Trillium US Inc.
E500® Dual Channel Temperature Monitor
User's Manual

Rev A / November 2015

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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http://www.trilliumus.com/

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
July 2008	1.0.1		Initial release
January 2013	1.0.2		Change to update corporate format
February 2013	1.0.3		Corrected Dimensions, Corrected Sensor connection, added weight
November 2015	A	2821	Rebranding and format changes, removed references to “backlit” LCD Display
Document Part Number: 97-00041-000			

2 Preface

2.1 About Trillium US Inc.

Trillium US Inc., a wholly-owned subsidiary of Trillium US Inc., 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 E500 Dual Channel Cryogenic Temperature monitor with the information needed to safely and efficiently operate the monitor 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 E500 Dual Channel Cryogenic Temperature monitor.

2.4 Compatibility

The E500 Dual Channel Cryogenic Temperature Monitor is compatible with most cryopumps and coldheads.

3 Introduction

3.1 E500 Dual Channel Cryogenic Temperature Monitor Features

The E500 Dual Channel Cryogenic Temperature Monitor 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

3.2 Description

The E500 Cryogenic Temperature Monitor 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 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 E500 specifications are listed in Table 3-1. The E500 rear panel is shown in **Figure 1** and described in Table 3-2.

Table 3-1: E500 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)	
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
	Max Switching Power	NO: 2,500 VA NC: 2,000 VA 150 W
Analog Output	0 – 10 V, 60mA max	
Dimensions	6.5” (W) x 7.5” (L) x 3.05” (H)	
Weight	3.2 lbs.	

Figure 1 – E500 Rear Panel

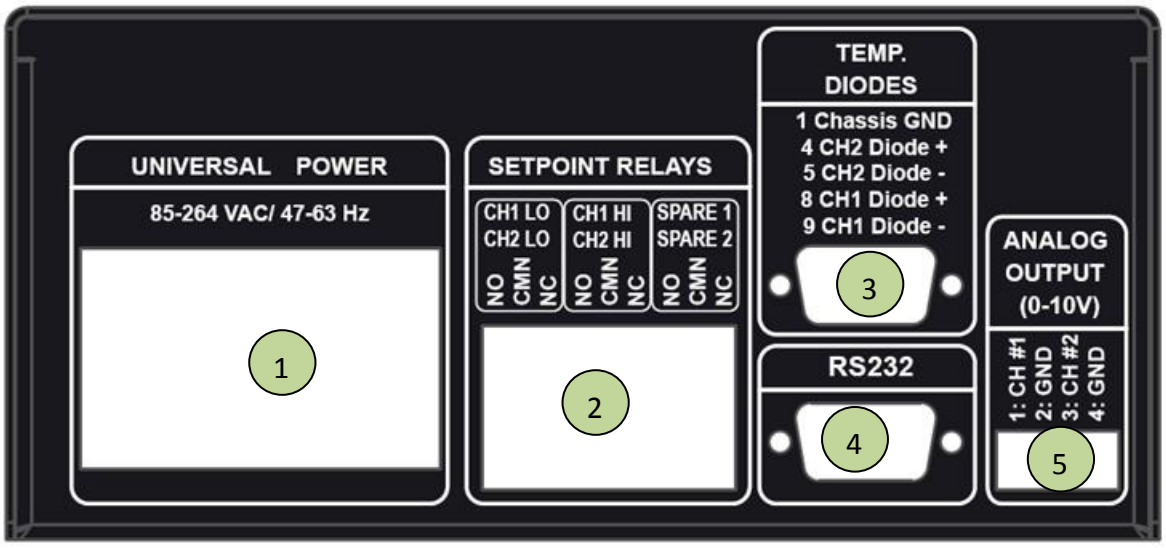


Table 3-2: Rear Panel Features

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 #2 Positive • Pin 5: Diode Sensor #2 Negative • Pin 6 – 7: NC • Pin 8: Diode Sensor #1 Positive • Pin 9: Diode Sensor #1 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 • Pin 2: GND • Pin 3: Channel #2 Voltage Output • Pin 4: GND

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 E500 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 E500 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: E500 Analog Output Pin-Out

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

6 E500 User Interface

The E500 provides a continuous display of the temperature measurements. The display interface also provides diode curve selection, and set point configuration.

6.1 Diode Curve Selection

The user can select the diode curve which corresponds to the temperature diode sensor connected to the E500. 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**.

E500 supports the following standard temperature sensor diodes:

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

6.2 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

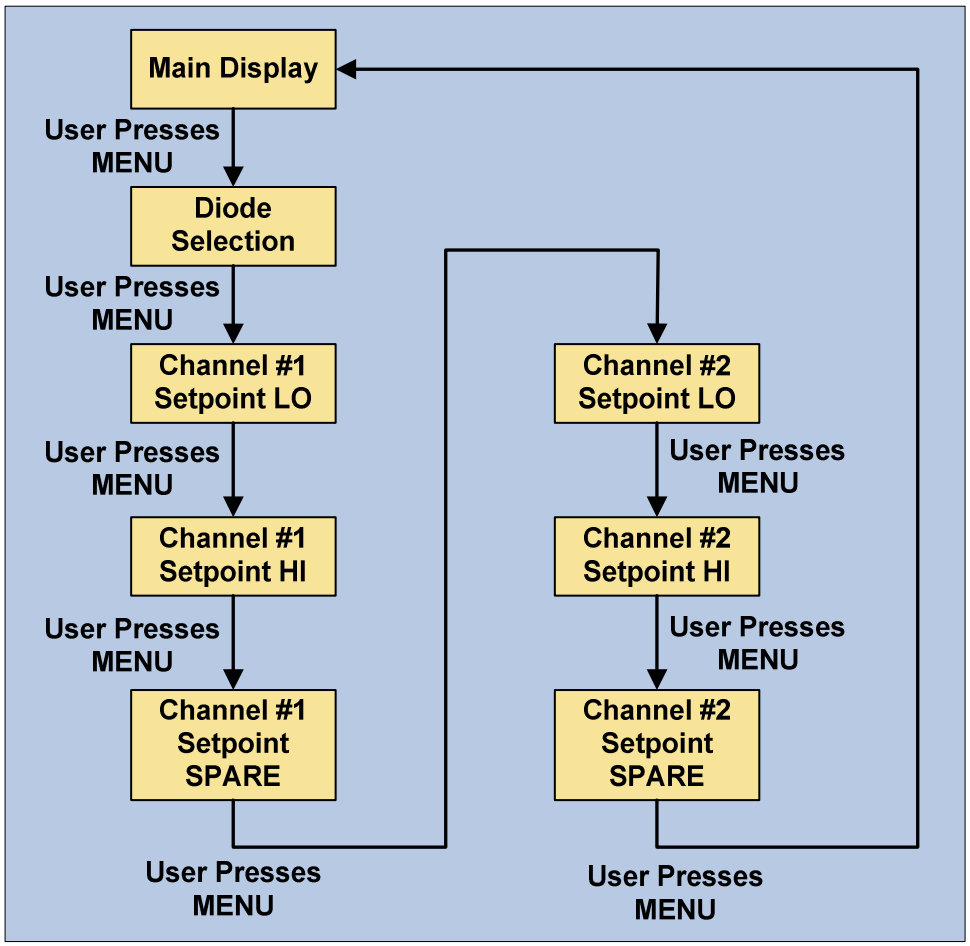
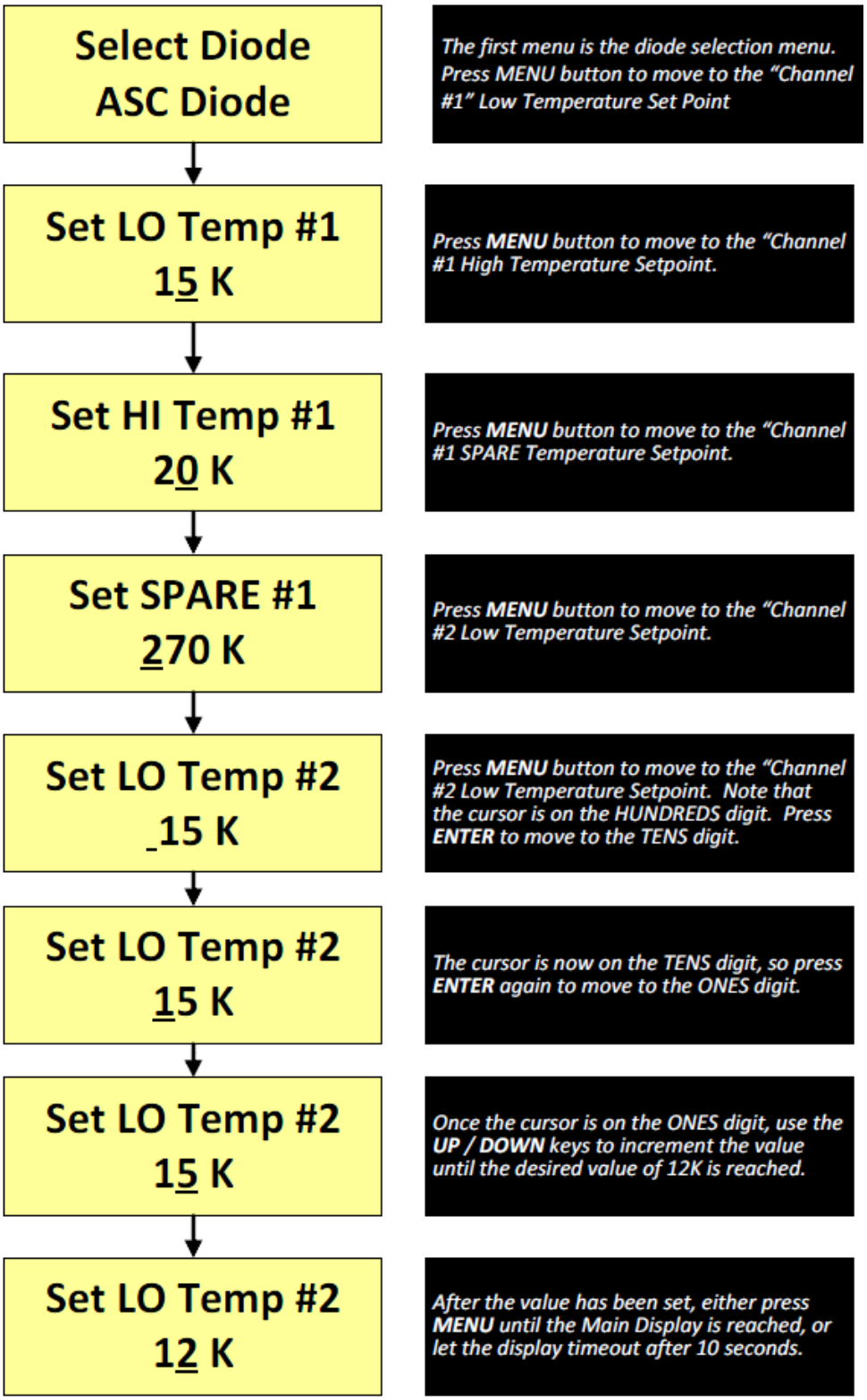


Figure 4 – Channel Set Point Example



6.3 Serial Port Interface

The E500 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 E500)		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

6.3.1 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

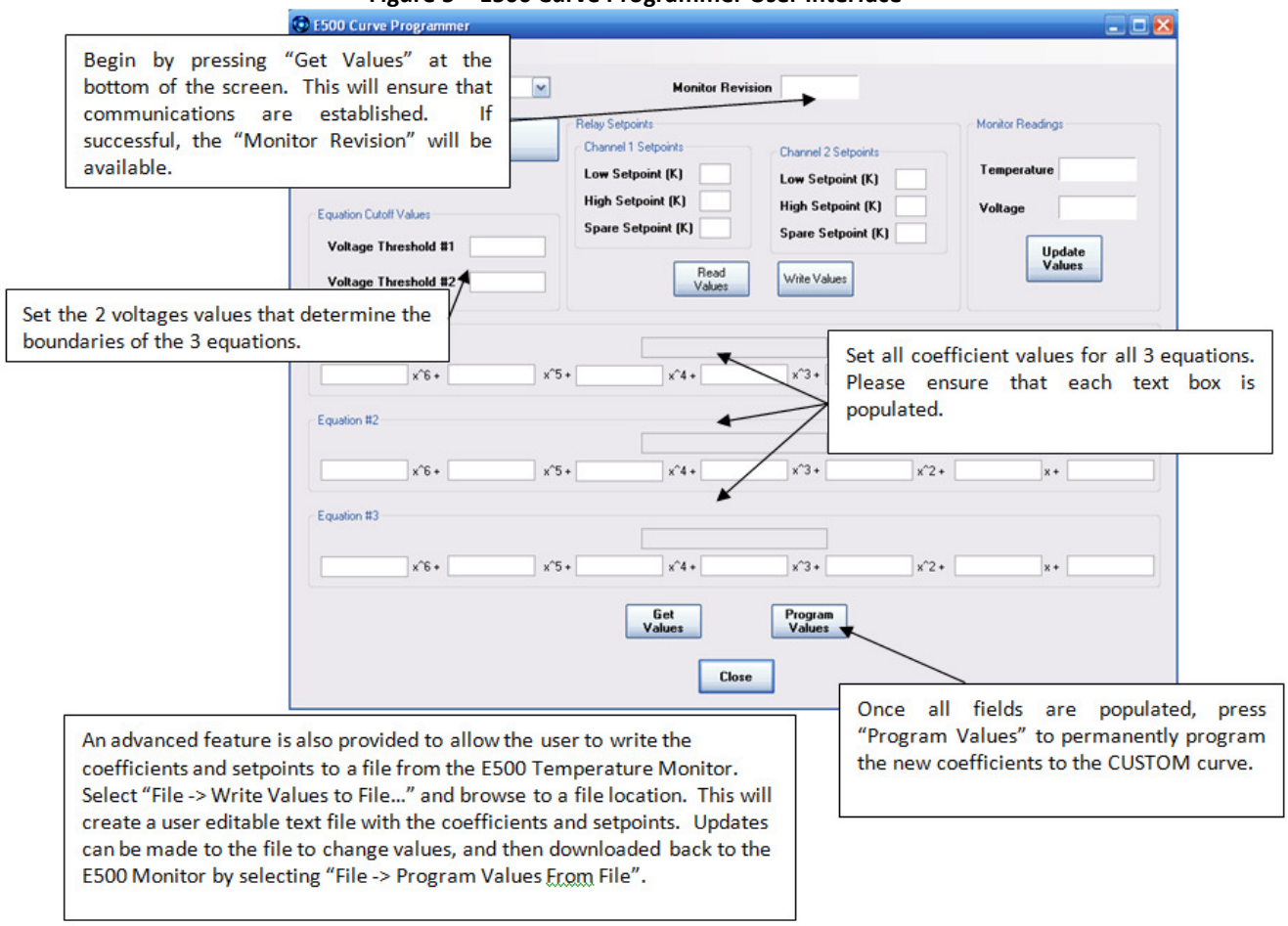
6.4 E500 Curve Programmer

To enter data for a user defined diode curve, the E500 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 – E500 Curve Programmer User Interface



7 Ordering Information

Table 7-1 contains the ordering information for the E500 Dual Channel Cryogenic Temperature Monitor. Customers can also order the optional diode cables listed in Table 7-2.

Table 7-1: E500 Dual Channel Cryogenic Temperature Monitor Ordering Information

Cryopump	Part Number
E500 Dual Channel Cryogenic Temperature Monitor	93-00040-000
19" Rack Mount Kit *(Fits up to 2 E500s)*	99-00072-000
19" Rack Mount Kit *(Fits single E500)*	99-00072-001
E500 Curve Programmer (to program custom diode curve)	10-00001-000

Table 7-2: E500 Optional Cables

Configuration	Cables	Part Number			
		10 Ft.	15 Ft.	20 Ft.	50 Ft.
Single Cryopump or coldhead	Standard Single Diode Cable	10133-10	10133-15	10133-20	10133-50
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