CGRID								JH2 30COND
	CLDST_TMP	BLK/BLU	I+	1	1							17	1
COLD STRUCT	CLDST_TMP	YEL/CLR	V+	2	2							18	2
TEMP	CLDST_TMP	RED	I-	3	3							19	3
SENSOR	CLDST_TMP	GRN	V-	4	4							20	4
				4PIN CGRID	4PIN CGRID								
	RSHLD_TMP	BLK/BLU	I+	1	1							21	5
RAD SHLD	RSHLD_TMP	YEL/CLR	V+	2	2							22	6
TEMP	RSHLD_TMP	RED	I-	3	3							23	7
SENSOR	RSHLD_TMP	GRN	V-	4	4							24	8
				4PIN CGRID	4PIN CGRID								
	RSCCC_TMP	BLK/BLU	I+	1	1							17	9
RAD CCC 1ST	RSCCC_TMP	YEL/CLR	V+	2	2							18	10
TEMP	RSCCC_TMP	RED	I-	3	3							19	11
SENSOR	RSCCC_TMP	GRN	V-	4	4							20	12
				4PIN CGRID	4PIN CGRID								
	RSHLD_TMP	BLK/BLU	I+	1	1							21	13
APD	RSHLD_TMP	YEL/CLR	V+	2	2							22	14
TEMP	RSHLD_TMP	RED	I-	3	3							23	15
SENSOR	RSHLD_TMP	GRN	V-	4	4							24	16

TEMPERATURE CONTROL SUBSYSTEM

55 PIN HERMETIC INTRF BD	55 PIN HERMETIC TEMP	TEMP 55 PIN CABLE	GLENAIR 55COND CABLE / GLENAIR 55COND	TEMP 55 PIN CABLE	TEMP 55 PIN	55 PIN INTRF BD	Signal	FILTER	DIN6-REAR PNL
									RED LAKESHORE MODEL 331 SENSOR CONN
JH1-1	p	p	RED_I+	p	p	JH1-1	RED_I+		5 [I+] CHNL A
JH1-2	BB	BB	RED_V+	BB	BB	JH1-2	RED_V+		4 [V+] CHNL A
JH1-3	q	q	RED_I-	q	q	JH1-3	RED_I-		1 [I-] CHNL A
JH1-4	V	V	RED_V-	V	V	JH1-4	RED_V-		2 [V-] CHNL A
								FILTER	CK05 .1uF Cer Cap
JH1-5	A	A	RED_HTR1	A	A	JH1-5	RED_HTR1	HI	HI
JH1-6	W	W	RED_HTR2	W	W	JH1-6	RED_HTR2		
JH1-7	X	X	RED_HTR3	X	X	JH1-7	RED_HTR3	LO	LO
JH1-8	B	B	RED_HTR4	B	B	JH1-8	RED_HTR4	GND	GND
									BLUE MODEL 331
JH1-9	Y	Y	BLU_I+	Y	Y	JH1-9	BLU_I+		5 [I+] CHNL A
JH1-10	C	C	BLU_V+	C	C	JH1-10	BLU_V+		4 [V+] CHNL A
JH1-11	CC	CC	BLU_I-	CC	CC	JH1-11	BLU_I-		1 [I-] CHNL A
JH1-12	r	r	BLU_V-	r	r	JH1-12	BLU_V-		2 [V-] CHNL A
								FILTER	CK05 .1uF BLUE
JH1-13	Z	Z	BLU_HTR1	Z	Z	JH1-13	BLU_HTR1	HI	HI
JH1-14	D	D	BLU_HTR2	D	D	JH1-14	BLU_HTR2		
JH1-15	E	E	BLU_HTR3	E	E	JH1-15	BLU_HTR3	LO	LO
JH1-16	s	s	BLU_HTR4	s	s	JH1-16	BLU_HTR4	GND	GND
									MONITOR MODEL218
JH1-17	F	F	STG1_I+	F	F	JH1-17	STG1_I+		IN1I+
JH1-18	a	a	STG1_V+	a	a	JH1-18	STG1_V+		IN1V+
JH1-19	b	b	STG1_I-	b	b	JH1-19	STG1_I-		IN1I-
JH1-20	t	t	STG1_V-	t	t	JH1-20	STG1_V-		IN1V-
JH1-21	G	G	STG2_I+	G	G	JH1-21	STG2_I+		IN2I+
JH1-22	c	c	STG2_V+	c	c	JH1-22	STG2_V+		IN2V+
JH1-23	u	u	STG2_I-	u	u	JH1-23	STG2_I-		IN2I-
JH1-24	DD	DD	STG2_V-	DD	DD	JH1-24	STG2_V-		IN2V-
JH2-1	n	n	STG2_I+	n	n	JH2-1	STG2_I+		IN3I+
JH2-2	U	U	STG2_V+	U	U	JH2-2	STG2_V+		IN3V+
JH2-3	T	T	STG2_I-	T	T	JH2-3	STG2_I-		IN3I-
JH2-4	AA	AA	STG2_V-	AA	AA	JH2-4	STG2_V-		IN3V-
JH2-5	z	z	STG2_I+	z	z	JH2-5	STG2_I+		IN4I+
JH2-6	m	m	STG2_V+	m	m	JH2-6	STG2_V+		IN4V+
JH2-7	k	k	STG2_I-	k	k	JH2-7	STG2_I-		IN4I-
JH2-8	S	S	STG2_V-	S	S	JH2-8	STG2_V-		IN4V-
JH2-9	GG	GG	STG2_I+	GG	GG	JH2-9	STG2_I+		IN5I+
JH2-10	j	j	STG2_V+	j	j	JH2-10	STG2_V+		IN5V+
JH2-11	P	P	STG2_I-	P	P	JH2-11	STG2_I-		IN5I-
JH2-12	R	R	STG2_V-	R	R	JH2-12	STG2_V-		IN5V-
JH1-28,29	J	J		J	J	JH1-28,29			
JH2-13	i	i	STG2_I+	i	i	JH2-13	STG2_I+		IN6I+
JH2-14	y	y	STG2_V+	y	y	JH2-14	STG2_V+		IN26+
JH2-15	N	N	STG2_I-	N	N	JH2-15	STG2_I-		IN6I-
JH2-16	h	h	STG2_V-	h	h	JH2-16	STG2_V-		IN6V-