Trillium US Inc.
E1000® Dual Channel Temperature Monitor / Water Pump Controller
User's Manual

Rev A / March 2016

For information about Trillium US Inc., visit the Trillium US Inc. Web site at:

http://www.trilliumus.com

How to Contact Trillium US Inc. Support:

support@trilliumus.com

For contact information and a complete listing of Direct Sales, Distributor, and Sales Representative contacts, visit the Trillium US Inc. Web site at:

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Trillium US Inc.
1340 Airport Commerce Dr.
Bldg. 1 Suite 175
Austin, Texas 78741 USA
TEL. +1 512 441 6893
FAX +1 512 443 6665
Email: cryo-sales@trilliumus.com

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1 Revision History

Date	Revision	ECR #	Description of Change
March 2010	1.0.0		New Document
April 2010	1.0.1		Added statement to clarify mode change sequence
December 2012	1.0.2		Update company name and address
March 2016	A	2887	Rebranding and format changes
Document Part Number: 97-00041-002			

2 Preface

2.1 About Trillium US Inc.

Trillium US Inc., an Oregon based company, specializes in the manufacture and repair of cryogenic vacuum pumps, cryocoolers (refrigerators) and helium compressors for semiconductor, optical coating, linear accelerators, medical equipment, and R&D applications.

You can find just what you need from our range of products and support services:

- New Equipment - cryopumps, compressors, cryocoolers, and cryopump controllers.
- Comprehensive range of accessories for the installation of whole systems and a complete range of spare parts to repair cryopumps and compressors.

2.2 Other Services from Trillium US Inc.

Trillium US Inc. offers comprehensive refurbishment services for its own equipment as well as for that of most of our competitors. Our products and services are available through our global network of agents and dealers.

- Repair and refurbishment services - We offer our own quality products, as well as most other manufactures models, often with off-the-shelf availability.
- Exchanges - We offer our own quality products, as well as most makes of cryopumps and helium compressors, which are refurbished and fully warranted.
- Technical Support - Our support engineers will help determine if your cryopump system is operating correctly so that you can get your system back to optimum efficiency as soon as possible.

    - To contact Trillium US Inc. Technical Support:
    - E-mail: support@trilliumus.com
    - Telephone: 1-512-441-9258 or Toll Free: 1-800-404-1055

- Installation - On-site installation services are available to guarantee performance and save you time.
- Training - We offer on-site training to help you and your staff to know more about your cryopump and compressor systems. Our training will give you confidence and the ability to maintain a highest possible uptime for your system.

2.3 About this Manual

The purpose of this manual is to provide our customers using the E1000 Dual Channel Cryogenic Temperature Monitor/Water Pump Controller with the information needed to safely and efficiently operate the device when operating as part of a cryogenic refrigeration system. Such a system is often comprised of the following equipment:

- Cryopump compressors
- Coldhead(s) or cryopump(s)
- Connecting helium lines
- Temperature monitor(s)

This manual describes the design, operation and maintenance of the E1000 Dual Channel Cryogenic Temperature Monitor/Water Pump Controller.

2.4 Compatibility

The E1000 Dual Channel Cryogenic Temperature Monitor/Water Pump Controller is compatible with most cryopumps and coldheads.

3 Introduction

3.1 E1000 Dual Channel Cryogenic Temp. Monitor/Water Pump Controller Features

The E1000 Dual Channel Cryogenic Temperature Monitor/Water Pump Controller features:

- Continuous visual update of two temperature sensors (channels) using an LCD display
- Drives two temperature diodes, intended for cryogenic temperature measurement
- Diode temperature curve selection from four pre-defined curves
- Supports one user-defined, programmable diode curve
- Six programmable setpoint relays (three per sensor/channel)
- Two 0 – 10 V analog outputs for temperature monitoring (one per sensor/channel)
- Provides an RS-232 serial port for a PLC or PC digital interface
- Independent control of two outputs

3.2 Description

The E1000 Cryogenic Temperature Monitor / Water Pump Controller drives two diode temperature sensors, and provides a visual display of the temperature on an LCD module. Typical applications include monitoring temperature of a two stage coldhead of a cryopump or cryocooler, using one diode (channel) for each stage. It can also be used to monitor two cryopumps or cryocoolers simultaneously, by using one diode (channel) for each coldhead. The E1000 also has the unique capability to control the temperature of a water pump to a user specified temperature from 90° to 130°K. While in the water pump mode, the coldhead power will be stopped when the water pump reaches the selected off temperature and will resume pumping when the upper temperature is reached. The high resolution measurement sensors provide noise rejection to deliver precise, accurate temperature readings. The diode curves are user selectable from four (4) pre-defined curves providing support for common diodes. In addition, a user-programmable curve is available for non-supported diodes. Temperature conversion is provided by a 10µA constant current source using a spline interpolation (piecewise polynomial).

3.2.1 Specifications

The E1000 specifications are listed in **Table 3-1**. The E1000 rear panel is shown in **Figure 1** and described in **Table 3-2**.

Table 3-1: E1000 Specifications

Item	Specification	
Features	Display 2 Temperatures	
	Four Selectable Diode Curves	
Power	110/220 VAC Input @ 50/60 Hz (Universal Input)	
Connectors	IEC Power Input	
	DB9F (Diode Driver)	
	DB9M (Serial Connector)	
Dry Contact Rating	Carry AC Current	10 A @ 250 VAC
	Carry DC Current	5 A @30 VDC
	Max Switching Voltage	400 VAC 300 VDC
	Max Switching Current	NO: 10 A NC: 8 A

Item	Specification	
	Max Switching Power	NO: 2,500 VA NC: 2,000 VA 150 W
Analog Output	0 – 10 V, 60mA max	
Dimensions	8.46” (W) x 8.61” (L) x 3.63” (H)	

Figure 1 – E1000 Rear Panel

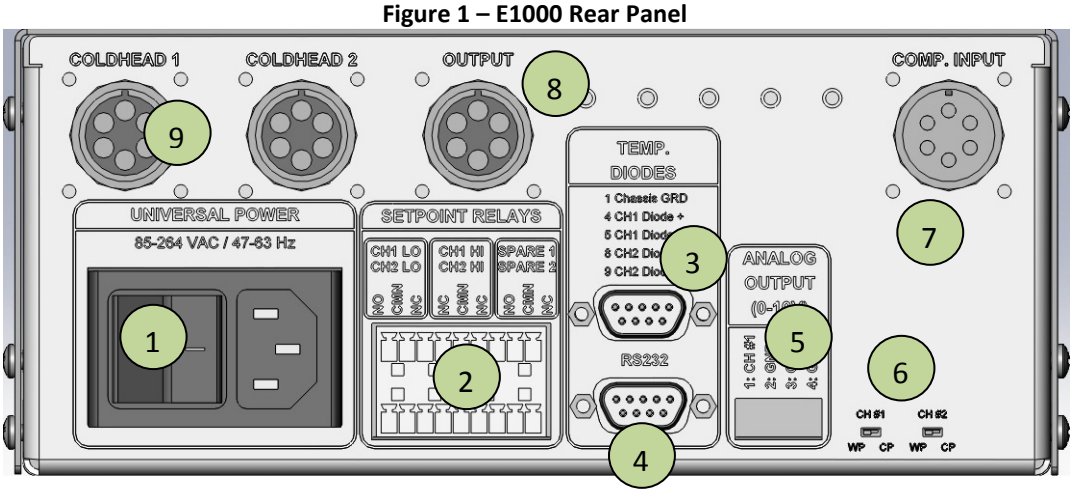


Table 3-2: Rear Panel Features

Feature	Description
1: IEC Power Entry	Universal Power input accepts 110 or 220 VAC at 50 or 60 Hz
2: Set Point Relays	Dry contacts are provided to trigger external equipment, or to provide status to control electronics, such as a PLC. Three relays are provided for each temperature channel. The top row connector is controlled by Channel #1 sensor, and the bottom is controlled by Channel #2. See **Table 4-1** for a detailed pin-out.
3: D-Sub 9 Female-Temp Sensors	Connect temperature sensor according to the following pin out: • Pin 1: Shield (GND) • Pin 2: No Connect (NC) • Pin 3: NC • Pin 4: Diode Sensor #1 Positive • Pin 5: Diode Sensor #1 Negative • Pin 6 – 7: NC • Pin 8: Diode Sensor #2 Positive • Pin 9: Diode Sensor #2 Negative
4: D-Sub 9 Male-RS-232 Serial Port	Provides serial interface to a remote serial device. The serial port is intended to be used with a standard “straight through” serial cable (not NULL Modem). • Pin 1: No Connect (NC) • Pin 2: RS-232 Transmit Out • Pin 3: RS-232 Receive In • Pin 4: NC • Pin 5: GND • Pin 6 – 9: NC
5: Analog Outputs	Analog outputs are provided for recorder logging, or as status to a PLC. The outputs provide 0 – 10 V for each channel. • Pin 1: Channel #1 Voltage Output

Feature	Description
	• Pin 2: GND • Pin 3: Channel #2 Voltage Output • Pin 4: GND
6: Mode Selection	2 miniature slide switches allow the user to select either Coldhead or Waterpump mode. In the coldhead mode, the channel will provide power to the output at all times and will operate the relays according to the user set temperatures. In the Cryopump mode, power will be supplied at all times to the coldhead, unless, the manual mode is selected. To change the Mode of the E1000, the power switch must be turned off and back on after changing the position of the switch.
7: Compressor Power In	Input drive power from the compressor. Requires special drive cable.
8: Compressor Power Out	Power out to drive and additional E1000. The power is fused at 3 amps.
9: Coldhead out	Output power to the coldhead or water pump. Uses standard cryopump drive cable.

4 Set Point Relay Pin-out

Table 4-1 describes the relay configuration. For each channel, 3 separate dry contacts are provided. Each dry contact has three connections: Normally Open, Normally Closed, and Common.

Table 4-1: Set Point Relay Pin-out

Pin-Out (left to right)	Top Row	Bottom Row	Relay Position
Pin 1	Channel 1 Low Relay	Channel 2 Low Relay	Normally Open
Pin 2			Common
Pin 3			Normally Closed
Pin 4	Channel 1 High Relay	Channel 2 High Relay	Normally Open
Pin 5			Common
Pin 6			Normally Closed
Pin 7	Channel 1 Spare Relay	Channel 2 Spare Relay	Normally Open
Pin 8			Common
Pin 9			Normally Closed

The dual row connector provided on the E1000 requires two male connectors for mating. The recommended mating connector is Phoenix Contact Part Number 1803646, see **Figure 2**. Note that if only one channel is utilized, only one Phoenix Contact connector is needed.

Figure 2 – Single Row Mating Connector (1803646)

5 Analog Outputs

The E1000 provides an analog output for each channel. A terminal block style plug is required to connect to the analog outputs. The recommended mating connector is Phoenix Contact Part Number 1803594. The outputs can provide a maximum output current of 60 mA each. To convert the output voltage to temperature, use the following formula:

Temperature (Kelvin) = 35 * Analog Output Voltage (in Volts)

This formula provides a maximum range of 0 – 350.0 °K. The pin-out (also shown on the back panel of the unit) is listed in **Table 5-1**:

Table 5-1: E1000 Analog Output Pin-Out

Pin	Signal
1	Channel #1 Analog Output
2	Ground
3	Channel #2 Analog Output
4	Ground

6 E1000 User Interface

The E1000 provides a continuous display of the temperature measurements. The display interface also provides diode curve selection, and set point configuration.

6.1 Manual / Auto Configuration

The user can manually control the operation of the coldhead by selecting the **CH1** or **CH2** switch from the front panel. Pushing the cold head switch causes the respective cold head to switch off. It the switch is pushed again the cold head is switched on. The manual mode will override the water pump control mode. To place the E1000 back into auto mode, use the menu function. Pressing the **MENU** button will take the operator to the Manual/Auto selection on the first press of the button. Pressing the **UP** or **DOWN** keys to change the mode.

6.2 Diode Curve Selection

The user can select the diode curve which corresponds to the temperature diode sensor connected to the E1000. To select a diode curve:

1. Press the **MENU** button.
2. Scroll through the standard diode options by pressing the **UP** and **DOWN** buttons.
3. When the appropriate diode curve has been selected, press **MENU**.

E1000 supports the following standard temperature sensor diodes:

- Trillium US Inc. Temperature Diode
- CTI Temperature Diode
- DT-470 Silicon Diode
- DT-670 Silicon Diode

6.3 Set Point Configuration

The user can individually configure each setpoint relay to a unique temperature. Each channel has 3 setpoints associated with its temperature measurement – LOW, HIGH, and SPARE. A flow chart is shown to aid in navigating the menus. In addition, an example is shown at the end of the section. If no buttons are pressed for roughly 10 seconds, the display times out and returns to the main menu. NOTE: the changes are stored and take effect if the menu times out. To configure a setpoint:

1. Press the **MENU** button twice. The first relay is "**Channel #1 LO**". When the temperature is below this value, the

relay is in the "Active" position. The temperature value is modified by pressing **UP** or **DOWN** for each digit. Once the digit has been set, press ENTER to move to the next digit.

2. Press the **MENU** button to configure "**Channel #1 HI**". When the temperature is above this value, the relay is in the "Active" position.
3. Press the **MENU** button to configure "**Channel #1 SPARE**". When the temperature is above this value, the relay is in the "Active" position.
4. Continue to press the **MENU** button to cycle through the Channel #2 set points.

Figure 3 shows how to access the set points via menu selection. **Figure 4** provides an example that will configure Channel #2 Low Set point Relay to 12 K. Begin by pressing **MENU** to navigate to the "**Select Diode**" display shown in **Figure 4**.

Figure 3 – Channel Set Point Access

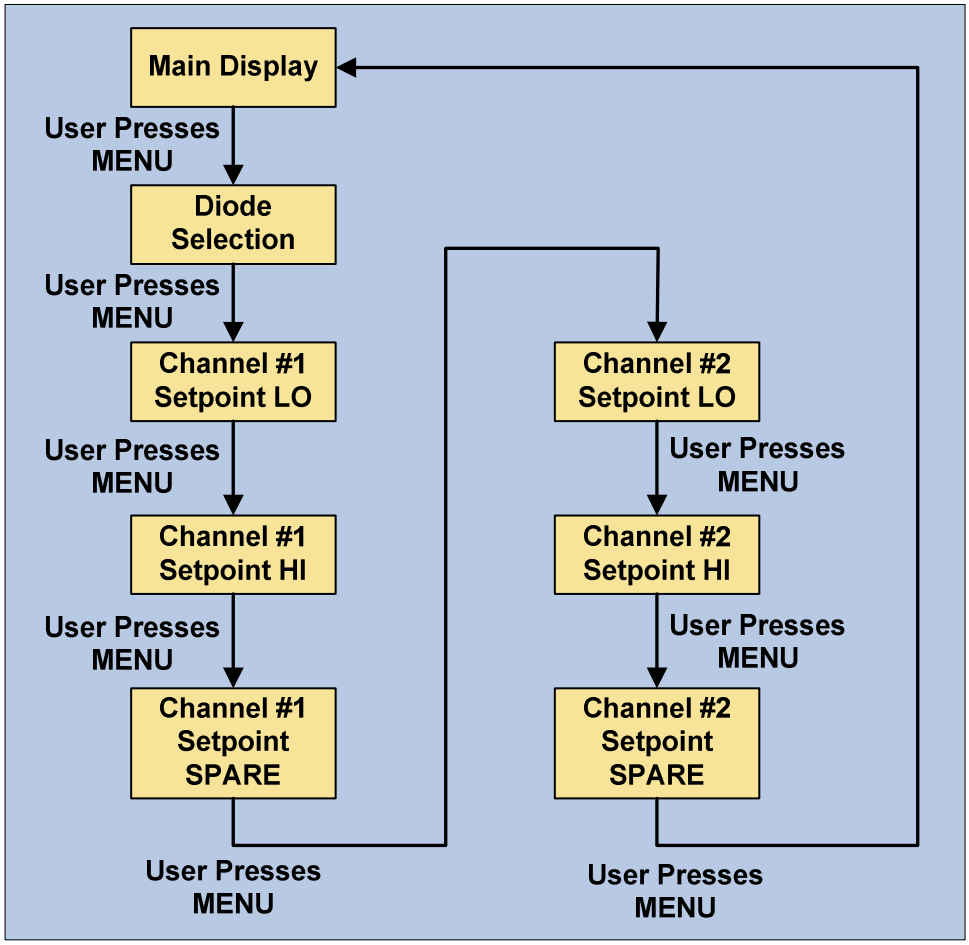
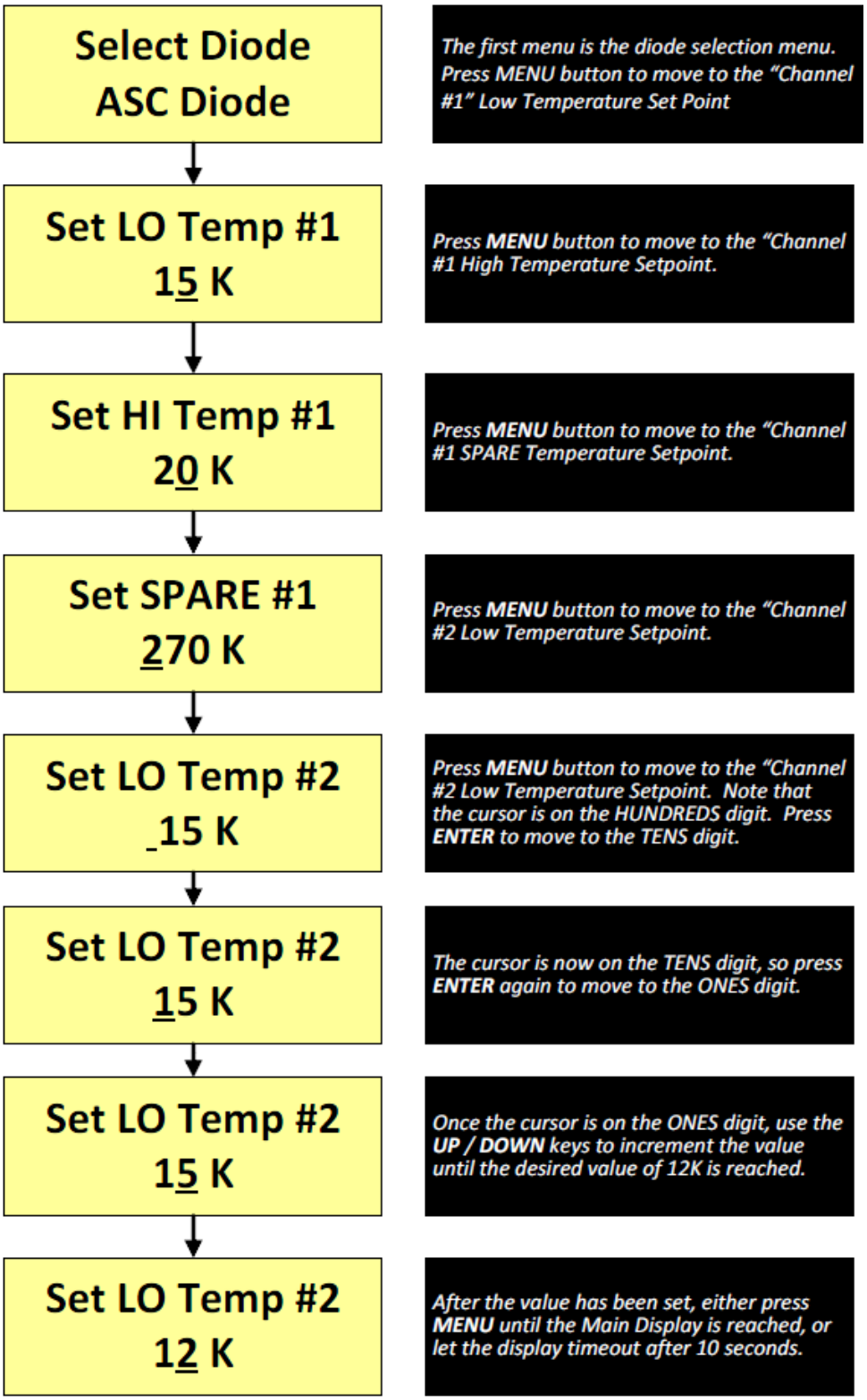


Figure 4 – Channel Set Point Example



6.4 Serial Port Interface

The E1000 provides a DB9 Male connector for serial port communications. A "straight through" serial cable is necessary for interfacing to the serial port. Only pins 2, 3, and 5 are required, see **Table 6-1**.

Table 6-1: Serial Port Pin-Out

DB9 Female (to E1000)		DB9 (to Controller)
1	----------	1
2	----------	2
3	----------	3
4	----------	4
5	----------	5
6	----------	6
7	----------	7
8	----------	8
9	----------	9

All commands start with '$', and end with \r\n. The serial port should be configured as shown in **Table 6-2**.

Table 6-2: Serial Port Settings

Baud Rate	19,200
Data Bits	8
Parity	NONE
Stop Bits	1
Flow Control	NONE

6.4.1 Serial Port Commands

Table 6-3 lists the provided serial port commands.

Table 6-3: Serial Port Commands

Command	Returns	Example	
GetRev	Revision x.x	Get Revision	SEND: $GetRev\r\n RECEIVE: $Revision 1.0\r\n
GetTemp (channel) Channel: 1 or 2	xxx.x or "OOR" if out of range	Get Channel 2 Temp	SEND: $GetTemp 2\r\n RECEIVE: $21.6\r\n
GetSetp (channel,relay) Channel: 0 or 1 (0-> Channel 1, 1-> Channel 2) Relay: 0, 1, or 2. 0->LO, 1->HI, 2->SPARE	xxx (integer)	Get Channel 2 SPARE set point	SEND: $GetSetp 1,2\r\n RECEIVE: $280\r\n
SetSetp (channel,relay,temp) Channel: 0 or 1 (0-> Channel 1, 1-> Channel 2) Relay: 0, 1, or 2. 0->LO, 1->HI, 2->SPARE Temp: xxx (integer, no decimal point)	$xxx\r\n (returns the new value stored)	Set Channel 1 LOW set point to 12K	SEND: $SetSetp 0,0,12\r\n RECEIVE: $12\r\n
GetVolt(channel) Channel: 1 or 2	x.xxxx	Get Channel 2 Voltage	SEND: $GetVolt 2\r\n RECEIVE: $1.2345\r\n

Command	Returns	Example	
Set Coldhead (Coldhead, on /off) Channel: 1 or 2	$0 or $1 (0/1 for OFF/ON)	Turn Channel 1 on manual	SEND: $SetColdhead 0,1\r\n
			RECEIVE: $0 or $1\r\n
GetColdhead x (where x is the Coldhead number, and it returns 0/1 for OFF/ON) Channel: 0 or 1	$0 or $1 (0/1 for OFF/ON)	Get the status of the coldhead	SEND: $SetColdhead 0,1\r\n
			RECEIVE: $0 or $1\r\n
GetMode 0 (Channel, Mode) Channel: 0 or 1	$0 or $1 (0 = Waterpump, 1 = Cryopump)	Get the mode of the output	$Getmode 0 \r\n
			$0 or $1\r\n

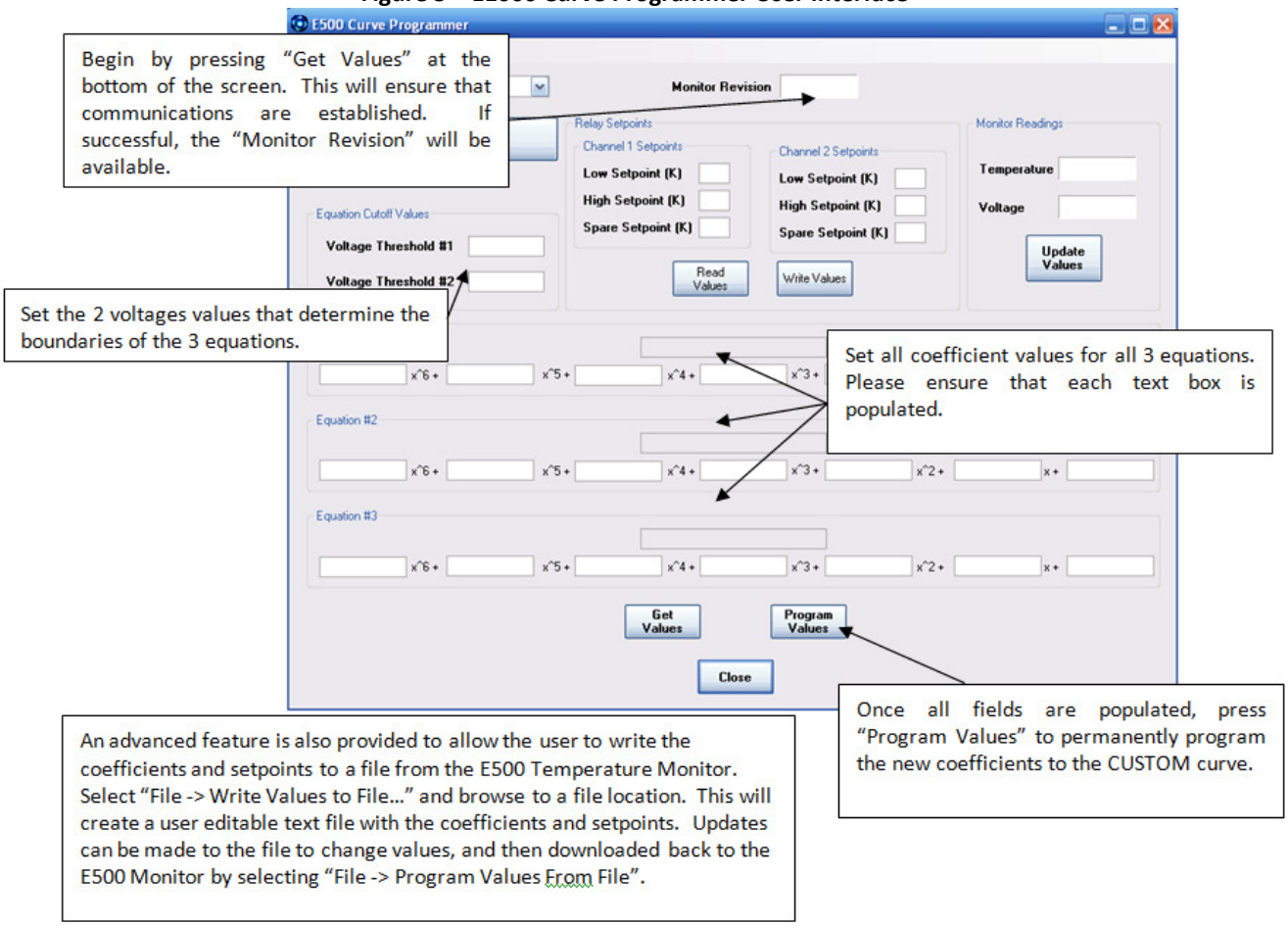
6.5 E1000 Curve Programmer

To enter data for a user defined diode curve, the E1000 Curve Programmer can be used. This utility allows the user to enter the polynomial coefficients that control the voltage to temperature conversion.

In order to determine appropriate values, several “Voltage vs. Temperature” data points should be viewed in graph form. The graph can be broken up piece-wise into a maximum of 3 equations. For each of the equations, a trend line should be developed using a program such as Microsoft Excel or Matlab. Up to a 6th order polynomial can be used for each equation to provide maximum flexibility.

Once the values have been chosen, the fields shown in **Figure 5** should be populated.

Figure 5 – E1000 Curve Programmer User Interface



7 Ordering Information

Table 7-1 contains the ordering information for the E1000 Dual Channel Cryogenic Temperature Monitor / Water Pump Controller. Customers can also order the optional diode cables listed in **Table 7-2.**

Table 7-1: E1000 Dual Channel Cryogenic Temperature Monitor Ordering Information

Cryopump	Part Number
E1000 Dual Channel Cryogenic Temperature Monitor / Water Pump Controller (with 10 ft cables)*	99-00079-000
19" Rack Mount Kit *(Fits single E1000)*	99-00101-000
E1000 Curve Programmer (to program custom diode curve)	10-00001-000

*Longer lengths available.

Table 7-2: E1000 Optional Cables

Configuration	Cables	Part Number			
		10 Ft.	15 Ft.	20 Ft.	50 Ft.
Single or dual E1000	Compressor Input Cable	81-00044-010	81-00044-015	81-00044-020	81-00044-050
Dual Diode Cryopump or coldhead	Dual Diode Cable	81-00016-010	81-00016-015	81-00016-020	81-00016-050
Two Cryopumps or coldheads	Dual Cryopump Diode Cable	81-00038-010	81-00038-015	81-00038-020	81-00038-050