Model 3700

Temperature Controller

User's Manual

Newport®
Experience | Solutions

9002635604 April 2014

EU Declaration of Conformity

We declare that the accompanying product, identified with the CE mark, complies with requirements of the Electromagnetic Compatibility Directive, 2004/108/EC and the Low Voltage Directive 2006/95/EC.

Model Number: 3700

Year CE mark affixed: 2009

Type of Equipment: Electrical equipment for measurement, control and laboratory use in industrial locations.

Manufacturer: Newport Corporation

1791 Deere Avenue
Irvine, CA 92606

Standards Applied:

Compliance was demonstrated to the following standards to the extent applicable:

BS EN61326-1: 2006 “Electrical equipment for measurement, control and laboratory use – EMC requirements”.

BS EN 61010-1:2010 “Safety requirements for electrical equipment for measurement, control and laboratory use”.

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Warranty

Newport Corporation warrants that this product will be free from defects in material and workmanship and will comply with Newport's published specifications at the time of sale for a period of one year from date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Newport's option.

To exercise this warranty, write or call your local Newport office or representative, or contact Newport headquarters in Irvine, California. You will be given prompt assistance and return instructions. Send the product, freight prepaid, to the indicated service facility. Repairs will be made and the instrument returned freight prepaid. Repaired products are warranted for the remainder of the original warranty period or 90 days, whichever first occurs.

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The above warranties do not apply to products which have been repaired or modified without Newport's written approval, or products subjected to unusual physical, thermal or electrical stress, improper installation, misuse, abuse, accident or negligence in use, storage, transportation or handling. This warranty also does not apply to fuses, batteries, or damage from battery leakage.

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First printing 2013

This manual has been provided for information only and product specifications are subject to change without notice. Any change will be reflected in future printings.

Newport Corporation
1791 Deere Avenue
Irvine, CA, 92606
USA

Part No. 90026356_04 December 2013

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Service Information

This section contains information regarding factory service for the source. The user should not attempt any maintenance or service of the system or optional equipment beyond the procedures outlined in this manual. Any problem that cannot be resolved should be referred to Newport Corporation.

Technical Support Contacts

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Newport Corporation Calling Procedure

If there are any defects in material or workmanship or a failure to meet specifications, promptly notify Newport's Returns Department by calling 1-800-222-6440 or by visiting our website at www.newport.com/returns within the warranty period to obtain a **Return Material Authorization Number (RMA#)**. Return the product to Newport Corporation, freight prepaid, clearly marked with the RMA# and we will either repair or replace it at our discretion. Newport is not responsible for damage occurring in transit and is not obligated to accept products returned without an RMA#.

E-mail: rma.service@newport.com

When calling Newport Corporation, please provide the customer care representative with the following information:

- Your Contact Information
- Serial number or original order number
- Description of problem (i.e., hardware or software)

To help our Technical Support Representatives diagnose your problem, please note the following conditions:

- Is the system used for manufacturing or research and development?
- What was the state of the system right before the problem?
- Have you seen this problem before? If so, how often?
- Can the system continue to operate with this problem? Or is the system non-operational?
- Can you identify anything that was different before this problem occurred?

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Table of Contents

List of Figures

List of Tables

1 Safety Precautions

1.1 Definitions and Symbols

The following terms and symbols are used in this documentation and also appear on the Model 3700 Temperature Controller where safety-related issues occur.

1.1.1 General Warning or Caution

Figure 1 General Warning or Caution Symbol

The Exclamation Symbol in the figure above appears on the product and in Warning and Caution tables throughout this document. This symbol designates that documentation needs to be consulted to determine the nature of a potential hazard, and any actions that have to be taken.

1.1.2 Electric Shock

Figure 2 Electrical Shock Symbol

The Electrical Shock Symbol in the figure above appears throughout this manual. This symbol indicates a hazard arising from dangerous voltage. Any mishandling could result in irreparable damage to the equipment, and personal injury or death.

1.1.3 European Union CE Mark

Figure 3 CE Mark

The presence of the CE Mark on Newport Corporation equipment means that this instrument has been designed, tested and certified as complying with all applicable European Union (CE) regulations and recommendations.

1.1.4 Alternating voltage symbol

Figure 4 Alternating Voltage Symbol

This international symbol implies an alternating voltage or current.

1.1.5 On

Figure 5 On Symbol

The symbol in the figure above represents a power switch position on the Model 3700 Temperature Controller. This symbol represents a Power On condition.

1.1.6 Off

Figure 6 Off Symbol

The symbol in the figure above represents a power switch position on the Model 3700 Temperature Controller. This symbol represents a Power Off condition.

1.1.7 Fuses

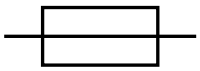

Figure 7 Fuse Symbol

The symbol in the figure above identifies the fuse location on the Model 3700 Temperature Controller.

1.1.8 USB

Figure 8 USB Symbol

The symbol in the figure above identifies the USB connector location on the Model 3700 Temperature Controller.

1.1.9 Frame or Chassis

Figure 9 Frame or Chassis Terminal Symbol

The symbol in the figure above appears on the Model 3700 Temperature Controller. This symbol identifies the frame or chassis terminal

1.1.10 Waste Electrical and Electronic Equipment (WEEE)

Figure 10 WEEE Directive Symbol

This symbol on the product or on its packaging indicates that this product must not be disposed of with regular waste. Instead, it is the user responsibility to dispose of waste equipment according to the local laws. The separate collection and recycling of the waste equipment at the time of

disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For information about where the user can drop off the waste equipment for recycling, please contact your local Newport Corporation representative.

1.1.11 Control of Hazardous Substances

Figure 11 RoHS Compliant Symbol

This label indicates the products comply with the EU Directive 2002/95/EC that restricts the content of six hazardous chemicals.

1.2 Warnings and Cautions

The following are definitions of the Warnings, Cautions and Notes that are used throughout this manual to call your attention to important information regarding your safety, the safety and preservation of your equipment or an important tip.

	**WARNING** **Situation has the potential to cause bodily harm or death.**

	**CAUTION** **Situation has the potential to cause damage to property or equipment.**

NOTE

Additional information the user or operator should consider.

1.2.1 General Warnings

Observe these general warnings when operating or servicing this equipment:

- Heed all warnings on the unit and in the operating instructions.
- Do not use this equipment in or near water.

- This equipment is grounded through the grounding conductor of the power cord.
- Route power cords and other cables so that they are not likely to be damaged.
- Disconnect power before cleaning the equipment. Do not use liquid or aerosol cleaners; use only a damp lint-free cloth.
- Lockout all electrical power sources before servicing the equipment.
- To avoid fire hazard, use only the specified fuse(s) with the correct type number, voltage and current ratings as referenced in the appropriate locations in the service instructions or on the equipment. Only qualified service personnel should replace fuses.
- To avoid explosion, do not operate this equipment in an explosive atmosphere.
- Qualified service personnel should perform safety checks after any service.

1.2.2 General Cautions

Observe these cautions when operating this equipment:

- If this equipment is used in a manner not specified in this manual, the protection provided by this equipment may be impaired.
- To prevent damage to equipment when replacing fuses, locate and correct the problem that caused the fuse to blow before re-applying power.
- Do not block ventilation openings.
- Do not position this product in such a manner that would make it difficult to disconnect the power cord.
- Position the equipment so that access to the mains disconnect On/Off switch is readily available.
- Use only the specified replacement parts.
- Follow precautions for static sensitive devices when handling this equipment.
- This product should only be powered as described in the manual.
- There are no user-serviceable parts inside the Model 3700 Temperature Controller.
- Adhere to good laser safety practices when using this equipment.

1.2.3 Summary of Warnings and Cautions

The following general warning and cautions are applicable to this instrument:

WARNING

Before operating the Model 3700 Temperature Controller, please read and understand all of Section 1.

WARNING

Do not attempt to operate this equipment if there is evidence of shipping damage or you suspect the unit is damaged. Damaged equipment may present additional hazards to you. Contact Newport technical support for advice before attempting to plug in and operate damaged equipment.

WARNING

To avoid electric shock, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury.

WARNING

Before cleaning the enclosure of the Model 3700 Temperature Controller, the AC power cord must be disconnected from the wall socket.

CAUTION

There are no user serviceable parts inside the Model 3700 Temperature Controller. Work performed by persons not authorized by Newport Corporation will void the warranty. For instructions on obtaining warranty repair or service, please refer to Section 8.

The Model 3700 is intended for use in an industrial environment. Use of this product in other environments, such as residential, may result in electromagnetic compatibility difficulties due to conducted as well as radiated disturbances.

1.3 Location of Labels and Warnings

1.3.1 Rear Panel

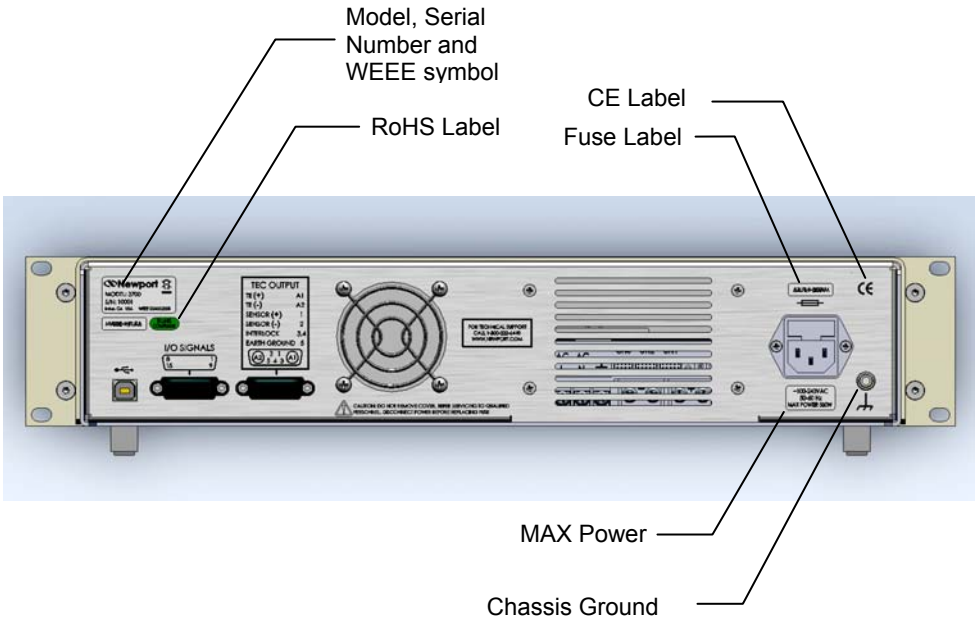

Figure 12 Rear Panel labels and warnings

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2 General Information

2.1 Introduction

Model 3700 Temperature Controller is a result of Newport's continuing commitment to deliver innovative solutions that enable its customers' success. It offers reliable, high output power at a very competitive price. The ergonomic layout and intuitive front panel controls make this versatile instrument extremely easy to use. A wide range of TEC temperature control and user safety features were thoroughly analyzed and designed into this instrument which complies with CE standards.

Key Product Features:

- USB Plug-and-Play Interface
- Temperature Controller
    - 336 Watt output power
    - Ultra stable bipolar output
    - Support for thermistors, AD590, LM335, and Pt RTD sensors.

2.1.1 High-Power Temperature Controller for TE Cooling Needs

The 300 Watt Temperature Controller is designed to meet your most demanding thermoelectric (TE) cooling needs. It can be operated in one of the following three modes:

- Constant Temperature
- Constant Resistance / Reference
- Constant TE Current

Short-term stability is better than 0.0009°C, while long-term stability is better than 0.0019°C. Four sensor types are compatible with this TEC:

- Thermistors
- AD590 series

- LM335 series
- 100Ω Platinum RTDs

With the sensor's calibration constants, the actual temperature is displayed in °C on the front panel.

Intuitive Controls and LCD Display

Improved data presentation and system control are achieved using a combination of LCD and 7-segment LED displays. The LCD display shows the entire system configuration as well as TEC status and the LED display provides high readability and quick temperature setting capability. "Menu Keys" guide you through initial system setup routines and operation. Real-time control of an output is accomplished either by entering the set point via the cursor keys or control knob. SETUP/ENTER and ARROW keys access saved system configurations and repetitive procedures. All controls are clearly marked and instructions easily understood for simple operation.

Support for Remote Data Collection

All control and measurement functions are accessible via the USB interface. As your instrumentation needs change the Model 3700 Temperature Controller will adapt to all your new applications giving you the ultimate in flexible laboratory equipment.

2.2 Available Options and Accessories

3150-02	Temperature Controller Cable
3150-04	Temperature Controller/Mount Cable
300-16	10.0 kΩ thermistor (± 0.2°C)
300-22	AD592CN IC Sensor

Newport Corporation also supplies temperature controlled mounts and other accessories. Please consult with your representative for additional information.

2.3 Specifications

	Model 3700
Maximum Power [W]	**336**
Output Current	
Range [A]	–14 to + 14
Resolution [mA] (manual / remote) (1)	1 / 0.1
Accuracy [%]	± 0.3
Noise/Ripple (mA rms) (2)	< 1
Compliance Voltage	
Range [V]	-24 to +24
Current Limit	
Range [A]	0 to 14
Resolution [mA] (manual / remote)	1 / 0.1
Accuracy [%]	± 0.3
Stability	
Short term [1 hour]	< 0.0009°C
Long term [24 hour]	< 0.0019°C
Temp Coefficient [°C/°C]	< 0.0005
Display Range	
Temperature [°C]	-100.00 to +250.00
Resistance Total Range [kΩ]	0.0001 to 2500.0
Resistance [kΩ] at 1 µA	0.1 to 2500.0
Resistance [kΩ] at 10 µA	0.01 to 250.00
Resistance [kΩ] at 100 µA	0.001 to 25.000
Resistance [kΩ] at 1 mA	0.0001 to 2.5000
Resistance [Ω] at 10 mA	0.1 to 250.0
Resistance RTD [Ω]	20 to 192
LM335 [mV]	2331 to 3731
AD590 [µA]	248.15 to 378.15
TE Current [A]	-14.000 to +14.000
TE Voltage [V]	-24.000 to 24.000

Display Resolution	
Temperature [°C]	0.001
Resistance [kΩ] at 1 µA	0.1
Resistance [kΩ] at 10 µA	0.01
Resistance [kΩ] at 100 µA	0.001
Resistance [kΩ] at 1 mA	0.0001
Resistance [kΩ] at 10 mA	0.0001
Resistance RTD [Ω]	0.001
LM335 [mV]	0.1
AD590 [µA]	0.01
TE Current [mA]	1
TE Voltage [mV]	1
Display Accuracy	
Temperature [°C] (3)	± 0.001
Resistance at 1 µA [%]	± 0.02
Resistance at 10 µA [%]	± 0.01
Resistance at 100 µA [%]	± 0.01
Resistance at 1 mA [%]	± 0.01
Resistance at 10 mA [%]	± 0.01
Resistance RTD [%]	± 0.01
LM335 [V] [%]	± 0.01
AD590 [µA] [%]	± 0.01
TE Current [%]	0.35
TE Voltage [%]	0.35
Auxiliary Temperature Sensor(4)	
Temperature Range [°C]	0 to +80.00
Temperature Resolution [°C]	0.0001
Resistance Range [kΩ] at 100 µA	0.1 to 25.0
Temperature Accuracy [°C] (3)	± 0.001
Resistance Accuracy at 100 µA [%]	± 0.01

(1) In remote mode the output current is rounded at 0.5 mA steps.

(2) Noise and rippled measured on a 1.6 ohm resistor on the full range between -14A to +14A

(3) Temperature accuracy reflects the accuracy of temperature change measurement. This is the uncertainty that the instrument brings into the measurements and it is not a reflection of the absolute temperature measurement, which depends on the thermistor accuracy.

(4) Remote mode only

Temperature Sensors	Thermistors	AD590	LM335	RTD (100Ω)
Temperature Control Resolution [°C]	0.0001	0.0001	0.0001	0.0001
Temperature Control Accuracy [°C] (1)	± 0.001	± 0.03	± 0.03	± 0.001
Sensor Bias Current [mA]	0.001, 0.01, 0.1,1, 10	—	1	1
Sensor Bias Voltage [V]	—	+ 4	—	—

Environmental Specifications	
Voltage Requirements	110/220 VAC, 50/60Hz
Power Requirements	MAX POWER = 500W
Chassis Ground	4 mm banana jack
Size (H x W x D) [in. (mm)]	3.47 (88.14) x 19.00 (482.60) x 12.24 (310.89)
Mainframe Weight [lb (kg)]	11.2 (5.1)
Operating Temperature	0°C to 40°C (<90% humidity non-condensing)
Storage Temperature	-30°C to + 60°C (<90% humidity non-condensing)
Relative Humidity, Storage	<90% humidity non-condensing
Altitude	<3000 meters (10000 feet)
Installation Category	II
Pollution Degree	2
Use Location	Indoor use only
I/O Signals	15-pin female D-sub
Output Connector	DA Size, 7W2

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3 Getting Started

3.1 Unpacking and Handling

It is recommended that the Model 3700 Temperature Controller be unpacked in a lab environment or work site. Unpack the system carefully; small parts are included with the instrument. Inspect the box carefully for loose parts. You are urged to save the packaging material in case you need to ship your equipment in the future.

3.2 Inspection for Damage

The Model 3700 Temperature Controller is carefully packaged at the factory to minimize the possibility of damage during shipping. Inspect the box for external signs of damage or mishandling. Inspect the contents for damage. If there is visible damage to the instrument upon receipt, inform the shipping company and Newport Corporation immediately. Carefully open the box and save the shipping material for later use.

WARNING

Do not attempt to operate this equipment if there is evidence of shipping damage or you suspect the unit is damaged. Damaged equipment may present additional hazards to you. Contact Newport technical support for advice before attempting to plug in and operate damaged equipment.

CAUTION

The user is advised to save the packaging material in case the unit has to be shipped to a different location. The packaging material is specially designed to protect the unit during shipping.

3.3 Parts List

The following is a list of parts included with the Model 3700 Temperature Controller:

1. Start Up Guide (Hardcopy).
2. CD with Software Drivers and Utilities, User's Manual, Start Up Guide.
3. IEC320 AC line cord with a NEMA 5-15P, or country-specific, connector.
4. Mating output connector

If you are missing any parts or have questions about the parts you have received, please contact Newport Corporation.

3.4 Choosing and Preparing a Suitable Work Surface

The Model 3700 Temperature Controller may be placed on any reasonably firm table or bench during operation. The unit may be mounted in a standard 19-inch rack provided that the primary support for the unit is a shelf within the rack.

3.5 Electrical Requirements

Before attempting to power up the unit for the first time, the following precautions must be followed:

WARNING

To avoid electric shock, connect the instrument to properly earth-grounded, 3-prong receptacles only. Failure to observe this precaution can result in severe injury.

- Have a qualified electrician verify the wall socket that will be used is properly polarized and properly grounded.
- Provide adequate distance between the Models 3700 Temperature Controller and adjacent walls for ventilation purposes. Do not let any other equipment blow hot air towards the Temperature Controller. Verify the correct rated fuses are installed according to the fuse marking on the rear panel.

- The output cables, which connect the TEC to the Model 3700, must have the proper gauge according to the user application. The Model 3700 can output high current, so it is recommended that the output cables be 12 AWG with a PVC jacket of minimum 105 ºC rating. The user should check the local applicable codes for proper cable size and connections to ensure personal safety and system reliability.

3.6 Power Supplies

AC power is supplied through the rear panel AC power entry module connector that provides in-line transient protection and RF filtering. The power entry module also contains the instrument's fuses.

WARNING

To avoid electric shock, connect the instrument to properly earth-grounded receptacles only. Failure to observe these precautions can result in fire, severe injury or death.

WARNING

To avoid electric shock, the appropriate fuses for the AC input power voltage must be installed in the instrument. Only qualified service personnel should replace fuses. Failure to observe these precautions can result in fire, severe injury or death.

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4 System Operation

WARNING

Before operating the Model 3700 Temperature Controller, please read and understand all of Section 1.

4.1 General Features

The Model 3700 Temperature Controller is a precision thermoelectric cooler controller. Features include:

Closed-case calibration

Operational with most thermistors, IC and RTD temperature sensors

Flexible setup with Save/Recall front panel functions

High temperature stability

Current Limit

4.2 TEC Safety Features

4.2.1 Conditions Which Will Automatically Shut Off the TEC Output

High Temperature Limit

Low Temperature Limit

Thermistor Resistance Limit

TEC Open

Sensor Open

Sensor Select changed

Sensor Shorted

Mode Change

4.3 Front Panel

The front panel of the Model 3700 Temperature Controller is designed for easy operation. It has various distinct areas, each with a specific set of related functions, and a control knob, as shown in Figure 13 below.

Figure 13 Front Panel Layout

4.3.1 Power ON / OFF Switch

The controller's main electrical power ON / OFF switch is located on the bottom left-hand corner of the front panel. With the 3700 connected to an AC power source, the instrument electrical power is completely turned-OFF when the rocker switch is in the "0" position. Conversely, the unit's electrical power is turned-ON when the rocker switch is in the "I" position.

During the power-up sequence, the following take place:

The instrument is restored to the state in which it was last turned OFF.

The output is turned OFF.

The instrument's firmware version is displayed on the LCD screen for a few seconds

The beeper is turned ON, if enabled, briefly.

4.3.2 OUTPUT ON Switch and Indicator

The switch will activate the ON LED and allow current flow to the TEC. However, current will not flow unless the TEC is correctly connected and the interlock pins (pin 3 & 4 of the TEC output connector) are not connected one to each other. This is the default behavior. The user can change this state to opposite, and direct the TEC to not turn the output on, unless the interlock pins are connected together, by reprogramming the Interlock Monitor (see HWCONFIG command in Section 5.5).

4.3.3 ERROR Indicator LED

The following conditions will cause the red ERROR LED and its protection circuitry to activate, automatically shutting off the output:

High Temperature Limit

Low Temperature Limit

Thermistor Resistance Limit (R Limit)

TEC Open

Sensor Open

Sensor Select changed

Sensor Shorted

Mode Change

To clear these conditions and to turn OFF the ERROR LED, all the error conditions must be addressed, and the output must be turned ON. See the Commands Section for additional information.

4.3.4 LIMIT Indicator LED

A soft limit occurs when the output current exceeds a preset limit value, clamping the current flow at that level and causing the LIMIT LED to blink. The LIMIT LED stops blinking and is turned OFF automatically when the output current does not exceed the current limit.

ERROR LED	LIMIT LED	CONDITION
ON	ON	Interlock asserted **OR** Internal temperature exceeds 75 °C **OR** Sensor Short **OR** Sensor Open **OR** Compliance voltage exceeds Vte limit **OR** Temperature outside T_High and T_Low limit settings **OR** Resistance outside R_High and R_Low limit settings
BLINKING	BLINKING	Output is enabled **AND** Internal temperature is between 73 and 75 °C **AND** Output current limit
OFF	BLINKING	Output is enabled **AND** Output current limit
BLINKING	OFF	Output is enabled **AND** Internal temperature is between 73 and 75 °C
OFF	OFF	No error condition detected

Table 1 Error and Limit LED Status Definition

4.3.5 MODE Switch

The Model 3700 Temperature Controller can be operated in one of the following modes:

- Constant Temperature
- Constant Resistance / Reference
- Constant Current

The default mode of operation is Constant Current. Pressing the MODE pushbutton switch repeatedly, allows users to cycle through the three modes. If the MODE switch is pressed when the output is enabled, the controller disables the output, generates a "MODE CHANGE" error and toggles the mode.

Constant Temperature Mode (Const Temp)

This mode holds the TEC at a constant temperature based on feedback from the sensor in the TEC mount, using "**Ts=**" and "**T=**" variables. In this mode, the 3700 uses a control loop comparing the sensor input to the temperature set point, driving the Ite current positive or negative to reach and maintain that set point. The thermistor sensor's input is converted to temperature for display of actual TEC temperature using Steinhart-Hart (S-H) equation. The RTD sensor's input is converted to temperature for display of actual TEC temperature using Callendar – van Dusen (C-vD) equation.

The sensor constants (both S-H and C-vD coefficients) can be modified using "TEC:CONST" command or through the front panel. The Ite current and compliance voltage are also displayed in this mode.

Constant Resistance/Reference Mode (Const R)

This mode operates identically to the Const Temp mode, but the sensor input is not converted to temperature, and is displayed in unconverted form. Likewise, the set point is used directly, not converted from temperature. Thermistor and RTD sensors use resistance ("**Rs=**" and "**R=**" variables), LM335 sensors use millivolts ("**vs=**" and "**v=**" variables), and AD590 sensors use microamps ("**is=**" and "**i=**" variables). Const R is primarily intended for users who know a sensor set point in "sensor" units, not in ºC. The Ite current and compliance voltage are also displayed in this mode.

Constant Current Mode (Const Ite)

Unlike the modes above, the Const Ite mode allows the operator to explicitly set the amount and direction of current flow through the TEC, using "**Is=**" and "**Ite=**" variables. If a sensor has been selected, the TEC temperature will be displayed. Although temperature is not a factor in the amount or direction of current flow, the high and low temperature limits are observed, and will shutdown the output if exceeded in Const Ite mode, if a sensor is selected. For no temperature limits, set the sensor type to "None." Use caution when limits are not active, as the temperature may exceed your TEC's thermal limits.

4.3.6 DISPLAY Section

The Model 3700 front panel has a 5 digit green LED array. This shows current in Amps, temperature in degrees Celsius, or resistance in kilo-ohms as selected by the user. Pressing the Display pushbutton switch repeatedly, cycles through display values as described below. Display modes can be toggled when the output is either ON or OFF or the unit is in Remote or Local Mode.

SETPOINT Display

The SETPOINT display mode is used to set the appropriate output value using the rotary control knob before turning the OUTPUT on. Once the control level is set, the OUTPUT may be turned on and the actual SENSOR or CURRENT value can be monitored. The table below shows the units selected based on sensor type and mode of operation.

Sensor Type	**R MODE**	**TEMP MODE**	**ITE MODE**
Thermistor	kΩ	°C	Amp
IC Sensors	—	°C	Amp
RTD	kΩ	°C	Amp
None	Not applicable	Not applicable	Amp

Table 2 Setpoint Display

LIMIT SET Display

This mode allows setting output current limit level with the control knob.

R/TEMP Display

The actual temperature sensor value is displayed in this mode. The value displayed depends on the sensor being used and the mode of operation. See table below for details.

Sensor Type	R MODE	TEMP MODE	ITE MODE
Thermistor	kΩ	°C	°C
IC Sensors	—	°C	°C
RTD	kΩ	°C	°C
None	Not applicable	Not applicable	Not applicable

Table 3 R/Temp Display

CURRENT Display

This readout monitors the actual current level being supplied to the TE module.

4.3.7 Control Knob

The control knob on the right side of the front panel sets the appropriate reference value corresponding to either resistance, temperature, or TE current (I_{TE}) to be maintained by the Model 3700 Temperature Controller.

The knob has an acceleration factor that causes the rate of change to increase as the knob is turned faster. Turning slowly allows for a fine adjustment at the smallest displayed decimal place.

4.4 Menu Section

In addition to displaying parameters available to be set on the 7-segment (right-side) of the instrument, the Menu (left side) section of the model 3700 front panel enables users to view/change many more parameters including feedback sensor type, PID values, and Steinhart-Hart or Callendar – van Dusen coefficients, for example. Prior error messages can be viewed as well.

4.4.1 Setup / Enter

The Setup/Enter key is used to (a) invoke the Setup screen, (b) accept parameter change, or (c) enter a lower menu level, depending on the screen displayed.

4.4.2 Esc

The Esc key is used to (a) cancel a parameter change or (b) back up one menu level.

4.4.3 Cursor Arrow Keys

Moves cursor up or down or between editable data fields. The down arrow decrements values in numerical entry fields, or selects a previous choice in a multi-choice entry field. The up arrow increments values in numerical entry fields, or selects a next choice in multi-choice entry fields. The right and left arrow keys are used to move the cursor position in numerical entry fields.

4.4.4 Display Elements

The Model 3700 uses a character display to depict information about the current state of the system. The display screens shown by the instrument can be classified as follows: title screen, measurement screen, setup screen and error message screen.

4.4.4.1 Title Screen

The title screen is displayed for a few seconds every time the instrument is powered ON. This screen is used to display the present firmware version of the instrument. A sample title screen is shown in Figure 14.

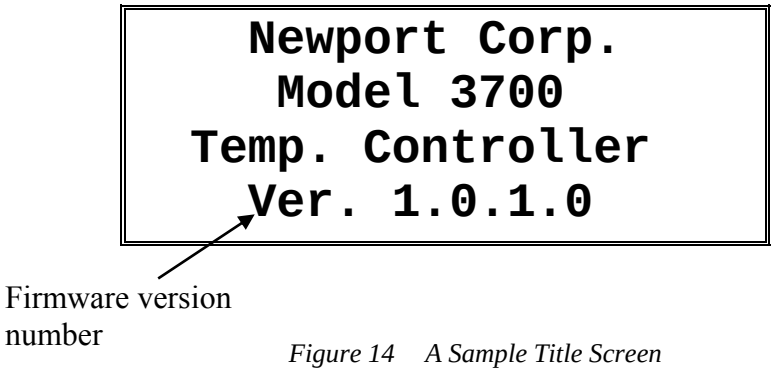


Figure 14 A Sample Title Screen

4.4.4.2 Measurement Screen

The measurement screen is displayed after the instrument has been powered ON for a few seconds. A sample measurement screen is shown in Figure 15.

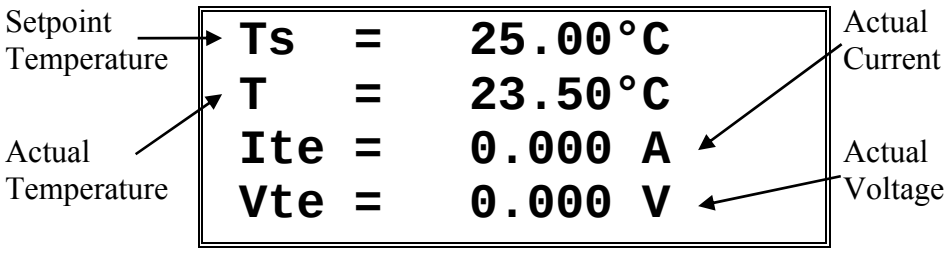


Figure 15 A Sample Measurement Screen

This is the topmost level display during normal operation, and it indicates the status of the instrument. The contents of this screen can vary depending upon the mode of operation and the type of sensor.

Some messages are displayed on this screen to draw users' attention to various events that may require them to take corrective action(s). For instance, a flashing "E" symbol is shown on the left-top corner of the display whenever the instrument generates an error message.

4.4.4.3 Setup Screens

The setup screens are used to modify TEC and system settings such as Ite set point, temperature set point, display brightness etc. The menu items listed in this screen can be in one of two states: *selected* or *unselected*. A selected item can be in one of two states: *idle* or *active*.

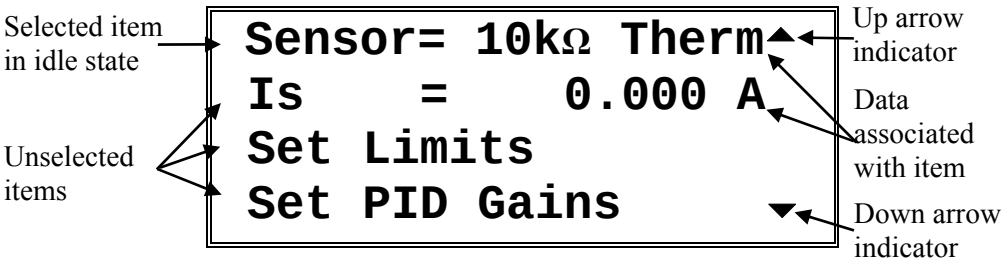


Figure 16 A Sample Setup Screen

A *selected* item in *idle* state is indicated by a diamond symbol (◆) placed to the left of the item. The idle state is the default state for a selected item. In this state, the present value of the item may be displayed next to the label depending upon the type of item. Pressing the SETUP/ENTER key will cause the instrument to display a sub-menu for that item, should one be available. Otherwise, it will change the display state for that item from *idle* to *active*.

A *selected* item in *active* state is indicated by flashing data associated with that item. The cursor arrow keys can be used to modify the data (numerical or non-numerical) as explained earlier. Once the data has be modified, pressing SETUP/ENTER key will cause the instrument to accept the new data and return the item to idle state. Pressing the Esc key will cause the display to ignore any changes made, and return to the previous menu.

An *unselected* item simply displays the item name. Depending upon the item (Mode, Sensor, Setpoint), it may also display data associated with that item.

The Setup screens also have up (▲) and down (▼) indicators to show that more items can be accessed by pressing UP and DOWN arrow keys respectively.

4.4.4.4 Menu Structure

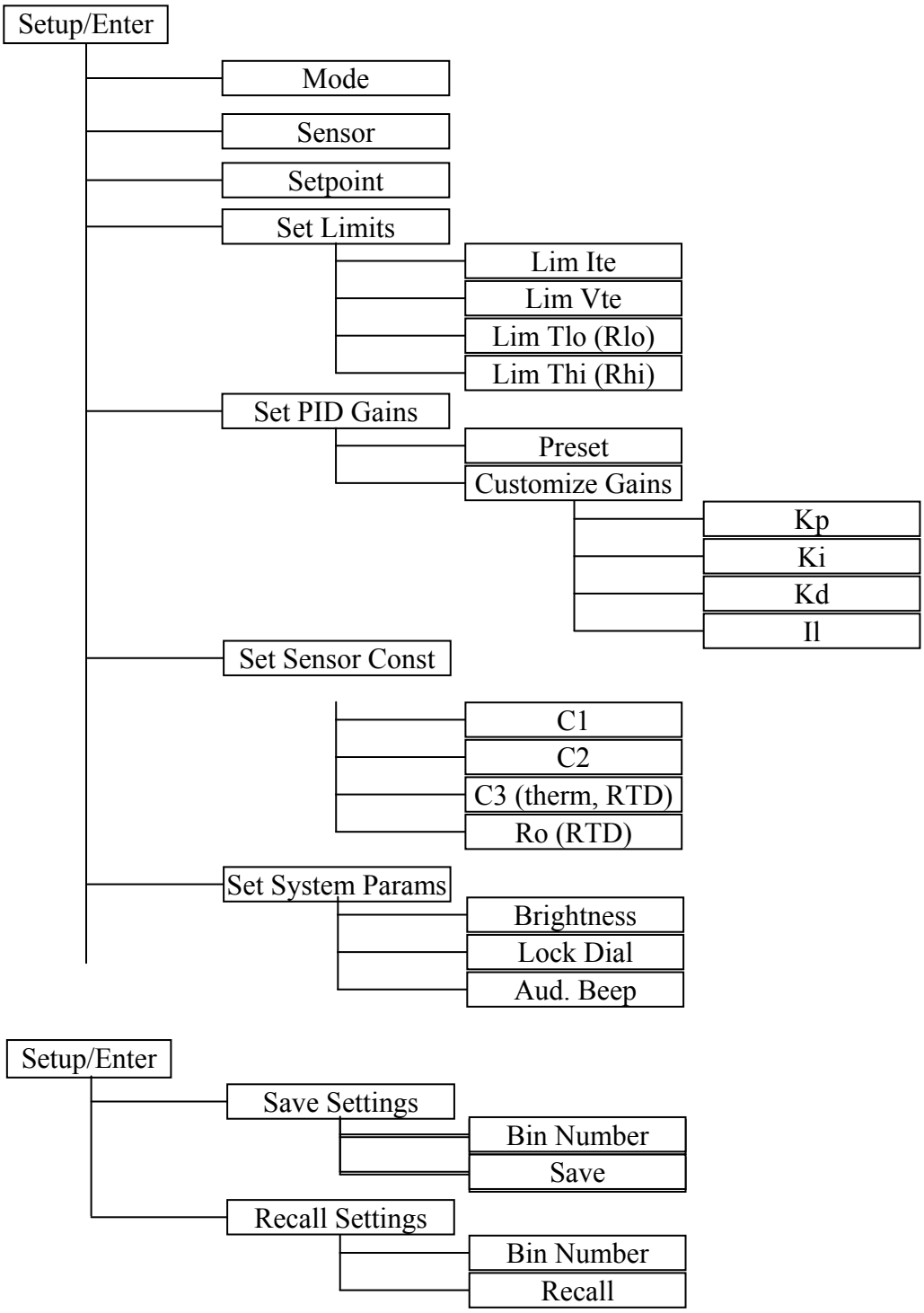


Figure 17 Model 3700 Menu Structure

Mode Menu

The Mode menu item is used to change the instrument's mode of operation.

To set the desired mode of operation, use the UP and DOWN arrow keys to select this menu item. By default, this item will be in idle state and the present mode of operation will be displayed next to the "Mode =" label. Press the SETUP/ENTER key to change this item's state from idle to active. Once the item is in active state, the present mode begins flashing. Use the UP and DOWN arrow keys to select the desired mode and press SETUP/ENTER key to accept the new mode. The new mode will take effect immediately, and the menu item will be returned to idle state. Press Esc key to cancel any changes.

Sensor Menu

The Sensor menu item is used to change the feedback sensor.

To set the desired sensor type, use the UP and DOWN arrow keys to select this menu item. By default, this item will be in idle state and the present sensor selection will be displayed next to the "Sensor =" label. Press the SETUP/ENTER key to change this item's state from idle to active. Once the item is in active state, the present sensor begins flashing. Use the UP and DOWN arrow keys to select the desired sensor and press SETUP/ENTER key to accept the new sensor. The new sensor selection will take effect immediately, and the menu item will be returned to idle state. Press Esc key to cancel any changes.

Setpoint Menu

The Setpoint menu item is used to change the controller setpoint value. The setpoint label and the value will vary based on the mode of operation and the type of sensor. The table below shows the setpoint labels, and units for different modes of operation and sensor types.

To set the desired setpoint value, use the UP and DOWN arrow keys to select this menu item. By default, this item will be in idle state and the present setpoint value will be displayed next to the setpoint label. Press the SETUP/ENTER key to change this item's state from idle to active. Once the item is in active state, the leading +/- indicator begins flashing. Use the cursor arrow keys to select the desired digit and to increment/decrement the value. Once the desired value has been entered, press SETUP/ENTER key to accept the new setpoint value. The new setpoint value will take effect immediately, and the menu item will be returned to idle state. Press Esc key to cancel any changes.

Mode	Thermistors	LM335	AD590	RTD
Constant Current	Label = “Is” Units = “A”	Label = “Is” Units = “A”	Label = “Is” Units = “A”	Label = “Is” Units = “A”
Constant Resistance	Label = “Rs” Units = “kΩ”	Label = “vs” Units = “mV”	Label = “is” Units = “uA”	Label = “Rs” Units = “kΩ”
Constant Temperature	Label = “Ts” Units = “°C”	Label = “Ts” Units = “°C”	Label = “Ts” Units = “°C”	Label = “Ts” Units = “°C”

Table 4 Setpoint Labels

Set Limits Menu

The Set Limits menu item is used to change the limit settings—current limit, voltage limit, temperature limits (in Constant Temperature mode) and resistance limits (in Constant Resistance mode).

To set the desired limits, use the UP and DOWN arrow keys to select this menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for setting the limits is shown in figure below. Use the UP and DOWN arrow keys to select a desired sub-menu item. By default, this item will be in idle state and the present limit value will be displayed. Press the SETUP/ENTER key to change this item’s state from idle to active. Once the item is in active state, the leading indicator begins flashing. Use the cursor arrow keys to select the desired digit and to increment/decrement the value. Once the desired value has been entered, press SETUP/ENTER key to accept the new limit value. The new limit value will take effect immediately, and the menu item will be returned to idle state. Press Esc key to cancel any changes or to return to Set Limits main menu.

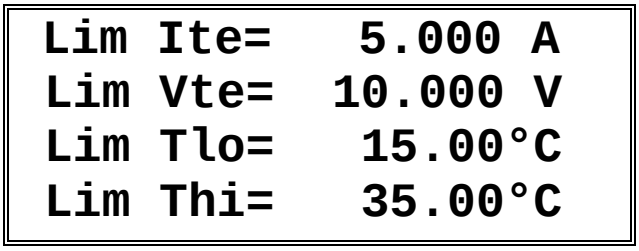


Figure 18 A Sample Set Limits Sub-menu

Set PID Gains Menu

The Set PID Gains menu item is used to change the PID control loop gains. These gains are used by the instrument to maintain the present temperature (in Constant Temperature mode) or resistance (in Constant Resistance mode) at their setpoint level; they are not used when the instrument is operated in Constant Current mode.

To select preset PID gains or to customize them, use the UP and DOWN arrow keys to select the Set PID Gains menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for setting the gains is shown in figure below.

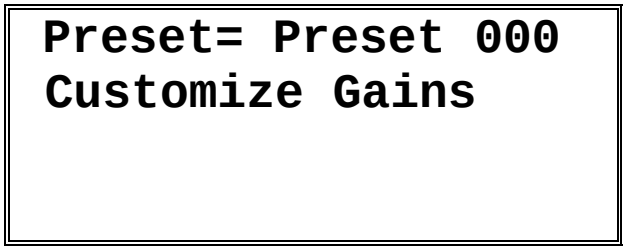


Figure 19 A Sample Set PID Gains Sub-menu

To select a preset PID gains bin, use the UP and DOWN arrow keys to select Preset sub-menu item. By default, this item will be in idle state and the present Preset bin number value will be displayed. Press the SETUP/ENTER key to change this item's state from idle to active. Once the item is in active state, the bin number begins flashing. Use the UP/DOWN arrow keys to select the desired bin number. Once the desired value has been selected, press SETUP/ENTER key to accept the new value. The PID gains associated with the new bin will take effect immediately, and the menu item will be returned to idle state. Press Esc key to cancel any changes or to return to Set PID Gains main menu.

To customize PID gains, use the UP and DOWN arrow keys to select Customize Gains sub-menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for customizing the gains is shown in figure below.

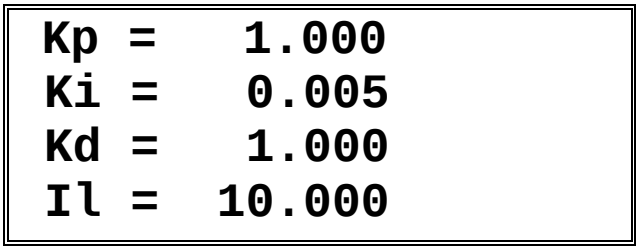


Figure 20 A Sample Customize PID Gains Sub-menu

Use the UP and DOWN arrow keys to select the PID gain that needs to be modified. Once the desired item has been selected, press the SETUP/ENTER key to change the item's state from idle to active. Once the item is in active state, the leading digit begins flashing. Use the cursor keys to specify a desired value. Once the desired value has been selected, press SETUP/ENTER key to accept the new value. The new PID gain will take effect immediately, and the menu item will be returned to idle state. Press Esc key to cancel any changes or to return to Set PID Gains main menu.

It is highly recommended that the output be turned OFF before the gains are customized.

Set Sensor Constants Menu

The Set Sensor Constants menu item is used to change the constants for the previously selected sensor. These constants are used to convert feedback signal from resistance (if sensor is a thermistor or an RTD) or voltage (if sensor is LM335) or current (if sensor is AD590) to temperature. Please refer the description of TEC:CONST command for further details on these constants.

To modify these constants, use the UP and DOWN arrow keys to select this menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for setting the sensor constants is shown in figure below. The contents of this screen will vary depending upon the sensor selected.

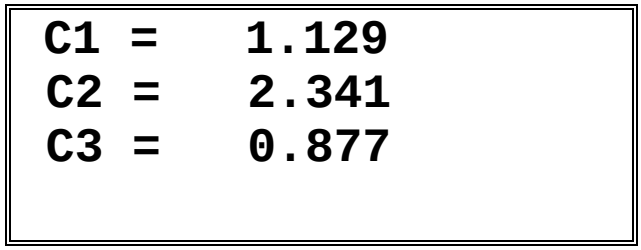


Figure 21 A Sample Sensor Constants Sub-menu

Use the UP and DOWN arrow keys to select the sensor constant that needs to be modified. Once the desired item has been selected, press the SETUP/ENTER key to change the item's state from idle to active. Once the item is in active state, the leading digit begins flashing. Use the cursor keys to specify a desired value. Once the desired value has been selected, press SETUP/ENTER key to accept the new value. The new sensor constant will take effect immediately, and the menu item will be returned to idle state. Press Esc key to cancel any changes or to return to Set Sensor Constants main menu.

It is highly recommended that the output be turned OFF before the gains are customized.

Set System Params Menu

The Set System Params menu item is used to change display brightness, lock the dial on the front panel or turn beeper ON/OFF.

To modify these constants, use the UP and DOWN arrow keys to select this menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for setting the system parameters is shown in figure below.

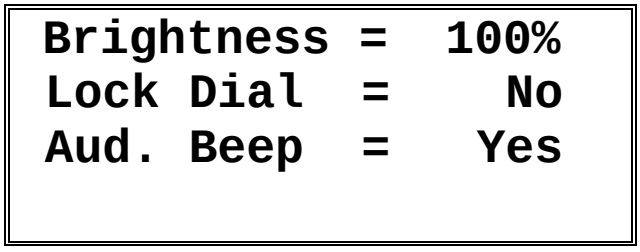


Figure 22 A Sample System Parameters Sub-menu

Use the UP and DOWN arrow keys to select the parameter that needs to be modified. Once the desired item has been selected, press the SETUP/ENTER key to change the item's state from idle to active. Once the item is in active state, use the cursor keys to specify a desired value. Once the desired value has been selected, press SETUP/ENTER key to accept the new value. The new parameters will take effect immediately, and the menu item will be returned to idle state. Press Esc key to cancel any changes or to return to Set System Params main menu.

Save Settings Menu

The Save Settings menu item is used to store the instrument's setup configurations for future use. For example, a specific test setup may be saved for later use, and then another setup may be used presently. When the user desires to perform the specific test, its setup is simply recalled.

Non-volatile flash memory is used for saving the instrument's parameters. When a save operation is performed, all of the parameters which are currently in effect on the instrument are stored. The user selects a "bin" number for saving the parameters, up to the maximum available in the instrument. Then, when that "bin" number is recalled, the instrument is reconfigured to the previously stored values. A special "bin 0" is reserved for the reset state. Recalling bin 0 will reset the unit to factory defaults.

To perform the save operation, use the UP and DOWN arrow keys to select this menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for setting the system parameters is shown in figure below.

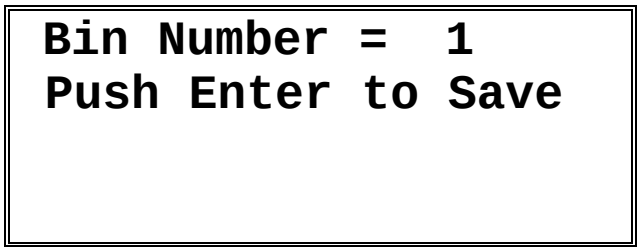


Figure 23 A Sample Save Parameters Sub-menu

Use the UP arrow key to select the Bin Number. Press the SETUP/ENTER key to change the Bin Number menu state from idle to active. Once the item is in active state,.use the cursor keys to select the desire bin number. Press SETUP/ENTER key to accept the desired bin.

Now, use the DOWN arrow key to select the menu item that states “Press Enter to Save”. Press SETUP/ENTER key with this menu item selected to save the system settings to the bin number selected earlier. The instrument will automatically return to the Measurement screen once the saving process has completed.

Recall Settings Menu

The Recall Settings menu item is used to recall previously saved instrument’s setup configurations. Recalling bin 0 will reset the unit to factory defaults.

To perform the recall operation, use the UP and DOWN arrow keys to select this menu item. Press the SETUP/ENTER key to enter a sub-menu for this item. A sample sub-menu for recalling the system parameters is shown in figure below.

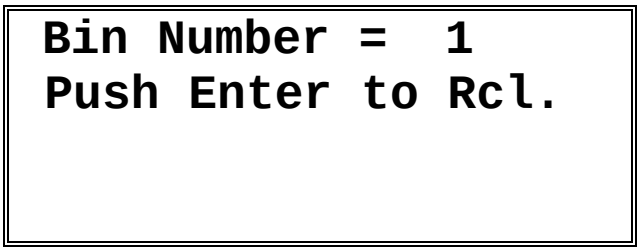


Figure 24 A Sample Save Parameters Sub-menu

Use the UP arrow key to select the Bin Number. Press the SETUP/ENTER key to change the Bin Number menu state from idle to active. Once the item is in active state,.use the cursor keys to select the desire bin number. Press SETUP/ENTER key to accept the desired bin.

Now, use the DOWN arrow key to select the menu item that states “Press Enter to Rcl”. Press SETUP/ENTER key with this menu item selected to recall the system settings from the bin number selected earlier. The

instrument will automatically return to the Measurement screen once the recalling process has completed.

4.4.4.5 Error Message Screen

Whenever the instrument generates an error message, a flashing "E" symbol is shown on the left-top corner of the Measurement screen as shown in figure below. Users can retrieve this error message from the instrument from the Error Message screen. To retrieve error messages, press the SETUP/ENTER key to view the setup menu. The first menu item will be "GET ERRORS" as shown in the figure below.

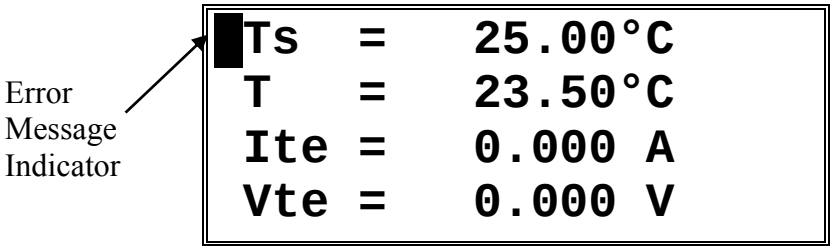


Figure 25 A Sample Measurement Screen when Errors Present

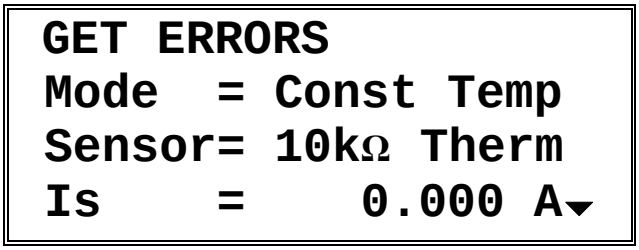


Figure 26 A Sample Setup Screen when Errors Present

Select the Get Errors menu item by pressing the UP arrow key. Once this item is selected press SETUP/ENTER key to enter the Error Messages screen. All the error messages generated are listed on this screen in a chronological order (oldest first). All the error messages can be viewed by pressing the UP and DOWN arrow keys. Press the Esc key to return to the Setup screen. Note that this process removes the errors from error buffer, and they will not be available for querying via USB communication interface.

4.5 Rear Panel

The Model 3700 rear panel has a TEC OUTPUT connector, an I/O Signals connector, a USB connector, and the AC power entry module.

Figure 27 Rear Panel

4.5.1 USB Interface

The instrument is designed to communicate with standard USB Host interfaces. The connector on the rear panel is a standard USB-B (Full-Size, Device).

4.5.2 Chassis GND

This 4 mm banana jack is connected to chassis ground. It is intended to be used as an additional earth ground connection for the TEC Driver enclosure.

4.5.3 AC Power Cord

All units are designed for 90-264VAC, 50/60 Hz operation. As such, they are rated for operation at 100VAC, 120VAC, 220VAC, and 240VAC mains voltages and 50 and 60 Hz mains frequency.

The line cord supplied with each unit should be plugged only into a properly grounded outlet to prevent electrical shock in the event of an internal short circuit to the metal cabinet. The detachable line cord should be connected to the IEC320 connector on the power entry module.

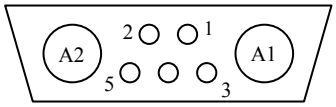
4.5.4 Fuses

The correct fuses must be installed into the fuse holder that is part of the AC power entry module. Please check the fuse label on the rear panel, before installing new fuses (see Figure 12).

	WARNING **To avoid electric shock, the appropriate fuses for the AC input power voltage must be installed in the instrument. Only qualified service personnel should replace fuses. Failure to observe these precautions can result in fire, severe injury or death.**

4.5.5 TEC Output Connector

A high power 7W2 female D-connector is used for input and output connections, as shown by the pin out diagram below.



Pin	Description	Cable Color Code
A1	TE+	Red
A2	TE-	Black
1	Sensor+	Green
2	Sensor-	White
3	Interlock	
4	Interlock	
5	Earth Ground	

Table 5 TEC Connector Pin-out (Viewed looking at Rear Panel of Instrument

4.5.5.1 TEC Interlock

The interlock pins are normally open. Current will not flow if these pins are shorted.

4.5.5.2 TEC Grounding Consideration

The TEC output is isolated from chassis ground, allowing either output terminal (TE+ or TE-) to be connected to Earth Ground at the user's option.

CAUTION

Do not connect the temperature sensor to Earth Ground at the same time with grounding either TE+ or TE-. Only one connection to ground is accepted. Failure to do so may result in the unit malfunction or/and damage. Be careful when connecting other instruments to 3700 Temperature Controller, as they may have their ground connected to the Earth Ground.

For example, oscilloscopes have the probe ground connected to Earth Ground. If either TE+ or TE- is already connected to Earth Ground, the oscilloscope may bring the second connection, causing malfunction or damage.

4.5.6 I/O Signals Connector

This female 15 pin D-connector provides access to various analog and digital input/output signals. The signal pin assignments for this connector are shown in Table 6, below. Detailed information on these signals is provided in Section 4.6.

Pin No.	Name	Descriptions
1	*Reserved*	
2	*Reserved*	
3	Analog Output	Programmable Analog Output signal. Works in conjunction with pin-10. (+5V to -5V into 10K load)
4	Aux Thermistor + Input	Aux Thermistor input. Works in conjunction with pin-11.
5	TTL Output	General Output. +5V TTL-Level Output
6	TTL Input	General Input. +5V (Digital) Pull Up
7	Fault Output	+5V TTL-Level Output
8	ON / OFF (Output)	Temperature controller output state. Can be connected to LDD Interlock Input. +5V TTL-Level Output
9	Chassis Ground	Chassis Ground
10	Analog Output Return	Programmable Analog Output Return
11	Aux Sensor - Input	Aux Thermistor Return
12	TTL Output Return	Digital Ground
13	TTL Input Return	Digital Ground
14	Fault Output Return	Digital Ground
15	ON / OFF Return	Digital Ground

Table 6 I/O Signals Connector Pin Assignments

4.6 I/O Signals

The rear panel I/O Signals Connector provides several signals for remotely controlling and monitoring the Model 3700 Temperature Controller.

There are three different grounds – the Chassis Ground, the Digital Ground, and the Analog Ground. The Analog Ground and the Digital Ground are isolated within the Model 3700.

The Chassis Ground is also isolated from the Analog Ground and Digital Ground. The Chassis Ground and Digital Ground are available to the user on the back panel DB-15 female connector. Although it is not required, these grounds may be connected together externally provided ground loops are not introduced. Such ground loops will degrade the performance of the unit. Because the USB interface is referenced to digital ground, users should be especially careful not to introduce a ground loop through an externally-connected computer, which usually connect the Digital Ground to Chassis Ground.

The best approach is to have the chassis ground connected in one single point in a system so that currents between the grounds are avoided.

CAUTION

Do not connect the temperature sensor to Earth Ground at the same time with grounding either TE+ or TE-. Only one connection to ground is accepted. Failure to do so may result in the unit malfunction or/and damage. Be careful when connecting other instruments to 3700 Temperature Controller, as they may have their ground connected to the Earth Ground.

For example, oscilloscopes have the probe ground connected to Earth Ground. If either TE+ or TE- is already connected to Earth Ground, the oscilloscope may bring the second connection, causing malfunction or damage.

4.6.1 ON / OFF Output

The ON/OFF signal is a TTL-Level output referenced to the unit's Digital Ground (pin-15). This signal is driven by an open-collector transistor output internally pulled to +5V via a 1.5 k Ohm resistor. In terms of logic state, this output signal goes LOW (0V) when the TEC output is turned ON and goes HIGH (+5V) when the TEC output is turned OFF.

This signal can be connected to the Interlock input of the laser diode driver so that the driver does not inadvertently output current to an attached laser diode

while the temperature controller output is OFF, thereby protecting the attached laser diode..

4.6.2 Fault

The Fault signal is a TTL-Level output referenced to the unit's Digital Ground. When a fault condition is detected, the unit will internally pull this signal to about +5V using a 1.5Kohm resistor. When a fault condition is not detected, the unit will sink up to 8 mA to Digital Ground.

4.6.3 TTL Input

The TTL Input signal is a TTL-Level input referenced to the unit's Digital Ground. The signal is internally pulled to about +5V via a 680 Ω resistor in series with the photodiode of an optical isolator integrated circuit. This is a general purpose input which can be monitored via software (see TEC:TTL:IN? command) and used for internal/external event synchronization. For convenience, digital ground is located at pin-13 of the same connector.

4.6.4 TTL Output

The TTL Output signal is a TTL-Level output referenced to the unit's Digital Ground. This signal is driven by an open-collector transistor output internally pulled to +5V via a 1.5 k Ohm resistor. This is a general purpose output which can be set via software (see TEC:TTL:OUT command) and used for internal/external event synchronization. For convenience, digital ground is located at pin-12 of the same connector.

4.6.5 Auxiliary Thermistor Input / Auxiliary Thermistor Input (Return)

This auxiliary sensor input facilitates the use of another (non-TEC) thermistor sensor for enhanced monitoring capability. This feature adds to the versatility of the model 3700 and aids the user in achieving stability objectives. For example, one could use this thermistor to monitor ambient temperature during the course of a prolonged experiment. The model 3700 controller has the unique ability to perform data acquisition functions whereby it can collect this auxiliary thermistor temperature concurrent with TEC temperature, current, and voltage. This information can then be uploaded to the PC via USB port and analyzed to help identify any significant correlation between lab environment/ambient temperature perturbation and TEC/laser temperature perturbation.

4.6.6 Analog Output / Analog Output (Return)

The Analog Output and Analog Output (Return) signals are a differential analog output loosely coupled to the unit's Analog Ground. This 12-bit, +/- 5V signal is software configurable which enables the user to easily monitor TEC feedback temperature, output voltage, or output current via a rear panel connector. Additionally, the user can write a value to the analog output register via software command thereby using it as a general purpose software controller analog output.

4.6.7 Chassis Ground

For convenience, the Model 3700 has a chassis ground connection on the I/O Signals connector.

5 Computer Interfacing

5.1 General Guidelines

The Model 3700 Temperature Controller has a USB interface to receive commands from, and send responses to, a host PC. The commands supported by the instrument can be divided into the following two categories: commands that cause it to take a desired action, and commands (queries) that cause it to return a stored value.

Query commands must end with a question mark (?). It is recommended that when a query command is sent, the response to that command from the instrument be read before issuing any other command.

Set commands, on the other hand, are used to configure/setup the instrument for a desired mode of operation. These commands take at least one parameter. The subsequent sections in this chapter detail the communication protocols supported by the instrument.

5.2 Computer Interface Terminology

Listed below are the key abbreviations and concepts used in the command reference section of this manual.

5.2.1 <…> Delimiting Punctuation

For the purposes of this manual, any string enclosed by <…> is considered to be a command, a string or numerical argument. The punctuation <…> is used to symbolize the typographic limits of the command, string or argument in question.

5.2.2 <CR> Carriage Return

The ASCII encoded byte 13 in decimal. (0D hex)

5.2.3 <LF> Line Feed

The ASCII encoded byte 10 in decimal. (0A hex)

5.2.4 (;) Semicolons

Semicolons are used to separate commands within a single transmission (concatenation).

5.2.5 Command Termination

All the commands sent to the driver must be terminated by a <CR><LF> sequence.

5.2.6 Response Termination

All the responses from the driver are terminated by a <CR><LF> sequence.

5.3 Controller Operation Mode

The Temperature Controller supports two modes of operation: LOCAL and REMOTE. The instrument will be in LOCAL mode, by default, following a power reset. In this mode, setpoint and output current limit values can be adjusted by turning the knob on front panel of the instrument. Output can be turned ON and OFF by pressing the output switch. Please refer the "System Operation" chapter for a detailed description on how to accomplish these tasks. When it is in REMOTE mode, knob control is disabled; setpoint and other settings can be adjusted only by issuing appropriate commands from a host PC. The REMOTE or LOCAL status indicator character can be found in the LCD display.

By default, the instrument enters REMOTE mode when it receives any command through USB communication interface. It can be setup to enter this state on any set command only by setting the appropriate bit in configuration register (refer "HWCONFIG" command). The instrument can be put back in LOCAL mode by issuing "LOCAL" command.

5.4 USB Communication

The instrument is designed to communicate with a host PC via a standard USB interface. Before connecting the instrument to the USB interface the user should install the application included in the software CD that accompanies the Temperature Controller. The application automatically installs the right USB drivers. Communication can be done through this interface by using the application or by developing software in the user's preferred programming language. The software CD contains communication drivers and example programs in the following programming languages: LabVIEW and C#.NET

5.5 Commands and Queries

There are two types of device commands: commands that cause the instrument to take a desired action, and queries that return a stored value or state of the instrument. Queries must end with a question mark (?), while commands may require parameter(s) to follow:

TEC:LIMit:Ite 10.00

For example, the value "10.00" in the command **TEC:LIMit:Ite 50.00** sets the output current limit at 10.00. The command/query MUST contain all of the letters shown in upper-case; lower-case letters in the commands are optional, and may be used for clarity.

The commands may be sent to the instrument in either upper or lower case or in any combination. For example, the following commands are equal:

TEC:LIMit:ITE 10.00

TEC:LIM:ITE 10.00

tec:LIM:ITE 10.00

Tec:Lim:Ite 10.00

COMMAND EXECUTION:

The controller interprets the commands in the order they are received and executes them sequentially. If a set of commands have to be executed closer to each other, these commands can be sent to the controller simultaneously by creating a command string with semicolon (;) used as a command separator. The command string length should not exceed 50 characters. In the example shown below, a command string was created with semicolon separating 5 queries. The controller responds to this command string with a response that has 5 values using a comma (,) as a separator.

COMMAND STRING:

TEC:OUT?;TEC:SET:I?;TEC:ITE?;TEC:VTE?

INSTRUMENT RESPONSE:

0, 5.0,0.0,0.00

COMMAND TERMINATION:

All commands sent to the instrument must be terminated by <Carriage Return><Line Feed>.characters. All responses sent out by the instrument are terminated by the same characters.

Commands and Queries Summary Table

Command Syntax	Command Description	Remarks
***IDN?**	Identification string query	
***RCL**	Recall settings	Restore instrument to setup state stored in its non-volatile local memory
***RST**	Reset instrument	
***SAV**	Save instrument's settings	Save instrument's current settings in its non-volatile local memory
***STB?**	Status Byte Query	Returns "error message available" status
ADDRess	Controller USB address set	
ADDRess?	Controller USB address query	
BEEP	Turns the beeper on or off, or beeps once	
BEEP?	Beeper status query	
BRIGHT	Display brightness set	
BRIGHT?	Display brightness query	
ERRors?	Error code query	
ERRSTR?	Error string query	
HWCONFIG	Hardware configuration set	
HWCONFIG?	Hardware configuration query	
LOCAL	Return to local mode	
TEC:ANALOG:MODE	Analog output mode set	
TEC:ANALOG:MODE?	Analog output mode query	
TEC:ANALOG:VOLT	Constant analog output voltage set	
TEC:ANALOG:VOLT?	Constant analog output voltage query	
TEC:AUX:CONST	Auxiliary thermistor constants set	
TEC:AUX:CONST?	Auxiliary thermistor constants query	
TEC:AUX:TEMP?	Auxiliary temperature query	
TEC:AUX:THERM	Auxiliary thermistor value set	
TEC:AUX:THERM?	Auxiliary thermistor value query	
TEC:COND?	TEC condition register query	
TEC:CONST	TEC feedback sensor constants set	Select desired sensor before setting constants
TEC:CONST?	TEC feedback sensor constants query	
TEC:GAIN:IL	PID control – integral limit set	
TEC:GAIN:IL?	PID control – integral limit query	
TEC:GAIN:KD	PID control – derivative gain set	
TEC:GAIN:KD?	PID control – derivative gain query	
TEC:GAIN:KI	PID control – integral gain set	
TEC:GAIN:KI?	PID control – integral gain query	
TEC:GAIN:KP	PID control – proportional gain set	
TEC:GAIN:KP?	PID control – proportional gain query	
TEC:GAIN:PRESET	PID control – preset gains select	
TEC:GAIN:PRESET?	PID control – preset gains select query	
TEC:Ite	Output current setpoint	
TEC:Ite?	Measured output current query	
TEC:LIM:Ite	Output current limit set	
TEC:LIM:Ite?	Output current limit query	

TEC:LIM:RHI	High resistance limit set	
TEC:LIM:RHI?	High resistance limit query	
TEC:LIM:RLO	Low resistance limit set	
TEC:LIM:RLO?	Low resistance limit query	
TEC:LIM:THI	High temperature limit set	
TEC:LIM:THI?	High temperature limit query	
TEC:LIM:TLO	Low temperature limit set	
TEC:LIM:TLO?	Low temperature limit query	
TEC:LIM:Vte	Compliance voltage limit set	
TEC:LIM:Vte?	Compliance voltage limit query	
TEC:MODE	TEC operation mode set	
TEC:MODE?	TEC operation mode query	
TEC:MODE:Ite	Set operation mode to constant current	
TEC:MODE:R	Set operation mode to constant resistance/reference	
TEC:MODE:T	Set operation mode to constant temperature	
TEC:OUTput	TEC output enable/disable status set	
TEC:OUTput?	TEC output enable/disable status query	
TEC:R	Constant R (resistance/reference) setpoint	Select desired sensor before setting setpoint
TEC:R?	Measured R (resistance/reference) query	Select desired sensor before querying R value
TEC:SENsor	Feedback sensor type set	
TEC:SENsor?	Feedback sensor type query	
TEC:SET:Ite?	Constant current setpoint query	
TEC:SET:R?	Constant R (resistance/reference) setpoint query	Select desired sensor before querying setpoint
TEC:SET:T?	Constant temperature setpoint query	
TEC:T	Constant temperature setpoint	
TEC:T?	Measured temperature query	
TEC:THERM	Custom thermistor rating set	
TEC:THERM?	Custom thermistor rating query	
TEC:TTL:IN?	TTL input state query	
TEC:TTL:OUT	TTL output state set	
TEC:Vte?	Measured compliance voltage query	

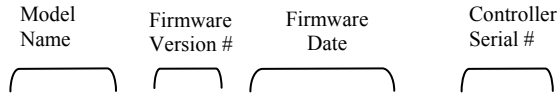
Table 7 Command Summary

*IDN?

Description Identification string query.

Syntax ***IDN?**

Remarks This query will cause the instrument to return an identification string.



NEWPORT XXXX vYYY mm/dd/yy, SNZZZZ

*RCL

Description Recall command.

Syntax ***RCL** *Bin*

Argument	Value	Description
Bin	0	Restores factory default settings
	1 to 5	Restores settings saved in specified bin

Remarks This command restores the instrument to the setup states saved in instrument's non-volatile flash memory. The parameters that can be restored are:

1. USB address
2. Beeper enable/disable state
3. LCD display brightness
4. Hardware configuration register value
5. Dial (rotary knob) lockout state
6. 7-segment display mode
7. Instrument mode of operation
8. Feedback Sensor type
9. Custom feedback thermistor value
10. Analog output mode
11. Auxiliary sensor constants
12. Auxiliary sensor resistance value
13. Constant output current setpoint
14. Constant R (resistance/reference) setppoint
15. Constant temperature setpoint
16. Output current limit
17. High resistance limit
18. Low resistance limit
19. High temperature limit
20. Low temperature limit
21. Compliance voltage limit
22. PID control gains (proportional, integral and derivative) and integral limit

See Also ***RST**, ***SAV**

*RST

Description Reset command.

Syntax ***RST**

Remarks This command performs a soft reset of the instrument.

See Also ***RCL**

*SAV

Description Save command.

Syntax ***SAV** *Bin*

Argument	Value	Description
Bin	1 to 5	Saves current settings to specified bin

Remarks This command stores the current state of the instrument in non-volatile flash memory. This state is then recalled using the ***RCL** command. See description of *RCL command for a list of values saved/recalled by the instrument.

See Also ***RCL**

*STB?

Description Status Byte Register query.

Syntax ***STB?**

Remarks This query returns the Status Byte Register.

Response	Description	
Status Byte Register	bit 0	Reserved
	bit 1	Reserved
	bit 2	Reserved
	bit 3	Reserved
	bit 4	Reserved
	bit 5	Reserved
	bit 6	Reserved
	bit 7	Error Message Available

ADDRess

Description USB address command.

Syntax **ADDRess** *Value*

Remarks This command sets the instrument USB address. After changing USB address, the communication with the instrument has to be re-initialized. This can be accomplished by

calling “InitSystem” function in the DLL available in the CD provided with the instrument.

Argument	Value	Description
Value	0	Reserved
	1 to 31	Valid USB address range

See Also **ADDRess?**

ADDRess?

Description USB address query.

Syntax **ADDRess?**

Remarks This query returns the instrument’s USB address.

Response	Description
address	USB address of instrument

See Also **ADDRess**

BEEP

Description Beep command

Syntax **BEEP** *beep set*

Remarks This command controls the instrument’s beeper. The beeper is used to signal error or warning conditions.

Response	Value	Description
beep set	0	Beeper off
	1	Beeper on
	2	Test beeper (100ms beep)

See Also **BEEP?**

BEEP?

Description Beep query

Syntax **BEEP?**

Remarks This query returns the enable status of the beeper.

Response	Description	
beep set	0	Beeper off
	1	Beeper on

See Also **BEEP**

BRIGHT

Description Display brightness command

Syntax **BRIGHT** *brightness*

Remarks This command controls the brightness of the controller display.

Argument	Value	Description
brightness	Integer	Brightness, in percentage, from 0% to 100%

See Also **BRIGHT?**

BRIGHT?

Description Display brightness query

Syntax **BRIGHT?**

Remarks This query returns the display brightness setting.

Response	Description
brightness	Display brightness, in percentage.

See Also **BRIGHT**

ERRors?

Description Error query.

Syntax **ERRors**?

Remarks This query returns a single error number that corresponds to an error occurred since the last query. This command also clears the read error from the error buffer. Refer to Appendix A for a list of error codes generated by the instrument

Response	Description
Error code	Error code number per Appendix A, 0 if no errors

See Also **ERRSTR?**

ERRSTR?

Description Error string query.

Syntax **ERRSTR**?

Remarks This query returns a single error code along with the corresponding error text string that occurred since the last error query. Refer to Appendix A for a list of error codes and strings generated by the instrument.

Response	Description
Error code, "text"	Error code and text for error code as per chapter, 0 if no errors

See Also **ERRors?**

HWCONFIG

Description Hardware configuration register command.

Syntax **HWCONFIG** *Value*

Remarks This command sets the hardware configuration register. Please refer the table below for a description of the various bits in this register.

Argument	Value	Description
Value	Integer	Valid values are between 0 and 255

Bit #	Meaning	Remarks
0	Remote mode	0* = switch to remote mode when any command is received over USB interface 1 = switch to remote mode only when any set command is received over USB interface Switching from remote to local mode is achieved when "LOCAL" command is received over USB interface
1	Reserved	
2	Reserved	
3	Interlock monitor	0 = TE mount connected when interlock is grounded 1* = TE mount connected when interlock is floating
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	

Table 8 HWCONFIG Register

* indicates factory default setting.

See Also **HWCONFIG?**

HWCONFIG?

Description Hardware configuration register query.

Syntax **HWCONFIG?**

Remarks This query returns the instrument's hardware configuration register.

Response	Description
Value	Hardware configuration register setting

See Also **HWCONFIG**

LOCAL

Description Return to local mode.

Syntax **LOCAL**

Remarks This command returns the instrument to local mode after being placed in remote mode by USB communication interface.

See Also **None**

TEC:ANALOG:MODE

Description Analog output mode command.

Syntax **TEC:ANALOG:MODE** *Value*

Remarks This command sets the instrument's analog output mode Please refer the table below for a description of the various bits in this register.

Argument	Value	Description
Value	Integer	Valid values are between 0 and 4

Value	Mode	Remarks
0*	Actual current	Analog output voltage is a function of measured output current
1	Actual voltage	Analog output voltage is a function of measured compliance voltage
2	Feedback sensor	Analog output voltage is a function of measured R (resistance/reference) value from selected feedback sensor
3	Auxiliary sensor	Analog output voltage is a function of auxiliary sensor input
4	Constant voltage	Output constant voltage; the voltage value can be changed using TEC:ANALOG:VOLT command

Table 9 Analog Output Mode Register

* indicates factory default setting.

See Also **TEC:ANALOG:MODE?; TEC:ANALOG:VOLT**

TEC:ANALOG:MODE?

Description Analog output mode query.

Syntax **TEC:ANALOG:MODE?**

Remarks This query returns the instrument's analog output mode setting.

Response	Description
Value	Analog output mode setting

See Also **TEC:ANALOG:MODE**

TEC:ANALOG:VOLT

Description Constant analog output voltage command.

Syntax **TEC:ANALOG:VOLT** *Value*

Remarks This command sets the instrument's constant analog output voltage value. This setting is used only when the analog output mode is set to 4 (constant voltage).

Argument	Value	Description
Value	Float	Valid values are between -2.5 and 2.5 V

See Also **TEC:ANALOG:VOLT?; TEC:ANALOG:MODE**

TEC:ANALOG:VOLT?

Description Constant analog output voltage query.

Syntax **TEC:ANALOG:VOLT?**

Remarks This query returns the instrument's constant analog output voltage setting.

Response	Description
Value	Constant analog output voltage setting

See Also **TEC:ANALOG:VOLT**

TEC:AUX:CONST

Description Auxiliary thermistor constants command.

Syntax **TEC:AUX:CONST** *C1, C2, C3*

Remarks This command sets the auxiliary thermistor constants for the Steinhart-Hart equation. This information is used by the instrument, in conjunction with auxiliary thermistor rating, to arrive at temperature sensed by the auxiliary thermistor.

Argument	Value	Description

C1	Float	$\pm 9.999 \times 10^{-3}$
C2	Float	$\pm 9.999 \times 10^{-4}$
C3	Float	$\pm 9.999 \times 10^{-7}$

Remarks **TEC:AUX:CONST 1.129241, 2.341077, 0.8775468**

Action: sets C1 to 1.129241 $\times 10^{-3}$, C2 to 2.341077 $\times 10^{-4}$, C3 to 0.8775468 $\times 10^{-7}$

See Also **TEC:AUX:CONST?; TEC:AUX:TEMP?; TEC:AUX:THERM**

TEC:AUX:CONST?

Description Auxiliary thermistor constants query.

Syntax **TEC:AUX:CONST?**

Remarks This query returns the auxiliary thermistor constants for the Steinhart-Hart equation.

Response	Description
C1,C2,C3	See TEC:AUX:CONST command for a description of these values

See Also **TEC:AUX:CONST; TEC:AUX:TEMP?; TEC:AUX:THERM**

TEC:AUX:TEMP?

Description Auxiliary temperature query.

Syntax **TEC:AUX:TEMP?**

Remarks This query returns the auxiliary temperature. To arrive at this temperature value, the instrument uses auxiliary thermistor value and auxiliary thermistor constants specified by user using TEC:AUX:THERM and TEC:AUX:CONST commands respectively.

Response	Description
Value	Auxiliary temperature

See Also **TEC:AUX:CONST; TEC:AUX:THERM**

TEC:AUX:THERM

Description Auxiliary thermistor rating.

Syntax **TEC:AUX:THERM** *Value*

Remarks This command sets the auxiliary thermistor rating. This information is used by the instrument, in conjunction with thermistor constants, to arrive at temperature sensed by the auxiliary thermistor.

Argument	Value	Description

Value	Float	Auxiliary thermistor rating in kΩ

See Also **TEC:AUX:THERM?; TEC:AUX:CONST; TEC:AUX:TEMP?**

TEC:AUX:THERM?

Description Auxiliary thermistor rating query.

Syntax **TEC:AUX:THERM?**

Remarks This query returns the auxiliary thermistor's rating.

Response	Description
Value	Auxiliary thermistor rating in kΩ

See Also **TEC:AUX:THERM**

TEC:COND?

Description TEC condition status register query.

Syntax **TEC:COND?**

Remarks This command returns the TEC condition status register.

Response	Description
Value	TEC condition status

Bit #	Meaning	Remarks
0	Output current limit	0 = Limit not reached; 1 = Limit reached
1	Compliance voltage limit	0 = Limit not reached; 1 = Limit reached
2	R/Temp limit	0 = Limit not reached; 1 = Limit reached
3	Reserved	
4	Interlock	0 = Grounded; 1 = Floating
5	Reserved	
6	Over voltage	0 = No fault; 1 = Output turned OFF due to compliance voltage exceeding voltage rating
7	Open circuit	0 = No fault; 1 = Output turned OFF due to open circuit condition
8	Short circuit	0 = No fault; 1 = Output turned OFF due to short circuit condition
9	Over temperature	0 = No fault; 1 = Output turned OFF due to internal temperature exceeding safe levels
10	Output current state	0 = Disabled; 1 = Enabled
11	Reserved	
12	Reserved	
13	Reserved	
14	Reserved	
15	Reserved	

See Also **TEC:MODE; TEC:MODE?**

-

TEC:CONST

Description TEC sensor constants command.

Syntax **TEC:CONST** *C1[, C2[, C3 [, Ro]]]*

Remarks This command sets the TEC constants for the Steinhart-Hart equation for thermistors, slope and offsets for AD590s and LM335s, or the Callendar – van Dusen constants for RTDs.

Argument	Description	
For thermistors		
C1	±9.999 x 10^{-3}	Steinhart-Hart constants
C2	±9.999 x 10^{-4}	
C3	±9.999 x 10^{-7}	
For LM335/AD590		
C1	±9.999 °C	Offset
C2	±9.999	Slope
For RTD		
C1	±9.999 x 10^{-3}	RTD Temperature constants
C2	±9.999 x 10^{-6}	
C3	±9.999 x 10^{-12}	
Ro	95.000 to 105.000 Ω	

If less than four parameters need to be changed, only the desired change needs to be specified, along with the separating commas (see examples).

When the LM335 or AD590 sensors are selected, only C1 and C2 are used. Therefore, only two parameters are required in those cases.

Examples **TEC:const 1.4**

Action: sets C1 to1.400; C2, C3, and Ro remain unchanged.

TEC:CONST 1.4,2.015

Action: sets C1 to 1.400, C2 to 2.015 for two-point calibration of AD590 or LM335 sensors (C3 and Ro remain unchanged, but are not used).

See Also **TEC:CONST?**

TEC:CONST?

Description TEC sensor constants query.

Syntax **TEC:CONST?**

Remarks This query returns the TEC constants for the Steinhart-Hart equation for thermistors, slope and offsets for AD590s and LM335s, or RTD constants.

Response	Description
C1	See **TEC:CONST** for a description of these constants.
C2	
C3	
Ro	

When the LM335 or AD590 sensors are selected, only C1 and C2 are used. Therefore, C3 values may be ignored for these cases.

See Also **TEC:CONST**

TEC:GAIN:IL

Description PID control – integral limit.

Syntax **TEC:GAIN:IL** *Value*

Remarks This command limits the integral factor contribution to PID closed loop control. It is useful for preventing integral wind-up.

Argument	Value	Description
Value	Float	Integral limit

See Also **TEC:GAIN:IL?; TEC:GAIN:KP; TEC:GAIN:KI; TEC:GAIN:KD**

TEC:GAIN:IL?

Description PID control – integral limit query.

Syntax **TEC:GAIN:IL?**

Remarks This query returns the integral limit value.

Response	Description
Value	Integral limit

See Also **TEC:GAIN:IL; TEC:GAIN:KP; TEC:GAIN:KI; TEC:GAIN:KD**

TEC:GAIN:KD

Description PID control – derivative gain factor.

Syntax **TEC:GAIN:KD** *Value*

Remarks This command sets the derivative gain factor, Kd, used in PID closed loop control.

Argument	Value	Description
Value	Float	Derivative gain factor

See Also **TEC:GAIN:KD?; TEC:GAIN:KP; TEC:GAIN:KI; TEC:GAIN:IL**

TEC:GAIN:KD?

Description PID control – derivative gain factor query.

Syntax **TEC:GAIN:KD?**

Remarks This query returns the derivative gain factor value.

Response	Description
Value	Derivative gain factor

See Also **TEC:GAIN:KD; TEC:GAIN:KP; TEC:GAIN:KI; TEC:GAIN:IL**

TEC:GAIN:KI

Description PID control – integral gain factor.

Syntax **TEC:GAIN:KI** *Value*

Remarks This command sets the integral gain factor, Ki, used in PID closed loop control.

Argument	Value	Description
Value	Float	Integral gain factor

See Also **TEC:GAIN:KI?; TEC:GAIN:KP; TEC:GAIN:KD; TEC:GAIN:IL**

TEC:GAIN:KI?

Description PID control – integral gain factor query.

Syntax **TEC:GAIN:KI?**

Remarks This query returns the integral gain factor value.

Response	Description
Value	Integral gain factor

See Also **TEC:GAIN:KI; TEC:GAIN:KP; TEC:GAIN:KD; TEC:GAIN:IL**

TEC:GAIN:KP

Description PID control – proportional gain factor.

Syntax **TEC:GAIN:KP** *Value*

Remarks This command sets the proportional gain factor, Kp, used in PID closed loop control.

Argument	Value	Description
Value	Float	Proportional gain factor

See Also **TEC:GAIN:KP?; TEC:GAIN:KI; TEC:GAIN:KD; TEC:GAIN:IL**

TEC:GAIN:KP?

Description PID control – proportional gain factor query.

Syntax **TEC:GAIN:KP?**

Remarks This query returns the proportional gain factor value.

Response	Description
Value	Proportional gain factor

See Also **TEC:GAIN:KP; TEC:GAIN:KI; TEC:GAIN:KD; TEC:GAIN:IL**

TEC:GAIN:PRESET

Description PID control – preset gains bin.

Syntax **TEC:GAIN:PRESET** *Value*

Remarks The 3700 Temperature Controller has 10 preset PID control loop settings. This command can be used to select any one of these settings. After issuing this command, the commands such as TEC:GAIN:KP?, TEC:GAIN:KD? etc. can be issued to query the actual PID control loop settings that come with the desired preset bin. While this command is used to select some predefined PID settings, it does not preclude the users from modifying the individual gain settings. If any one of the gain settings is different from the predefined settings, the instrument assumes that the preset bin is a "custom" bin (bin number = 10).

Argument	Value	Description
Value	0 to 9	PID preset bin number

See Also **TEC:GAIN:KP; TEC:GAIN:KI; TEC:GAIN:KD; TEC:GAIN:IL**

TEC:GAIN:PRESET?

Description PID control – preset gains bin query.

Syntax **TEC:GAIN:PRESET?**

Remarks This query returns the PID preset bin number.

Response	Description
Value	PID preset bin number

See Also **TEC:GAIN:KP?; TEC:GAIN:KI?; TEC:GAIN:KD?; TEC:GAIN:IL?**

TEC:Ite

Description TEC I_{TE} set point command.

Syntax **TEC:Ite** *set point*

Remarks This command sets the TEC control current set point.

Argument	Value	Description
set point	float	set point in Amps

See Also **TEC:ITE?, TEC:LIMit:ITE, TEC:SET:ITE?**

TEC:Ite?

Description TEC measured output current query.

Syntax **TEC:Ite?**

Remarks This query returns the value of the measured TEC output current.

Response	Description
measured output	Current in Amps

The TEC current is constantly measured and updated, regardless of the TEC mode of operation.

This measurement is updated approximately once every 10 milliseconds.

See Also **TEC:Ite**

TEC:LIMit:Ite

Description TEC I_{TE} current limit command

Syntax **TEC:LIMit:Ite** *limit*

Remarks This command sets the TEC ITE current limit value.

Argument	Value	Description
limit	float	Limit in Amps

The factory default current limit is 0 Amps.

See Also **TEC:ITE**

TEC:LIMit:Ite?

Description TEC I_{TE} current limit query

Syntax **TEC:LIMit:Ite?**

Remarks This query returns the value of the TEC current limit.

Response	Description
limit	Limit in Amps

See Also **TEC:LIMit:Ite**

TEC:LIMit:RHI

Description TEC R_{HI} limit command.

Syntax **TEC:LIMit:RHI** *limit*

Remarks This command sets the TEC sensor high resistance limit value.

Argument	Value	Description
limit	float	Thermistor limit in kΩ or AD590 limit in μA or LM335 limit in mV or RTD limit in Ω

See Also **TEC:LIMit:RHI?, TEC:R**

TEC:LIMit:RHI?

Description TEC R_{HI} limit query.

Syntax **TEC:LIMit:RHI?**

Remarks This query returns the TEC sensor high resistance limit value.

Response	Description
limit	Thermistor limit in kΩ or AD590 limit in μA or LM335 limit in mV or RTD limit in Ω

See Also **TEC:LIMit:RHI**

TEC:LIMit:RLO

Description TEC R_{LO} limit command.

Syntax **TEC:LIMit:RLO** *limit*

Remarks This command sets the TEC sensor low resistance limit value.

Argument	Value	Description
limit		Thermistor limit in kΩ or AD590 limit in μA or LM335 limit in mV or RTD limit in Ω

See Also **TEC:LIMit:RLO?, TEC:R**

TEC:LIMit:RLO?

Description TEC R_{LO} limit query.

Syntax **TEC:LIMit:RLO?**

Remarks This query returns the TEC sensor low resistance limit value.

Response	Description
limit	Thermistor limit in kΩ or AD590 limit in μA or LM335 limit in mV or RTD limit in Ω

See Also **TEC:LIMit:RLO**

TEC:LIMit:THI

Description TEC T_{HI} limit command.

Syntax **TEC:LIMit:THI** *limit*

Remarks This command sets the TEC sensor high temperature limit value.

Argument	Value	Description
limit	float	Limit in °C, -100 to 240 (200 for LM335 and AD590)

See Also **TEC:LIMit:THI, TEC:T**

TEC:LIMit:THI?

Description TEC T_{HI} limit query

Syntax **TEC:LIMit:THI?**

Remarks This query returns the value of the TEC sensor high temperature limit.

Response	Description
limit	Limit in °C, -100 to 240 (200 for LM335 and AD590)

See Also **TEC:LIMit:THI**

TEC:LIMit:TLO

Description TEC T_{LO} limit command.

Syntax **TEC:LIMit:TLO** *limit*

Remarks This command sets the TEC sensor low temperature limit value.

Argument	Value	Description
limit	float	Limit in °C, -100 to 240 (200 for LM335 and AD590)

See Also **TEC:LIMit:TLO?, TEC:T**

TEC:LIMit:TLO?

Description TEC T_{LO} limit query

Syntax **TEC:LIMit:TLO?**

Remarks This query returns the value of the TEC sensor low temperature limit.

Response	Description
limit	Limit in °C, -100 to 240 (200 for LM335 and AD590)

See Also **TEC:LIMit:TLO**

TEC:LIMit:Vte

Description TEC V_{TE} limit command.

Syntax **TEC:LIMit:Vte** *limit*

Remarks This command sets the compliance voltage limit value.

Argument	Value	Description
limit	float	Voltage limit from 0 to 22.0V

See Also **TEC:LIMit:Vte?, TEC:Vte?**

TEC:LIMit:Vte?

Description TEC V_{TE} limit query

Syntax **TEC:LIMit:Vte?**

Remarks This query returns the compliance voltage limit value.

Response	Description
limit	Voltage limit from 0 to 22.0V

See Also **TEC:LIMit:Vte**

TEC:MODE

Description TEC operation mode command.

Syntax **TEC:MODE** *mode*

Remarks This command sets the TEC's mode of operation.

Argument	Value	Description
mode	0	constant current
	1	constant R
	2	constant T

See Also **TEC:MODE?; TEC:MODE:Ite; TEC:MODE:R; TEC:MODE:T**

TEC:MODE?

Description TEC control mode query.

Syntax **TEC:MODE?**

Remarks This query returns the selected TEC control mode.

Response	Value	Description
mode	0	constant current
	1	constant R
	2	constant T

See Also **TEC:MODE; TEC:MODE:Ite; TEC:MODE:R; TEC:MODE:T**

TEC:MODE:ITE

Description TEC ITE mode command.

Syntax **TEC:MODE:ITE**

Remarks This command selects TEC constant current mode.

Changing modes causes the output to be forced off, and the new mode's set point value will be displayed.

See Also **TEC:I; TEC:MODE?**

TEC:MODE:R

Description TEC R mode command.

Syntax **TEC:MODE:R**

Remarks This command selects TEC constant thermistor resistance/linear sensor reference mode.

Since sensor resistance (or linear sensor reference) is a function of temperature, this mode also controls the TEC output temperature, but it bypasses the use of the conversion constants for set point calculation. This allows finer control of temperature in cases where the sensor's temperature model (and therefore the constants) is not known.

Changing modes causes the output to be forced off, and the new mode's set point value will be displayed.

See Also **TEC:MODE?, TEC:R**

TEC:MODE:T

Description TEC temperature mode command.

Syntax **TEC:MODE:T**

Remarks This command selects TEC constant temperature mode.

Since TEC temperature is derived from thermistor or RTD resistance, or, linear sensor current or voltage, constant R and T modes are related. In T mode the set point is converted to resistance voltage or current by using the appropriate constants and conversion model.

Changing modes causes the output to be forced off, and the new mode's set point value will be displayed.

See Also **TEC:MODE?, TEC:T**

TEC:OUTput

Description TEC output enable command.

Syntax **TEC:OUTput** *enable*

Remarks This command enables or disables the TEC output.

Argument	Value	Description
enable	0	off
	1	on

After the output is turned on, it may be useful to wait until the output is stable before performing further operations.

See Also **TEC:OUTput?**

TEC:OUTput?

Description TEC output enable query.

Syntax **TEC:OUTput?**

Remarks This query returns the status of the TEC output.

Response	Value	Description
enable	0	off
	1	on

Although the status of the switch is on, the output may not have reached the set point value.

See Also **TEC:OUTput**

TEC:R

Description TEC R set point command.

Syntax **TEC:R** *set point*

Remarks This command sets the TEC constant thermistor or RTD resistance or linear sensor voltage or current set point.

Argument	Value	Description
set point	float	Thermistor set point in kΩ or AD590 set point in μA or LM335 set point in mV or RTD set point in Ω

See Also **TEC:LIMit:RHI; TEC:LIMit:RLO; TEC:R?**

TEC:R?

Description TEC measured R query.

Syntax **TEC:R?**

Remarks This query returns the value of the TEC thermistor or RTD resistance, AD590 current, or LM335 voltage measurement.

Response	Description
R value	Measured Thermistor resistance in kΩ or Measured AD590 current in μA or Measured LM335 voltage in mV or Measured RTD resistance in Ω

This measurement is updated approximately once every 10 milliseconds.

See Also **TEC:R**

TEC:SENsor

Description TEC sensor select command.

Syntax **TEC:SENsor** *sensor*

Remarks This command is used to set the sensor type. This value is a coded representation of the sensor type/thermistor current.

Argument	Value	Description
sensor	0	None
	1	100Ω Thermistor
	2	1.0kΩ Thermistor
	3	10.0kΩ Thermistor
	4	100.0kΩ Thermistor
	5	1.0MΩ Thermistor
	6	LM335
	7	AD590
	8	RTD
	9	Custom Thermistor

See Also **TEC:SENsor?**

TEC:SENsor?

Description TEC sensor select query.

Syntax **TEC:SENsor?**

Remarks This query returns the sensor type. This value is a coded representation of the sensor type/thermistor current.

Argument	Value	Description
sensor	0	None
	1	100Ω Thermistor
	2	1.0kΩ Thermistor
	3	10.0kΩ Thermistor
	4	100.0kΩ Thermistor
	5	1.0MΩ Thermistor
	6	LM335
	7	AD590
	8	RTD
	9	Custom Thermistor

See Also **TEC:SENsor**

TEC:SET:ITE?

Description TEC ITE set point query.

Syntax **TEC:SET:ITE?**

Remarks This query returns the TEC constant current set point value.

Response	Description
set point	ITE set point in Amps

See Also **TEC:I**

TEC:SET:R?

Description TEC R set point query.

Syntax **TEC:SET:R?**

Remarks This query returns the TEC constant thermistor or RTD resistance or linear sensor voltage or current set point value.

Response	Description
set point	Thermistor set point in kΩ or AD590 set point in μA or LM335 set point in mV or RTD set point in Ω

See Also **TEC:R**

TEC:SET:T?

Description TEC temperature set point query.

Syntax **TEC:SET:T?**

Remarks This query returns the TEC constant temperature set point value in °C.

Response	Description
set point	Set point in °C

See Also **TEC:T**

TEC:T

Description TEC temperature set point command.

Syntax **TEC:T** *set point*

Remarks This command sets the TEC constant temperature set point.

Argument	Value	Description
set point	float	Set point in °C

See Also **TEC:SET:T?, TEC:T**

TEC:T?

Description TEC measured temperature query.

Syntax **TEC:T?**

Remarks This query returns the value of the TEC temperature measurement.

Response	Description
measured temp	Measured temperature in °C

This measurement is updated approximately once every 10 milliseconds.

See Also **TEC:T**

TEC:THERM

Description Custom thermistor feedback sensor rating.

Syntax **TEC:THERM** *rating*

Remarks This command sets the custom thermistor feedback sensor rating. This information is used by the instrument, in conjunction with thermistor constants, to arrive at temperature sensed by the custom thermistor.

Argument	Value	Description
rating	float	resistance in kΩ

See Also **TEC:THERM?; TEC:CONST**

TEC:THERM?

Description Custom thermistor feedback sensor rating query.

Syntax **TEC:THERM?**

Remarks This query returns the custom thermistor feedback sensor rating.

Response	Description
rating	resistance in kΩ

See Also **TEC:THERM**

TEC:TTL:IN?

Description TTL input state query.

Syntax **TEC:TTL:IN?**

Remarks This query returns the TTL input state.

Response	Description
value	0 or 1 depending upon whether the TTL input is LOW or HIGH

See Also **TEC:TTL:OUT**

TEC:TTL:OUT

Description TTL output state command

Syntax **TEC:TTL:OUT** *Value*

Remarks This command sets the TTL output state.

Argument	Value	Description
Value	0 or 1	0 = TTL output LOW; 1 = TTL output HIGH

See Also **TEC:TTL:IN?**

TEC:Vte?

Description TEC compliance voltage query

Syntax **TEC:V?**

Remarks This query returns the TEC compliance voltage.

Response	Description
voltage	TEC voltage in volts

See Also **TEC:I?**

6 Principles of Operation

6.1 Introduction

Features of the Model 3700 Temperature Controller include:

- High-stability, low noise design
- Fault detection
- Current, voltage and temperature limiting

CAUTION

Although ESD (electrostatic discharge) protection is designed into the driver, operation in a static-free work area is recommended.

6.2 TEC Handling Precautions

TECs are sensitive to static discharge and guidelines should be followed at all times when handling laser diodes:

a. All operators must have a properly grounded wrist strap before handling any TEC.

b. All soldering iron tips must be properly grounded.

c. All related test and assembly equipment must be properly grounded

NOTE

Always follow the TEC manufacturer's specifications for maximum temperatures and current.

CAUTION

Before connecting the TEC to the unit, be sure that the output is OFF. Before turning on the TEC output, be sure that the current limit and voltage compliance limit has been correctly set.

NOTE

The cable connections to the TEC must be secure to avoid an open circuit, should they be jostled or bumped. Should an open circuit occur during TEC operation, the TEC output will normally be turned off automatically.

NOTE

Special circuits in the TEC driver are present for detecting intermittent contacts and connections. These circuits detect the abrupt change in current that occurs when the output circuit is opened, and the model 3700 will generate an error.

Electrostatic discharge (ESD) can cause TEC failure. In order to optimize immunity from radiated or conducted electromagnetic energy, e.g., static discharge, adhere to the following guidelines for the TEC:

- Use anti-static wrist straps (grounded with 1 MΩ resistor), anti-static floor coverings, grounded soldering irons, and grounded work areas. Ionized air blowers are also recommended.
- Short TEC leads whenever the laser is transported or stored.
- If industrial loads are switched in or near your laboratory, use isolation transformers and/or a surge suppressor power strip with your laser current source.
- Isolate your TEC driver with a surge suppresser when using a common line with laboratory power supplies, soldering irons, or other electronic instruments. Avoid using such devices on the same surge suppresser as your laser source.
- Make sure all the cables to the TEC are securely fastened. Avoid "bundling" current source cables with other cables in your laboratory.
- Set current and voltage limits to appropriate levels, following the TEC manufacturer's recommendations (or to just above the expected operating current). Suggestions include setting the compliance voltage no more than 10% above V_f, and setting the current limit at or below the maximum operating current of the TEC .
- Avoid ground loops.

6.3 TEC Controller Operation

6.3.1 Thermistor and Thermistor Current Selection

6.3.1.1 Introduction

Choosing the right sensing current depends on the range of temperature you want to measure and the resolution you require at the highest measured temperature. To correctly set the thermistor current you must understand how the thermistor and the 3700 interact.

6.3.1.2 Thermistor Range

Thermistors can span a wide temperature range, but their practical range is limited by their non-linear resistance properties. As the sensed temperature increases, the resistance of the thermistor decreases significantly and the thermistor resistance changes less for an equivalent temperature change. Consider the temperature and sensitivity figures below.

Temperature	Sensitivity
-20°C	5600 ohms/°C
25°C	439 ohms/°C
50°C	137 ohms/°C

In the 3700 the practical upper temperature limit is the temperature at which the thermistor becomes insensitive to temperature changes. The maximum ADC input voltage of the 3700 limits the lower end of the temperature range. Thermistor resistance and voltage are related through Ohm's Law (V = I x R). The 3700 supplies bias current to the thermistor, and as the resistance changes, a changing voltage signal is available to the thermistor inputs of the 3700. The 3700 is capable of supplying the following bias currents to the thermistor: 10 mA (100 Ohm), 1 mA (1 kOhm), 100 μA (10 kOhm), 10 μA (100 kOhm), 1 μA (1 MOhm). The 3700 will over-range when the input voltage exceeds about 2.5 Volts. Figure 28 graphically shows the lower temperature and upper voltage limits for a typical 10 kOhm thermistor. The practical temperature ranges for a typical 10 K thermistor (a 10 K thermistor has a resistance of 10 k Ohms at 25°C) are given in the table below.

Sensing Current	Temperature Range
10 μA	-35 to 40°C
100 μA	+8 to 80°C

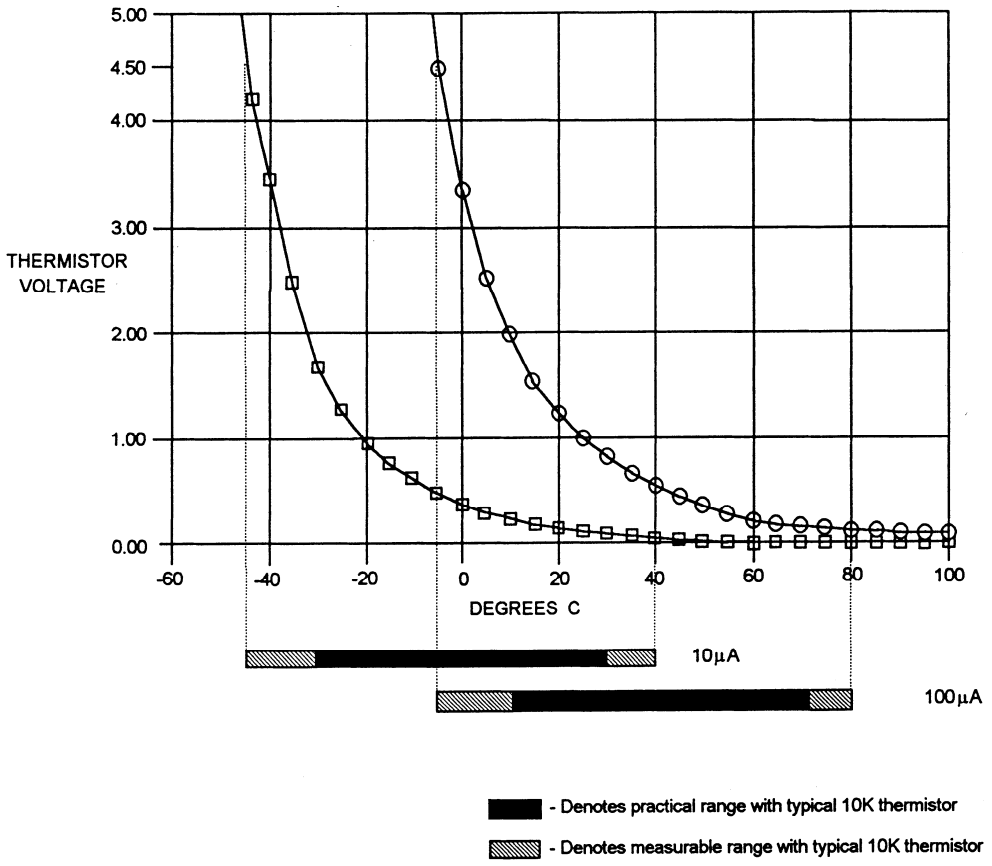


Figure 28 Thermistor Temperature Range

6.3.1.3 Temperature Resolution

You must also consider measurement resolution since the resolution decreases as the thermistor temperature increases. The microprocessor converts this digital number to resistance, stores this resistance, then converts it to a temperature using the Steinhart-Hart equation, and stores this temperature. A temperature change of one degree centigrade will be represented by a greater resistance increase (and therefore more ADC counts) at lower temperatures because of the non-linear resistance of the thermistor. Resolution figures for a typical 10 kΩ thermistor are given below.

Temperature	Voltage at 10 µA	Resolution
-20 °C	56.0 mV/°C	0.018 °C/mV
25 °C	4.4 mV/°C	0.230 °C/mV
50 °C	1.4 mV/°C	0.700 °C/mV

For this thermistor, a temperature change from -20°C to -19°C will be represented by 737 ADC counts (if supplied with 10µA). The same thermistor will only change about 18 ADC counts from 49°C to 50°C.

6.3.1.4 Selecting Thermistor Current

To select the current setting for a typical 10 kΩ thermistor, determine the lowest temperature you will need to sample and select the current according to the range limits given above. If the temperature you want to sample is below -10°C you should use the 10µA setting.

With the current set to 10µA the best resolution you will see will be a 1.0°C temperature change. If, for example, the lower limit is 0°C you can choose either setting, but there is a tradeoff in terms of resolution. If you need better than 0.1°C measurement resolution you will have to change to 100µA.

If you need high resolution over a narrow range, for a very accurate measurement, you can set the current setting for the maximum resolution. For example, at a high temperature of 15°C, you require a measurement resolution of at least 0.05°C. This resolution is within the range of either setting, but at the 10µA setting the resolution is only 0.2°C while at the 100 µA setting the resolution is better than .05 °C.

Generally, it is best to use the 100µA setting for all measurements of -10°C or greater with a 10 K thermistor.

6.3.1.5 Selecting Thermistors

The type of thermistor you choose will depend primarily on the operating temperature range. These guidelines for selecting the range and resolution will apply to any thermistor. 10 K thermistors are generally a good choice for most laser diode applications where high stability is required near room temperatures. Similarly, 10 K thermistors are often a good choice for cooling applications where you want to operate at temperatures from -40°C to room temperature.

If you require a different temperature range or the accuracy you need can't be achieved with either current setting, select another thermistor. Thermistor temperature curves, supplied by the manufacturer, show the resistance versus temperature range for many other thermistors. Contact a Newport application engineer with your specific application.

6.3.1.6 The Steinhart-Hart Equation

The Steinhart-Hart equation is used to derive temperature from the non-linear resistance of an NTC (Negative Temperature Coefficient) thermistor.

The following section contains an explanation of the Steinhart-Hart equation and the values of these constants for some common thermistors.

Two terminal thermistors have a non-linear relationship between temperature and resistance. The resistance versus temperature characteristics for a family of similar thermistors is shown in Figure 29. It has been found empirically that the resistance versus temperature relationship for most common negative temperature coefficient (NTC) thermistors can be accurately modeled by a polynomial expansion relating the logarithm of resistance to inverse temperature. The Steinhart-Hart equation is one such expression and is given as follows:

$$1/T = C1 + C2\ (\text{Ln}\ R) + C3\ (\text{Ln}\ R)^3 \qquad \text{(Eq. 1)}$$

where T is in Kelvin. To convert T to °C, subtract 273.15.

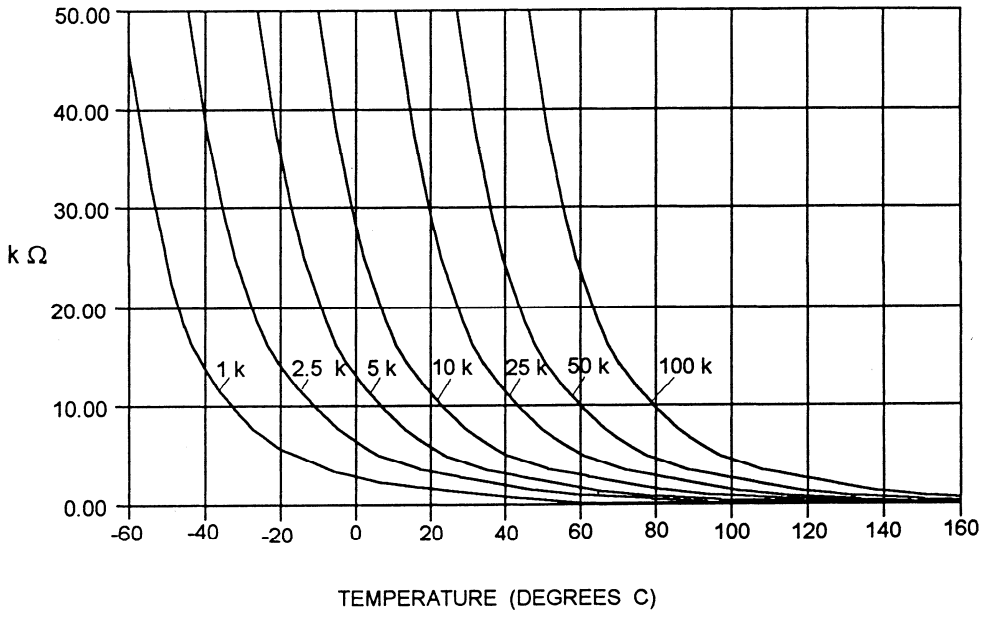


Figure 29 Thermistor Resistance verus Temperature

Once the three constants C1, C2, and C3 are accurately determined, only small errors in the calculation of temperature over wide temperature ranges exist. The equation will produce temperature calculation errors of less than 0.01°C over the range -20 °C to 50 °C.

The constants C1, C2, and C3 are expressed in the form n.nnnn, simplifying entry into the 3700.

6.3.1.7 Table of Constants

Common thermistors and the appropriate calibration constants for the temperature range -20 °C to 50 °C are listed in Table 10. The Model 3700 uses the BetaTHERM 10K3 thermistor values by default.

Manufacturer	*C1 * 10^{-3}*	*C2 * 10^{-4}*	*C3 * 10^{-7}*
BetaTHERM 10K3	**1.129241**	**2.341077**	**0.877547**
BetaTHERM 0.1K1	1.942952	2.989769	3.504383
BetaTHERM 0.3K1	1.627660	2.933316	2.870016
BetaTHERM 1K2	1.373419	2.771785	1.999768
BetaTHERM 1K7	1.446659	2.682454	1.649916
BetaTHERM 2K3	1.498872	2.379047	1.066953
BetaTHERM 2.2K3	1.471388	2.376138	1.051058
BetaTHERM 3K3	1.405027	2.369386	1.012660
BetaTHERM 5K3	1.287450	2.357394	0.950520
BetaTHERM 10K3	1.129241	2.341077	0.877547
BetaTHERM 10K4	1.028444	2.392435	1.562216
BetaTHERM 30K5	0.933175	2.213978	1.263817
BetaTHERM 30K6	1.068981	2.120700	0.901954
BetaTHERM 50K6	0.965715	2.106840	0.858548
BetaTHERM 100K6	0.827111	2.088020	0.805620

Table 10 Thermistor Constants

6.3.2 AD590 and LM335

6.3.2.1 General

The 3700 uses two constants (C1 and C2) for calibrating the two linear thermal sensing devices, the AD590 and the LM335. C1 is used as the zero offset value, and C2 is used as the slope or gain adjustment. Therefore, C1 has a nominal value of 0, and C2 has a nominal value of 1 when using the AD590 or LM335. In order to calibrate a linear sensor device, the sensor must be operated at an accurately known, stable temperature. For example, the sensor may be calibrated at 0 °C if the sensor is placed in ice water until its temperature is stable. A highly accurate temperature probe, thermometer, environmental chamber, etc., may also be used to determine the known temperature for calibration.

6.3.2.2 AD590 Sensor

The AD590 is a linear thermal sensor that acts as a current source. It produces a current, i, which is directly proportional to absolute temperature, over its useful range (-50 °C to + 150 °C). This nominal value can be expressed as:

$$i = 1\ \mu A / K$$

where i is the nominal current produced by the AD590, and K is in Kelvin.

The 3700uses i to determine the nominal temperature, T_n, by the formula:

$$T_n = (i / (1\ \mu A / K)) - 273.15$$

where T_n is in °C.

The displayed temperature, $T_d = C1 + (C2 * T_n)$, is then computed, where C1 and C2 are the constants stored in the 3700for the AD590. The AD590 grades of tolerance vary, but typically, without adjusting C1 and C2, the temperature accuracy is ±1°C over its rated operating range. However, the AD590 is not perfectly linear, and even with C1 accurately known there is a non-linear absolute temperature error associated with the device. This non-linearity is shown in Figure 30, reprinted from Analog Devices specifications, where the error associated with C1 is assumed to be zero.

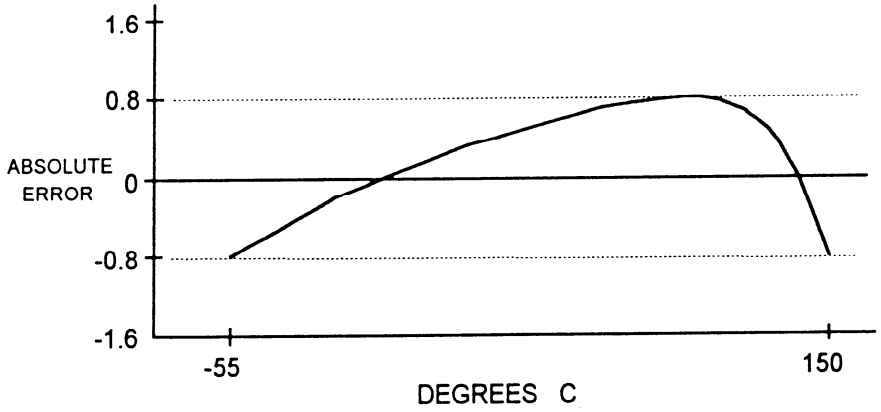


Figure 30 AD590 Nonlinearity

If a maximum absolute error of 0.8°C is tolerable, the one point calibration of C1 should be used. If a greater accuracy is desired, the two point method of determining C1 and C2 should be used. Note however, the absolute error curve is non-linear, therefore the constant C2 will vary for different measurement points.

6.3.2.3 LM335 Sensor

The LM335 is a linear thermal sensor that acts as a voltage source. It produces a voltage, v, which is directly proportional to absolute temperature,

over its useful range (-40°C to + 100°C). This nominal value can be expressed as:

$$v = 10mV / K$$

where v is the voltage produced by the LM335 and K is Kelvin.

The 3700 uses v to determine the nominal temperature, T_n, by the formula:

$$T_n = (v / (10mV / K)) - 273.15$$

where T_n is in °C.

The temperature, T_d, which is displayed by the 3700 is calculated as follows:

$$T_d = C1 + (C2 * T_n)$$

where C1 and C2 are the constants stored in the 3700 for the LM335.

When the LM335 is calibrated to 25°C, C1 = 0 and C2 = 1, and the temperature accuracy is typically ±0.5°C over the rated operating range. However, the LM335 is not perfectly linear, and even with C1 accurately known there is a non-linear absolute temperature error associated with the device. This non-linearity caused error is typically ±0.3°C, with the error associated with C1 assumed to be zero.

If a maximum absolute error of ±0.3°C can be tolerated, the one point calibration of C1 should be used. If a greater accuracy is desired, the two point method of determining C1 and C2 should be used. Note however, the absolute error associated with the constant C2 may vary over different temperature ranges.

6.3.2.4 Determining C1 and C2 for the AD590 and LM335

The nominal values of C1 and C2 are 0 and 1, respectively, for both types of devices. These values should be used initially for determining C1 and C2 in the methods described below.

The One Point method is easiest, but it ignores the non-linearity of the device. It is most useful when a high degree of temperature accuracy is not required.

The Two Point method can achieve a high degree of accuracy over a narrower operating temperature range, but requires two accurate temperature measurements.

One Point Calibration Method

The accuracy of this procedure depends on the accuracy of the externally measured temperature. It is used to determine the zero offset of the device, and it assumes that the gain (slope) is known.

1. Allow the 3700 to warm up for at least one hour. Select the desired sensor type in the setup menu.

2. Set the C1 parameter to zero. Set the C2 parameter to 1.

3. Place the sensor at an accurately known and stable temperature, T_a . Connect the sensor to the 3700 for normal Constant temperature operation. Allow the 3700 to stabilize at the known temperature, T_a and read the displayed temperature, T_d.

4. Determine the new value of C1 from the formula:

$$C1 = T_a - T_d$$

   and enter the new C1 value.

Two Point Calibration Method

The accuracy of this procedure depends on the accuracy of the externally measured temperature. It is used to determine the zero offset of the device and the gain (slope).

1. Allow the 3700 to warm up for at least one hour. Select the desired sensor type in the setup menu.

2. Set the C1 parameter to zero. Set the C2 parameter to 1.

3. Place the sensor at an accurately known and stable temperature, T_{a1}. Connect the sensor to the 3700 for normal Constant temperature operation. Allow the 3700 to stabilize at the known temperature, T_{a1} and read the displayed temperature, T_{d1}. Record these values.

4. Repeat Step 3 for another known temperature, T_{a2}, and the corresponding displayed temperature, T_{d2}. The two known temperatures should at the bounds of the intended operating range.

For best results, make the range between T_{a1} and T_{a2} as narrow as possible.

5. Determine the new value of C1 and C2 from the following calculations.

$$C2 = (T_{a1} - T_{a2}) / (T_{d1} - T_{d2}), \text{ and}$$

$$C1 = T_{a1} - (T_{d1} * C2)$$

6. Enter the new C1 and C2 values.

6.3.3 RTD Sensors

The following equation is used in temperature to resistance conversions:

$$R_T = R_0 [1 + (C1 \times T) + (C2 \times T^2) + (C3 \times (T-100) \times T^3)] \text{ for } T < 0°C$$
$$R_T = R_0 [1 + (C1 \times T) + (C2 \times T^2)] \text{ for } T >= 0°C$$

where: R_T is the resistance in Ω at temperature T.

T is the temperature in °C.

6.3.3.1 RTD Constants

The constants entered for an RTD depend on the type of curve it has. Table 11 shows three standard types.

Curve	TCR (Ω/Ω/°C)	C1	C2	C3	R_0
Laboratory	.003926	3.9848×10^{-3}	-0.58700×10^{-6}	-4.0000×10^{-12}	100.00
US	.003910	3.9692×10^{-3}	-0.58495×10^{-6}	-4.2325×10^{-12}	100.00
European	.003850	3.9080×10^{-3}	-0.58019×10^{-6}	-4.2735×10^{-12}	100.00

Table 11 RTD Constants

The Ro constant also applies for RTD sensors. It is the RTD value at 0^o C and is nominally 100.00 Ω, but can be varied from 95.00 Ω to 105.00 Ω.

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7 Tips and Techniques

7.1 Introduction

This section explains operational details of the Model 3700 Temperature Controller and provides application examples.

7.2 TEC Limits

The TEC driver has several limits to protect the TEC from damage. The limits include current and compliance voltage.

7.2.1 Current Limit

There are two types of current limit:

- In the first type, the TEC controller processor does not allow the driver output to exceed the limit's set point via front panel or USB command. This form of limiting is called the **soft limit**, and does not affect the operation of the TEC except to limit the drive current.
- In the second type, the high-speed DSP processor monitors the actual TEC current and if that exceeds the limit set point for any reason then the output is immediately shut down. This form of limit is called the **hard limit**. The TEC will always be shut down on a hard limit.

7.2.2 Voltage Limit

The control processor continuously monitors output condition and prevents overdriving the TEC voltage. When the voltage limit is reached, the output current is shut off to prevent damage to the TEC.

7.2.3 Operating at or Near Io and Vte Limits

Because of the sensitivity of the limit circuits, operating at or near the limit unless necessary is not recommended. AC line transients, RF interference, or static can be enough to trigger these limits. Triggers for hard limits and voltage compliance limits vary, but can include the following:

- Static discharges, which may cause enough noise to trigger the circuit.
- Turning on the laser when its set point is at or near the limit. Turning on the output with the set point at the limit can cause a small overshoot in the drive current, which the limit circuitry may pick up as a hard limit and shut down the laser.

7.3 Grounding a TEC

The laser outputs are isolated from earth (chassis) ground. Isolating the TEC case avoids damaging the device from multiple ground loop potentials, AC transients, or static discharge. Since test equipment probes, signal sources, and package mounts are often partially earth grounded, it is often necessary to also bond the device case to earth ground. It is strongly recommended that a single point ground scheme be established, specifically at the binding post. This will help minimize noise, transients, and ground loop hazards. Be sure to include any signal generators in your ground circuit.

CAUTION

Do not connect the temperature sensor to Earth Ground at the same time with grounding either TE+ or TE-. Only one connection to ground is accepted. Failure to do so may result in the unit malfunction or/and damage. Be careful when connecting other instruments to 3700 Temperature Controller, as they may have their ground connected to the Earth Ground.

For example, oscilloscopes have the probe ground connected to Earth Ground. If either TE+ or TE- is already connected to Earth Ground, the oscilloscope may bring the second connection, causing malfunction or damage.

If you have additional questions about your earth grounding method, contact a Newport applications engineer.

8 Maintenance and Service

	**WARNING** **There are no user serviceable parts inside the Model 3700 Temperature Controller. Work performed by persons not authorized by Newport Corporation will void the warranty.**

8.1 Enclosure Cleaning

	**WARNING** **Before cleaning the enclosure of the Model 3700 Temperature Controller, the AC power cord must be disconnected from the wall socket.**

The source enclosure should only be cleaned with a mild soapy water solution applied to a damp lint-free cloth. Do not use an acetone or alcohol solution; this will damage the finish of the enclosure.

8.2 Obtaining Service

The Model 3700 TEC Driver contains no user serviceable parts. To obtain information regarding factory service, contact Newport Corporation or your Newport representative. Please have the following information available:

1. Instrument model number (on the rear panel)
2. Instrument serial number (on rear panel or bottom of enclosure)
3. Description of the problem.

If the instrument is to be returned to Newport Corporation, you will be given a Return Number, which you should reference in your shipping documents. Please fill out a copy of the service form, located on the following page, and have the information ready when contacting Newport Corporation. Return the completed service form with the instrument.

8.3 Service Form

Newport Corporation U.S.A.
Office: 800-222-6440
FAX: 949/253-1479

Name _____ **Return Authorization #_____**
(Please obtain RA# prior to return of item)

Company _____
(Please obtain RA # prior to return of item)

Address _____ _____Date _____

Country _____ Phone Number _____

P.O. Number _____ FAX Number _____

Item(s) Being Returned:

Model # _____ Serial # _____

Description _____

Reason for return of goods (please list any specific problems):

_____

_____

_____

_____

_____

9 Appendix A – Error Messages

9.1 Introduction

The communication errors can be retrieved with the following commands: ERR? or ERRSTR?. The descriptions of the returned errors are detailed in the next sections.

9.2 Error Description

A description of error codes and corresponding error strings generated by the TEC Driver is given below:

Error Code	Error String	Description
0	NO ERROR	No error exists in the error buffer
116	SYNTAX ERROR	This error is generated when the instrument receives a command that cannot be processed. Some typical causes: a. Using ASCII characters outside of a string constant that are not defined by the command language syntax. b. Missing space between a set command and parameter. c. Missing "?" character in case of query
126	WRONG NUM OF PARAMS	This error is generated when the instrument is unable to process a command due to a mismatch between the number of parameters received and the number of parameters required for the command.
200	REMOTE MODE	This error is generated when the instrument is in REMOTE mode and the user tries to change settings using front panel.
201	VALUE OUT OF RANGE	This error is generated when the instrument is unable to process a command because the parameter value received is out of range of the acceptable values for the command.
402	SENSOR OPEN	The output has been turned OFF because the input voltage from AD590 sensor is less than –0.50V or voltage from LM335 sensor is greater than 1.50V. Once the fault is corrected, "TEC:OUTput 1" command must

		be issued to clear the error indication, and to restore current to the TE module.
405	VOLTAGE LIMIT	The output has been turned OFF because the forward voltage drop of a TE module exceeds the compliance voltage specified in the Specification table. Once the fault is corrected, "TEC:OUTput 1" command must be issued to clear the error indication, and to restore current to the TE module.
406	RESISTANCE LIMIT	The output has been turned OFF because the measured resistance/reference value is either less than or greater than the specified RLO and RHI limits respectively. "TEC:OUTput 1" command must be issued to clear the error indication, and to restore current to the TE module.
407	TEMPERATURE LIMIT	The output has been turned OFF because the measured temperature value is either less than or greater than the specified TLO and THI limits respectively. "TEC:OUTput 1" command must be issued to clear the error indication, and to restore current to the TE module.
409	SENSOR CHANGE	The output has been turned OFF because the feedback sensor type was changed either through the setup menu on front panel or through PC communication (TEC:SENsor command).
415	SENSOR SHORT	The output has been turned OFF because the input voltage from AD590 sensor is greater than 1.50V or voltage from LM335 sensor is less than –0.50V. Once the fault is corrected, "TEC:OUTput 1" command must be issued to clear the error indication, and to restore current to the TE module.
419	MODE CHANGE	The output has been turned OFF because a mode change was commanded using either "TEC:MODE:Ite" or "TEC:MODE:R" or "TEC:MODE:T" commands or through front-panel interface.
420	INTERLOCK ERROR	The output has either been turned OFF or cannot be turned ON because the instrument detected a TE module disconnect.
434	SENSOR MISMATCH	This error is generated when user tries to set custom thermistor sensor rating using TEC:THERM command, but the sensor type is not a Custom Thermistor.
901	SYSTEM OVER TEMP	The output has been turned OFF because the temperature inside the instrument has exceeded safe levels. Please allow the unit to cool down before turning the output ON again.

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