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User's Guide

LDC-3700B Series
Laser Diode Controller



ILX Lightwave
Laser Diode Instrumentation & Test Systems

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TABLE OF CONTENTS

Safety Information and the Manual ix
General Safety Considerations ix
Safety Marking Symbols x
Returning an Instrument xi
Claims for Shipping Damage xii
Comments, Suggestions, and Problems xiii

Chapter 1 Introduction and Specifications

Product Overview 1
Initial Inspection 1
Installing the LDC-3700B 2
Grounding Requirements 2
AC Line Power Requirements 2
GPIB Connector 2
The GPIB Address 3
Tilt-Foot Adjustment 3
Rack Mounting 3
Operating the LDC-3700B Laser Diode Controller 3
How to Obtain Repair Services 5
Specifications[1] 6
Temperature Controller Specifications[1] 8
General LDC-3700B Specifications 9
Available Options and Accessories 11

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Chapter 2 Operations

Applying Power to your LD Controller 13
The Power On Sequence 13

The Power On State 14
37x4B Series Default Configuration: 14

Connecting to the Laser Controller 15

Connecting the Laser Current Source 17
Interlock Connections 17
Photodiode Connections 17
Setting the PD bias 18
Grounding Considerations 18

Connecting to the TE Controller 19

TEC Grounding Considerations 19

Operating from the Front Panel 20

The Laser Controller Display 20

Operating a Laser in Constant Current “I” Mode 20
Set Up the Controller 20
Set the Range 21
Select the Laser Display 21
Adjusting the Set Point 21
Set Current Source Limit 22
Set Compliance Voltage Limit 23
Automatic Shutoff Conditions for Laser Output 24

Operating a Laser in Constant Power Mode, P 24
Entering Photodiode Responsivity values 24
LASER Error Indicators 28

Operating the TE Controller from the Front Panel 29

The TEC display 29

Operating the Controller in Temperature Mode, T 29
Setting up the Temperature Controller 29
Temperature Controller Sensor Selection 30
Setting Temperature Sensor Constants 31
Setting TE Control Loop Gain 32
Setting Temperature Controller Limits 33
Adjusting the Temperature Set Point 34
Operating the Controller in Resistance (Sensor) Mode, R 35
Operating the Controller in Constant Current Mode, I_{TE} 35
Automatic Shut Off Conditions for TEC Output 35
TEC Error Indicators 36

Functions and Features 37

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Saving and Recalling from the Front Panel 37
Using the Laser Compliance Voltage Adjustment 38
Using the LDC-3700B Controller's Trigger Function 38
Modulating the Controller Laser Current Source 39
Boosting the TE Controller 41

Chapter 3 Remote Operation

Basic GPIB Concepts 43

Data and Interface Messages 43
Talkers, Listeners, and Controllers 44
GPIB Cable Connections 44
The GPIB Connector 44
Reading the GPIB Address 45
Changing the GPIB Address 45
Changing Operation from Local to Remote 46

Command Syntax 46

Letters 46
White Space 47
Terminators 47
Command Separators 48
Parameters 48
Command Tree Structure 49
Syntax Summary 50

IEEE488.2 Common Commands 52

LDC-3700B Commonly Used Commands 53

Status Reporting 54
Event and Condition Registers 54
Operation Complete Definition 55
Output Off Registers 57

Command Timing 60
Sequential/Overlapped Commands 60
Query Response Timing 60

Chapter 4 Command Reference

GPIB Command Reference Summary 62

Command Reference 67

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Chapter 5 Calibration and Troubleshooting

Calibration Overview 131

Recommended Equipment 132
Local Calibration of the LDC-3700B Temperature Controller 133
Calibrating the Thermistor 133
AD590 Sensor Calibration 134
LM335 Sensor Calibration 134
ITE Current Calibration 135
Local Calibration of the Laser Current Source 136

Current Source Calibration 136
I_{PD} Current Calibration 137
Laser Forward Voltage Measurement Calibration 138

Remote Calibration of the LDC-3700B Controller 139
Thermistor Calibration 140
AD590 Sensor Calibration 140
LM335 Sensor Calibration 141
I_{TE} Current Calibration 141
TEC Voltage Calibration 142
Current Source Calibration 143
I_{PD} Current Calibration 144
Laser Forward Voltage Measurement Calibration 146

Troubleshooting 147

Error Messages 149

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LIST OF FIGURES

Figure 1.1 LDC 3700B Series Controller Front View 4
Figure 1.2 LDC-3700B Rear Panel 4
Figure 2.1 Laser Diode Connection Configurations 16
Figure 2.2 Back Panel LD Connector 17
Figure 2.3 Rear Panel TEC Connector 19
Figure 2.4 LDC-3700B Series Rear Panel 39
Figure 2.5 Rear Panel TEC Connector 41
Figure 3.1 GPIB Cable Connections 44
Figure 3.2 GPIB Connector Diagram 45
Figure 3.3 Command Path Structure 50
Figure 3.4 Common Command Diagrams 52
Figure 3.5 Status Reporting Scheme 56
Figure 3.6 LASER Output Off Register 58
Figure 3.7 TEC Output Off Register 58
Figure 5.1 I_{PD} Calibration Circuit 132

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

LIST OF FIGURES

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

LIST OF FIGURES

Figure 1.1 LDC 3700B Series Controller Front View 4
Figure 1.2 LDC-3700B Rear Panel 4
Figure 2.1 Laser Diode Connection Configurations 16
Figure 2.2 Back Panel LD Connector 17
Figure 2.3 Rear Panel TEC Connector 19
Figure 2.4 LDC-3700B Series Rear Panel 39
Figure 2.5 Rear Panel TEC Connector 41
Figure 3.1 GPIB Cable Connections 44
Figure 3.2 GPIB Connector Diagram 45
Figure 3.3 Command Path Structure 50
Figure 3.4 Common Command Diagrams 52
Figure 3.5 Status Reporting Scheme 56
Figure 3.6 LASER Output Off Register 58
Figure 3.7 TEC Output Off Register 58
Figure 5.1 I_{PD} Calibration Circuit 132

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LIST OF FIGURES

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CHAPTER 1

INTRODUCTION AND SPECIFICATIONS

This chapter is an introduction to the LDC-3700B Series Laser Diode Controllers and contains unpacking information, instructions on how to install and apply power, maintenance information, specifications, and listings of the LDC-3700B options and accessories.

Product Overview

The LDC-3700B Series Laser Diode Controllers are a combination current source/temperature controller. The current source provides a high stability output with a fully redundant current limit and multiple laser protection features. The built-in temperature controller can work with most temperature sensors and TE modules to deliver precise laser temperature control over a wide range of temperatures. The LDC-3700B Series' fast, sophisticated GPIB option lets you automate your experiment.

Initial Inspection

When you receive your LDC-3700B Controller, verify that the following items were shipped with the instrument:

- LDC-3700B Laser Diode Controller
- LDC-3700B Series Manual
- Power Cord
- Shipping Kit

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Installing the LDC-3700B

This section provides information about the necessary requirements to install the LDC-3700B and how to begin operating the instrument.

Grounding Requirements

The LDC-3700B Laser Diode Controller comes with a three conductor AC power cable. The power cable must be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire connected to an electrical ground (safety ground). The LDC-3700B supplied power cable meets all applicable national safety standards.

AC Line Power Requirements

You can operate the LDC-3700B Series Controllers from a single phase power source delivering nominal line voltages of 100, 120, 220, 230-240 VAC (all values RMS) from 50 to 60 Hz. The line power voltage can vary ±10%. Maximum power consumption is 360 VA (Volt-Amps). The instrument's operational voltage is configured at the factory and cannot be changed. However, check to make sure the voltage printed on the back panel of the instrument matches the power-line voltage in your area.

WARNING

Before connecting the LDC-3700B Laser Diode Controller to a power source, verify that the AC power source matches the setting of the LDC-3700B's voltage printed on the rear panel of the instrument.

To avoid electrical shock hazard, connect the instrument to properly earth-grounded electrical receptacles only. Failure to observe this precaution can result in severe injury or death.

GPIB Connector

The IEEE 488.2 GPIB interface connector is located on the rear panel, directly above the power input module and fuse (See Figure 1.2 on page 4). Attach the GPIB cable to the 24-pin connector located on the rear panel. The connector is tapered to ensure proper orientation. Finger tighten the two screws on the cable connector.

A total of 15 devices can be connected together on the same GPIB interface bus. The cables have single male/female connectors on each end so that several cables can be stacked. This allows more than one cable to be attached to any one device. However, the maximum length of the GPIB cables must not exceed 20 meters (65 feet) total, or 2 meters (6.5 feet) per device.

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The GPIB Address

The talk and listen addresses on the LDC-3700B Series Laser Diode Controller are identical. This GPIB address is read locally by pressing the GPIB LOCAL switch with the address displayed on the "TEC" display. The controller comes from the factory configured with the GPIB address set to zero. You can change the LDC-3700B's GPIB address locally (via front panel). A procedure for changing the address can be found in the section Changing the GPIB Address on page 45.

Tilt-Foot Adjustment

The LDC-3700B Series Laser Diode Controller comes standard with folding front legs and two rear feet for use as a bench top instrument. Extending the front feet so that the instrument front panel sits up makes it easier to view the LED displays. To use them, place the unit on a stable base and rotate the front legs downward until they lock into position.

Rack Mounting

The LDC-3700B Series Laser Diode Controller can be mounted in a standard 19-inch rack with the optional rack mount kits. The kits contain a rack mount flange and hardware for mounting on either side of the enclosure. All rack mount accessory kits contain detailed mounting instructions.

Operating the LDC-3700B Laser Diode Controller

Now that the LDC-3700B Laser Diode Controller is installed and ready for use, you can begin to learn about its operation. The following figures are front and rear photographic copies showing the functional keypad groupings, rear panel connectors, and so on. Use these figures to familiarize yourself with the LDC-3700B Controller. After that, use Chapter 2 for fundamentals of operating the controller.

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Figure 1.1 LDC 3700B Series Controller Front View

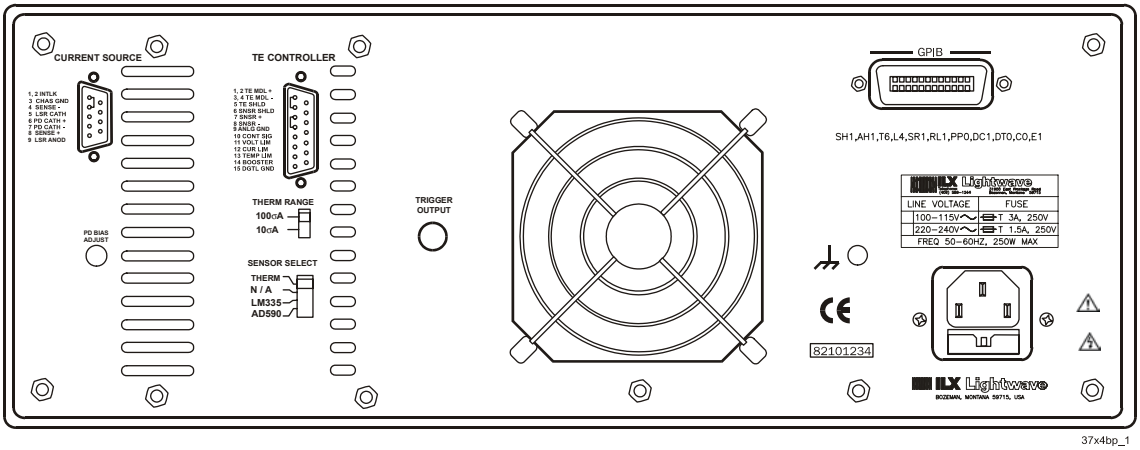


Figure 1.2 LDC-3700B Rear Panel

WARNING

Potentially lethal voltages exist within the LDC-3700B Series Laser Diode Controller. To avoid electric shock, do not perform any maintenance on the instrument. Qualified service personnel are required to wear protective eyeglasses and anti-static wrist bands while working on the LDC-3700B Series Laser Diode Controller circuit boards. High voltages are present on and around the controller's printed circuit boards.

There are no user serviceable parts in the instrument, including the external fuses in the AC power entry module. Contact ILX Customer Service for information about servicing the instrument.

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How to Obtain Repair Services

You may have to return your controller to the ILX Lightwave facility at some time for repair or service whether it is under warranty or not. There is a charge for repairs after the warranty period has expired. See Returning an Instrument on page xi for shipping information and Customer Service contact information.

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Specifications[1]

	LDC-3714B	LDC-3724B	LDC-3744B
DRIVE CURRENT OUTOUT			
Output Current Range	0 to 50 mA 0 to 100 mA	0 to 200 mA 0 to 500 mA	0 to 2000 mA 0 to 4000 mA
Setpoint Resolution	1 uA 2 uA	4 uA 10 uA	40 uA 80 uA
Setpoint Accuracy (% of FS)	±0.05%	±0.05%	±0.05%
Compliance Voltage	0-10V; adjustable	0-10V; adjustable	0-10V; adjustable
Temperature Coefficient	<50 ppm/°C	<50 ppm/°C	<100 ppm/°C
Short-Term Stability (1 hour)[2]	<20 ppm	<20 ppm	<20 ppm
Long-Term Stability (24 hours)[3]	<40 ppm	<40 ppm	<40 ppm
Noise and Ripple (uA rms)[4]			
High Bandwidth Mode	<1.5 uA	<4 uA	<15 uA <20 uA
Low Bandwidth Mode	<1.5 uA	<2 uA	<10 uA
Transients			
Operational[5]	<2 mA	<3 mA	<4 mA
1 kV EFT	<5 mA	<8 mA	<10 mA
Surge[6]	<8 mA	<12 mA	<8 mA
COMPLIANCE VOLTAGE ADJUST			
Range	0 - 10 V	0 - 10 V	0 - 10 V
Resolution	50 mV	50 mV	50 mV
Accuracy	±2.5%	±2.5%	±2.5%
DRIVE CURRENT LIMIT SETTINGS			
Range	0 to 50.5 mA 0 to 101 mA	0 to 202 mA 0 to 505 mA	0 to 2020 mA 0 to 4040 mA
Resolution	0.25 mA 0.5 mA	1 mA 2.5 mA	10 mA 20 mA
Accuracy	±0.5 mA ±1 mA	±2 mA ±5 mA	±20mA ±40 mA
PHOTODIODE FEEDBACK			
Type	Differential	Differential	Differential
PD Reverse Bias	0 - 5 V adjustable	0 - 5 V adjustable	0 - 5 V adjustable
PD Current Range	5 to 5000 uA	5 to 5000 uA	5 to 10000 uA
Output Stability[7]	0.02%	0.02%	0.02%

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	LDC-3714B	LDC-3724B	LDC-3744B
Accuracy, setpoint (% of FS)	±0.05%	±0.05%	±0.05%
EXTERNAL ANALOG MODULATION			
Input	0 - 10 V, 10 kΩ	0 - 10 V, 10 kΩ	0 - 10 V, 10 kΩ
Transfer Function	5 mA/V 10 mA/V	20 mA/V 50 mA/V	200 mA/V 400 mA/V
Bandwidth (3 dB)[8]			
High Bandwidth	DC to 1 MHz	DC to 1 MHz	DC to 250MHz
Low Bandwidth	DC to 15 kHz	DC to 15 kHz	DC to 10 kHz
TRIGGER OUTPUT			
Type	TTL	TTL	TTL
Pulse Width	13 us	13 us	13 us
Delay	12 ms	12 ms	12 ms
MEASUREMENT (DISPLAY)			
Output Current Range	0 to 50.000 mA 0 to 100.00 mA	0 to 200.00 mA 0 to 500.00 mA	0 to 2000.0 mA 0 to 4000.0 mA
Output Current Resolution	0.001 mA 0.002 mA	0.01 mA	0.1 mA
Output Current Accuracy	±0.05% FS	±0.05% FS	±0.1% FS
Photodiode Current Range	0 to 5000 uA	0 to 5000 uA	0 to 10000 uA
Photodiode Current Resolution (uA)	1 uA	1 uA	1 uA
Photodiode Current Accuracy	±2 uA	±2 uA	±4 uA
PD Responsivity Range (uA/mW)[9]	0.00 to 1000.00	0.00 to 1000.00	0.00 to 1000.00
PD Responsivity Resolution (uA/mW)	0.01 uA/mW for all product ranges		
Optical Power Range (mW)	0.00 to 100.00	0.00 to 500.00	0.00 to 5000.0
Optical Power Resolution (mW)	0.01	0.01	0.1
Forward Voltage Range (V)	0.000 to 10.000	0.000 to 10.000	0.000 to 10.000
Forward Voltage Resolution	1 mV	1 mV	1 mV
Forward Voltage Accuracy[10]	±2 mV	±2 mV	±2 mV

LASER CURRENT SOURCE NOTES

1. All values after a one-hour warm-up period at room temperature, 25°C.
2. Over any 1-hour period, half-scale output.
3. Over any 24-hour period, half-scale output.
4. Measured optically, evaluating noise intensity of a laser diode into a photodetector with 150 kHz bandwidth.
5. Maximum output current transient resulting from normal operational situations (e.g., power on-off, current on-off), as well as accidental situations (e.g., power line plug removal).
6. Maximum output current transient resulting from a 1000V power-line transient spike.
7. Maximum monitor photodiode current drift over any 30 minute period. Assumes zero drift in responsivity of photodiode.
8. 50% modulation depth at mid-scale output. Higher bandwidth is possible with smaller modulation signal.
9. Responsivity value is user-defined and is used to calculate the optical power.
10. Four wire voltage measurement at the load. Voltage measurement accuracy while driving calibration load. Accuracy is dependent upon load and cable used.

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Temperature Controller Specifications[1]

TEMPERATURE CONTROL OUTPUT			
Temperature Control Range[2]	-100.0 °C to +199.9 °C		
Thermistor Setpoint	Resolution	Accuracy[3]	
-20 °C to 20 °C	0.1 °C	±0.2 °C	
20 °C to 50 °C	0.2 °C	±0.2 °C	
AD590 & LM335 Setpoint[4]			
-20 °C to 50 °C	0.01 °C	±0.1 °C	
Short Term Stability (1 hr)[5]	<0.004 °C		
Long Term Stability (24 hrs)[6]	<0.01 °C		
Output Type	Bipolar, constant current source		
Compliance Voltage	>8 V DC		
Short Circuit Output Current	4 Amps		
Maximum Output Power	32 Watts		
Current Noise and Ripple[7]	<1 mA rms		
Current Limit Range	0 to 4 Amps		
Current Limit Set Accuracy	±0.05 Amps		
Control Algorithm	Smart Integrator, Hybrid PI		
TEMPERATURE SENSOR			
Types			
Thermistor	NTC (2-wire)		
IC Temperature Sensor	AD590/LM335		
RTD Sensor[8]	P_t100/Other 100-ohm RTD		
Thermistor Sensing Current	10 uA/100 uA		
Sensor Bias	AD590 = 8 V	LM335 = 1 mA	RTD = 0.8 mA[8]
Useable Thermistor Range	25 to 450,000 T, typical		
Typical Sensor Output[9]			
AD590 Current Output	I(25 °C) = 298.2 uA, I_t = 1 uA/K		
LM335 Voltage Output	V(25 °C) = 2.73 V, V_t = 10 mV/K		
RTD (P_t100) Resistance	R(25 °C) = 109.73 T		
User Calibration	Thermistor: Steinhart-Hart, 3 constants IC Sensors, RTD = Two-point		

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TEC MEASUREMENT (DISPLAY)			
	Range[10]	Resolution	Accuracy
Temperature			
10 uA Setting[11]	-100.0 °C to 199.9 °C	0.01 °C	±0.1 °C
100 uA Setting[12]	-100.0 °C to 199.9 °C	0.01 °C	±0.05 °C
Thermistory Resistance			
10 uA Setting	0.01 to 450.00 kT	0.01 kT	±0.05%
100 uA Setting	0.001 to 45.000 kT	0.001 kT	±0.05%
TE Current	-4.000 to 4.000 A	0.001 A	±0.04 A
Voltage (remote only)[13]	-10.000 to 10.000 V	1 mV	±30 mV

TEMPERATURE CONTROL NOTES

1. All values after a one-hour warm-up period at room temperature, 25°C.
2. Software limits of range. Actual range possible depends on the physical load, thermistor type, and TE module used.
3. Accuracy figures are quoted for a typical 10 kT thermistor and 100 uA current setting. Accuracy figures are relative to the calibration standard. Both resolution and accuracy are dependent upon the user-defined configuration of the instrument.
4. Accuracy depends on the sensor model selected, the calibration standard, and the user-defined onfiguration of the instrument.
5. Over any 1-hour period, half-scale output, controlling an LDM-4412 mount @ 25 °C, with 10 kT thermistor on 100 uA setting.
6. Over any 24-hour period, half-scale output, controlling an LDM-4412 mount @ 25 °C, with 10 kT thermistor on 100 uA setting.
7. Measured at 1 Amp output over a bandwidth of 10 Hz - 10 MHz.
8. When ordered with TSC-599 RTD Sensor Converter.
9. Nominal temperature coefficients, I_t and V_t, apply over the rated IC temperature sensor range.
10. Software limits of display range.
11. Using a 100 kT thermistor, controlling an LDM-4412 mount over -30 °C to +25 °C.
12. Using a 10 kT thermistor, controlling an LDM-4412 mount over -30 °C to +25 °C.
13. Voltage measurement accuracy whil driving calibration load. Accuracy is dependent upon load used.

General LDC-3700B Specifications

CONNECTORS	
Photodiode Monitor and Current Source Connector	9-pin, D-sub, female
External Modulation Connector	BNC
Temperature Controller	15-pin, D-sub, female
Trigger Output	BNC
Chassis Ground	4 mm banana jack
GPIB INTERFACE	
Meets ANSI/IEEE Std 488.1 - 1987	
Meets ANSI/IEEE Std 488.2 - 1987	
GENERAL	

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Size (H x W x D)	5.0” x 13.9” x 13.6” (127 mm x 353 mm x 345 mm)
Weight	
LDC-3714B	~22.5 lbs. (10.2 kg)
LDC-3724B	~22.5 lbs. (10.2 kg)
LDC-3744B	~25 lbs. (11.3 kg)
Power Requirements	100 - 115 VAC, 220 - 240 VAC, 48 - 66 Hz
Temperature	0 ^{o}C to +40 ^{o}C operating -40 ^{o}C to +70 ^{o}C storage
Humidity	< 90% relative humidity, non-condensing
Laser Safety Features	Key switch, interlock and output delay (meets CDRH US21 1040.10)
LASER Display Type	5-digit, green LED
TEC Display Type	5-digit, green LED

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Available Options and Accessories

Options and accessories available for the LDC-3700B Series Controllers include the following:

Table 1.1 Options and Accessories

DESCRIPTION	MODEL NUMBER
Rack mount flange kit (enables installation into a standard 19 inch wide rack)	RM-136
Temperature Controlled Laser Diode Mount	LDM-4407
Temperature Controlled Laser Diode Mount (available with collimating assembly)	LDM-4412
DIL Laser Diode Mount	LDM-4982
Butterfly Laser Diode Mount	LDM-4894
High Power Laser Diode Mount	LDM-4442
Current Source Interconnect Cable (unterminated)	CC-301S
Current Source Interconnect Cable (terminated)	CC-305S
TEC Interconnect Cable (unterminated)	CC-501S
TEC Interconnect Cable (terminated)	CC-505S
Calibrated 10 kΤ Thermistor	TS-510
Uncalibrated 10 kΤ Thermistor	TS-520
Uncalibrated AD590LH IC Temperature Sensor	TS-530
Uncalibrated LM335AH IC Temperature Sensor	TS-540
RTD Temperature Sensor Converter	TSC-599

Other Laser Diode Mounts and Thermistor models are available. Please contact ILX Lightwave for information on additional options for your applications.

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CHAPTER 2

OPERATIONS

This chapter introduces you to the operation of the LDC-3700B Series Controllers. It offers instructions for connecting your laser to the current source and temperature controller and describes powering up the instrument. This chapter also contains step by step procedures that teach you how to operate your controller in Constant Current Mode, Constant Power Mode, and to operate the temperature controller in Constant Temperature Mode. ILX recommends that you review the contents of this chapter at a minimum before operating your new controller.

Applying Power to your LD Controller

To turn on the LDC-3700B Controller, rotate the key in the "POWER" section of the front panel from "O" to "I". This action initiates the power on sequence. If the LDC-3700B does not appear to turn on, verify that it is connected to line power. If line power is not the problem, remove the power cord and check the line power fuse.

> **Note:** The instrument contains a laser current source that has remote interlock capability. This allows you to connect the interlock circuit to an external switch for safety. If the interlock is removed, the laser current output is disabled. Refer to the laser module manual for details about the interlock function.
>
> The instrument is also equipped with a laser enable key switch. This ensures that the laser current can be turned on only if the key is inserted and in the On position.

The Power On Sequence

During the power-up sequence, the following takes place. For about three seconds all indicators light up, and all of the 7-segment displays indicate "8". Then all lamps are turned off for three seconds. Next, the firmware version displays in the LASER display section followed by the TEC sensor switch position displayed on the TEC display. Then, a self-test is performed to ensure that the instrument's hardware and processor are communicating. After this test, the instrument is ready to operate, and is configured to the state it was in when the power was last shut off.

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The Power On State

You can choose to "clear" the last saved instrument state by recalling the default values. These values are stored in BINS to which you can save or recall instrument configurations (described in more detail in Chapter 5). "BIN 0" contains all of the default configurations listed below.

Note: If the instrument cannot successfully complete the power on test, an error message of E-512 or E-513 will be displayed on the Laser Display. See Troubleshooting on page 147 for a list of error codes and actions to take when your instrument indicates these errors.

37x4B Series Default Configuration:

- GPIB mode in LOCAL via front panel, or in REMOTE via GPIB
- TEC and LASER adjust not selected
- TEC DISPLAY enabled, in T mode
- TEC Display showing actual temperature
- Resistance/Reference Set Point = 1 ohm or mA or mV (depending on the setting of the SENSOR SELECT switch)
- I_{TE} Set Point = 1.0 Amp
- LIM T_{HI} set to 99.9 ^{o}C
- TEC Tolerance values = 0.2°C, 5 seconds
- C1 = 1.125 (x 10^{-3})
- C3 = 0.855 (x 10^{-7})
- LIM I (high range) = 1000 mA (3744B), 125 mA (3724B),
- LIM I (low range) = 500 mA (3744B), 50 mA (3724B),
- LIM V = 10 volts
- LASER output off
- Constant I, low bandwidth mode selected
- LASER STEP value = 1
- 1.00 mA, 1.0 seconds (3724B/3714B)
- LASER IPD Set Point = 0 mA
- RECALL BIN number = 0
- PARAMETERS not selected
- TEC output off
- Constant T mode selected
- Temperature Set Point = 20 ^{o}C
- LIM ITE set to 2.0 Amps
- TEC STEP value = 1
- GAIN = 30
- C2 = 2.347 (x 10^{-4})
- CAL PD = 0 mA/mW
- 25 mA (3714B)
- 12.5 mA (3714B)
- LIM P = 5000 mW (3744B), 1000 mW (3724B), 200 mW (3714B)
- LASER DISPLAY enabled, in I mode
- LASER display showing actual current (0.00 with output off)
- LASER Tolerance values = 10.0 mA, 1.0 seconds (3744B),
- LASER I Set Point = 0 mA
- LASER P_{PD} Set Point = 0 mW

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Connecting to the Laser Controller

When connecting your laser diode or any other sensitive devices to the LDC-3700B Series Laser Diode Controller, ILX recommends that the instrument be powered up and the LASER output be off (LASER MODE) ON LED unlit. In this condition, a low impedance shunt is active across the output terminals. When disconnecting devices, it is only necessary to turn the LASER Output off.

ILX also recommends that the connections to the LDC-3700B Series Laser Diode Controller output be made using twisted wire pairs with an earth-grounded shield (see Figure 2.1 on page 16). The output terminals of the instrument are left floating relative to earth ground to suppress AC power-on/power-off transients that may occur through an earth-ground path. If the output circuit is earth-grounded at some point (such as through the laser package and mount), the user must be careful to avoid multiple earth grounds in the circuit. Multiple earth grounds may provide circuit paths that induce spurious currents in the photodiode feedback circuit and output leads.

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CAUTION

If a circuit opens during laser operation (while the LASER is ON), the laser may be damaged by a momentary circuit break-and-remake before the final circuit break. The cable connections to the laser must be secure enough that they will not open-circuit, should they be jostled or bumped..

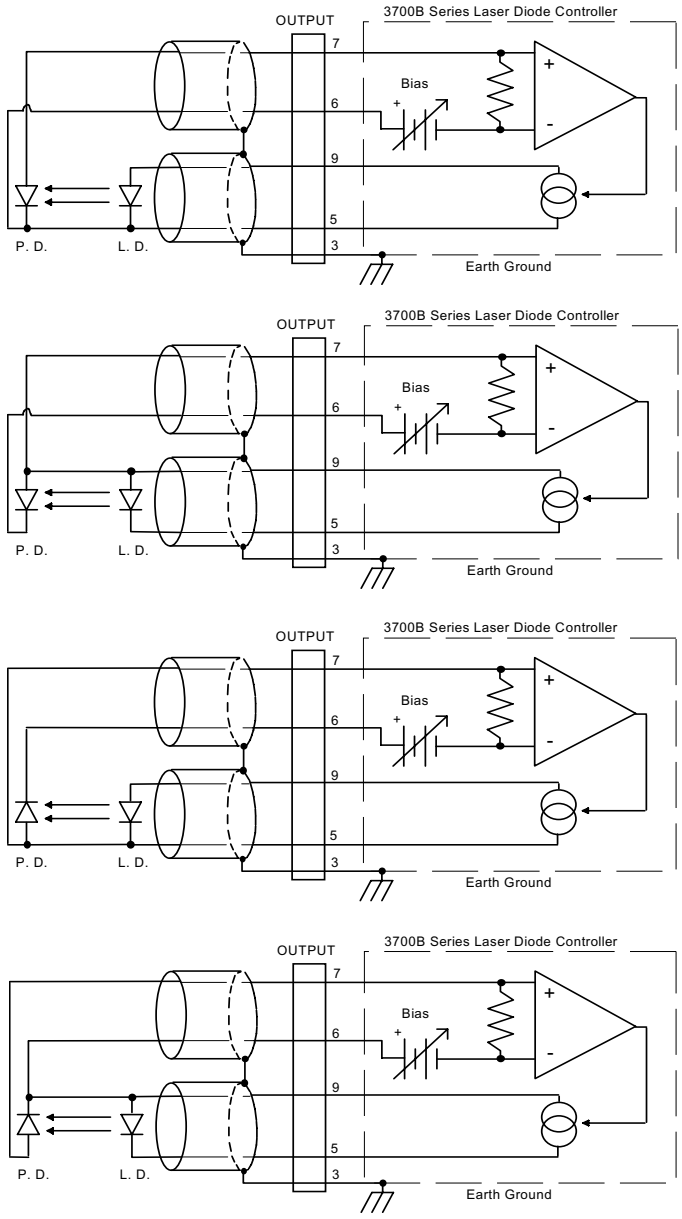


Figure 2.1 Laser Diode Connection Configurations

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Connecting the Laser Current Source

The 9-pin connector marked CURRENT SOURCE on the back panel of your Controller, is used to connect your laser diode to the controller. There are connections provided for laser cathode and anode, photodiode cathode and anode, chassis ground and interlock. The pinout diagram for this connector is shown in Figure 2.2.

Make sure the laser current and voltage measurement connections are correct: connect pin 4, Cathode Voltage Sense, and pin 5, Laser Cathode, to the laser diode cathode; and connect pin 8, Anode Voltage Sense, and pin 9, Laser Anode, to the laser diode anode.

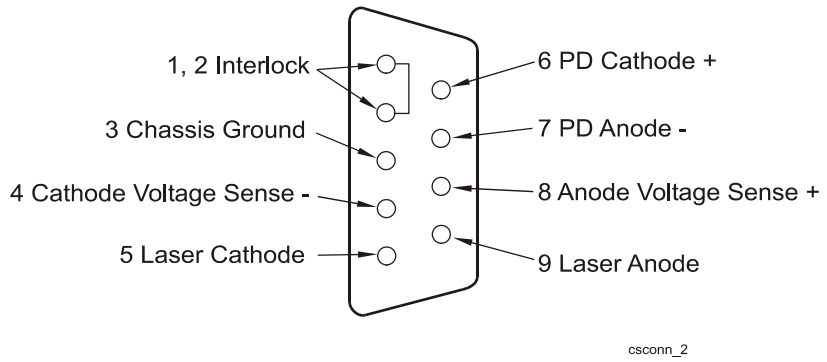


Figure 2.2 Back Panel LD Connector

Interlock Connections

In order for the laser output to be enabled, a short must exist between the Interlock pins (pins 1 and 2) of the connector. The short can be a direct short across the pins or a switch to prevent laser operation until the switch is closed. If a short does not exist between these two pins, the INTERLOCK LED illuminates on the front panel and the laser output is disabled.

CAUTION

The interlock terminals on the LASER connector, pins 1 and 2, must be kept isolated from all other connections including earth ground.

Photodiode Connections

Many laser diode modules contain an internal photodiode that monitors the back-facet emission of the laser. Usually, this photodiode is internally connected to either the laser anode or cathode.

The photodiode and laser connections to the LDC-3700B Series Laser Diode Controller are electrically isolated from ground and each other. So, if a 4-pin

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connection is made (no common connections) no additional jumpers are required. Figure 2.1 on page 16 shows the recommended connections and shielding for 3-pin lasers (where the common connection is internal to the device). A 4-pin laser should be connected with the same shielding as shown in Figure 2.1 on page 16, but the common connection (between the photodiode and the laser) is optional.

Setting the PD bias

The LDC-3700B Series Laser Diode Controller provides an adjustable reverse bias of 0 - 5 VDC for the photodiode. To set the photodiode bias to 5 volts reverse bias, turn the back panel PHOTODIODE BIAS ADJUST fully clockwise. To set the photodiode bias to 0 volts reverse bias, turn the back panel PHOTODIODE BIAS ADJUST fully counter-clockwise

Grounding Considerations

The LASER outputs of the LDC-3700B Series Laser Diode Controller are isolated from chassis ground allowing either output terminal to be grounded at the user's option. Figure 2.1 on page 16 shows the proper earth-ground shielding for laser diode/photodiode connections.

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Connecting to the TE Controller

The 15 pin connector marked TE CONTROLLER on the rear panel of your Controller, is used to make connections to the thermoelectric (TE) modules of your laser or laser mount, and the temperature sensor. There are connections provided for TE module, TE module shield, TE sensor, digital and analog ground, and a special TE booster feature connection. The pinout diagram for this connector is shown in Figure 2.3.

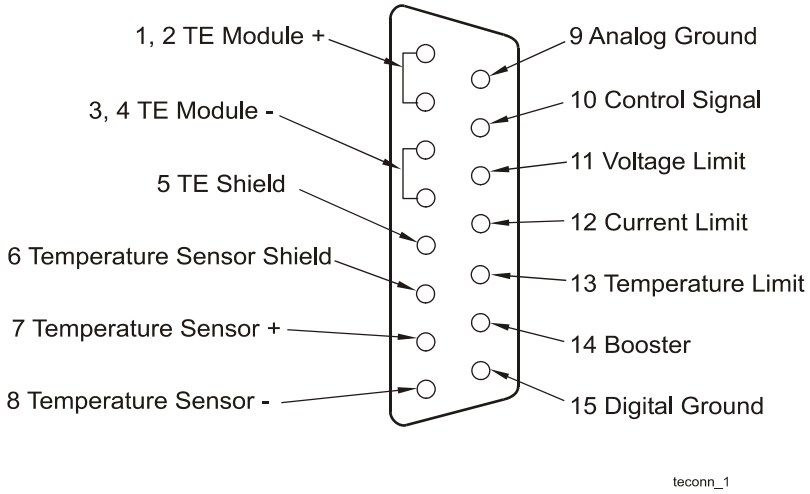


Figure 2.3 Rear Panel TEC Connector

Pins 1 and 2, and 3 and 4, are connected together in pairs internally to allow high current flow to the TEC module (Peltier device). Pins 7 and 8 are connected to the sensor (i.e. thermistor). Pins 9 through 15 are normally not used and should be left unconnected. They are intended for use with an external TE Booster.

TEC Grounding Considerations

The TEC outputs of the LDC-3700B Series are isolated from chassis ground, allowing either output terminal to be grounded. If a terminal is grounded, make sure to connect it only to the Earth ground.

⚠ CAUTION

Connecting one of the TEC output terminals to analog or digital ground causes catastrophic damage to the instrument.

For the TEC connector, if any one terminal pin is grounded, then no other terminal pin can be grounded. Do NOT connect the Sensor (-) and TE Module (-) to the same ground; damage to the instrument and devices will occur.

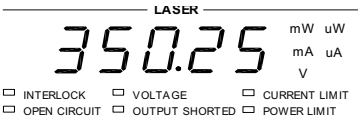
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Operating from the Front Panel

This section describes fundamentals of operation for your LDC-3700B Series Controller Laser Current Source in two operating modes, Constant Current (I), and Constant Power (P).

The Laser Controller Display

The **LASER display** is used to show LASER control parameters such as laser drive current (mA), laser current limit (mA), laser forward voltage (V), monitor photodiode current (σA), and laser optical power (mW) in both set point and measurement modes. It will also display error codes which relate to LASER operation. Error indicators underneath the display indicate control errors and are explained in the section titled "LASER ERROR INDICATORS". All laser control parameters are displayed on this portion of the controller's display section with the appropriate enunciator illuminated.

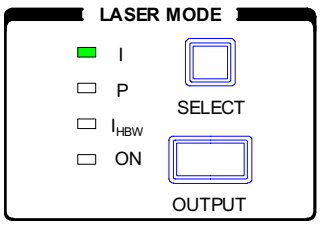


Operating a Laser in Constant Current "I" Mode

Suppose you have an LDC-3724B Laser Diode Controller and you want to run the instrument in Constant Current, low bandwidth mode, with a set point of 150 mA and a current limit of 175 mA. This particular mode uses a low-pass filter on the laser drive current output to significantly reduce noise. In this mode a modulation input of up to 10 kHz may be used, via the front panel MOD EXTERNAL connector. Follow the instructions below in the sequence presented.

Set Up the Controller

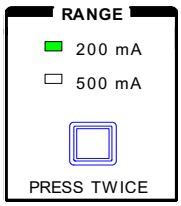
Set the LDC-3700B in Constant Current low bandwidth mode by selecting **I** in the **LASER MODE** section of the front panel. Do this by toggling the **SELECT** push button until the **I** indicator is illuminated. Repeatedly pressing the (**LASER MODE**) **SELECT** switch cycles through the current (**I**), light power (**P**), or high bandwidth current ($\mathbf{I}_{HBW}$) control modes.



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Set the Range

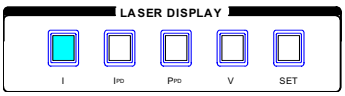
Next, in the **RANGE** section set the laser controller's current source range by selecting the 200 mA range indicated by the accompanying LED. You will need to press the **SELECT** push button twice to change the range. It must be pressed twice quickly (within less than 1 second) to switch between modes, and the LASER output must be off (LASER MODE ON indicator unlit) in order to change ranges.



Select the Laser Display

Configure the display so that it reads in mA by selecting **I** in the **LASER DISPLAY** section of the front panel (directly underneath the **LASER** display. The enunciators next to the display will indicate the display mode (mA illuminates when "I" is pressed). The **LASER DISPLAY** switch section is also used to select the $\mathbf{I_{PD}}$ (photodiode current, σA), $\mathbf{P_{PD}}$ (laser power, mW), or **V** (forward voltage, V) measurement or set point values. The **SET** switch can be used to view the set point of any of the **LASER DISPLAY** parameters. When the (**LASER DISPLAY**) **SET** switch is pressed, a display set point value is indicated by the corresponding display mode enunciator flashing.

At this point the Controller is in Constant Current Mode, (I), in the 200 mA range, and the display is reading in mA. Next, we need to adjust the set point of the laser current source. The controller can be changed to set point mode a couple of ways.



Adjusting the Set Point

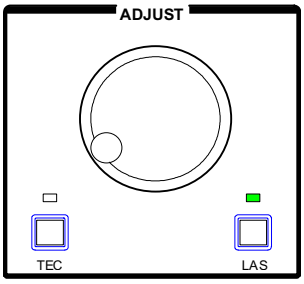
To adjust the set point of the Controller current source to 150 mA, set the instrument to **LAS** mode by pressing the appropriate push button in the **ADJUST** section of the front panel. The **LAS** indicator will be illuminated. Turn the adjust knob clockwise to increase the set point (as indicated on the **LASER** display), or counterclockwise to decrease the set point. When the **ADJUST** knob is turned, the controller automatically changes to set point mode indicated by the display mode enunciator flashing. Before adjusting the set point check the **LASER** display for proper display mode; the display mode determines which set point is being adjusted. Adjust the set point to 150 mA. Pressing the **SET** switch in the **LASER**

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DISPLAY section will also change the controller to set point mode. Make sure that the **mA** enunciator next to the display is illuminated before adjusting the set point. After an adjustment has been made, and the (**LASER DISPLAY**) **SET** switch and **ADJUST** knob are released, the **SET** mode will time out in three seconds. The new set point will be stored in non-volatile memory. If the original display mode differed from the newly adjusted set point, the **LASER** display will revert to the original display mode (**I**, $\mathbf{I_{PD}}$, or $\mathbf{P_{PD}}$).

> **Note:** When adjusting any LASER parameter, display mode or operating mode, the **LAS** indicator in the **ADJUST** section must be lit.

We are not quite ready to turn on the laser. One of the laser protection features our controllers offer is a fully independent hardware current limit. The current limit protects your laser by never allowing the laser drive current to exceed the limit independent of the set point and the controller mode (Constant Current or Constant Power).



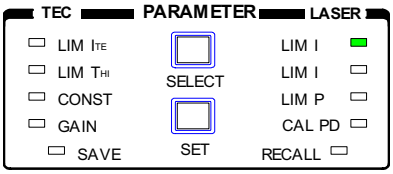
Set Current Source Limit

To set the current source limit, use the **SELECT** push button in the **PARAMETER/LASER** section of the front panel to select **LIM I**. You will notice there are two **LIM I** selections, one in blue text and the other in black text. The blue text limit selection corresponds to the blue text current source range as indicated in the **RANGE** section. The **LASER** display will be indicating the limit set point in mA indicated by the **LIM I** LED, for its corresponding range. Press and hold the (**PARAMETER**) **SET** push button and rotate the adjust knob, clockwise to increase the limit set point value, or counterclockwise to decrease the limit set point value. Set the limit to 175 mA. Once the **SET** push button is released, the new parameter value is stored in non-volatile memory.

When the LASER current limit is reached, the **CURRENT LIMIT** error indicator flashes. The current limit setting is independent of the voltage drop of the device connected to the LASER output, and therefore, no dummy load is required for precise adjustment of the current limit. Furthermore, since the current limit

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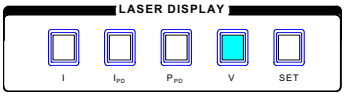
circuitry is fully independent of the main current control, the current limit can be adjusted safely, even while the LASER output is active.



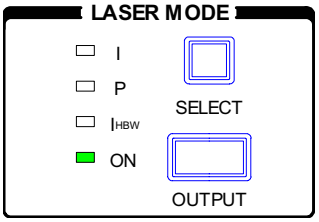
Set Compliance Voltage Limit

A new feature of the 3700B Series instruments is an adjustable voltage limit. This allows an extra level of laser protection in the event of an intermittent open circuit. For maximum protection via the fastest open-circuit detection, the voltage limit should be set to a value slightly greater than the intended operating voltage.

To set the LASER voltage limit, use the **SELECT** push button in the **PARAMETER/LASER** section of the front panel to select **LIM I** (either range) and then press and hold the **(PARAMETER) SET** push button. Then press the **LASER DISPLAY V** push button. The **LASER** display will then indicate the LASER voltage limit setting. While holding the **(PARAMETER) SET** push button, adjust the voltage limit using the adjust knob.



In the **LASER MODE** section of the front panel, press the push button labeled **OUTPUT**. The accompanying LED labeled **ON** will illuminate indicating that the laser current source's output is enabled. The instrument drives the current source to the value set by the corresponding **LASER MODE** set point. The Output switch has a toggling action. Pressing the switch again disables the current source output. When the LASER output is off, an internal short is placed across the LASER output and the Output Shorted indicator illuminates. The default condition for the current source output is off when the instrument is first powered up.



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Automatic Shutoff Conditions for Laser Output

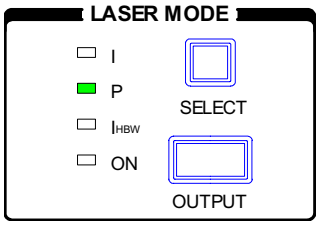
The following conditions automatically cause the instrument to disable the current source output from the instrument:

- LASER High Power Limit
- LASER Interlock/Key Lock turned off
- LASER Open Circuit or Voltage Limit
- TEC High Temperature Limit Condition

Operating a Laser in Constant Power Mode, P

Suppose you want to operate a 3 mW laser in constant power at 1 mW. The 3700B Series Controller allows you to operate the instrument current source driver in a Constant Power mode. In this mode, the controller drives current to the laser to reach a set power value in mW. The control loop feedback parameter is photodiode current which the controller converts to optical power via a user defined photodiode responsivity number. If laser power changes due to internal or environmental conditions, the controller will increase/decrease the current to the laser to maintain the power set point. The following paragraphs detail the instrument configuration in Constant Power Mode.

To set the LDC-3700B in Constant Power mode, select **P** in the **LASER MODE** section of the front panel by toggling the **SELECT** push button. Repeatedly pressing the (**LASER MODE**) **SELECT** switch cycles through the current (**I**), light power (**P**), or high bandwidth current ($\mathbf{I_{HBW}}$) control modes. The LED indicator shows the selected mode.

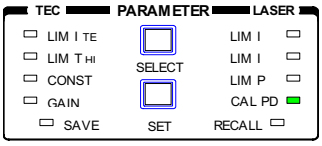


Entering Photodiode Responsivity values

The photodiode responsivity, **CAL PD**, is used to convert between photodiode current and optical power of the laser diode. To enter the **CAL PD** parameter, select **CAL PD** with the **SELECT** push button by toggling down past **LIM P.** The indicator becomes lit when **CAL PD** is selected and the display indicates the responsivity parameter in σA/mW (not enunciated). Rotate the adjust knob in the **ADJUST** section while holding the **(PARAMETER) SET** push button to enter a

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new value for responsivity. When the correct value is displayed, store the number by releasing the **SET** push button.

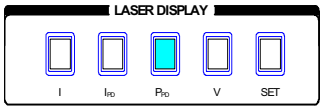


To calculate the responsivity:

1. Measure (with a calibrated detector) the output power of the device.
2. Measure the corresponding photodiode current.
3. Calculate the responsivity by dividing the photodiode current by the optical power noting the units required are σA/mW.

The LDC-3700B Controllers can be put into a special mode with the **CAL PD** parameter set to zero. When the **CAL PD** value is zero, the LASER output will be controlled to the $\mathbf{I_{PD}}$ set point value, therefore, the instrument is in Constant I_{PD} mode. The LASER display will indicate "-.-" in P_{PD} mode.

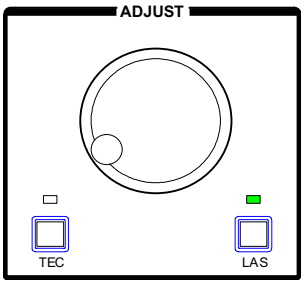
Next, configure the display so that it reads in **mW** by selecting $\mathbf{P_{PD}}$ in the **LASER DISPLAY** section of the front panel (directly underneath the **LASER** display). The **LASER DISPLAY** switch section is used to select the **I** (laser current), $\mathbf{I_{PD}}$ (photodiode current), $\mathbf{P_{PD}}$ (Laser power), or **V** (forward voltage) measurement values or set point values. The display enunciator, mW will illuminate when $\mathbf{P_{PD}}$ is selected.



Adjust the Constant Power set point of the controller to 1.00 mW. To do this, set the instrument to "LAS" mode by pressing the appropriate push button in the "ADJUST" section of the front panel. Turn the adjust knob clockwise to increase the set point (as indicated on the **LASER** display), or counterclockwise to decrease the set point. When the **ADJUST** knob is turned, the controller automatically changes to set point mode indicated by the display mode enunciator flashing. Before adjusting the set point check the **LASER** display for proper display mode. The display mode determines which set point is being adjusted. Adjust the set point to 1.00 mW. Pressing the **SET** switch in the **LASER DISPLAY** section will also change the controller to set point mode. Make sure that the mW enunciator next to the display is illuminated before adjusting the set point. After an adjustment has been made, and the (**LASER DISPLAY**) **SET** switch and **ADJUST** knob are released, the **SET** mode will time out in three seconds. The new set point will be stored in non-volatile memory. If the original display mode differed

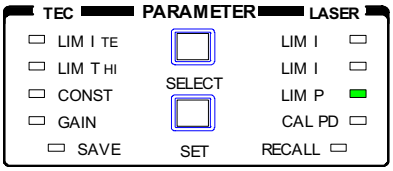
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from the newly adjusted set point, the **LASER** display will revert to the original display mode (**I**, $\mathbf{I_{PD}}$, or $\mathbf{P_{PD}}$).



Before the laser output is enabled, the power limit for the laser under test should be set. In Constant Power mode, this is accomplished by setting a Power limit, **LIM P** value. The LDC-3700B Controller uses the responsivity value entered to calculate a power limit. This is a software limit only.

To set the Constant Power limit, use the **SELECT** push button in the **PARAMETER/LASER** section to select **LIM P**. When the **LIM P** is indicated by the accompanying LED, the **LASER** display will indicate the limit set point in **mW**. Press and hold the **SET** push button and rotate the adjust knob clockwise to increase the limit set point value, or counterclockwise to decrease the limit set point value. Set the limit to 1.50 mW. When the desired value is reached, release the **SET** push button to store the new limit value.



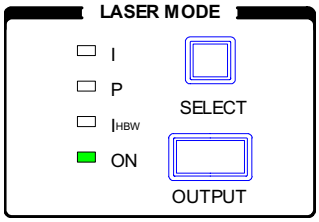
The LIM P is the absolute limit of optical power, as detected by the unit via the monitor PD feedback loop. In order for this limit to be meaningful, the monitor photodiode responsivity (**CAL PD**) must be adjusted correctly. This limit is a software limit only. The LASER output is normally turned off if this limit is reached (See LASer:ENABle:OUTOFF command in Chapter 4 for instructions on disabling this function). The maximum **LIM P** value is 100.0 mW (LDC-3714B), 500.0 mW (LDC-3724B), and 5000 mW (LDC-3744B).

Also, in constant power mode the LASER current limit and voltage limit values are in effect. Refer to the discussion on page 8 which describes how to set these limits.

Now the instrument is configured to operate in Constant Power Mode. In the **LASER MODE** section, enable the output of the laser current source by depressing the **OUTPUT** push button once. The accompanying led labeled **ON** will illuminate indicating that the laser output is on and current is being driven to

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the laser. The Controller's laser source will drive the laser to the Constant Power set point and maintain closed loop control with the PD current measurement.



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LASER Error Indicators

The LDC-3700B Series Laser Diode Current Source Controllers indicate general LASER operational error conditions. Each error condition results in a controller action as shown in the following table.

Table 2.1 Laser Error Indicators

Error Condition	Action
Interlock	Output off, INTERLOCK light flashes at 1 Hz
Open circuit	Output off, OPEN CIRCUIT light flashes at 1 Hz. If this condition was caused by an excessively high compliance voltage, the VOLTAGE LIMIT light will also be turned on.
Output shorted	OUTPUT SHORTED light comes on. This indicator becomes lit whenever the LASER output is off.
Current limit	CURRENT LIMIT light flashes at 1 Hz
Voltage limit	VOLTAGE LIMIT light flashes at 1 Hz. This indicator warns that the output is within 0.25 volts of Voltage Limit. If voltage limit is reached, the LASER output will shut off.
Optical Output Power Limit	Output off, POWER LIMIT light flashes at 1 Hz

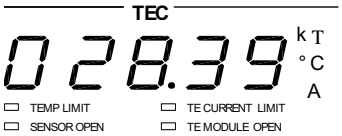
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Operating the TE Controller from the Front Panel

This section describes how to operate your LDC-3700B Series Controller Temperature Controller in Constant Temperature Mode, **T**. There are several modes in which you can operate the temperature controller, Constant Temperature, Constant Resistance (Sensor), and Constant I_{TE} (TE module current). Operating in Constant Temperature Mode is presented in the following sections, however the same operating principles apply to the other operating modes.

The TEC display

The **TEC display** is used to show TEC control parameter values such as temperature, ^{o}C, temperature limit, I_{TE} limit (A), thermistor resistance (kT), and TE current (A) measured and set point values. It may also display errors which relate to TEC operation. Error indicators underneath the **TEC** display indicate control errors and are explained in the section titled "TEC ERROR INDICATORS". All TEC control parameters are displayed on this portion of the controller's display section with the appropriate enunciator illuminated. In the case of the temperature sensor constants, the **LASER** display section displays which constant you are viewing or adjusting (C1, C2 or C3) and the **TEC** display section displays the value.



Operating the Controller in Temperature Mode, T

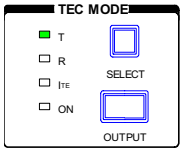
Suppose you need to operate and temperature control a telecom laser with an internal TE module. The maximum TE module operating current for this device is 4 Amps. A typical operating mode would be to control the laser diode temperature to 35 ^{o}C with the temperature sensor type being a 10K thermistor. In this experiment, the maximum operating temperature will be 40 ^{o}C. To configure the LDC-3700B Controller, you will need to select a sensor type and the sensor current range via the rear panel, enter the correct thermistor constants, select the Temperature Control mode, set the control loop gain, and set appropriate temperature and TE module current limits.

Setting up the Temperature Controller

Set the LDC-3700B in Temperature Control mode by selecting **T** in the **TEC MODE** section of the front panel. Do this by toggling the **SELECT** push button until the **T** indicator is illuminated. Repeatedly pressing the **SELECT** switch cycles

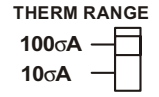
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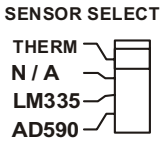
through the **T** (temperature), **R** (resistance/sensor), and $\mathbf{I_{TE}}$ (TE module current) instrument operating modes.



Temperature Controller Sensor Selection

Because we have selected a 10 kΤ thermistor as our temperature sensing element and we have chosen 35 °C as our set point temperature, we need to set the **SENSOR SELECT** switch to **THERM** and the **THERM RANGE** switch to **100** σA.





Your LDC-3700B's Temperature Controller operates in a closed loop fashion with a temperature sensor being the feedback element. For the controller to operate correctly, the type of sensor needs to be selected on the rear panel of the instrument. The **SENSOR SELECT** switch allows you to select a temperature sensor type and, in the case of a thermistor sensor, the source current level. For thermistors, LM335 and AD590 temperature sensors, use the lower switch to select the appropriate sensor type. When the sensor switch is changed, a sensor position code will be indicated on the TEC display.

> **Note:** Note, for RTD sensors, the RTD Temperature Sensor Converter option is required, ILX Model 599.

Table 2.2 shows the **SENSOR SELECT** positions and corresponding position code.

Thermistor resistance changes with temperature. A constant current source integrated into the controller supplies current through the thermistor so that a temperature change results in a voltage change across the thermistor. This voltage change is sensed by the controller and fed back to the control loop. If you have the thermistor sensor selected, then select an appropriate current range with the upper switch. The 10 σA and 100 σA designations are current levels supplied by the controller. The selected supply current depends on the thermistor operating temperature range and the required temperature resolution. A general rule of thumb for a 10 kΤ thermistor is to use the 10 σA range for temperatures between -30 °C and +30 °C , and the 100 σA range for temperatures between +10 to +70 °C For a more complete description of thermistor selection see our Application Note #2 titled, "Selecting and Using Thermistors for Temperature Control".

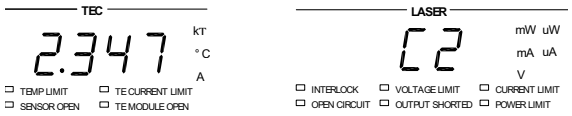
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Table 2.2 SENSOR SELECT Switch Positions

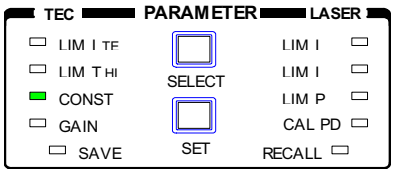
Switch Position	Code
100 σA	--01
10 σA	--02
LM335	--03
AD590	--04

Setting Temperature Sensor Constants

After the sensor type is selected, it will be necessary to enter the sensor calibration constants into the controller for accurate conversion to actual temperature. These constants are used in a temperature conversion equation to calibrate the TEC and are supplied with your thermistor's data sheet. The Steinhart-Hart equation is used to derive temperature from the non-linear resistance of an NTC (Negative Temperature Coefficient) thermistor. Linear equations are used to convert sensor voltage or current signals to actual temperature when an LM335 or AD590 sensor is used. (See the TEC Specifications in Chapter 1 for these equations). When **CONST** is selected in the **TEC PARAMETER** section of the front panel, the constant's name will be displayed on the **LASER** display, and the value will be displayed on the **TEC** display.



To adjust the value of C1, C2, or C3, press the (**PARAMETER**) **SELECT** button until it sequences to **CONST** on the TEC side. The **CONST** indicator will be illuminated. The **LASER** display will read **C1** and the value will be displayed on the **TEC** display. To change the value, press and hold in the **SET** switch, and turn the **ADJUST** knob until the correct value is displayed. Release the **SET** switch to store the new value. Pressing the **SELECT** push button will toggle through each constant (C1, C2, and C3). When C3 is not used it should be set to zero.



The ILX Lightwave Application Note #17 contains information on sensor calibration constants for AD590 and LM335 sensors. Since these devices are

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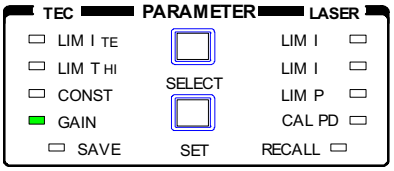
used over their linear range, the constants C1 and C2 are used in this case to determine a linear approximation of the temperature, rather than the Steinhart-Hart non-linear approximation which applies for thermistors. The appropriate algorithms are automatically implemented whenever the sensor type is selected via the rear panel **SENSOR SELECT** switch.

Setting TE Control Loop Gain

For best temperature control loop performance, the control loop gain needs to be set. The GAIN function sets the analog feedback gain which, in part, determines how fast the actual temperature reaches and settles to the set-point temperature. If the gain is set too low (1 is lowest), the TE cooler will take longer to reach the temperature set-point. If it is set too high (300 is highest), the actual temperature may overshoot and may oscillate around the set temperature resulting in long temperature settling times. The allowed GAIN values in the LDC-3700B's Temperature Controller are: 1, 3, 10, 30, 100 and 300. These values define the proportional loop gain of our hybrid PI temperature control loop.

The gain setting depends on the type of TE module and thermal load that you are using, but we can suggest guidelines for selecting the proper gain. Set the gain to 1 and increase it until the actual temperature oscillates around the set temperature. Then reduce the gain to the next lower value.

To set the gain, press the **(PARAMETER) SELECT** switch until the **GAIN** indicator is lit. The **TEC** display will show the value of the control loop GAIN. To change the **GAIN**, press and hold in the **SET** switch, at the same time turn the **ADJUST** knob until the desired new value is on the TEC display, then release the **SET** switch. When the **SET** switch is released, the new value will be stored in non-volatile memory.

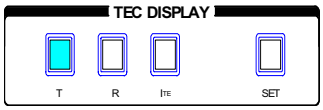


At this point the sensor type is selected, the appropriate constants are entered and the temperature control loop gain is set. Next, the display will be configured to read in the correct units for operation in Constant Temperature mode. The enunciators next to the TEC display will indicate the display mode corresponding to the switch pressed (^{o}C will illuminate when the T push button is pressed).

The **TEC DISPLAY** section is used to select the displayed temperature, **T**, sensor value, **R**, or TE module current, $\mathbf{I_{TE}}$. Press **T** for temperature and the display will indicate measured temperature in ^{o}C. When the **R** switch is pressed, the display will show the measured thermistor resistance in kT**,** the measured LM335 voltage in mV (not annunciated), or the measured AD590 current in σA (not annunciated),

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depending on the position of the back panel **SENSOR SELECT** switch. When **I_{TE}** is pressed, the **A** annunciator will illuminate and the display will show measured TE module current in amps. Likewise, if the **SET** switch is pressed (and **R** mode is selected), the display will show the thermistor resistance set point value in kT**,** or the LM335 set point voltage in mV (not annunciated), or the AD590 set point current in σA (not annunciated), depending on the position of the **SENSOR SELECT** switch on the rear panel. If **I_{TE}** is selected and the **SET** push button is pressed, the instrument will display the TE module current set point in Amps.

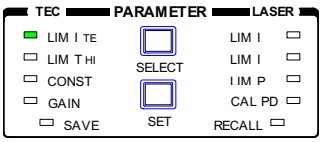


Setting Temperature Controller Limits

The LDC-3700B Controller is capable of protecting your thermoelectric (TE) modules. The Temperature Controller current limit function, **LIM I_{TE}**, limits the controller's output current so that the instrument does not provide more current than your TE module can safely handle. During controller operation, if the TEC current limit is reached, the **TE CURRENT LIMIT** error indicator (underneath the TEC display) will flash. The TEC current limit is displayed in Amps.

Note, it is normal for the TE Current limit to be reached when the TEC output is first turned on. Typically the TE current will be maximum (in limit) until the actual temperature is within a few degrees of the set point.

To set the TE module current limit to 2 Amps, press the (**PARAMETER**) **SELECT** switch until the **LIM I_{TE}** indicator is lit. Press and hold in the **SET** switch while turning the **ADJUST** knob until 2.000 A is displayed on the **TEC** display. When the **SET** switch is released, this new value will be stored in non-volatile memory.



The Temperature Controller temperature limit function, **LIM T_{HI}**, sets the maximum temperature the controller allows before generating an error condition and action. During controller operation, if this limit is reached, the **TEMP LIMIT** error indicator will flash and the **LASER** and **TEC** output will be shut off to protect the laser.

> **Note:** The maximum temperature limit becomes the maximum set point temperature as well.

To set the controller temperature limit to 40 ^{o}C, press the (**PARAMETER**) **SELECT** switch until the **LIM T_{HI}** indicator illuminates. Press and hold in the **SET** switch and turn the **ADJUST** knob until the **TEC** display indicates 40 ^{o}C. When

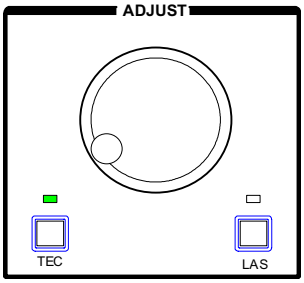
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the **SET** switch is released, the new value is stored in non-volatile memory and becomes the maximum set point value.

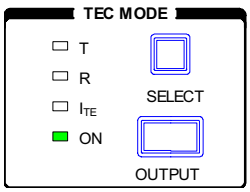
Adjusting the Temperature Set Point

Now, you are ready to adjust the set point operating temperature of the controller to 35 °C. The LDC-3700B Series Temperature Controller will monitor actual temperature and adjust TE current to maintain the thermal load at the set point temperature.

To adjust the Temperature Set Point to 35 °C, set the instrument to **TEC** mode by pressing the **TEC** push button in the **ADJUST** section. This instrument mode will be indicated by the **TEC** LED. Turn the adjust knob clockwise to increase the set point (as indicated on the **TEC** display), or counterclockwise to decrease the set point. When the adjust knob is turned, the controller automatically changes to set point mode indicated by the display enunciator flashing. Before adjusting the set point check the **TEC** display for proper display mode. The display mode determines which set point is being adjusted. Adjust the set point temperature to 35 °C. Three seconds after the set point is adjusted to the new value, the instrument will return to measurement mode. Pressing the **SET** switch in the **TEC** display switch section will also change the controller to set point mode and display the set point corresponding to the display mode.



Once the sensors, temperature control loop parameters and set points are established, the output of the temperature controller can be enabled. With the output enabled, as indicated by the **ON** LED, the temperature controller will drive current to the TE modules to cool or heat the load depending on the difference between the set point and the actual temperature. Press the **OUTPUT** switch once to enable the **TEC** output, and again to disable the output. The default condition for the **TEC** output is off when the instrument is first powered up.



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Operating the Controller in Resistance (Sensor) Mode, R

Selecting **R** in the TEC mode section of the front panel selects constant resistance mode. In this mode, the temperature controller will maintain temperature so that the temperature sensor's resistance, current, or voltage remain constant, depending on whether the sensor is a thermistor, AD590, or LM355. This mode is useful if the sensor constants are not known or the sensor values are only known at the operating temperature. When using this operating mode, the control setpoint must be in terms of the sensor output units, namely kT, uA, or mV.

Operating the Controller in Constant Current Mode, I_{TE}

Selecting $\mathbf{I_{TE}}$ in the TEC mode section of the front panel selects constant TE current mode. In this mode, the temperature controller will output a constant current when the output is enabled, regardless of temperature. The output will only be disabled by manually turning the output off or if the temperature hits the high temperature limit. This mode is useful if a fixed thermal load requires heating or cooling and absolute thermal control is not required. Setting a positive current value is defined to produce cooling of the load while a negative value defines heating of the load.

Automatic Shut Off Conditions for TEC Output

The following conditions will automatically cause the instrument to disable the TEC output:

- High Temperature Limit
- Connecting pins 13 and 15 on the TEC connector (external/booster temperature limit switch)
- Booster Changed (while Output is enabled), (see Chapter 5)
- Sensor Open (while Output is enabled)
- TEC Module Open (while Output is enabled)
- SENSOR SELECT Switch Moved (while Output is enabled)
- Sensor Shorted (while Output is enabled)
- TEC mode changed (while output is enabled)

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TEC Error Indicators

The LDC-3700B Series Laser Diode TEC Controllers indicate general TEC operational error conditions. Each error condition results in a controller action as shown in the following table.

Table 2.3 TEC Error Indicators

Error Condition	Action
Temperature limit	TEMP LIMIT light flashes at 1 Hz
Open sensor	Output off, SENSOR OPEN indicator LED flashes at 1 Hz
TE Current limit	TE CURRENT LIMIT light flashes at 1 Hz
TE Module Open	TE MODULE OPEN indicator LED flashes at 1 Hz (not in effect when booster source is used)
TE Compliance Voltage Limit	TE CURRENT LIMIT light flashes at 2 Hz

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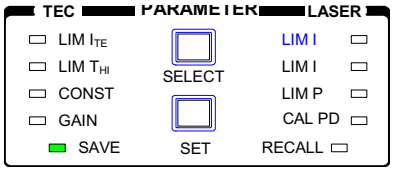
Functions and Features

This section introduces you to the LDC-3700B Controller's functions and operating features such as event triggering, analog modulation of laser injection current, TEC boosting and Save and Recall.

Saving and Recalling from the Front Panel

For applications where you might need to alternate between particular instrument configurations, the LDC-3700B Controllers offer a unique SAVE AND RECALL feature. The SAVE feature allows you to easily store all front panel settings for any given instrument configuration. These settings, which are stored in one of ten memory bins, can be retrieved at any time with the RECALL function. This saves setup time, and it reduces the chance of setup error for tests which are periodically repeated. For example, using the configuration described in Chapter 2 where the controller is operating in Constant Current and Temperature modes, the instrument parameters saved by using the SAVE function would be Constant Current Mode, 200 mA range, a limit set point of 175 mA, a laser current set point of 150 mA, Display Mode I, Constant Temperature mode, thermistor constants C1, C2, and C3, a temperature set point of 35 ^{o}C, a loop gain of 30, temperature limit of 40 ^{o}C, and a TE current limit of 2A. Once this set up is saved, the LDC-3700B Controller may be configured for another unique set up. You can recall the original set up for the first experiment any time using the RECALL function.

To enter the **SAVE**/**RECALL** mode, first exit both **TEC** and **LASER** modes (both **TEC** and **LAS** indicators in the **ADJUST** section off). Press the **SELECT** switch in the **PARAMETER** section. The **SAVE** indicator LED becomes lit and the unit displays the **SAVE** "bin" on the **TEC** display. If another bin number is desired, press the **SET** switch and rotate the **ADJUST** knob until the desired bin number is displayed. Releasing the **SET** switch completes the **SAVE** operation and all of the instrument parameters are saved to the indicated bin number as they appear on the front panel.



To recall a previously saved instrument set up, press the **SELECT** switch until the **RECALL** indicator led becomes lit. The instrument will display a **RECALL** "bin" number on the **TEC** display. If you desire to change the **RECALL** bin, press the **SET** switch and rotate the **ADJUST** knob until the desired bin number is displayed. Releasing the **SET** switch completes the **RECALL** operation. The

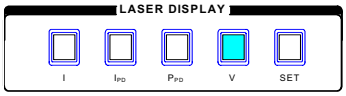
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instrument is restarted and the front panel parameters are reconfigured to the new parameters saved under that bin number.

Using the Laser Compliance Voltage Adjustment

For applications where you need to have critical protection of the laser we recommend the following. Using a 1 T resistor or other non-critical load, set the LASER voltage limit as described in Chapter 2.

Then with the LASER output on, slowly increase the LASER current and watch the LASER voltage measurement. (Press the **LASER DISPLAY V** push button to see the voltage). At about 0.25 volts below the LASER voltage limit value, the VOLTAGE LIMIT warning indicator will become lit on the **LASER display**. Continue to adjust the current up until the voltage limit is reached and the output is shut off. Record the voltage at which the LASER output shuts off. It should be within the specification of the LASER voltage limit accuracy. However, there is typically some offset error. For example, if the LASER voltage limit is set to 5.0 volts, the actual voltage where it shuts off may be 4.9 volts. This error term of 0.1 volts should be considered when setting the LASER compliance voltage limit.



The closer the LASER voltage limit shut off point is to the operating voltage of your laser, the faster the circuit will work in the event of an open circuit. Some experimentation may be necessary for optimum results.

Using the LDC-3700B Controller's Trigger Function

For applications where you need to synchronously initiate a measurement task from a remote instrument with the LDC-3700B Controller, the controller offers a trigger output signal. The TTL pulse is initiated with any change in set point of the laser current source and after the analog output has settled. A typical application for utilization of this feature is laser characterization tasks where an L-I curve is generated. For a programmed step in laser current, a light measurement can be triggered for each step in laser current. The trigger output is enabled only in remote mode via the IEEE 488.2 GPIB Interface.

> **Note:** The minimum step change time required for a corresponding trigger pulse is 20 ms. Care should be used with respect to the timing of any set point commands in relation to the actual hardware function. The INC and DEC commands have a fixed minimum step time of 20 ms which allows for the hardware initiation of a set point change and the settling of the output. The LDI command does not. With this command, some trigger pulses may be missed if the program step time is less than the 20 ms minimum.

A one shot trigger pulse will occur on power up of the instrument due to the states of the processor I/O.

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A standard BNC connector on the rear panel of the LDC-3700B Controller is available for connecting any standard BNC terminated cable.

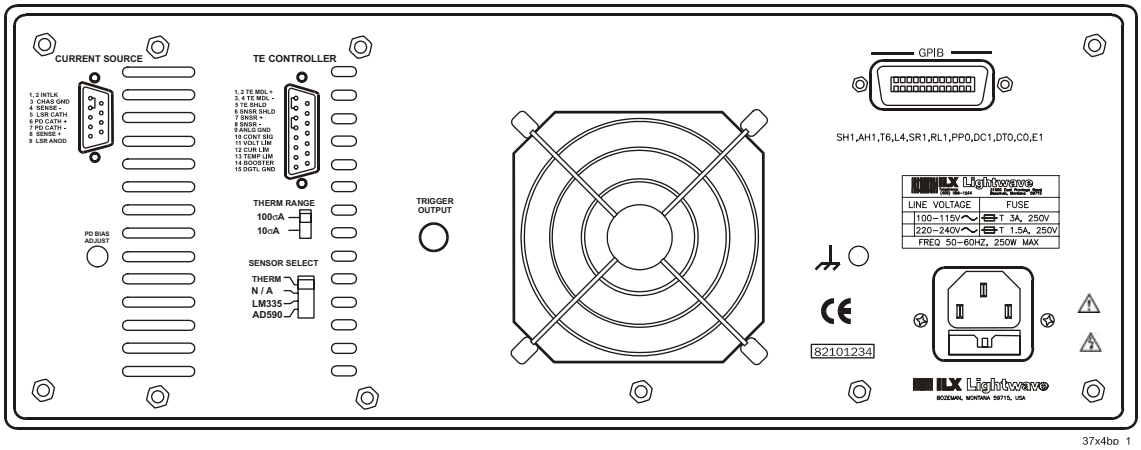
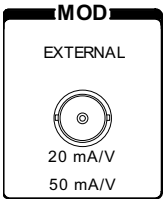


Figure 2.4 LDC-3700B Series Rear Panel

Modulating the Controller Laser Current Source

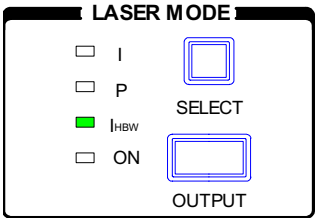
The LDC-3700B Series Laser Diode Controller allows a modulated signal to be superimposed on the LASER injection current. For example, assume you are using an LED for your experiment where you need operate the led in constant current at P_{OP} = 1 mW, and a modulated injection current from 3 to 30 kHz. The experiment requires the LDC-3724B's laser controller to be configured for the 200 mA range, high bandwidth mode with a limit of 175 mA. The allowable bandwidth of the modulated signal, defined as the 3 dB roll off point, is dependent on the LDC-3700B Series family member, the LASER current range, and the LASER mode (constant current low/high bandwidth). See the section, LASER CURRENT SOURCE SPECIFICATIONS, in Chapter 1 for external analog modulation bandwidth specifications.

Setting up the controller for a modulated laser injection current is easy. The (**MOD**) **EXTERNAL** connector (BNC), on the front panel, is the input for the modulated signal. The modulation port input impedance is 10 kΤ. The transfer function (mA/V) shown is for the LDC-3724B. This transfer function varies by model and laser drive current output range. The transfer function for the low and high current ranges of the LDC-3714B are 5 mA/V and 10 mA/V, and 200 mA/V and 400 mA/V, for the LDC-3744B.

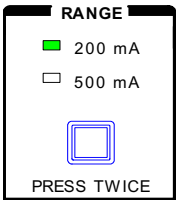


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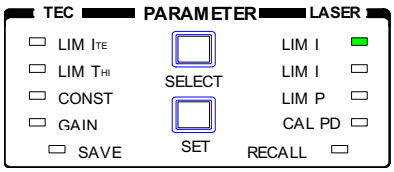
Set the LDC-3700B in Constant Current High Bandwidth Mode by selecting $\mathbf{I_{HBW}}$ in the **LASER MODE** section of the front panel. Do this by toggling the **SELECT** push button until the $\mathbf{I_{HBW}}$ indicator is illuminated. Repeatedly pressing the (**LASER MODE**) **SELECT** switch cycles through the current (**I**), light power (**P**), or high bandwidth current ($\mathbf{I_{HBW}}$) control modes.



Set the laser controller's current source range by selecting the 200 mA range indicated by the accompanying LED. You will need to press the select push button twice to change the range. It must be pressed twice quickly (within less than 1 second) to switch between modes, and the LASER output must be off (LASER MODE ON indicator unlit) in order to change ranges.



The limit clamp function for DC output current applies to the modulated current as well protecting your laser in any mode. To accomplish setting the current source limit, use the **SELECT** push button in the **PARAMETER**/**LASER** section of the front panel to select **LIM I**. You will notice there are two **LIM I** selections, one in blue text and the other in black text. These limit selections correspond to the current source range as indicated in the **RANGE** section. When the blue **LIM I** is indicated by the accompanying LED, the **LASER** display will be indicating the limit set point in mA for the controller's low range. Press the (**PARAMETER**) **SET** push button and rotate the adjust knob, clockwise to increase the limit set point value, or counterclockwise to decrease the limit set point value. Set the limit to 175 mA. Once the **SET** push button is released, the new parameter value is stored in non-volatile memory.

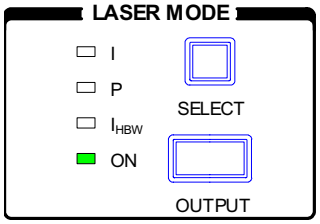


When the laser current limit is reached, the **CURRENT LIMIT** error indicator flashes. The current limit setting is independent of the voltage drop of the device connected to the laser output, and therefore, no dummy load is required for

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precise adjustment of the current limit. Furthermore, since the current limit circuitry is fully independent of the main current control, the current limit can be adjusted safely, even while the **LASER** output is active.

Now you are ready to modulate the laser injection current. To enable the controller output, in the **LASER MODE** section of the front panel, press the push button labeled **OUTPUT**. The accompanying LED labeled **ON** will illuminate indicating that the laser current source's output is enabled. The instrument will drive the current source to the value set by the corresponding **LASER MODE** set point . When the **LASER** output is off, an internal short is placed across the laser output. This condition is indicated by the **OUTPUT SHORTED** indicator becoming lit. To disable the output, press the **OUTPUT** push button again.



Boosting the TE Controller

For users who need more than 16 Watts of TE Controller power, a booster current source may be required and the LDC-3700B Series Temperature Controller may be used as the control element. This section describes the use of the LDC-3700B's Temperature Controller as a remote temperature controller.

Whenever a connection is present between the **BOOSTER PRESENT** (pin 14) and **DIGITAL GROUND** (pin 15) of the back panel TEC Input/Output connector (see Figure 2.5), the LDC-3700B's TEC OUTPUT will be disabled. In this case, a BOOST CONTROL signal voltage equal to ±10.0 volts will be available for controlling an independent current source. This control voltage is available between the **BOOST CONTROL** (pin 10) and **AGND** (pin 9).

1, 2	TE Module (+)
3, 4	TE Module (-)
5	TE Module Shield
6	Sensor Shield
7	Sensor (+)
8	Sensor (-)
9	Analog Ground
10	Control Signal
11	Voltage Limit
12	Current Limit
13	Temp. Limit
14	Booster Present
15	Digital Ground

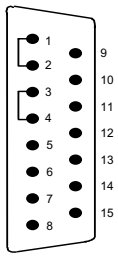


Figure 2.5 Rear Panel TEC Connector

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All functions of the temperature controller can be utilized as in normal TEC operation with the exception of the TE Current Limit. When the controller is configured in BOOSTER MODE, the LIM I value may be increased above the normal operating maximum of 4.0 Amps, to a maximum of 10.0 Amps. The control signal voltage, ±10 V is linearly proportional to the control current, which is limited by the **LIM I** parameter.

Pins 11 and 12 are outputs from the TEC controller hardware. These lines are TTL-level indicators of the TEC voltage and limit conditions, respectively. They are useful for external sensing of these conditions in addition to the normal status reporting of the LDC-3700B Series instrument.

Pin 13 is used as an external shutoff switch. Although it is labeled as "Temp. Limit", its function is to shut off the TEC controller. This function is controlled by applying a TTL-level signal to pin 13. When this input is high, the LDC-3700 Series instrument will shut the TEC controller off.

The feedback loop **GAIN** will require adjustment when a booster current source is used. The higher thermal loads will require larger or smaller **GAIN** values in order to settle to the set temperatures in a desirable fashion. See "Setting TE Control Loop Gain" in Chapter 2.

For remote operation using the GPIB interface, during controller operation, the Booster Enabled condition is reported in the TEC Condition Status register. If the status of the connection between the **BOOSTER PRESENT** and **DIGITAL GROUND** changes, this event will also be reported in the TEC Event Status Register. These events may be used to trigger a service request.

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CHAPTER 3

REMOTE OPERATION

GPIB (General Purpose Interface Bus) is the common name for *ANSI/IEEE Standard 488.2-1987*, an industry standard for interconnecting test instruments in a system. Everything you can do from the front panel can also be done remotely, and in some cases, with more flexibility. For instance, in remote mode, you have access to commands for functions not found on the front panel, such as commands that will increment (INC) and decrement (DEC) the current set point by a pre-defined step value. Also, you may only query the TEC voltage via remote control. The following sections show you the fundamentals of operating your LDC-3700B Laser Diode Controller remotely through the GPIB interface.

Basic GPIB Concepts

The information in this basic concepts discussion is normally not necessary to successfully operate the LDC-3700B through its GPIB interface, because your computer's GPIB controller usually handles them for you. However this is a useful perspective in understanding GPIB.

Data and Interface Messages

GPIB devices communicate with each other by sending data and interface messages. Data contains device-specific information such as programming instructions, measurement results, and instrument status. Each device has an address number, and ignores all data traffic not addressed to it. Depending on its content, data is often called a "device dependent message" or a "device dependent command". Interface messages manage the bus, with functions such as initializing the bus and addressing or unaddressing devices. In addition, some individual bus lines are designated for this purpose.

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Talkers, Listeners, and Controllers

Every GPIB system consists of one or more "talkers" and "listeners", and often at least one "controller". Talkers supply data. Listeners accept data. A system can consist of simply a talker and listener, for example a meter connected to a datalogger or chart recorder. Controllers designate talkers and listeners. A controller is necessary when the active talkers or listeners must be changed. When the controller is a computer, it often also designates itself as a listener so it can collect data from designated talkers.

If there is more than one controller, only one can be the Controller In Charge (CIC). Control can be passed from one controller to another. In a multiple controller system, there can be one "System Controller'\" capable of asserting control (becoming CIC).

GPIB Cable Connections

Standard GPIB connectors can be connected together (stacked), allowing you to configure the system linearly, or in a star configuration.

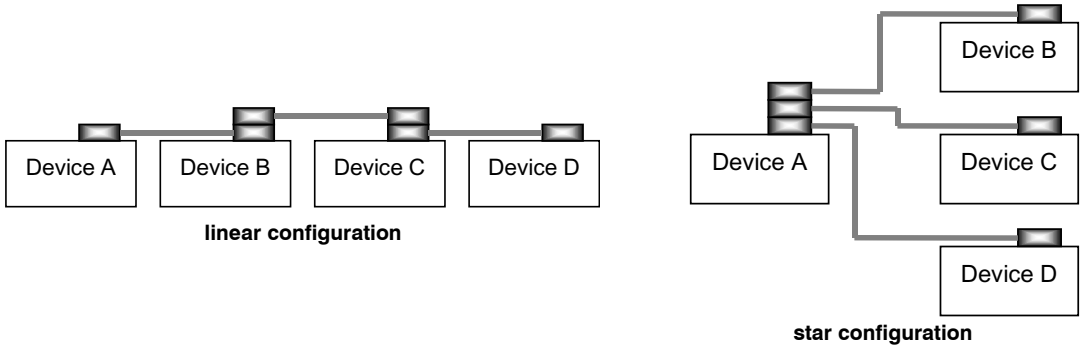


Figure 3.1 GPIB Cable Connections

The GPIB Connector

The standard GPIB connector consists of 16 signal lines in a 24-pin stackable connector. The extra pins are used for some twisted-pair wires. There are eight data input/output (IO) lines, three handshake lines, and five interface management lines.

Eight data input/output (DIO) lines carry both data (including device dependent commands) and interface messages. The ATN interface management line determines whether these lines contain data or interface messages.

Three handshake lines ensure that all data and messages are reliably transferred:

- NRFD (not ready for data) indicates whether a device can receive the next byte of data or message.

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- NDAC (not data accepted) indicates whether a receiving device has accepted a byte of data or message.
- DAV (data valid) indicates that the signal levels on the data lines are stable and available for the receiving device(s) to accept.

Five interface management lines control the flow of information:

- ATN (attention) is set by the controller in charge to define the I/O lines for data or interface messages.
- IFC (interface clear) is set by the system controller to initialize the bus and assert itself as controller in charge.
- REN (remote enable) is set by the controller to place addressed devices into remote or local (front panel) control mode.
- SRQ (service request) can be set by any device in the system to request service from the controller.
- EOI (end or identify) is used by talkers to identify the end of a message.

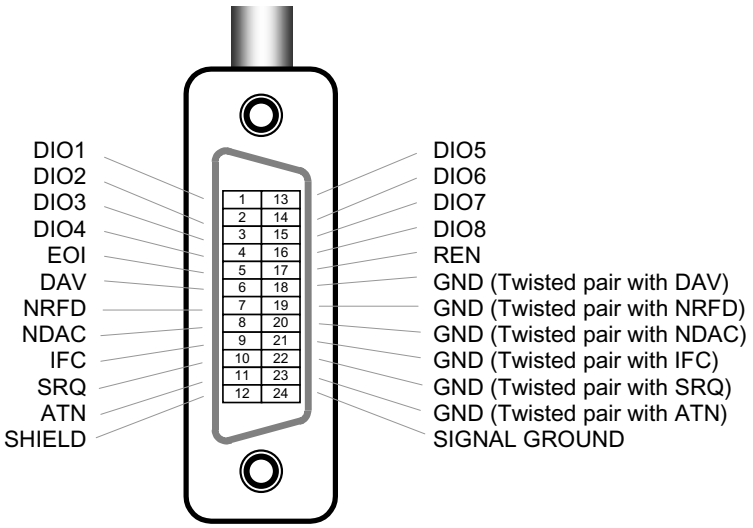


Figure 3.2 GPIB Connector Diagram

Reading the GPIB Address

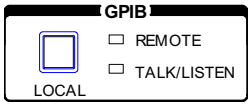
Before you can operate the LDC-3700B from a remote location, you need to know its GPIB address. Simply press the LOCAL switch in the section labeled GPIB on the front panel. The instrument will display the address on the TEC display. The default address from the factory is address "Adr 01".

Changing the GPIB Address

Every device on the GPIB bus must have a unique address. If it is necessary to change the address, press and hold in the (PARAMETER) SET switch while

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displaying the GPIB address. Turn the ADJUST knob until the desired address value is displayed, then release the SET switch. The new GPIB address will then be stored in non-volatile memory. The allowable address range is 0-30 for primary GPIB addressing. Extended GPIB addressing is not implemented on the LDC-3700B Series Laser Diode Controller at this time.



Changing Operation from Local to Remote

Sending a command over the GPIB bus automatically puts the instrument in REMOTE mode. The REMOTE indicator identifies when the controller is in remote operation mode. When the instrument is in REMOTE mode, pressing the LOCAL switch returns the instrument to LOCAL control mode unless the Local Lockout state has been activated by the host computer. Local Lockout disables all LDC-3700B Series Laser Diode Controller front panel switches until this condition is changed by the host computer. When the instrument is put in Local Lockout Mode by the host computer, the REMOTE indicator will flash at a 1 Hz rate to indicate that the front panel is completely disabled by Local Lockout. The TALK/LISTEN indicator illuminates when the instrument is communicating over the GPIB bus.

Command Syntax

This section describes command syntax and structure. You need this information to effectively write GPIB control programs. The syntax of GPIB commands follow the rules defined in the ANSI/IEEE 488.2-1987 standard.

Letters

Any GPIB command or query must contain all of the letters which are shown in upper case in the command definition. Some of the device dependent commands include additional optional letters shown in lower case in the command reference (Chapter 4, Command Reference). Upper/lower case does not matter, it is used in this manual to identify optional letters. The optional letters must be in the correct sequence. Some examples of what works, and what does not:

Okay	Not Okay
DIS	DS
Disp	dsp
Displ	dply

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Displa	DSPLY
Display	disply

White Space

"White space" is normally the space character (space bar). A single white space must separate a command from its parameters or data. For example:

Okay	Not Okay
DELAY 500	DELAY500

To enhance readability you can also use one or more white spaces before a comma, semicolon, or terminator. Since your computer normally puts the terminator at the end of each command string (line), this simply means that an extra space character at the end of your command line works OK.

A query has no space between the mnemonic and the question mark. For example:

Okay	Not Okay
TIMER?	TIMER ?

Note that too many consecutive white spaces can overflow the 256-byte data I/O buffer.

Terminators

A program message terminator identifies the end of a command string. These are the valid terminator sequences:

- <NL>
- <^END>
- <NL><^END>

Many computers terminate with <CR><NL><^END> (Carriage Return - New Line - EOI). A carriage return (<CR>)is read as white space.

The LDC-3700B terminates its responses with <CR><NL><^END>, unless you use the **TERM** command to change it.

If you encounter problems with GPIB communications, the terminator string can sometimes be the cause. Refer also to your GPIB interface (controller) manual.

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Command Separators

You can put more than one command on the same line (same command string) if you separate them with a semicolon. The semicolon can be preceded by one or more spaces. Examples:

```
TEC:DIS 1; tec:set:t?;
TEC:MODE:t ; TEC:T 25 ; TEC:Const 1, 2, 3.5 ; TEC:OUT 1g1
```

Parameters

Some commands require a parameter. The parameter must be separated from the command by at least one space.

The syntax symbol `<nrf value>` refers to the flexible numeric representation defined by the GPIB standard. It means that you can represent numbers in integer or floating point form, or in engineering/scientific notation. The IEEE-488.2 standard uses the names NR1, NR2, and NR3 respectively to denote "integer", "floating point", and "scientific notation". For example the number "twenty" may be represented by any of the following ASCII strings:

Integer	20	+20	NR1
Floating point	20.0	+20.0	NR2
Scientific notation	2.0E+1 2.0e+1	+2.0E+1 +2.0e+1	NR3

For more information on these definitions, refer to the IEEE-488.2 standard.

There are no default values for omitted parameters. If a command is expecting a parameter and none is entered, an error is generated.

For further clarity in programming, the (Boolean) values of one (1) and zero (0) may be used or their names as indicated in the following table.

Table 3.1 Substitute Parameter Names

SUBSTITUTE NAME	VALUE
ON	1
OFF	0
OLD	1
NEW	0
TRUE	1
FALSE	0
SET	1
RESET	0

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If multiple parameters are expected, they should be separated with commas. For example, to set the Steinhart-Hart constants on the LDC-3700B Series Laser Diode Controller (C1, C2, and C3) the following command could be sent:

```
TEC:CONST 1.111, 2.004, 0.456
```

If not all of the parameters need to be changed the other parameters may be omitted. For example:

```
TEC:CONST 1.111, , 0.456
```

A query has no space between the mnemonic and the question mark, as in:

```
LAS:LDI?
```

Command Tree Structure

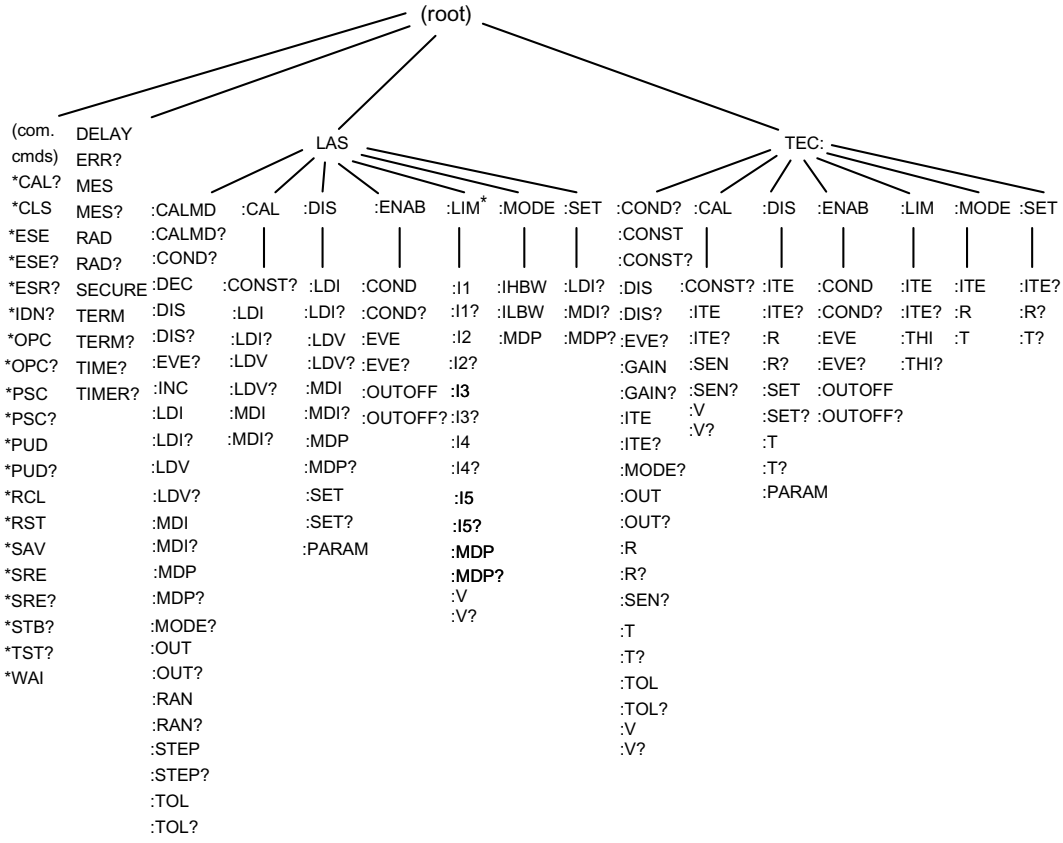
Many of the LDC-3700B remote commands require a compound structure. This is done to distinguish between different commands of the same type and to designate the side of the LDC-3700B the command is intended; TEC (thermoelectric controller) or LAS (laser current source). The first mnemonic opens a path to a set of commands relating to that path. The second mnemonic then defines the actual command.

The compound command structure is similar to a directory path structure, as found in DOS. For example, commands which deal with the LDC-3700B TEC have the path "TEC:", as in the command to set the TEC display to measured resistance,

```
TEC:DIS:R
```


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This structure is illustrated in Figure 3.3. Table 4.1 on page 62 lists all of the LDC-3700B device-dependent commands, with the full path shown for each command and a brief explanation of its usage.



* (I1 - LDC-3714B and LDC-3744B only, I2 - LDC-3724B and LDC-3724B only, I3 - LDC-3744B only, I4 - LDC-3744B only, I5 - LDC-3714B and LDC-3724B only)

Figure 3.3 Command Path Structure

Syntax Summary

GPIB commands must contain all of the letters shown in upper case in the command definition. Optional letters shown in lower case for some device dependent commands in the command reference (Chapter 4) are useful for clarity, but must be in the correct sequence.

A single white space must separate a command from its parameters or data. White space is normally the space character (space bar). Other control characters are also interpreted as white space. Do not use white space before the question mark in a query command.

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If you encounter problems with GPIB communications, the terminator string can be the cause. Refer also to your GPIB interface (controller) manual. The instrument accepts <NL>, or <^END>, or <NL><^END> as a command line terminator. Many computers terminate with <CR> <NL> <^END> (Carriage Return - New Line - EOI). The instrument ignores <CR> (Carriage Return) as white space. The LDC-3700B terminates its responses with <CR><NL><^END>, unless you use the **TERM** command to change it.

You can put more than one command on the same line (same command string) if you separate them with a semicolon.

GPIB uses a flexible representation for numeric parameters: integer, floating point, or engineering/scientific notation. There are no default values for omitted parameters.

Some device-dependent GPIB commands are compound commands, in which the first mnemonic opens a path to a set of commands relating to that path. The second mnemonic then defines the actual command.

Following are examples of invalid syntax command strings that will produce errors:

Table 3.2 Invalid Syntax Command Strings

COMMAND	COMMENT
`TEC:MODE T`	Missing colon, MODE? expected.
`TEC:MODE:R DEC`	Missing semicolon, DEC command generates an error.
`LAS:DIS ?`	Space not allowed before question mark, DIS command expected.
`Las:LDI33;dis?`	Space missing between LDI command and the parameter value, 33.

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IEEE488.2 Common Commands

The IEEE488.2 Common Commands and Queries are distinguished by the "*" which begins each mnemonic. The diagrams below show the syntax structure for common commands, common command queries, and common commands with numeric data required.

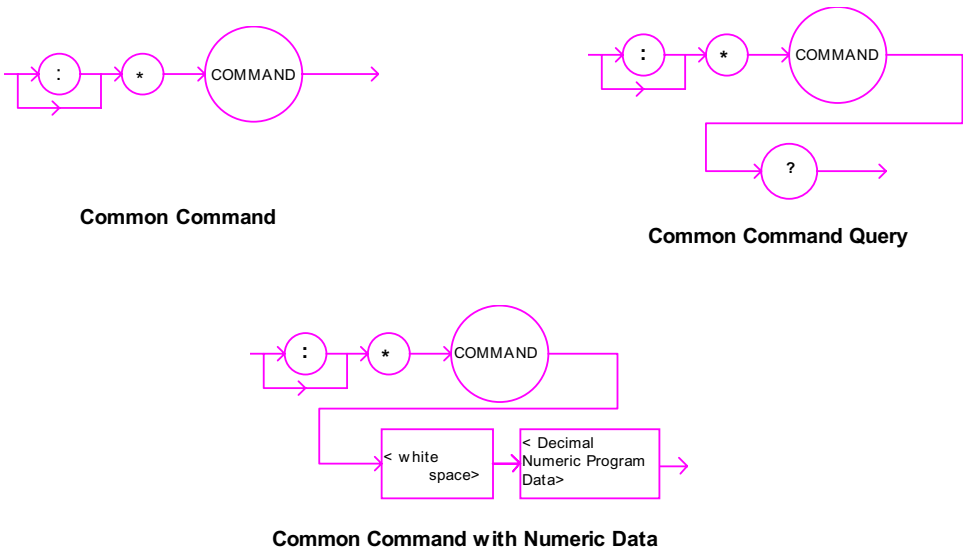


Figure 3.4 Common Command Diagrams

Numeric data is required with *PSC (1 = on, 0 = off), *RCL (0 to 10, see front panel RECALL function), *SAV (1 to 10, see front panel SAVE function), *ESE (0 to 255, see Figure 3.2), *SRE (0 to 255, see Figure 3.2), and *PUD (used at factory only).

A list of all of the IEEE 488.2 Common Commands supported by the LDC-3700B:

)B@K>	)BKR	)DRD
)DRD>	)DRQ>	)ÏCM>
)NOB	)NOB>	)ORB
)ORB>	)OTC	)OTC>
)QBK	)QRS	)R@U
)RQD>	)RQD	)RSA>
)SRS>	)V@Ï	

See the Command Reference on page 67 for descriptions of all the commands, including common commands, supported by the LDC-37x4B.

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LDC-3700B Commonly Used Commands

The LDC-3700B complete command set contains over 110 commands that allow you to operate the controller for a variety of applications. Within the command set, however, is a smaller subset of commands that will meet most of your needs.

Table 3.3 LDC-3700B Commonly Used Commands

Name	Parameters	Function
DELAY	1	Used to create a delay in the execution of further commands.
ERR?	NONE	Returns errors generated since the last query.
Laser		
LAS:CALMD	1	Used to set the CAL PD (monitor responsivity) constant.
LAS:LDI	1	Used to set the LAS constant current source set point value.
LAS:LDI?	NONE	Used to return the constant current source measured value
LAS:LDV?	NONE	Used to return the measured laser voltage value
LAS:LIM:I1	1	Used to set the LASER current source limit (high range for 3714B, low range for 3744B).
LAS:LIM:I2	1	Used to set the LASER current source limit (low range for 3724B/3744B).
LAS:LIM:I3	1	Used to set the LASER current source limit (high range for 3744B).
LAS:LIM:I4	1	Used to set the LASER current source limit (high range for 3744B)
LAS:LIM:I5	1	Used to set the LASER current source limit (low range for 3714B, high range for 3724B).
LAS:LIM:MDP	1	Used to set the constant optical power (from monitor PD) limit value.
LAS:LIM:V	1	Used to set the LASER current source compliance voltage limit value.
LAS:MDP	1	Used to set the constant optical power set point
LAS:MDP?	NONE	Returns the actual monitor PD power value
LAS:MODE?	NONE	Returns the mode, I (current), IHBW (high bandwidth) or P (optical power).
LAS:MODE:IHBW	NONE	Sets the mode to constant current, high bandwidth mode.
LAS:MODE:ILBW	NONE	Sets the mode to constant current (low bandwidth) mode.
LAS:MODE:MDP	NONE	Sets the mode to constant optical power mode.
LAS:OUT	1	Used to enable/disable the current source output
LAS:OUT?	NONE	Returns the current source output status.
LAS:RAN	1	Sets the laser current output range.
TE Controller		
TEC:CONST	1 - 3	Used to enter temperature sensor constants, C1, C2, and C3
TEC:CONST?	NONE	Used to read back the temperature sensor constant values.
TEC:GAIN	1	Used to set the TEC control loop gain parameter.

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Table 3.3 LDC-3700B Commonly Used Commands

TEC:LIM:ITE	1	Used to set the TEC constant current source limit value.
TEC:LIM:THI	1	Used to set the TEC upper temperature limit value.
TEC:MODE:T	NONE	Sets the instrument to constant temperature mode.
TEC:OUT	1	Used to enable/disable the TEC output.
TEC:OUT?	NONE	Returns the TEC output status.
TEC:T	1	Used to set the TEC (temperature) set point.
TEC:T?	NONE	Returns the TEC measured temperature value.
TEC:V?	NONE	Returns the TEC voltage measurement value.

Status Reporting

This section contains information that is relevant for understanding instrument error and status reporting. It also contains information regarding the use of the instrument status for generating interrupts for interrupt driven programs or subroutines. Understanding the Operation Complete definition for the instrument is useful for programming synchronization. The Output Off Register section also contains information on configuring the conditions which force the laser current source and/or TEC output off.

Event and Condition Registers

In addition to the required IEEE488.2 status reporting structures, the LDC-3700B remote interface provides Event and Condition Registers for TEC and LASER controller operations. The Event Registers are used to report events which occur during the operation of the LDC-3700B Series Laser Diode Controller. Events differ from conditions in that events signal an occurrence once, and are not reset until the Event Register is queried or the LDC-3700B Series Laser Diode Controller is powered off. Conditions reflect the current state of the device, and therefore may change many times during operation. Querying a Condition Register does not change its contents.

Figure 3.5 on page 56 shows the status reporting scheme of the LDC-3700B Series Controller. Each of the registers which may be accessed by a command or query has the appropriate command or query written above or below the register representation. For example, the LASER Condition Register may be queried via the "LASer:COND?" query.

The condition or event registers are logically ANDed with their respective enable registers. These bits are then logically ORed to form a summary message in the status byte for that particular register.

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Operation Complete Definition

Note that Bit 0 of the Standard Event Status Register contains the status of the Operation Complete flag. Enabling this bit via the *ESE command allows the user to update bit 5 of the status byte. Then, if the SRE mask has bit 5 set, and the user issues an *OPC command, the SRQ signal will be generated upon completion of the currently processed commands. This may be used to initiate service request routines which depend on the completion of all previous commands.

For example, the user may set the TEC output to 30 ^{o}C, enable an SRQ on Operation Complete (set *ESE 1 and *SRE 32), and have an SRQ handling routine in the user's software which reads a new measurement after the 30 ^{o}C value has been reached. This allows the use of the operation complete features of the
LDC-3700B Series Laser Diode Controller, without the need for program looping or polling which can tie up the GPIB. Operation Complete on the LDC-3700B Series Laser Diode Controller is defined as:

- No operations to the LASER current source hardware are pending.
- No operations to the TEC hardware are pending.
- No EEPROM (non-volatile) memory write cycles are in progress.

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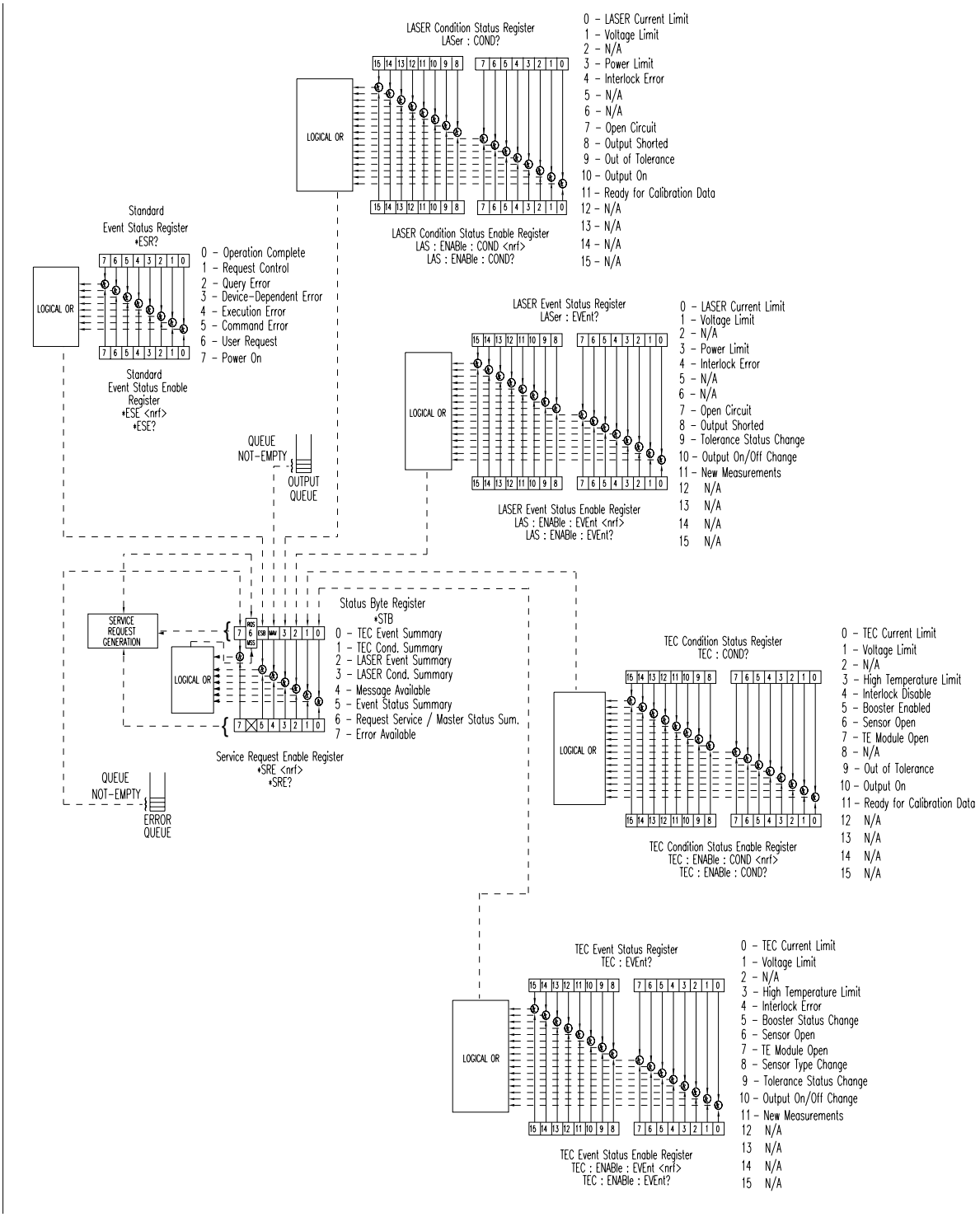


Figure 3.5 Status Reporting Scheme

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Note: If the GPIB times out while waiting for a response, either set the GPIB time-out longer or use SRQ generated interrupts in your program. See your GPIB manual for time-out configuration or SRQ programming setup. The *OPC, *OPC?, and *WAI commands should not be used inside a calibration routine.

Output Off Registers

The Output Off Enable Registers allow you to determine which conditions and events in the TEC and LASER controllers can cause their outputs to be turned off. These registers are configured in a manner which is similar to the status reporting registers. However, their outputs are not reported in the Status Byte Register. Rather, they go to the hardware which controls the output switching for that function (LASER or TEC). The events and conditions which may be set to cause the TEC and LASER outputs to be turned off are shown in Figure 3.6 on page 58 and Figure 3.7 on page 58.

The default (factory) settings for these registers are shown in Table 3.4. These settings are not effected by the *PSC (Power-On Status Clear) command.

Table 3.4 Default Settings for Output Off Registers

LASER Output Off Register	
0- disabled	8- N/A
1- disabled	9- disabled
2- N/A	10- disabled
3- enabled	11- enabled
4- N/A	12- N/A
5- N/A	13- N/A
6- N/A	14- N/A
7- N/A	15- N/A

TEC Output Off Register	
0- disabled	8- enabled
1- disabled	9- disabled
2- N/A	10- enabled
3- enabled	11- N/A
4- N/A	12- N/A
5- enabled	13- N/A
6- enabled	14- N/A
7- enabled	15- N/A

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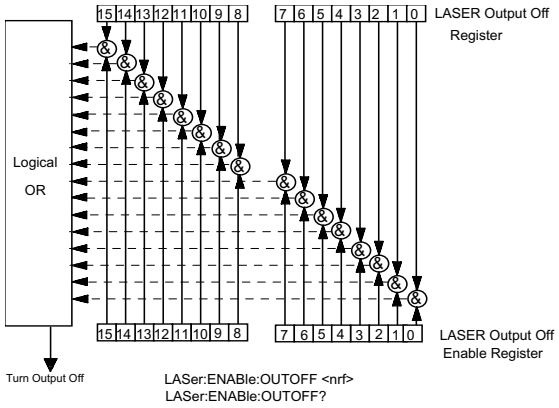


Figure 3.6 LASER Output Off Register

Bit Reference

0- LASER Current Limit	8- N/A
1- LASER Voltage Limit	9- LASER Output Changed to be out of Tolerance
2- N/A	10- TEC Output is Off Event
3- LASER Power Limit (output on)	11- TEC High Temperature Limit Condition
4- N/A	12- N/A
5- N/A	13- N/A
6- N/A	14- N/A
7- N/A	15- N/A

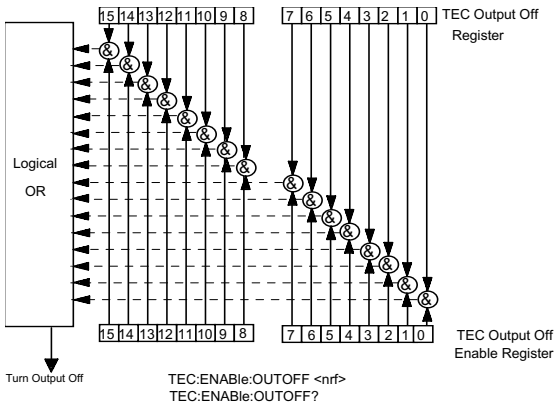


Figure 3.7 TEC Output Off Register

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Bit Reference

0- TEC Current Limit	8- Sensor Type Change (while output on) Eve.
1- TEC Voltage Limit	9- Outside of TEC Tolerance Cond.
2- N/A	10- Sensor Shorted (while output on) Cond.
3- High Temperature Limit	11- N/A
4- N/A	12- N/A
5- Booster Changed (while output on) Eve.	13- N/A
6- Sensor Open (while output on) Cond.	14- N/A
7- TEC Module Open (output on) Cond.	15- N/A

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Command Timing

This section describes, for each device-dependent command, whether that command is performed in an overlapped or sequential manner. In other words, it states whether the next command may begin while this command is being executed, or if the next command must wait until this command is completed before its execution begins. See Operation Complete Definition on page 55 for conditions about setting the operation complete flag.

Sequential/Overlapped Commands

All device-dependent commands are executed in an overlapped manner: subsequent commands may begin before the current command is completed. Some common commands are sequential; the next command must wait until this command is completed. All device-dependent commands are executed in an overlapped manner, except the "DELAY" command which is sequential. The operation complete flag is set after the conditions outlined in the Operation Complete Definition have been satisfied.

The *WAI (common command) is an example of a sequential command which forces the next command to wait until the no-operation-pending flag is true. This is essentially the same as waiting for the OPC flag to become true, because the no-operations-pending flag is used to set the OPC flag (bit 0 of the Standard Event Status Register).

Commands which change the status of the instrument limits, or change its mode or current range, step value, or status enable registers, will not have their OPC flag set until all current writing to non-volatile memory has been completed. This ensures the OPC flag is never set prematurely.

Query Response Timing

Query responses are evaluated at the time the query request is parsed, and not at the time the response message is sent. In most cases this does not create a problem since the time between parsing a query and sending its response is small.

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CHAPTER 4

COMMAND REFERENCE

This chapter is a guide to all of the device-dependent commands for the LDC-3700B Series Laser Diode Controller. This chapter is divided into two parts. The first part contains an overview of the remote commands used by the LDC-3700B Series Laser Diode Controller. The second part contains all of the LDC-3700B Series Laser Diode Controller commands in alphabetical order. The commands which emulate local (front panel) operation are denoted by the solid box next to the Local label in the upper left corner of the command description.

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GPIB Command Reference Summary

This section contains all of the commands for the LDC-3700B Series Laser Diode Controller, listed in alphabetical order. Sub-sections for each path are presented, listing the commands which are legal for that path. See Figure 3.3 on page 50 for command path tree structure.

Table 4.1 GPIB Command Summary Reference List

Name	Parameters	Function
*CAL?		Used for the A/D calibration procedure.
*CLS		Resets the Standard Event Register, Status Byte and Error Queue to zero.
DELAY	1	Used to create a delay in the execution of further commands.
ERR?	NONE	Returns errors generated since the last query.
*ESE		Used to load the Standard Event Status Enable Register.
*ESE?		Sets the summary bit (bit 5) in the Status Byte.
*ESR?		Returns the value of the **STANDARD EVENT REGISTER**.
*IDN?		Returns the **DEVICE IDENTIFICATION** string.
LAS:CALMD	1	Used to set the CAL PD (monitor responsivity) constant.
LAS:CALMD?	NONE	Returns the CAL PD (monitor responsivity) constant.
LAS:CAL:CONST?	1	Factory use only.
LAS:CAL:LDI	NONE	Used to enter the laser current calibration mode.
LAS:CAL:LDI?	NONE	Returns the ready state for entering the laser current calibration value.
LAS:CAL:LDV	NONE	Used to enter the laser voltage calibration mode.
LAS:CAL:LDV?	NONE	Returns the ready state for entering the laser voltage calibration value.
LAS:CAL:MDI	NONE	Used to enter the monitor photodiode current calibration mode.
LAS:CAL:MDI?	NONE	Returns the ready state for entering the monitor PD current calibration value.
LAS:COND?	NONE	Returns the value of the LASER condition register.
LAS:DEC	0, 1 or 2	Used to decrease the laser current set point value by one or more steps.
LAS:DIS	1	Turns the LASER display on or off.
LAS:DIS?	NONE	Returns the LASER display value.
LAS:DIS:LDI	NONE	Turn on/off LASER display to show laser output current.
LAS:DIS:LDI?	NONE	Returns status of laser output current display, on/off.
LAS:DIS:LDV	NONE	Turn on/off LASER display to show laser output voltage.
LAS:DIS:LDV?	NONE	Returns status of laser output voltage display, on/off.
LAS:DIS:MDI	NONE	Turn on/off LASER display to show PD monitor current.
LAS:DIS:MDI?	NONE	Returns status of photo diode monitor current display, on/off.
LAS:DIS:MDP	NONE	Turns on/off LASER display to show PD monitor power.
LAS:DIS:MDP?	NONE	Returns status of photodiode monitor power display, on/off.
LAS:DIS:PARAM	NONE	Enables LASER display to show parameter values.

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Table 4.1 GPIB Command Summary Reference List

Name	Parameters	Function
LAS:DIS:SET	NONE	Shows the LASER display set point corresponding to mode.
LAS:DIS:SET?	NONE	Returns status of LASER set point display, on/off.
LAS:ENAB:COND	1	Sets the enable register for LASER conditions.
LAS:ENAB:COND?	NONE	Returns the value of the LAS conditions enable register.
LAS:ENAB:EVE	1	Sets the enable register for LAS events.
LAS:ENAB:EVE?	NONE	Returns the value of the LAS event enable register.
LAS:ENAB:OUTOFF	1	Sets the enable register for LAS conditions which turn the LAS output off.
LAS:ENAB:OUTOFF?	NONE	Returns the value of the LAS outoff enable register.
LAS:EVENT?	NONE	Returns the value of the LAS event register.
LAS:LDI	1	Used to set the LASER constant current source set point value.
LAS:LDI?	NONE	Used to return the constant current source measured value
LAS:INC	0, 1 or 2	Used to increment the LASER set point value by one or more steps.
LAS:LDV	1	Used to set the laser voltage value for calibration.
LAS:LDV?	NONE	Used to return the measured laser voltage value
LAS:LIM:I1	1	Used to set the LASER current source limit (low range for 3714B/3744B).
LAS:LIM:I1?	NONE	Used to return the LASER current source limit (low range for 3714B/3744B).
LAS:LIM:I2	1	Used to set the LASER current source limit (low range for 3724B).
LAS:LIM:I2?	NONE	Used to return the LASER current source limit (low range for 3724B).
LAS:LIM:I3	1	Used to set the LASER current source limit (high range for 3744B).
LAS:LIM:I3?	NONE	Used to return the LASER current source limit (high range for 3744B).
LAS:LIM:I4	1	Used to set the LASER current source limit (high range for 3744B).
LAS:LIM:I4?	NONE	Used to return the LASER current source limit (high range for 3744B).
LAS:LIM:I5	1	Used to set the LASER current source limit (high range for 3714B/3724B).
LAS:LIM:I5?	NONE	Used to return the LASER current source limit (high range for 3714B/3724B).
LAS:LIM:MDP	1	Used to set the constant optical power (from monitor PD) limit value.
LAS:LIM:MDP?	NONE	Used to return the optical power (from monitor PD) limit value.
LAS:LIM:V	1	Used to set the LASER compliance voltage limit value.
LAS:LIM:V?	NONE	Used to return the LASER compliance voltage limit value.
LAS:MDI	1	Used to set the constant optical power set point, if PD responsivity is 0.
LAS:MDI?	NONE	Used to return the monitor PD current measured value.
LAS:MDP	1	Used to set the constant optical power set point.

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Table 4.1 GPIB Command Summary Reference List

Name	Parameters	Function
LAS:MDP?	NONE	Returns the actual monitor PD power value.
LAS:MODE?	NONE	Returns the mode, I (current), IHBW (high bandwidth) or P (optical power).
LAS:MODE:IHBW	NONE	Sets the mode to constant current, high bandwidth.
LAS:MODE:ILBW	NONE	Sets the mode to constant current (low bandwidth) mode.
LAS:MODE:MDP	NONE	Sets the mode to constant optical power mode.
LAS:OUT	1	Used to enable/disable the current source output.
LAS:OUT?	NONE	Returns the current source output status.
LAS:RAN	1	Sets the laser current output range.
LAS:RAN?	NONE	Returns the laser current output range.
LAS:SET:LDI?	NONE	Returns the laser constant I (current) set point.
LAS:SET:MDI?	NONE	Returns the laser constant optical power set point.
LAS:SET:MDP?	NONE	Returns the constant P (optical power) set point
LAS:STEP	1	Used to set the LASER set point step value.
LAS:STEP?	NONE	Returns the LASER set point step value.
LAS:TOL	2	Used to set the LASER set point tolerance value and time period value.
LAS:TOL?	NONE	Used to return the LASER set point tolerance value and time period value.
MES	1	Used to enter a string message of up to 16 bits.
MES?	NONE	Returns a previously stored ASCII message.
*OPC		Generates the **OPERATION COMPLETE** message in the Standard Event Status Register .
*OPC?		Places an ASCII character 1 into the Output Queue.
*PSC		Used to avoid any undesirable service requests.
*PSC?		Queries the power-on-status-clear flag.
*PUD		Stores data unique to the instrument.
*PUD?		Retrieves the contents of the *PUD storage area.
RAD	1	Sets the radix type for numerical data. Decimal, binary, octal, or hexadecimal.
RAD?	NONE	Used to return the radix type for numerical data.
*RCL	1	Recall a stored setup configuration
*RST		Performs a device reset.
*SAV	1	Save the current setup configuration
SECURE	1	Used to gain access to protected data.
*SRE		Sets the Service Request Enable Register bits to allow generation of the user-selectable service requests.
*SRE?		Determines the current contents of the Service Request Enable Register.
*STB?		Reads the Status Byte.
TEC:CAL:CONST?	1	Factory use only.
TEC:CAL:ITE	1	Used to enter the TEC current source calibration mode.

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Table 4.1 GPIB Command Summary Reference List

Name	Parameters	Function
TEC:CAL:ITE?	NONE	Returns the ready state for entering a TE current source calibration value.
TEC:CAL:SEN	1	Used to enter the sensor calibration mode.
TEC:CAL:SEN?	NONE	Returns the ready state for entering a sensor calibration value.
TEC:CAL:V	1	Used to enter the TEC voltage calibration mode.
TEC:CAL:V?	NONE	Returns the ready state for entering a TEC voltage calibration value.
TEC:CONST	1 - 3	Used to enter temperature sensor constants, C1, C2, and C3
TEC:CONST?	NONE	Used to read back the temperature sensor constant values.
TEC:DIS	1	Turns the TEC display on or off.
TEC:DIS?	NONE	Returns the TEC display value, on/off.
TEC:DIS:ITE	NONE	Turn on/off TEC display to show TEC current.
TEC:DIS:ITE?	NONE	Returns status of TE current display, on/off.
TEC:DIS:R	NONE	Turn on/off display to show the temperature sensor value, V, I, or R.
TEC:DIS:R?	NONE	Returns status of sensor value display, on/off.
TEC:DIS:SET	NONE	Shows the TEC display set point corresponding to TEC mode
TEC:DIS:SET?	NONE	Returns status of TEC set point display, on/off.
TEC:DIS:T	NONE	Turns on/off TEC display to show temperature.
TEC:DIS:T?	NONE	Returns status of temperature display, on/off.
TEC:ENAB:COND	1	Sets the enable register for TEC conditions.
TEC:ENAB:COND?	NONE	Returns the value of the TEC conditions enable register.
TEC:ENAB:EVE	1	Sets the enable register for TEC events.
TEC:ENAB:EVE?	NONE	Returns the value of the TEC event enable register.
TEC:ENAB:OUTOFF	1	Sets the enable register for TEC conditions which turn the TEC output off.
TEC:ENAB:OUTOFF?	NONE	Returns the value of the TEC outoff enable register.
TEC:EVENT?	NONE	Returns the value of the TEC event register.
TEC:GAIN	1	Used to set TEC control loop gain parameter.
TEC:GAIN?	NONE	Used to return the TEC control loop gain parameter.
TEC:ITE	1	Used to set the TEC current (ITE) set point.
TEC:ITE?	NONE	Returns the measured TEC current (ITE) value.
TEC:LIM:ITE	1	Used to set the TEC constant current source limit value.
TEC:LIM:ITE?	NONE	Used to return the TEC constant current source limit value.
TEC:LIM:THI	1	Used to set the TEC upper temperature limit value.
TEC:LIM:THI?	NONE	Returns the TEC upper temperature limit value.
TEC:MODE?	NONE	Returns the mode, ITE (TEC current), R (sensor) or T (temperature).
TEC:MODE:ITE	NONE	Sets the mode to constant TEC current mode.
TEC:MODE:R	NONE	Sets the mode to constant thermistor resistance/linear sensor reference mode.
TEC:MODE:T	NONE	Sets the TEC mode to constant temperature mode.

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Table 4.1 GPIB Command Summary Reference List

Name	Parameters	Function
TEC:OUT	1	Used to enable/disable the TEC current output.
TEC:OUT?	NONE	Returns the TEC OUTPUT status.
TEC:R	1	Sets the constant sensor mode, resistance, voltage, or current.
TEC:R?	NONE	Returns the measured temperature sensor value.
TEC:SEN?	NONE	Returns the position of the SENSOR SELECT switch.
TEC:SET:ITE?	NONE	Returns the constant ITE (TEC current) set point.
TEC:SET:R?	NONE	Returns the constant R (temperature sensor value) set point.
TEC:SET:T?	NONE	Returns the constant T (temperature) set point.
TEC:T	1	Used to set the TEC constant T (temperature) set point.
TEC:T?	NONE	Returns the TEC measured temperature value.
TEC:TOL	1 or 2	Used to set the TEC set point tolerance value and time period value.
TEC:TOL?	NONE	Used to return the TEC set point tolerance value and time period value.
TEC:V	1	Used to enter the TEC voltage value during calibration.
TEC:V?	NONE	Used to return the TEC voltage measurement value.
TERM	1	Used to add a carriage return to the device terminator.
TERM?	NONE	Returns the status of the TERM command.
TIME?	NONE	Returns the elapsed time since the instrument was last powered up.
TIMER?	NONE	Returns the elapsed time since the timer was last reset.
*TST?		Initiates an internal self-test and returns a response when complete.
*WAI		Prevents executing any further commands until the No-Operation-Pending flag is true.

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Command Reference

The following pages contain a reference for the device-dependent commands of the LDC-3700B Series Laser Diode Controller. This reference contains useful information for both local and remote operation of the LDC-3700B.

In some references, parentheses are used to signify the labeled area for a particular switch or LED indicator on the front panel. For example, (TEC DISPLAY) SET refers to the switch labeled "SET" in the TEC DISPLAY area of the front panel.

---

*CAL?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action	Adjusts the internal analog to digital (A/D) converter to reference points, then reports results.
Results	Zero = OK Non-zero = calibration error
Note	A/D referencing is performed each 10 minutes of inactive time.
Example	*CAL?

---

*CLS

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action	Clears status event registers: Event Status, Event Status Enable, and Error Queue.
Note	Useful to clear registers before enabling service requests (SRQ).
Example	***CLS**

DELAY <nrf value>

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action	The DELAY command causes the execution of commands to be delayed by a user-defined time. This command is similar to the *WAI common command, except that execution resumes after the specified number of milliseconds, instead of waiting for the Operation-Complete flag to be set.
Parameters	An <nrf value> which represents the delay time, in milliseconds.
Notes:	The Operation-Complete flag is held false until the delay period elapses, but the *OPC? query will not execute until the delay period has elapsed. This command is useful for creating delays which don't require a lot of program code and don't tie up the GPIB during execution. The delay time is approximate, with an error of about 10%. Care should be taken to set the GPIB time-out appropriately for use with the Delay command. After this command (or the *WAI) command is sent, the 3700B Series Controller may receive up to 20 more commands before the delay period is over. If more

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than 20 commands are sent before the delay or wait period is over, the additional commands will be ignored and an error E220 will be generated.

Examples "DELAY 500" -action: Further commands and queries are not executed until about 0.5 seconds have elapsed from the time this command is executed.

"Tec:T 22;Delay 2000;Tec:T?" -actions: The TEC is set to 22.0∀C, then the LDC-3700B Series Laser Diode Controller waits for about 2.0 seconds before returning the measured temperature.

---

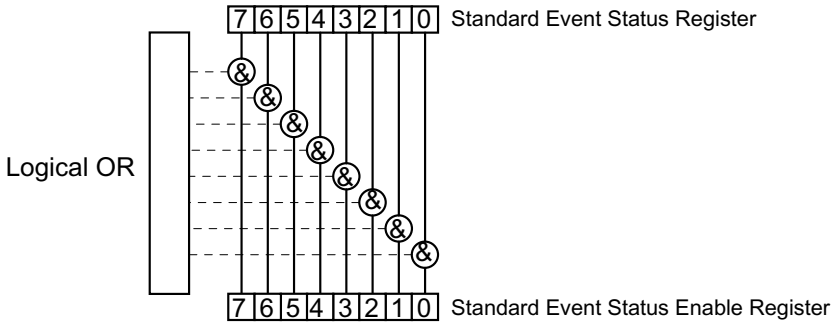
*ESE <nrf value>

Dudms Rs`str Dm`akd

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Enables bits in the standard event status enable register.

Response The value must be between 0 and 255.



Bit Reference

0- Operation Complete	4- Execution Error
1- N/A	5- Command Error
2- Query Error	6- User Request
3- Device Dependent Error	7- Power On

Notes Bit 5 of the status byte register is set if any enabled conditions are true.

Setting bit 0 allows you to generate service requests from overlapped commands as previous oper-ations complete. This may be useful for ensuring that an operation is complete before starting a measurement.

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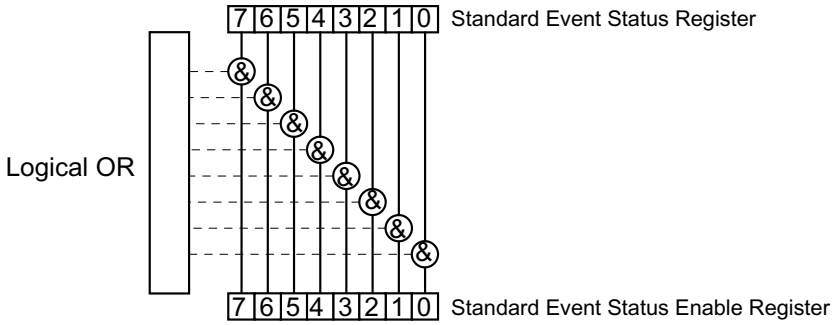
*ESE?

Dudms Rs`str Dm`akd>

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the value in the standard event status enable register.

Response The value must be between 0 and 255.



Bit Reference

0- Operation Complete	4- Execution Error
1- N/A	5- Command Error
2- Query Error	6- User Request
3- Device Dependent Error	7- Power On

Notes Bit 5 of the status byte register is set if any enabled conditions are true. Response is the sum of the enabled bits.

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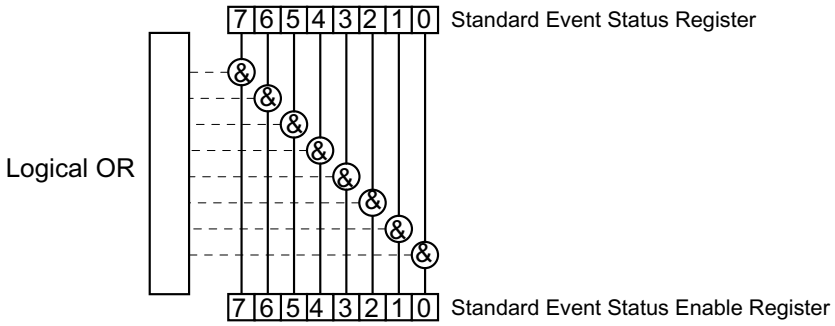
*ESR?

Rs`mc`qc Dudms Rs`str Qdfhrsdq>

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the value in the standard event status register.

Response The value must be between 0 and 255.



Bit Reference

0- Operation Complete	4- Execution Error
1- N/A	5- Command Error
2- Query Error	6- User Request
3- Device Dependent Error	7- Power On

Notes Response is the sum of the enabled bits.
This command allows you to determine which type of error has occurred.

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ERRors?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The ERRors? query returns a list of command and device errors which have occurred since the last query. These errors are notated by a number which corresponds to the type of error which occurred. See Chapter 3 for information regarding error handling.

Parameters: None.

Notes: The response data will be a list of the current errors. The errors are represented by numbers and are separated by commas. A response of 0 indicates that no errors were reported. The response data is sent as character data. Up to 10 error codes are stored between error queries.

Examples: "ERR?" -response: 0, means no errors reported.

"Errors?" -response: 201,407, means that the <PROGRAM DATA> (parameter) value out of range error and the High Temperature Limit error were reported since the last query.

*IDN?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action: Requests the instrument to identify itself.

Response: Returns a comma delimited standard format ASCII identification string, from information stored in the instrument during manufacture.

LASer:CAL MD <nrf value>
PD <nrf value>

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:CALMD command sets the laser's photodiode feedback responsivity (the CAL PD parameter).

Parameters: An <nrf value>, in microamps/milliwatt. The range is 0 to 1000.

Notes: If the parameter is set to 0, the LDC-3700B Series Laser Diode Controller will operate in a constant I_{PD} mode, when Constant P mode is selected.

The parameter should be set to 0 for I_{PD} operation modes. Otherwise, the value of this parameter is used to convert between I_{PD} and P_{PD} values. The units of this parameter are microamps/milliwatt.

Examples: "LAS:CALMD 0" -action: sets the CAL PD parameter to 0. This enables the constant I_{PD} mode of operation.

"Laser:Calmd 1" -action: sets the CAL PD parameter to 1.00 microamp/milliwatt. Therefore, a photodiode feedback current of 1 microamp will cause the P_{PD} display to read 1 milliwatt.

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LASer:CAL MD?
PD?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:CALMD? query returns the value of the laser's photodiode feedback responsivity (CAL PD parameter) setting.

Notes
If this value is 0, the LDC-3700B Series Laser Diode Controller will be set to operate in constant I_{PD} mode, and the I_{PD} set point value will be in effect. If this value is non-zero, the LDC-3700B Series Laser Diode Controller will be set to operate in constant P_{PD} mode, and the P_{PD} set point value will be in effect.

If this value is 0, the front panel P_{PD} will display "-.-", and no P_{PD} value can be calculated.

Examples
"LASER:CALMD?" -response: 0, means the LDC-3700B Series Laser Diode Controller is set for operation in constant I_{PD} mode (if P mode is also selected).

"Las:Calmd?" -response: 1.1, means the LDC-3700B Series Laser Diode Controller is set for operation in constant P_{PD} mode (if P mode is also selected) and the responsivity is set to 1.1 σA/mW. 1.1 σA of photodiode feedback current represents 1 mW of optical power.

LAS:CAL:CONST?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LAS:CAL:CONST? query returns a stored calibration value. It is intended for factory use only.

LASer:CAL: LDI
I

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:CAL:LDI command is used to enter the LASER current set point, measurement, and limit (in low bandwidth mode) calibration mode.

Parameters
None.

Notes
Since the limit circuit is the same for both high and low bandwidth modes, it is only calibrated when low bandwidth mode is selected.

After this command is issued, the LDC-3700B Series Laser Diode Controller will allow calibration of the current set point, measurement, and limit (if low bandwidth mode is selected). This procedure is outlined in Chapter 6.

The calibration defaults to the selected bandwidth setting. Therefore, it is necessary to select the desired bandwidth (I or I_{HBW}), and turn the LASER output on before performing the calibration for that bandwidth.

Calibration is performed at the current set point, wherever it is set. If the LASER output is not on, E 517 is displayed.

In remote operation, the LASer:CAL:LDI? query may be used to determine if the LDC-3700B Series Laser Diode Controller is ready for the user to enter a value.

Examples
"Las:CAL:Ldl" -action: the LDC-3700B enters calibration mode for LASER current.

"Las:Cal:LDI" -action: the LDC-3700B enters calibration mode for L

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LASer:CAL: LDI? / I?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:CAL:LDI? query is used to determine that the LDC-3700B Series Laser Diode Controller is ready for a value to be entered during the calibration cycle of the LASer:CAL:LDI mode.

Notes — After this query is issued and a response of 1 is received, the LDC-3700B Series Laser Diode Controller will be ready for the user to enter a current value via the LASer:LDI command (see Chapter 6).

Examples — "LASer:CAL:LDI?" -response: 1, means the LDC-3700B Series Laser Diode Controller is ready for the user to enter a current value via the LASer:LDI command.

LASer:CAL:LDV

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:CAL:LDV command is used to enter the LASER voltage measurement calibration mode.

Parameters — None.

Notes — After this command is issued, the LDC-3700B Series Laser Diode Controller will allow calibration of the laser voltage measurement.

The LASer:CAL:LDV? query may be used to determine if the LDC-3700B Series Laser Diode Controller is ready for the user to enter a value.

Examples — "Las:CAL:Ldv" -action: the LDC-3700B Series Laser Diode Controller enters calibration mode for LASER voltage.

"Las:Cal:LDV" -action: the LDC-3700B Series Laser Diode Controller enters calibration mode for LASER voltage.

LASer:CAL:LDV?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:CAL:LDV? query is used to determine that the LDC-3700B Series Laser Diode Controller is ready for a value to be entered during the calibration cycle of the LASer:CAL:LDV mode.

Notes — After this query is issued and a response of 1 is received, the LDC-3700B Series Laser Diode Controller will be ready for the user to enter a voltage value via the LASer:LDV command (see Chapter 6).

Examples — "LASer:CAL:LDV?" -response: 1, means the LDC-3700B Series Laser Diode Controller is ready for the user to enter a voltage value via the LASer:LDV command.

"LASer:Cal:LdV?" -response: 0, means the LDC-3700B Series Laser Diode Controller is not yet ready for the user to enter a LASER voltage value.

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LASer:CAL: **IPD** / **MDI**

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:CAL:MDI command is used to enter the LASER photodiode current calibration mode.

Parameters: None.

Notes: After this command is issued, the LDC-3700B Series Laser Diode Controller will automatically enter the LASER photodiode current calibration mode for the current LASER range. When the LDC-3700B Series Laser Diode Controller is ready, the user should enter the true measured value. This procedure is outlined in Chapter 6.

If the LASER output is not ON, or if the P mode is not selected, error code E 516 will be generated.

In remote operation, the LASer:CAL:MDI? query may be used to determine if the LDC-3700B Series Laser Diode Controller is ready for the user to enter a value via the LASer:MDI command.

Examples: "Las:CAL:MDI" -action: the LDC-3700B Series Laser Diode Controller enters the LASER photodiode current calibration mode.

"LAS:Cal:MDI" -action: the LDC-3700B Series Laser Diode Controller enters the LASER photodiode current calibration mode.

LASer:CAL: **IPD?** / **MDI?**

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:CAL:MDI? query is used to determine that the LDC-3700B Series Laser Diode Controller is ready for a value to be entered during the calibration cycle of the LASer:CAL:MDI mode.

Notes: After this query is issued and a response of 1 is received, the LDC-3700B Series Laser Diode Controller be ready for the user to enter a photodiode current value via the LASer:MDI command (see Chapter 6).

Examples: "LAS:CAL:MDI?" -response: 1, means the LDC-3700B Series Laser Diode Controller is ready for the user to enter a photodiode current value via the LASer:MDI command.

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LASer:COND?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:COND? query returns the value of the status condition register of the LASER operations.

-where the response is the sum of the following:

1 - LASER Current Limit	256 - Output is shorted
2 - LASER Voltage Limit	512 - Output is outside tolerance limit
4 - N/A	1024 - Output on/off state
8 - Power limit	2048 - Ready for calibration data state
16 - Interlock disabled	4096 - N/A
32 - N/A	8192 - N/A
64 - N/A	16384 - N/A
128 - Open circuit	32768 - N/A

Notes

The LASER conditions which are reported to the status byte are set via the LASer:ENABle:COND command.

The Open circuit condition is only present while the LASER output is on, and when the hardware detects this condition, it will turn the LASER output off. Therefore, the Open Circuit condition is fleeting and may be missed via the LAS:COND? query. Therefore, the user should test for the Open Circuit Event via the LAS:EVEnt? query.

The LASER condition status is constantly changing, while the event status is only cleared when the event status is read or the *CLS command is issued.

Examples

"LAS:COND?" -response: 513, means that the LASER limit current and out of tolerance LASER conditions currently exist.

"Radix Hex; Laser:Cond?" -response: #H108, means that the LASER Output shorted and Power limit conditions currently exist.

LASer:DEC <nrf value>,<nrf value>

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DEC command decrements the selected laser control mode set point by one or more steps. Optional parameters allow multiple steps to be decremented and the time (in milliseconds) between decrements to be set, respectively.

Parameters

0, 1, or 2. The first optional parameter is the number of steps, and the second optional parameter is the number of milliseconds between steps.

Notes

The decremental default amount is one step. The step size can be edited via the LAS:STEP command. LDC-3714B default values are 0.001/0.002 mA (50/100 mA range), 0.01 mW, or 1 σA (if CALMD = 0), depending on the mode of operation. LDC-

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3724B default values are 0.01 mA, 0.01 mW, or 1 σA. LDC-3744B default values are 0.1 mA, 0.1 mW, or 1 σA.

If the first optional parameter is used, but not the second, the user may decrement the LASER set point by a multiple of the LAS:STEP size, without changing the LAS:STEP size.

If the both optional parameters are used, the user may create an automated stepping ramp function for the LASER output.

If the first optional parameter is entered as zero, "LAS:DEC 0", the command will do nothing.

The minimum time to complete one decrement is about 20 msec. Therefore, values for the second optional parameter (time between decrements) have a practical minimum of 20.

Examples "LAS:MODE:I; LAS:STEP 3; LAS:DEC" -action: The laser source current set point is decremented by 0.3 mA (LDC-3744B), or 0.03 mA (LDC-3724B), or 0.003 mA (LDC-3714B on 50 mA range), or 0.006 mA (LDC-3714B on 100 mA range).

"LAS:MODE:I; LAS:STEP 3; LAS:DEC 3" -action: The laser source current set point is decremented by three times the amount described in the first example.

"LAS:MODE:I; LAS:STEP 3; LAS:DEC 3,5000" -action: The laser source current set point is decremented by the amount described in the first example, three times, with 5 seconds between decremental steps.

LASer:DISplay <nrf value>

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay command enables or disables (turns off) the LASER display and LASER section's indicator LEDs.SYNTAX DIAGRAM

Parameters An <nrf value>;-where 1 = on, 0 = off.

Notes Turning the LASER display and LEDs off means that a message of all blank spaces is sent to the LASER display, and all of the LASER section's indicator LEDs will be turned off.

Examples "las:dis 1" -action: turns the LASER display on and enables the LASER indicator LEDs.

"Laser:dis Off" -action: turns the LASER display and disables the LASER indicator LEDs.

LASer:DISplay?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay? query returns the value shown on the LASER display.

Notes Returns the actual (6-character) string from the output buffer to the LASER display. If the display is disabled, it returns " .".

Examples "LAS:DIS?" -response: "- 99.9", means the LASER display shows "- 99.9".

"Laser:DISp?" -response: " 0.6", means the LASER display shows " 0.6".

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LASer:DISplay: **LDI** / **I**

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:LDI command sets the laser display to show the constant current measurement.

Parameters None.

Notes The actual LASER I display is turned off automatically when another LASER DISPLAY selection is enabled.

Examples "LAS:DIS:LDI" -action: enables the LASER display for current values.

LASer:DISplay: **LDI?** / **I?**

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:LDI? query returns the status of the (LAS DISPLAY) I switch.

Notes In local operation, the status of the I switch is indicated by the enunciator next to the LASER display (mA will be illuminated when the display is in I mode).

Examples "LAS:DIS:LDI?" -response: 0, means that the (LASER DISPLAY) I switch is not currently active, laser current is not displayed.

"Las:dis:ldI?" -response: 1, means that the (LASER DISPLAY) I switch is currently active, laser current may be displayed.

LASer:DISplay: **V** / **LDV**

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:LDV command sets the laser display to show the laser forward voltage measurement.

Parameters None.

Notes The actual LASER V display is turned off automatically when another LASER DISPLAY selection is enabled.

Examples "LAS:DIS:LDV" -action: enables the LASER display for forward voltage values in Volts.

LASer:DISplay: **V?** / **LDV?**

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:LDV? query returns the status of the (LAS DISPLAY) V switch.

Notes In local operation, the status of the V switch is indicated by the enunciator next to the LASER display (V will be illuminated when the display is in V mode).

Examples "LAS:DIS:LDV?" -response: 0, means that the (LASER DISPLAY) V switch is not currently active, laser voltage is not displayed.

"LAS: DIS:LDV?" -response: 1, means that the (LASER DISPLAY) V switch is currently active, laser voltage may be displayed.

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LASer:DISplay: **IDP** / **MDI**

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:MDI command sets the laser display to show the monitor photodiode current measurement.

Parameters: None.

Notes: The actual (LASER DISPLAY) I_{PD} display is turned off automatically when another LASER DISPLAY selection is enabled.

Examples: "LAS:DIS:MDI" -action: enables the LASER display for photodiode current values.
Laser:Disp:Mdi" -action: enables the LASER display for photodiode current values.

LASer:DISplay: **IDP?** / **MDI?**

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:MDI? query returns the status of the (LASER DISPLAY) I_{PD} switch.

Notes: In local operation, the status of the I_{PD} switch is indicated by the enunciator next to the LASER display (σA will be illuminated when the display is in I_{PD} mode).

Examples: "LAS:DIS:MDI?" -response: 0, means that the (LASER DISPLAY) I_{PD} switch is not currently active, laser photodiode monitor current is not displayed.
"Las:dis:MDI?" -response: 1, means that the (LASER DISPLAY) I_{PD} switch is currently active, monitor PD current may be displayed.

LASer:DISplay: **PPD** / **MDP**

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:MDP command sets the laser display to show the monitor photodiode power measurement.

Parameters: None.

Notes: The actual (LASER) P_{PD} display is turned off automatically when another LASER DISPLAY selection is enabled.

Examples: "Las:Display:MDp" -action: enables the LASER display for photodiode power values.
"Laser:Disp:MDP" -action: enables the LASER display for photodiode power values.

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LASer:DISplay: PPD? MDP?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:MPD? query returns the status of the (LASER DISPLAY) P_{PD} switch.

Notes — In local operation, the status of the P_{PD} switch is indicated by the enunciator next to the LASER display (mW will be illuminated when the display is in P_{PD} mode).

Examples — "LAS:DISp:MDp?" -response: 0, means that the (LASER DISPLAY) P_{PD} switch is not currently active, laser photodiode monitor power is not displayed.

"Las:dis:MDP?" -response: 1, means that the (LASER DISPLAY) P_{PD} switch is currently active, PD power may be displayed.

LASer:DISplay:PARAM

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:PARAM command enables the LASer display to show the LASER parameter values.

Parameters — None.

Notes — This command has the same effect as pressing the (PARAMETER) SELECT switch while in LASER mode. The selected parameter will be displayed for three seconds. The actual LASER PARAM display is turned off automatically when a LASER display selection is enabled.

Each time the command is issued, the next LASER parameter will be selected, see Chapter 2 for more information.

Examples — "Laser:Display:Param" -action: selects a LASER parameter and displays its value.

"LAS:DIS:PARAM" -action: selects a LASER parameter and displays a its value.

LASer:DISplay:SET

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:SET command sets the laser display to show the set point of the selected LASER DISPLAY mode.

Parameters — None.

Notes — Using this command has the same effect as physically holding the (LASER DISPLAY) SET switch down (in).

Examples — "Las:Dis:Set" -action: enables the LASER display for the set point of the selected mode: LDI, MDI (I_{PD}) or MDP (P_{PD})

"LAS:Dis:Set" -action: enables the LASER display for the set point of the selected display mode.

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LASer:DISplay:SET?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:DISplay:SET? query returns the status of the (LASER DISPLAY) SET switch.

Notes — The set point display will not time out when REMOTE operation is used. (It will be continuously displayed.)

Examples — "LAS:DISPLAY:SET?" -response: 0, means the measured value is enabled for the LASER display.

"Las:Dis:Set?" -response: 1, means the set point value is enabled for the LASER display.

LASer:ENABle:COND <nrf value>

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:ENABle:COND command sets the condition status enable register of the LASER operations for summary (in bit 3 of the status byte) and generation of service requests.

Parameters — An <nrf value> whose sum represents the enabled bits:

1 - LASER Current Limit	256 - Output is Shorted
2 - LASER Voltage Limit	512 - Output is Outside Tolerance Limit
4 - N/A	1024 - Output On/Off State
8 - Power Limit	2048 - Ready for Calibration Data State
16 - Interlock Disabled	4096 - N/A
32 - N/A	8192 - N/A
64 - N/A	16384 - N/A
128 - Open Circuit	32768 - N/A

Notes — The enabled or disabled LASER conditions can be read by using the LASer:ENABle:COND? query.

The LASER condition status can be monitored by the LASer:COND? query. If any of the enabled LASER conditions are true, bit 3 of the status byte register will be set.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (for more information see the *PSC definition, in the IEEE488.2 specification).

Examples — "LAS:ENAB:COND 129" -action: enables the LASER status condition register so that the Open circuit and LASER current limit conditions will be summarized in the status byte (bit 3).

Laser:Enable:Cond #H0F9B" - action: enables the LASER status condition register so that any and all of the above conditions will be reported in the status byte register (bit 3).

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LASer:ENABle:COND?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:ENABle:COND? query returns the value of the status condition enable register of the LASER operations.

The response is the sum of the following:

1 - LASER Current Limit	256 - Output is Shorted
2 - LASER Voltage Limit	512 - Output Changed to be In/Out of Tolerance
4 - N/A	1024 - Output On/Off State
8 - Power Limit	2048 - Ready for Calibration Data State
16 - Interlock Disabled	4096 - N/A
32 - N/A	8192 - N/A
64 - N/A	16384 - N/A
128 - Open Circuit	32768 - N/A

Notes: The enabled LASER conditions can be set by using the LASer:ENABle:COND command.

The LASER condition status can be monitored by the LASer:COND? query.

Examples: "LAS:ENAB:COND?" -response: 17, means that the Laser Current Limit and Interlock disabled LASER conditions will be reported (in summarized form) to the status byte (bit 3).

"Radix Hex; Laser:Enable:Cond?" -response: #H0F9B, means that all of the above conditions will be reported (in summarized form) to the status byte (bit 3).

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LASer:ENABle:EVEnt <nrf value>

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:ENABle:EVEnt command sets the status event enable register of the LASER operations. These events are summarized in bit 2 of the status byte register.

Parameters An <nrf value> whose sum represents the bits which are enabled:

1 - LASER Current Limit	256 - Output is Shorted
2 - LASER Voltage Limit	512 - Output Changed to be In/Out of Tolerance
4 - N/A	1024 - Output On/Off State Changed
8 - Power Limit	2048 - New Measurements Taken
16 - Interlock Changed State	4096 - N/A
32 - N/A	8192 - N/A
64 - N/A	16384 - N/A
128 - Open Circuit	32768 - N/A

Notes The enabled LASER events can be read by using the LASer:ENABle:EVEnt? query. The LASER event status can be monitored by the LASer:EVEnt? query.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (for more information see the *PSC definition, in the IEEE488.2 specification).

Examples "LAS:ENAB:EVENT 136" -action: enables the LASER status event register so that the Open circuit and Power limit events will be reported (in summarized form) to the status byte (bit 2).

"Laser:Enable:Event #H0F9B" -action: enables the LASER status event register so all of the above events will be reported (in summarized form) to the status byte (bit 2).

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LASer:ENABle:EVEnt?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:ENABle:EVEnt? query returns the value of the status event enable register of the LASER operations.

1 - LASER Current Limit	256 - Output is Shorted
2 - LASER Voltage Limit	512 - Output Changed to be In/Out of Tolerance
4 - N/A	1024 - Output On/Off State
8 - Power Limit	2048 - New Measurements Taken
16 - Interlock State Changed	4096 - N/A
32 - N/A	8192 - N/A
64 - N/A	16384 - N/A
128 - Open Circuit	32768 - N/A

Notes The enabled LASER events can be set by using the LASer:ENABle:EVEnt command. The LASER event status can be monitored by the LASer:EVEnt? query.

Examples "LAS:ENAB:EVE?" -response: 1040, means that the Output on/off state change and Interlock changed LASER events will be reported (in summarized form) to the status byte register (bit 2).

"Radix Hex; Las:Enab:Eve?" -response: #HF9B, means that all of the above events will be reported (in summarized form) to the status byte register (bit 2).

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LASer:ENABle:OUTOFF <nrf value>

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:ENABle:OUTOFF command sets the status outoff enable register of the LASER operations (things which will turn the LASER output off).

Parameters An <nrf value> whose sum represents the enabled bits:

1 - LASER Current Limit	256 - N/A
2 - LASER Voltage Limit	512 - Output is Out of Tolerance
4 - N/A	1024 - TEC Output Off
8 - Power Limit (With Output On)	2048 - TEC High Temperature Limit Condition
16 - N/A	4096 - N/A
32 - N/A	8192 - N/A
64 - N/A	16384 - N/A
128 - N/A	32768 - N/A

Notes The enabled LASER outoff bits can be read by using the LASer:ENABle:OUTOFF? query.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (for more information see the *PSC definition, in the IEEE488.2 specification).

The factory default value for this register is #B0000100000001000, or #H808, or 2056 decimal.

Examples "LAS:ENAB:OUTOFF 9" -action: enables the LASER status outoff register so that Power limit and LASER current limit conditions will cause the LASER output to be turned off.

"Las:Enab:Outoff #HE0B" -action: enables the LASER status outoff register so that any or all of the above conditions will cause the LASER output to be turned off.

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LASer:ENABle:OUTOFF?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:ENABle:OUTOFF? query returns the value of the status outoff enable register of the LASER operations.

-where the response is the sum of the following:

1 - LASER Current Limit	256 - N/A
2 - LASER Voltage Limit	512 - Output is Out of Tolerance
4 - N/A	1024 - TEC Output Off
8 - Power Limit (With Output On)	2048 - TEC High Temperature Limit Condition
16 - N/A	4096 - N/A
32 - N/A	8192 - N/A
64 - N/A	16384 - N/A
128 - N/A	32768 - N/A

Notes — The enabled LASER events can be set by using the LASer:ENABle:OUTOFF command. The LASER output status can be monitored by the LASer:EVEnt? query.

Examples — "LAS:ENAB:OUTOFF?" -response: 2049, means that TEC High Temperature Limit and Current Limit Conditions will cause the LASER output to be turned off.

"Radix Hex; Las:Enab:Eve?" -response: #HE0B, means that all of the above conditions will cause the LASER output to be turned off.

LASer:EVEnt?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:EVEnt? query returns the value of the status event register of the LASER operations.

-where the response is the sum of the following:

1 - LASER Current Limit	256 - Output is Shorted
2 - LASER Voltage Limit	512 - Output Changed to be In/Out of Tolerance
4 - N/A	1024 - Output On/Off State Changed
8 - Power Limit	2048 - Measurement Ready
16 - Interlock Disabled	4096 - N/A
32 - N/A	8192 - N/A
64 - N/A	16384 - N/A
128 - Open Circuit	32768 - N/A

Notes — The LASER conditions that are reported in the status byte can be set by using the LASer:ENABle:EVEnt command.

The LASER event status is only cleared when the event status is read or by the *CLS command, while the condition status is constantly changing.

Examples — "LAS:EVE?" -response: 513, means that the LASER output tolerance changed and current limit events have occurred since the last LASer:EVEnt? query.

"Radix Hex; Laser:Event?" -response: #H88, means that the LASER Power limit and Open circuit events have occurred since the last LASer:EVEnt? query.

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LASer:INC <nrf value>,<nrf value>

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:INC command increments the selected laser control mode set point by one or more steps. Optional parameters allow multiple steps to be incremented and the time (in milliseconds) between increments to be set, respectively.

Parameters: 0, 1, or 2. The first optional parameter is the number of steps, and the second optional parameter is the number of milliseconds between steps.

Notes: The decremental default amount is one step. The step size can be edited via the LAS:STEP command. LDC-3714B default values are 0.001/0.002 mA (50/100 mA range), 0.01 mW, or 1 σA (if CALMD = 0), depending on the mode of operation. LDC-3724B default values are 0.01 mA, 0.01 mW, or 1 σA. LDC-3744B default values are 0.1 mA, 0.1 mW, or 1 σA.

If the first optional parameter is used, but not the second, the LASER set point is incremented by a multiple of the LAS:STEP size, without changing the LAS:STEP size. The second optional parameter is the time, in msec, between steps.

If both optional parameters are used, the user may create an automated stepping ramp function for the LASER output.

If the first optional parameter is entered as zero, "LAS:INC 0", the command will do nothing.

The minimum time to complete one increment is about 20 msec. Therefore, values for the second optional parameter (time between increments) have a practical minimum of 20.

Examples: "LAS:MODE:I; LAS:STEP 3; LAS:INC" -action: The laser source current set point is incremented by 0.3 mA (LDC-3744B), or 0.03 mA (LDC-3724B), or 0.003 mA (LDC-3714B on 50 mA range), or 0.006 mA (LDC-3714B on 100 mA range).

"LAS:MODE:I; LAS:STEP 3; LAS:INC 3" -action: The laser source current set point is incremented by three times the amount described in the first example.

"LAS:MODE:I; LAS:STEP 3; LAS:INC 3,5000" -action: The laser source current set point is incremented by the amount described in the first example, three times, with 5 seconds between incremental steps.

"LAS:STEP 1; LAS:Mode:P; Las:INC" -action: The power set point is incremented by 0.1 mW (LDC-3744B) or 0.01 mW (LDC-3724B or LDC-3714B).

LASer:LDI

I
LDI

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LDI command sets the laser control current.

Parameters: An <nrf value> which represents the (laser) output current, in mA.

Notes: Set point is the same for both low and high bandwidth output modes.

Examples: "Las:LDI 400" -action: sets the laser output current to 400.00 mA.

"LAS:ldi 1000" -action: sets the laser output current to 1000.0 mA.

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LASer:LDI?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LDI? query returns the value of the measured laser current.

Notes — Response is the measured laser output current, for either low or high bandwidth modes.
This measurement is updated approximately once every 600 msec.

Examples — "LAS:ldi?" -response: 30.0, means the measured laser output current is 30.0 mA.
"Laser:LDI?" -response: 100.0, means the measured laser output current is 100.0 mA.

LASer:LDV

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LDV command sets the laser voltage for calibration of the laser voltage measurement.

Parameters — An <nrf value> which represents the (laser) output voltage, in volts.

Notes — Set point is the same for both low and high bandwidth output modes and is entered only for LDV calibration.

Examples — "Las:LDV 4" -action: enters a value of 4.000 volts.
"LAS:ldv 1.025" -action: enters a value of 1.025 volts.

LASer:LDV?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LDV? query returns the value of the measured laser voltage.

Notes — This measurement is updated approximately once every 600 msec.

Examples — "LAS:ldv?" -response: 3.03, means the measured laser output voltage is 3.03 volts.
"Laser:LDV?" -response: 1.0, means the measured laser output voltage is 1.000 volt.

LASer:LIMit:I1

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I1 command sets the LASER current limit value for the 100 mA range on the LDC-3714B and the 2000 mA range on the LDC-3744B. (Not applicable for LDC-3724B).

Parameters — An <nrf value> which represents the LASER limit current, in mA.

Notes — The current limit is in effect in all modes of operation of the laser output with respect to the output range (low/high).

Examples — "LAS:LIM:I1 80" -action: the LASER current limit is set to 80 mA.
":Laser:Limit:I1 60" -action: the LASER current limit is set to 60 mA.

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LASer:LIMit:I1?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I1? query returns the value of the LASER current limit for the 100 mA range on the LDC-3714B or the 2000 mA range on the LDC-3744B. (Not applicable for LDC-3724B).

Notes — The current limit is valid for all modes of Laser operation.

Examples — "LAS:LIM:I1?" -response: 40, means the laser current limit is 40 mA.

"Laser:LIM:I1?" -response: 500, means the laser current limit is 500 mA (LDC-3744B only).

LASer:LIMit:I2

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I2 command sets the LASER current limit value for the 200 mA range on the LDC-3724B. and the 2000 mA range on the LDC-3744B. (Not applicable for LDC-3714B).

Parameters — An <nrf value> which represents the LASER limit current, in mA.

Notes — The current limit is in effect in all modes of operation of the laser output with respect to the output range (low/high).

Examples — "LAS:LIM:I2 180" -action: the LASER current limit is set to 180 mA.

":Laser:Limit:I2 160" -action: the LASER current limit is set to 160 mA.

LASer:LIMit:I2?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I2? query returns the value of the LASER current limit for the 200 mA range on the LDC-3724B or the 2000 mA range of the LDC-3744B. (Not applicable for LDC-3714B).

Notes — The current limit is valid for all modes of Laser operation for the respective output range.

Examples — "LAS:LIM:I2?" -response: 40, means the laser current limit is 40 mA.

"Laser:LIM:I2?" -response: 150, means the laser current limit is 150 mA .

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LASer:LIMit:I3

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I3 command sets the LASER current limit value for the 4000 mA range on the LDC-3744B. (Not applicable for LDC-3724B or LDC-3714B). This command is for compatibility with programs written for the LDC-3742B.

Parameters: An <nrf value> which represents the LASER limit current, in mA.

Notes: The current limit is in effect in all modes of operation of the laser output and the respective output range.

Examples: "LAS:LIM:I3 800" -action: the LASER current limit is set to 800 mA.

":Laser:Limit:I3 2600" -action: the LASER current limit is set to 2600 mA.

LASer:LIMit:I3?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I3? query returns the value of the LASER current limit for the 4000 mA range on the LDC-3744B. (Not applicable for LDC-3724B or LDC-3714B).

Notes: The current limit is valid for all modes of Laser operation.

Examples: "LAS:LIM:I3?" -response: 400, means the laser current limit is 400 mA (LDC-3744B only).

"Laser:LIM:I3?" -response: 1500, means the laser current limit is 1500 mA (LDC-3744B only).

LASer:LIMit:I4

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I4 command sets the LASER current limit value for the 4000 mA range on the LDC-3744B. (Not applicable for LDC-3724B or LDC-3714B).

Parameters: An <nrf value> which represents the LASER limit current, in mA.

Notes: The current limit is in effect in all modes of operation of the laser output and the respective output range

Examples: "LAS:LIM:I4 800" -action: the LASER current limit is set to 800 mA.

":Laser:Limit:I4 2600" -action: the LASER current limit is set to 2600 mA.

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LASer:LIMit:I4?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I4? query returns the value of the LASER current limit for the 4000 mA range on the LDC-3744B. (Not applicable for LDC-3724B or LDC-3714B).

Notes — The current limit is valid for all modes of Laser operation.

Examples — "LAS:LIM:I4?" -response: 400, means the laser current limit is 400 mA (LDC-3744B only).

"Laser:LIM:I4?" -response: 1500, means the laser current limit is 1500 mA (LDC-3744B only).

LASer:LIMit:I5

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I5 command sets the LASER current limit value for the 50 mA range on the LDC-3714B and the 500 mA range on the LDC-3724B. (Not applicable for LDC-3744B).

Parameters — An <nrf value> which represents the LASER limit current, in mA.

Notes — The current limit is in effect in all modes of operation of the laser output with respect to the current output range.

In local operation, the limit current is entered by selecting LIM I parameter, pressing and holding in the (PARAMETER) SET switch, adjusting the ADJUST knob until the desired value is displayed, and then releasing the SET switch.

Examples — "LAS:LIM:I5 50" -action: the LASER current limit is set to 50 mA.

":Laser:Limit:I5 160" -action: the LASER current limit is set to 160 mA (LDC-3724B only).

LASer:LIMit:I5?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:I5? query returns the value of the LASER current limit for the 50 mA range on the LDC-3714B or the 500 mA range on the LDC-3724B. (Not applicable for LDC-3744B).

Notes — The current limit is valid for all modes of Laser operation with respect to the current output range.

Examples — "LAS:LIM:I5?" -response: 400, means the laser current limit is 400 mA (LDC-3724B only).

"Laser:LIM:I5?" -response: 50, means the laser current limit is 50 mA.

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LASer:LIMit:MDP

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:MDP command sets the laser monitor photodiode power limit value.

Parameters: An <nrf value> which represents the laser monitor photodiode power limit, in mW.

Notes: When constant MDP mode is used, the output is limited only by the LIM I value.

The LIM MDP condition may be used to shut the LASER output off, but this requires the use of the LASer:ENABle:OUTOFF command to set bit 3 of the LASER OUTOFF ENABLE register.

Examples: "LAS:LIM:MDP 10" -action: sets the laser output power limit to a value which corresponds to producing 10.00 mW of PD feedback (optical) power.

"Las:Limit:MDp 5" -action: sets the laser output power limit to a value which corresponds to producing 5.00 mW of PD feedback (optical) power.

LASer:LIMit:MDP?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:MDP? query returns the value of the laser monitor PD power limit.

Notes: The (LASER) MDP limit is in effect for both laser output current ranges.

Examples: "LAS:LIM:MDP?" -response: 3.0, means the monitor PD power limit is set to 3.0 mW.

":LAS:Limit:MDP?" -response: 10.0, means the monitor PD power limit is set to 10.0 mW.

LASer:LIMit:V

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:V command sets the LASER compliance voltage limit value.

Parameters: An <nrf value> which represents the LASER limit voltage, in volts.

Notes: The voltage limit setting is useful for laser protection. When the maximum operating voltage of a laser is known, the user may set the voltage limit to a value slightly higher than the maximum operating voltage. Then, if the laser is accidentally disconnected, the current source will quickly sense the over-voltage and shut off.

In local operation, the voltage limit is entered by selecting the LIM I parameter, pressing and holding in the (PARAMETER) SET switch, and then pressing the (LAS DISPLAY) V switch. Turn the ADJUST knob until the desired value is displayed, and then release the SET switch.

Examples: "LAS:LIM:V 5.0" -action: the LASER compliance voltage limit is set to 5.0 volts.

":Laser:Limit:V 4.60" -action: the LASER compliance voltage limit is set to 4.6 volts.

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LASer:LIMit:V?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:LIMit:V? query returns the value of the LASER compliance voltage limit setting.

The voltage limit is valid for all modes of Laser operation.

In local operation, the voltage limit is seen by selecting the LIM I parameter, pressing and holding in the (PARAMETER) SET switch, and then pressing the (LAS DISPLAY) V switch.

Examples "LAS:LIM:V?" -response: 4.5, means the laser compliance voltage limit is 4.5 volts.

"Laser:LIM:V?" -response: 10.0, means the laser compliance voltage limit is set to 10.0 volts.

LASer:MDI

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MDI command sets the value of the optical power set point, in σA, if the CALMD (CAL PD) responsivity is 0.

Parameters An <nrf value> which represents the photodiode feedback current, in σA.

Notes If the CALMD (CAL PD) parameter is not set to 0, the LAS:MDI value will not be used. In this case, the measured MDI would be converted to MDP (P_{PD}, by the CAL PD factor), and the MDP (P_{PD}) set point would be used.

Examples "Las:Mdi 40" -action: The LASER output is controlled so that the photodiode feedback current remains constant at 40 σA.

"Laser:MDI 200" -action: The LASER output is controlled so that the photodiode feedback current remains constant at 200 σA.

LASer:MDI?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MDI? query returns the value of the laser photodetector current measurement, in σA.

Notes The response is in σA. The response is valid, even when the unit is not in constant P mode.

This measurement is updated approximately once every 600 msec.

Examples "Las:Mode:MDP; Las:Calmd 0; Las:MDi?" -response: 100.0, means 100 σA of photodetector current. This feedback is controlling the laser current output.

"LAS:MODE:IHBW; LAS:MDI?" -response: 20.0, means 20 σA of photodetector current, but photodiode monitor current is not controlling the laser output current.

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LASer:MDP

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MDP command sets the value of the optical power set point, in mW, if the CALMD (CAL PD) responsivity is greater than 0.

Parameters: An <nrf value> which represents the photodiode feedback power, in mW.

Notes: If the CALMD (CAL PD) parameter is set to 0, the LAS:MDP value will not be used. In this case, the measured MDP would be invalid, and the MDI (I_{PD}) set point would be used.

Examples: "Las:Mdp 40" -action: The LASER output is controlled so that the photodiode feedback power remains constant at 40 mW.

"Laser:MDP 200" -action: The LASER output is controlled so that the photodiode feedback power remains constant at 200 mW.

LASer:MDP?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MDP? query returns the value of the laser photodetector power measurement, in mW.

Notes: The response is in mW. The response is valid, even when the unit is not in constant P mode.

This measurement is updated approximately once every 600 msec.

Examples: "Las:Mode:MDP; Las:Calmd 460; Las:MDp?" -response: 100.0, means 100 mW of photodetector power. This feedback is controlling the laser current output.

"LAS:MODE:IHBW; LAS:MDP?" -response: 20.0, means 20 mW of photodetector power, but pho-todiode monitor current is not controlling the laser output current.

LASer:MODE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MODE? query returns the selected laser control mode.

Notes: I_{HBW} mode is the same as I mode (low bandwidth), except that the output low bandpass filter is dis-abled in I_{HBW} mode.

Examples: "LAS:MODE?" -response: ILBW, means that constant I (current) mode is in effect for the laser output.

":Las:Mode?" -response: MDP, means that constant P (power) mode is in effect for the laser output, and CALMD > 0.

"Las:Mode?" -response: MDI, means that constant P (power) mode is in effect for the laser output,

"Laser:MODE?" -response: IHBW, means that constant I_{HBW} (current, high bandwidth) mode is in effect for the laser output.

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LASer:MODE:IHBW

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MODE:IHBW command selects laser high bandwidth constant current mode.

Parameters: None.

Notes: This mode of operation is constant I mode with the output lowpass filter disabled.

Examples: "LAS:Mode:Ihbw" -action: enables the laser high bandwidth constant current mode.

LASer:MODE:ILBW

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MODE:ILBW command selects laser constant current mode.

Parameters: None.

Notes: Constant I mode (low bandwidth) enables the output low bandpass filter.

Examples: "LAS:MODE:ILBW" -action: sets the laser output for constant I mode (low bandwidth).

LASer:MODE:MDP

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:MODE:MDP command selects laser constant power mode.

Parameters: None.

Notes: This mode of laser operation requires the laser's monitor PD feedback to maintain constant optical power or constant monitor current.

In this mode, the displayed parameter will be either I_{PD} (if CALMD = 0) in σA, or P_{PD} (if CALMD > 0) in mW.

Examples: "LAS:MODE:MDP" -action: sets the laser output mode of operation to constant optical power mode.

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LASer:OUTput

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:OUTput command turns the laser output on or off.

Parameters: An <nrf value>; 1 = on, 0 = off.

Notes: There is a 2-second delay after the output is turned on before the output shorting relay is opened. Following this, the output current ramps up to the current set point slowly to protect the laser. Therefore, the time to turn the output on and reach the set point current varies from 2 to about 3 seconds.

After the output is turned on, it may be useful to wait until the output is stable (within tolerance) before performing further operations, but it is not necessary. When the LASER output is off, it is safe to connect or disconnect devices to the LASER output terminals.

When the LASER output is off, an internal short is placed across the output terminals. This condition causes the OUTPUT SHORTED light to come on.

Examples: "LAS:I 20; LAS:OUT ON" -action: sets the laser output current to 20 mA and then turns the output on.

LASer:OUTput?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:OUTput? query returns the status of the laser output switch.

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

Examples: "Las:OUT?" -response: 0, means that the output switch is disabled, devices may be safely disconnected or connected at the LASER output terminals.

"LAS:OUT?" -response: 1, means that the LASER output switch is enabled, LASER output is present.

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LASer:RANge

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:RANge command selects the laser's drive current output range.

Parameters An <nrf value> which represents the laser current output range.
For LDC-3714B:5 = 50 mA, and 1 = 100 mA range.
For LDC-3724B: 2 = 200 mA, and 5 = 500 mA range.
For LDC-3744B: 1 = 2000 mA, and 3 = 4000 mA range,
2 = 2000 mA, and 4 = 4000 mA range.

Notes This range setting effects the Laser Drive Current output current range only.
The Laser Drive Current output should be "off" when this command is issued. If the Laser Diode Current output is "on" when this command is issued, the LDC-3700B Series Laser Diode Controller will generate error #515, and the range will not be changed.

Examples "LAS:RAN 2" -action: sets the laser output drive current range to 200 mA (LDC-3724B only).
"Laser:range 1" -action: sets the laser output drive current range to 100 mA (LDC-3714B only) or 1000 mA (LDC-3744B only).

LASer:RANge?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:RANge? query returns the value of the Laser Drive Current range.

Notes The resolution and accuracy of the laser limit current are dependent on the Laser Drive Current output range.

Examples "LAS:RAN?" -response: 1, means that the Laser Drive Current range is 100 mA (LDC-3714B only).
"LAS:range?" -response: 2, means that the Laser Drive Current range is 200 mA (LDC-3724B only) or 2000 mA (LDC-3744B only).

LASer:SET:LDI?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:SET:LDI? query returns the constant I value which is used for both output ranges and both bandwidths.

Notes In local operation, the constant I set point is read by selecting I or IHBW mode, pressing the SET switch in the LASER DISPLAY area of the front panel, and then visually reading the LASER display.

Examples "LAS:SET:LDI?" -response: 50.0, means the laser output current set point value is 50.0 mA.
"Laser:set:ldi?" -response: 1200.0 means the laser output current set point value is 1200.0 mA.

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LASer:SET:MDI?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:SET:MDI? query returns the laser monitor PD current set point value (when CALPD = 0), in σA.

Notes — The monitor photodiode current is directly proportional to the laser optical output power. Therefore, the I_{PD} set point may be used to control optical output of the laser.

Examples — "las:set:mdi?" -response: 30.0, means the laser monitor PD current is set point is 30 σA, for use in constant P mode with CALPD = 0.

"LAS:Set:MDI?" -response: 100.0 means the laser monitor PD current is set point is 100 σA, for use in constant P mode with CALMD = 0.

LASer:SET:MDP?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:SET:MDP? query returns the laser monitor PD power set point value (when CALMD [CAL PD] is not zero), in mW.

Notes — This set point is used in constant MDP mode only.

Examples — "LAS:Set:MDP?" -response: 10.0, means the laser monitor PD feedback set point is 10.0 mW (CALPD > 0).

"Laser:Set:MDP?" -response: 25.0, means the laser monitor PD feedback set point is 25.0 mW (CALPD > 0).

LASer:STEP

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:STEP command is used to increment or decrement the selected laser control mode set point by the given amount, when used with the LASer:INC or LASer:DEC command.

Parameters — An integer value of the step amount, in the range 1 to 9999.

Notes — The step of 1 corresponds to the smallest display resolution for the mode. For example, a step of 1 means 0.1 mA (3744B) or 0.01 mA (3724B) or 0.002 mA (3714B, 100 mA range) or 0.001 mA (3714B, 50 mA range), 0.01 mW, or 1 σA (if CALPD = 0).

Examples — "Las:Mode:i; Las:Idi 20; Las:Step 100; Las:Inc; Las:set:Idi?" -action: sets the step to 1.0 mA (3724B), so the Las:set:Idi? query will return a value of 21.0 mA.

"LAS:STEP 1000" -action: sets the step size to 1000; could mean 10.0 mA (3724B), 10.0 mW, or 100 σA.

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LASer:STEP?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:STEP? query is used to read back the LASer STEP value. This value is used to increment or decrement the selected laser control mode set point by the given amount, when used with the LASer:INC or LASer:DEC command.

Examples "Las:Mode:LDI; Las:Step?" -response: 1 means the step size is 0.1 mA (3744B), since Const I mode is in effect.

"LAS:MODE:MDP; LAS:CALMD 1; LAS:STEP?" -response: 10 means the step size is 0.1 mW, since Const P mode is in effect.

LASer:TOLerance

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:TOLerance command allows the programmer to determine the LASER current tolerance, and time window for it to occur, in order that the operation complete flag be set after a "LASer:OUTput 1" command is issued, or the LASER set point is changed.

Parameters Two <nrf values>; the first represents the LASER current tolerance, in mA, with a range of 0.1 to 100.0 mA; and the second represents the time window, in seconds, with a range of 0.001 to 50.000 seconds.

Notes The LDC-3700B Series Laser Diode Controller defaults to a tolerance of 10.0 mA for 5 seconds, unless changed by the LASer:TOLerance command.

If the LDC-3700B Series Laser Diode Controller is operated in P mode, the current tolerance parameter is not used. Instead a fixed value of 50 σA is used for the I_{PD} current. A fixed value of 10 mW (LDC-3744B) or 1 mW (LDC-3714B or LDC-3724B) is used for P_{PD} power, and only the time window parameter may be adjusted.

If the tolerance is set too tight it may never be achieved. This is due to the calibration of the set point and measurement values.

Examples "Las:Tol 0.5,10" -action: the LDC-3700B Series Laser Diode Controller's LASER current source will be in tolerance when the LASER current is within 0.5 mA for 10.000 seconds.

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LASer:TOLerance?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The LASer:TOLerance? query allows the programmer to determine how the LASER current tolerance is set.

Notes — The tolerance of the LDC-3700B Series Laser Diode Controller LASER current may be used to delay programming after an "LASer:OUTput 1" command is issued or the set point is changed.

A change of the output into or out of tolerance flag sets a flag in the LASER status event register, and so entering or exiting LASER current tolerance may be used to generate service requests.

Examples — "Las:Tol?" -response: "0.2,5.0", means the LDC-3700B Series Laser Diode Controller has a LASER current tolerance setting of 0.2 mA with a time window of 5.000 seconds.

"LASER:TOL?" -response: "1.0,20.0", means the LDC-3700B Series Laser Diode Controller has a LASER current tolerance setting of 1.0 mA with a time window of 20.000 seconds.

MESsage

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MESsage command allows the user to enter an ASCII string of up to 16 non-zero characters. This command may be useful for storing messages which relate to a test or configuration.

Parameters — An ASCII string that is 1 - 16 bytes in length.

Notes — The message may contain any ASCII character, but will be terminated when a NULL terminator character is received. If the message has less than 16 bytes, the software will fill the remaining mes-sage space with the space character. After 16 bytes have been entered, the software will null-terminate the string.

Examples — MESSAGE "This is a test." -action: The string, "This is a test. " will be stored in non-volatile mem-ory.

Mes "Test 3" -action: The string, "Test 3 " will be stored in non-volatile memory.

MESsage?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The MESsage? query returns the previously stored message. This message will always be 16 bytes long and enclosed in quotes. The message is entered via the MESsage command.

Notes — The response data will be a 16-byte long string. If there is no previously stored message, the response will be " ", all spaces.

Examples — "MES?" -response: "Test 3 ", means the previously stored message was "Test 3".

"Message?" -response: "This is a test. ", means the previously stored message was "This is a test."

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*OPC

Nodq`shnm Bnl okdsd

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Sets the operation complete bit in the Event Status Register when all pending overlapped commands have been completed.

Response None.

Example `*OPC`

*OPC?

Nodq`shnm Bnl okdsd Ptdqx

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Places an ASCII character 1 into the intrument's Output Queue when all pending operations have been finished.

Response 1 - when all overlapped commands are complete.

Example `*OPC?`

*PSC <nrf value>

Onvdqĺnm Rs`str Bkd`q

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Sets automatic power-on clearing of the enable registers.

Values 0 = disable power-on clearing
1 = enable power-on clearing

Notes Any non-zero value is interpreted as 1.

Registers affected:
Condition Status Enable Service Request Enable
Event Status Enable Standard Event Status Enable
Factory default condition: disabled.

In the disabled state, the values of the enable registers are saved through power OFF/ON. The power-on status clear flag (see PSC?) is set false, disallowing service request interrupts after power-on.

In the enabled state, the enable registers are cleared during power ON. The power-on status clear flag (see PSC?) is set true, allowing service request interrupts after power-on.

Examples
***PSC 0** Disable automatic power-on clearing of the enable registers.
***PSC 1** Enable automatic power-on clearing of the enable registers.

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*PSC?

On v dqånm Rs`str Bkd`q>

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the state of the power-on status clear flag.

Response
0 The enable registers are saved through power OFF/ON.
1 The enable registers are cleared during power ON.

Registers affected:
Condition Status Enable: Service Request Enable
Event Status Enable: Standard Event Status Enable

See Chapter Three for more information on register structure.

Example ***PSC?** Request state of power-on status clear flag.

*PUD

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Stores data unique to the instrument, such as calibration date and serial number. This data is protected from change by the "SECURE <nrf>" command and is usually entered by the factory.

Notes The arbitrary block program data is exactly 25 bytes long.

*PUD?

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the factory-stored identification string.

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RADix

COMMON
DEVICE DEPENDENT
FRONT PANEL

The RADix command allows the programmer to select the radix type for status, condition, and event query response data. Decimal, binary, hexadecimal, and octal are allowed.

Parameters — Character program data is expected, as shown above.

Notes — DECimal is the default type. Only the first three letters of the words decimal, hexadecimal, binary, or octal are required.

When the RADIX is selected, all status, condition, and event queries will return values in the new radix.

In the cases where the radix is not DECimal, the flexible numeric type <nrf value> (as shown in the Command Reference diagrams) will be replaced by HEX, BIN, or OCT representation.

All of the above radixes may be used to enter program data at any time, without the need for issuing the RADix command. The proper prefix must also be used with Hex (#H), binary (#B), or octal (#O).

This command may be useful for setting up status reporting blocks. The bit-wise status representation may be more easily read in BIN, HEX, or OCT.

Examples — "RAD dec" -action: the decimal radix is selected.

"rad hex; *ESR?" -action: the hexadecimal radix is selected; -response: #H80, means power-on was detected.

RADix?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The RADix? query allows the programmer to determine which radix type for status, condition, and event query response data is currently selected. Decimal, binary, octal, and hexadecimal are allowed.

Notes — DEC is the default type. The LDC-3700B Series Laser Diode Controller defaults to this radix at power-up.

The RADix command is used to select the desired radix. Once it is changed, the new radix will remain in effect until the power is shut off or a new RADix command is issued.

Examples — "RAD?" -response: Dec, means the selected radix is decimal.

"rad?" -response: Hex, means the selected radix is hexadecimal.

"RADIX?" -response: Oct, means the selected radix is octal.

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*RCL <nrf value>

Qdb`kk

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Recalls a stored setup configuration from memory.

Value range 0 through 10

Notes Setup **0** has a factory-set default configuration.

If you use GPIB to recall setup **0** (***RCL 0**), GPIB mode is set to REMOTE. If you recall setup "0" by the front panel, GPIB mode is set to LOCAL.

Same function as **RECALL** on the front panel.

Use ***SAV** to store various setup configurations for convenient recall.

The current setup is automatically stored and recalled at next power-ON, unless you use ***PSC** to tell the instrument not to do so.

Examples ***RCL 0** Recall the factory default setup.

*RST

Qdrds

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Performs a device reset and the following:

Sets OCIS state

Sets OQIS state

Notes **OCIS** = Operation-complete Command Idle State. This is the same state as after ***OPC**: no further operations to complete.

OQIS = Operation-complete Query Idle State. This is the same state as after ***OPC?**: no further operations to complete.

These idle states allow the 8033 to complete its reset process (no operations pending) before con-tinuing with other operations.

Example *RST

*SAV <nrf value>

R`ud

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Saves the current setup configuration in memory.

Value range 1 through 10

Notes Configuration **0** is reserved for a factory-set default configuration. See ***RCL**.

It is normally not necessary to save the current setup for next power-ON. The current setup is automatically stored for recall at next power-ON unless you use ***PSC** not to do so.

Example ***SAV 2**—Save the current setup configuration as #2.

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*SRE <nrf value>

Rdquhbd Qdptdrs Dm`akd

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Enables bits in the service request enable register.

Notes Response is the sum of the enabled bits.

Example ***SRE 136** Enable the service request enable register condition summary and error message bits (8 + 128 = 136).

*SRE?

Rdquhbd Qdptdrs Dm`akdc>

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the value in the service request enable register.

Notes Response is the sum of the enabled bits.

See Chapter Three for more information about register structure.

Example ***SRE?** Response **136** means the service request enable register condition summary and error message bits are enabled (8 + 128 = 136).

*STB?

Rs`str Axsd>

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Requests the value in the status byte register.

Notes Response is the sum of the enabled bits.

See Chapter Three for more information about register structure.

Example ***STB?**óResponse **200** means the status byte condition and master status summary bits, and error message bits, are enabled. (8 + 64 + 128 = 200)

TEC:CAL:CONST?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:CAL:CONST? query returns a stored calibration value. It is intended for factory use only.

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TEC:CAL:ITE

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:CAL:ITE command is used to enter the TEC's current set point, measurement, and limit calibration mode.

Parameters: None.

Notes: This is a service related command. When this command is issued, the front panel becomes disabled, and the appropriate adjustments are made to the operating modes. This mode should not be entered unless the user has the proper measurement equipment in place. See Chapter 6.

After this command is issued, the LDC-3700B Series Laser Diode Controller will automatically change to ITE mode, turn the TEC output on, determine its zero current offset, set the ITE limit to 4.0 amps, and drive the output to 1.0 amps. This procedure is outlined in Chapter 6.

The TEC:CAL:ITE? query (or bit 11 of the TEC status condition register) may be used to determine if the LDC-3700B Series Laser Diode Controller is ready for the user to enter a value.

Examples: "Tec:CAL:ITE" -action: the LDC-3700B Series Laser Diode Controller enters calibration mode for current.

"Tec:Cal:Ite" -action: the LDC-3700B Series Laser Diode Controller enters calibration mode for current.

TEC:CAL:ITE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:CAL:ITE? query is used to determine that the LDC-3700B Series Laser Diode Controller is ready for a value to be entered during the calibration cycle of the TEC:CAL:ITE mode.

Notes: This query can be used to poll the LDC-3700B Series Laser Diode Controller after the TEC:CAL:ITE command to determine if its waiting for a value. If the response is 1, the LDC-3700B Series Laser Diode Controller is ready to receive a calibration value via the TEC:ITE command (see Section 6.3.8). This query may then be repeated for the second half of the calibration cycle. (A query of the TEC condition status register, bit 11, has the same results.)

Examples: "Tec:CAL:ITE?" -response: 1, means the LDC-3700B Series Laser Diode Controller is ready for the user to enter a current value via the TEC:ITE command.

"Tec:Cal:Ite?" -response: 0, means the LDC-3700B Series Laser Diode Controller is not yet ready for the user to enter a current value, or it is not in the TEC current calibration cycle.

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TEC:CAL:SENsor

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:CAL:SENsor command sets the TEC's sensor calibration mode for the activated (via the rear panel switch) sensor, and it enters that mode.

Parameters: None.

Notes: After this command is issued, the front panel is disabled, and the LDC-3700B Series Laser Diode Controller will automatically enter the sensor calibration mode. When the LDC-3700B Series Laser Diode Controller is ready, the SET switch will become enabled, and the user should enter the true measured value. This procedure is outlined in Chapter 6.

The TEC:CAL:SENsor? query may be used to determine if the LDC-3700B Series Laser Diode Controller is ready for the user to enter a value.

Examples: "Tec:CAL:Sen" -action: the LDC-3700B Series Laser Diode Controller enters calibration mode for the sensor which is selected by the back panel switch.

"Tec:Cal:Sensor" -action: the LDC-3700B Series Laser Diode Controller enters calibration mode for the sensor which is selected by the back panel switch.

TEC:CAL:SENsor?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:CAL:SENsor? query is used to determine that the LDC-3700B Series Laser Diode Controller is ready for a value to be entered during the calibration cycle of the TEC:CAL:SENsor mode.

Notes: This query can be used to poll the LDC-3700B Series Laser Diode Controller after the TEC:CAL:SEN command to determine if it is waiting for a value. If the response is 1, the LDC-3700B Series Laser Diode Controller is ready to receive a calibration value via the TEC:R command (Chapter 6). (A query of the TEC condition status register, bit 11, has the same results.)

Examples: "Tec:CAL:SEN?" -response: 1, means the LDC-3700B Series Laser Diode Controller is ready for the user to enter a resistance value via the TEC:R command.

"Tec:Cal:Sensor?" -response: 0, means the LDC-3700B Series Laser Diode Controller is not yet ready for the user to enter a resistance value.

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TEC:CAL:V

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:CAL:V command enters the calibration mode for TEC voltage measurement.

Parameters: None.

Notes: After this command is issued, the front panel is disabled, and the LDC-3700B Series Laser Diode Controller will automatically enter the TEC voltage calibration mode. When the LDC-3700B Series Laser Diode Controller is ready the user should enter the true measured value. This procedure is outlined in Chapter 6.

The TEC:CAL:V? query may be used to determine if the LDC-3700B Series Laser Diode Controller is ready for the user to enter a value.

Examples: "Tec:CAL:V" -action: the LDC-3700B Series Laser Diode Controller enters TEC voltage measurement calibration mode.

TEC:CAL:V?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:CAL:V? query is used to determine that the LDC-3700B Series Laser Diode Controller is ready for a value to be entered during the calibration cycle of the TEC:CAL:V mode.

Notes: This query can be used to poll the LDC-3700B Series Laser Diode Controller after the TEC:CAL:V command to determine if it is waiting for a value. If the response is 1, the LDC-3700B Series Laser Diode Controller is ready to receive a calibration value via the TEC:V command (Chapter 6). (A query of the TEC condition status register, bit 11, has the same results.)

Examples: "Tec:CAL:V?" -response: 1, means the LDC-3700B Series Laser Diode Controller is ready for the user to enter a resistance value via the TEC:V command.

"Tec:Cal:v?" -response: 0, means the LDC-3700B Series Laser Diode Controller is not yet ready for the user to enter a voltage value.

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TEC:COND?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:COND? query returns the value of the status condition register of the TEC operations.

1 - TE Current Limit	256 - N/A
2 - Voltage Limit Error	512 - Output Out of Tolerance
4 - N/A	1024 - Output On
8 - High Temperature Limit	2048 - Ready for Calibration Data
16 - TEC Interlock Enable	4096 - N/A
32 - Booster Enable	8192 - N/A
64 - Sensor Open	16384 - N/A
128 - TE Module Open	32768 - N/A

Notes
The enabled TEC conditions can be set by using the TEC:ENABle:COND command.

The TEC condition status is constantly changing, while the event status is only cleared when the event status is read or the *CLS command is issued.

Examples
"TEC:COND?" -response: 513, means that the Output Out of Tolerance and TE Current Limit TEC conditions currently exist.

"Radix Hex; TEC:Cond?" -response: #H82, means that the TE Module Open and Voltage Limit TEC conditions currently exist.

TEC:CONST

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:CONST command sets the TEC's Steinhart-Hart equation constants.

Parameters
One, two, or three <nrf values>, for the three Steinhart-Hart equation constants or the two linear calibration constants for linear IC sensors. With v1.9 and higher, the range of values is -99.999 to +99.999 for all three constants (previously was -9.999 to +9.999). However, for a thermistor sensor, these values are scaled by the appropriate exponential value for the Steinhart-Hart equation.

Notes
If less than three 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 via the SENSOR SELECT switch, only C1 and C2 are used. Therefore, only two parameters are required in those cases.

Examples
"Tec:CONST 1, 2.33, 0.5 " -action: sets C1 to 1.000, C2 to 2.330, and C3 to 0.500.

"TEC:const 1.4, ," -action: sets C1 to 1.400, C2 and C3 unchanged.

"TEC:Const ,4.5,0.3" -action: sets C2 to 4.500, C3 to 0.300, and C1 is 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 is unchanged, but not used).

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TEC:CONST?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:CONST? query returns the value of the TEC's Steinhart-Hart constants or the linear sensor conversion constants.

Notes
The response is always in the form: C1, C2, C3.

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

Examples
"TEC:CONST?" -response: 1.111,2.03,0.85 means C1 = 1.111, C2 = 2.030, and C3 = 0.850.

"TEC:Const?" -response: 1.00,2.222,0.07 means C1 = 1.000, C2 = 2.222, and C3 = 0.070.

TEC:DISplay

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay command enables or disables (turns off) the TEC display and TEC section's indicator LEDs.

Parameters
An <nrf value>; 1 = on, 0 = off.

Notes
Turning the TEC display and LEDs off means that a message of all blank spaces is sent to the TEC display, and all of the TEC section's indicator LEDs will be turned off.

Examples
"TEC:DIS 0" -action: the TEC display will be blanked, and all of the TEC indicator LEDs will be turned off.

"tec:dis 1" -action: the TEC display and LEDs will be enabled.

"tec:display on" -action: the TEC display and LEDs will be enabled.

TEC:DISplay?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay? query returns the contents of the TEC display.

Notes
Returns the actual (6-character) string from the output buffer to the TEC display. If the display is disabled, it returns " .".

Examples
"TEC:DIS?" -response: "- 99.9", means "- 99.9" is on the TEC display.

"Tec:DISp?" -response: " 0.6", means " 0.6" is on the TEC display.

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TEC:DISplay:ITE

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay:ITE command enables the TEC display to show the TE current measurement.

Parameters None.

Notes The actual TEC ITE display is turned off automatically when another TEC display selection is enabled.

Examples ":Tec:Display:Ite" -action: enables the TEC display for measured current values.
"TEC:DIS:ITE" -action: enables the TEC display for measured current values.

TEC:DISplay:ITE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay:ITE? query returns the status of the (TEC DISPLAY) ITE switch.

Notes The response will be the status of the TEC DIS ITE switch; 1 = on, 0 = off.

Examples "TEC:DIS:ITE?" -response: " 0", means that the TEC DIS ITE switch is not enabled, TEC output current is not displayed.
"Tec:DISp:Ite?" -response: "1", means that the TEC DIS ITE switch is enabled, TEC current may be displayed.

TEC:DISplay:PARAM

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay:PARAM command enables the TEC display to show the parameter values.

Parameters None.

Notes This command has the same effect as pressing the (PARAMETER) SELECT switch while in TEC mode. The selected parameter will be displayed for three seconds. The actual TEC PARAM display is turned off automatically when a TEC display selection is enabled.
Each time the command is issued, the next TEC parameter will be selected, see Section 2.9.

Examples ":Tec:Display:Param" -action: selects a TEC parameter and displays its value.
"TEC:DIS:PARAM" -action: selects a TEC parameter and displays its value.

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TEC:DISplay:R

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay:R command sets the TEC display to show the thermistor resistance, AD590 current, or LM335 voltage measurement.

Parameters: None.

Notes: The actual TEC R display is turned off automatically when another TEC display selection is enabled.

Examples: "TEC:DIS:R" -action: enables the TEC display for measured resistance or linear sensor reference values.

"TEC:Display:R" -action: enables the TEC display for measured resistance or linear sensor reference values.

TEC:DISplay:R?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay:R? query returns the status of the (TEC DISPLAY) R switch.

Notes: The response will be the status of the TEC DIS R switch, 1 = on, 0 = off.

Examples: "TEC:Dis:R?" -response: 0, means that the TEC DIS R switch is not active. Therefore, TEC thermistor resistance, or AD590 current, or LM335 voltage is not displayed.

"Tec:dis:R?" -response: 1, means that the TEC DIS R switch is active. Therefore, TEC thermistor resistance, or AD590 current, or LM335 voltage may be displayed.

TEC:DISplay:SET

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay:SET command sets the TEC display to show the currently selected mode's set point value.

Parameters: None.

Notes: Using this command has the same effect as physically holding the (TEC DISPLAY) SET switch down (in).

Examples: "Tec:Dis:Set" -action: enables the TEC display for the set point of the selected mode: ITE, R or T.

"TEC:Dis:Set" -action: enables the TEC display for the set point of the selected mode: ITE, R or T.

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TEC:DISplay:SET?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay:SET? query returns the status of the TEC display set point switch.

Notes
The set point display will not time out when remote operation is used. (It will be continuously displayed.)
In local operation, the status of the (TEC DISPLAY) SET switch is determined by visually inspecting the LED indicator on the switch (lit = ON).

Examples
"TEC:DISPL:SET?" -response: 0, means the set point value is disabled for the TEC display.
"Tec:Dis:Set?" -response: 1, means the set point value is enabled for the TEC display.

TEC:DISplay:T

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay:T command enables the TEC display to show the TEC load temperature measurement.

Parameters
None.

Notes
The actual TEC T display is turned off automatically when another TEC display selection is enabled.

Examples
"Tec:Dis:T" -action: enables the TEC display for the TEC load's measured temperature.
"TEC:DIS:T" -action: enables the TEC display for the TEC load's measured temperature.

TEC:DISplay:T?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:DISplay:T? query returns the status of the (TEC DISPLAY) T switch.

Notes
The response will be the status of the TEC DIS T switch, 1 = on, 0 = off.

Examples
"TEC:Dis:T?" -response: 0, means that the TEC DIS T switch is not enabled, TEC load temperature is not displayed.
"Tec:dis:T?" -response: 1, means that the TEC DIS T switch is enabled, temperature may be displayed.

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TEC:ENABle:COND

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:ENABle:COND command sets the status condition enable register of the TEC operations. These conditions are summarized in bit 1 of the status byte.

Parameters An <nrf value> whose sum represents the enabled bits:

1 - TE Current Limit	256 - N/A
2 - Voltage Limit Error	512 - Output Out of Tolerance
4 - N/A	1024 - Output On
8 - High Temperature Limit	2048 - Ready for Calibration Data
16 - TEC Interlock Enable	4096 - N/A
32 - Booster Enable	8192 - N/A
64 - Sensor Open	16384 - N/A
128 - TE Module Open	32768 - N/A

Notes The enabled TEC conditions can be read by using the TEC:ENABle:COND? query.

The TEC condition status can be monitored by the TEC:COND? query. If any of the enabled TEC conditions are true, bit 1 of the status byte register will be set.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (see *PSC, Chapter 3).

Examples "TEC:ENAB:COND 513" -action: enables the TEC status condition register so that the Output Out of Tolerance and TE Current Limit conditions will be reported in the status byte register.

"Tec:Enable:Cond #H0DFB" -action: enables the TEC status condition register so that any and all of the above conditions will be reported in the status byte register.

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TEC:ENABle:COND?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:ENABle:COND? query returns the value of the status condition enable register of the TEC operations.

1 - TE Current Limit	256 - N/A
2 - Voltage Limit Error	512 - Output Out of Tolerance
4 - N/A	1024 - Output On
8 - High Temperature Limit	2048 - Ready for Calibration Data
16 - TEC Interlock Enable	4096 - N/A
32 - Booster Enable	8192 - N/A
64 - Sensor Open	16384 - N/A
128 - TE Module Open	32768 - N/A

Notes The enabled TEC conditions can be set by using the TEC:ENABle:COND command.
The enabled TEC condition status can be monitored by the TEC:COND? query.

Examples "TEC:ENAB:COND?" -response: 129, means that the TE Module Open and TE Current Limit conditions may be reported in the status byte register.
"Radix Hex; TEC:Enable:Cond?" -response: #H0EFB, means that any and all of the above conditions will be reported in the status byte register.

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TEC:ENABle:EVEnt

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:ENABle:EVEnt command sets the status event enable register of the TEC operations. These events are summarized in bit 0 of the status byte register.

Parameters An <nrf value> whose sum represents the enabled bits:

1 - TE Current Limit	256 - N/A
2 - Voltage Limit Error	512 - Output Changed to be In/Out of Tolerance
4 - N/A	1024 - Output On/Off Changed
8 - High Temperature Limit	2048 - New Measurements Taken
16 - TEC Interlock Disabled	4096 - N/A
32 - Booster Enable	8192 - N/A
64 - Sensor Open	16384 - N/A
128 - TE Module Open	32768 - N/A

Notes The enabled TEC events can be read by using the TEC:ENABle:EVEnt? query.

The enabled TEC event status can be monitored by the TEC:EVEnt? query.

The enable registers normally retain their values at power-up (as they were at power-down) unless the power-on status clear flag is set true (see *PSC, Chapter 3).

Examples "Tec:Enab:EVENT 160" -action: enables the TEC status event register so that the TE Module Open and Booster Changed conditions will be reported (in summarized form) to the status byte register (bit 1).

"Tec:Enable:EVEnt #H0EFB" -action: enables the TEC status event register so that any and all of the above events will be reported (in summarized form) to the status byte register (bit 1).

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TEC:ENABle:EVEnt?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:ENABle:EVEnt? query returns the value of the status event enable register of the TEC operations

1 - TE Current Limit	256 - N/A
2 - Voltage Limit Error	512 - Output Changed to be In/Out of Tolerance
4 - N/A	1024 - Output On/Off Changed
8 - High Temperature Limit	2048 - New Measurements Taken
16 - TEC Interlock Disabled	4096 - N/A
32 - Booster Enable	8192 - N/A
64 - Sensor Open	16384 - N/A
128 - TE Module Open	32768 - N/A

Notes
The enabled TEC events can be set by using the TEC:ENABle:EVEnt command.
The TEC event status can be read and reset by issuing the TEC:EVEnt? query.

Examples
"TEC:ENAB:EVE?" -response: 520, means that the High Temperature Limit and Output Out of Tolerance TEC events will be reported (in summarized form) to the status byte register (bit 0).
"Radix Hex; TEC:Enab:Eve?" -response: #H0EFB, means that all of the above events will be reported (in summarized form) to the status byte register (bit 0).

TEC:ENABle:OUTOFF

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:ENABle:OUTOFF command sets the status outoff enable register of the TEC operations (things which will turn the TEC output off).

Parameters
An <nrf value> whose sum represents the enabled bits:

1 - TE Current Limit Condition	256 - Sensor Change (While Output On) Event
2 - Voltage Limit Condition	512 - Output Out of Tolerance Condition
4 - N/A	1024 - Sensor Shorted (While Output On) Condition
8 - High Temperature Limit Condition	2048 - N/A
16 - TEC Interlock Changed Condition	4096 - N/A
32 - Booster Changed (While Output On) Event	8192 - N/A
64 - Sensor Open (While Output On) Condition	16384 - N/A
128 - Module Open (While Output On) Condition	32768 - N/A

Notes
The enabled TEC outoff bits can be read by using the TEC:ENABle:OUTOFF? query.
The value of the TEC outoff enable register is stored in non-volatile memory and is retained at power-up.
The factory default setting for this register is #H5E8, or 1512 decimal.
The High Temperature Limit Condition, Sensor Open (While Output On) Condition, and Sensor Type Change (While Output On) Event bits will not be in effect and will not cause

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the TEC output to be shut off, if the LDC-3700B Series Laser Diode Controller is in ITE mode.

WARNING: If the Output Out of Tolerance Change Event bit is set when the power is off, the TEC output will not be able to be turned on until this bit is reset.

Examples "TEC:ENAB:OUTOFF 9" -action: enables the TEC status outoff register so that a High Temperature Limit Condition or a TE Current Limit Condition will cause the TEC output to be turned off.

"Tec:Enab:Outoff #H17FB" -action: enables the TEC status outoff register so that any and all of the above conditions will cause the TEC output to be turned off.

TEC:ENABle:OUTOFF?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:ENABle:OUTOFF? query returns the value of the status outoff enable register of the TEC operations (things which will turn the TEC output off).

1 - TE Current Limit Condition	256 - Sensor Change (While Output On) Event
2 - Voltage Limit Condition	512 - Output Out of Tolerance Condition
4 - N/A	1024 - Sensor Shorted (While Output On) Condition
8 - High Temperature Limit Condition	2048 - N/A
16 - TEC Interlock Changed Condition	4096 - N/A
32 - Booster Changed (While Output On) Event	8192 - N/A
64 - Sensor Open (While Output On) Condition	16384 - N/A
128 - Module Open (While Output On) Condition	32768 - N/A

Notes The enabled TEC outoff events and conditions (which can turn the TEC output off) can be set by using the TEC:ENABle:OUTOFF command.

Examples "TEC:ENAB:OUTOFF?" -response: 258, means that a Sensor Type Change Condition or a Voltage Limit Condition will cause the TEC output to be turned off.

"Radix Hex; TEC:Enab:Outoff?" -response: #H17FB, means that all of the above conditions will cause the TEC output to be turned off.

"Radix Bin; TEC:Enab:Outoff?" -response: #B1001, means that the High Temperature Limit and TE Current Limit conditions will cause the TEC output to be turned off.

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TEC:EVEnt?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:EVEnt? query returns the value of the status event register of the TEC operations.

1 - TE Current Limit	256 - Sensor Type Changed
2 - TE Voltage Limit	512 - Output Changed to be Out of Tolerance
4 - N/A	1024 - Output On/Off Changed
8 - High Temperature Limit	2048 - New Measurements Taken
16 - TEC Interlock Disabled	4096 - N/A
32 - Booster Changed	8192 - N/A
64 - Sensor Open	16384 - N/A
128 - TE Module Open	32768 - N/A

Notes
The TEC conditions which are reported to the status byte are set via the TEC:ENABle:EVEnt command.

The TEC event status is only cleared when the event status is read or a *CLS command is issued, while the condition status is constantly changing.

Examples
"TEC:EVE?" -response: 513, means that the Output went In or Out of Tolerance and the TE Current Limit events have occurred since the last TEC:EVEnt? query.

"Radix Hex; TEC:Event?" -response: #H82, means that the Voltage Limit and TE Module Open events have occurred since the last TEC:EVEnt? query.

TEC:GAIN

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:GAIN command sets the TEC control loop gain.

Parameters
An <nrf value> between 1 - 300, the value will be stored to the nearest of: 1, 3, 10, 30, 100, or 300.

Notes
If the user enters a gain value which is greater than 300, a value of 300 will be stored. If the user enters a gain value which is less than 1, a value of 1 will be stored.

If the user enters a value which is not legal, the LDC-3700B Series Laser Diode Controller will round that value to the nearest legal value, if possible.

Examples
"TEC:GAIN 100" -action: the TEC control loop gain is set to 100.

"Tec:gain 3" -action: the TEC control loop gain is set to 3.

"TEC:Gain 200" -action: the TEC control loop gain is set to 100 (the LDC-3700B Series Laser Diode Controller rounds 200 to the nearest valid number).

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TEC:GAIN?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:GAIN? query returns the value of the control loop gain.

Notes — If a value other than 1, 3, 10, 30, 100, or 300 is entered via the GAIN command, the nearest valid value will be stored.

Examples — "TEC:Gain?" -response: 30.0, means the control loop gain is set to 30.

"Tec:GAIN?" -response: 100.0, means the control loop gain is set to 100.

TEC:ITE

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:ITE command sets the TEC control current set point. It is also used to enter the TEC current calibration value.

Parameters — An <nrf value> which represents the ITE set point current, in Amps. In ITE current calibration mode, the <nrf value> represents the measured current value in Amps.

Notes — This set point is used by the TEC's constant ITE mode only.

In local operation, the ITE set point is entered by selecting (ADJUST) TEC and ITE modes, pressing the (TEC DISPLAY) SET switch, adjusting the ADJUST knob (within 3 seconds), and then releasing the SET switch when the desired value is shown on the TEC display.

Examples — "TEC:ITE 1" -action: sets the TEC output current set point to 1.000 Amps.

"TEC:MODE:ITE; Tec:Ite 3.5" -action: sets the TEC output current set point to 3.500 Amps and the output is controlled to that value.

TEC:ITE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:ITE? query returns the value of the measured TEC output current.

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

This measurement is updated approximately once every 600 msec.

If an external booster is used, the ITE measurement will remain zero, as the internal output section is disabled in that case.

In local operation, the ITE measured value is determined by pressing the ITE switch in the TEC DISPLAY area of the front panel, and visually reading the value on the TEC display.

Examples — "TEC:ITE?" -response: 2.43, means the measured TEC output current is 2.430 Amps.

"Tec:Ite?" -response: -3.27, means the measured TEC output current is -3.270 Amps.

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TEC:LIMit:ITE

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:LIMit:ITE command sets the TEC TE current limit value.

Parameters: An <nrf value> representing the limit value of the TE current, in Amps.

Notes: This value also limits the TEC booster output signal voltage to a value which is proportional to the TEC limit current (approximately 1 V/A).

Examples: "TEC:LIM:ITE 3.5" -action: the TEC current limit is set to 3.500 amps.

"Tec:Limit:Ite 4.0" -action: the TEC current limit is set to 4.000 amps.

TEC:LIMit:ITE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:LIMit:ITE? query returns the value of the TEC's TE current limit.

Notes: The ITE limit value is in effect for all modes of TEC operation.

Examples: "TEC:LIM:ITE?" -response: 3.5, means the TEC output current limit is 3.500 amps.

"Tec:Limit:Ite? -response: 4.0, means the TEC output current limit is 4.000 amps.

TEC:LIMit:THI

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:LIMit:THI command sets the TEC high temperature limit value.

Parameters: An <nrf value> which represents the upper bound of the TEC load temperature, in ∀C.

Notes: The THI limit value must be in the range 0 - 199.9 ∀C. The THI limit value also becomes the maximum temperature set point.

The default setting of the TEC outoff enable register forces the TEC output to be shut off if the high temperature limit is reached. (See the TEC:ENABle:OUTOFF command.)

Examples: "TEC:LIM:THI 100" -action: sets the TEC load temperature limit to 100.0∀C.

"Tec:Lim:thi 30.3" -action: sets the TEC load temperature limit to 30.3∀C.

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TEC:LIMit:THI?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:LIMit:THI? query returns the value of the TEC load's high temperature limit.

-where the response is the temperature limit set point value.

Notes
The temperature limit is valid for R and T modes of TEC output operation.

In local operation, the THI limit value is read by pressing the (TEC PARAMETER) SELECT switch until the LIM T_{HI} indicator is lit, and reading the value on the TEC display.

If the high temperature limit is set too low, the TEC output may not be able to be turned on, if the high temperature condition is also used to turn the TEC output off (see TEC:ENABle:OUTOFF).

Examples
"TEC:LIM:Thi?" -response: 30.5, means the TEC load's high temperature limit is 30.5∀C.

"Tec:Limit:THI? -response: 184.7, means the TEC load's high temperature limit is 184.7∀C.

TEC:MODE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:MODE? query returns the selected TEC control mode.

Notes
The TEC mode is also the parameter which is controlled. The TEC output is kept at the set point.

Examples
"Tec:MODE?" -response: ITE, means that constant ITE (current) mode is in effect for the TEC output.

":TEC:Mode?" -response: R, means that constant R (resistance/reference) mode is in effect for the TEC output.

"Tec:Mode?" -response: T, means that constant T (temperature) mode is in effect for the TEC output.

TEC:MODE:ITE

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:MODE:ITE command selects TEC constant TE current mode.

Parameters
None.

Notes
This mode keeps the TEC current constant, regardless of load temperature variations.

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

Examples
"TEC:MODE:ITE" -action: sets the TEC controller for constant TEC current operation.

"Tec:Mode:Ite" -action: sets the TEC controller for constant TEC current operation.

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TEC:MODE:R

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:MODE:R command selects TEC constant thermistor resistance/linear sensor reference mode.

Parameters: None.

Notes: Since sensor resistance (or linear sensor reference) is a function of temperature, this mode also controls the TEC output load 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.

Examples: "TEC:MODE:R" -action: sets the TEC controller for constant thermistor resistance/linear sensor reference operating mode.

"Tec:Mode:R" -action: sets the TEC controller for constant thermistor resistance/linear sensor reference operating mode.

TEC:MODE:T

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:MODE:T command selects TEC constant temperature control mode.

Parameters: None.

Notes: Since TEC load temperature is derived from sensor resistance/reference, constant R and T modes are related. In T mode the set point is converted to resistance or reference 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.

Examples: "TEC:MODE:T" -action: sets the TEC controller for constant load temperature operating mode.

":tec:mode:T" -action: sets the TEC controller for constant load temperature operating mode.

TEC:OUTput

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:OUTput command turns the TEC output on or off.

Parameters: An <nrf value>; 1 = on, 0 = off.

Notes: After the output is turned on, it may be useful to wait until the output is stable (within tolerance) before performing further operations, but it is not necessary.

Examples: "TEC:OUTPUT 1" -action: turns the TEC output on.

"Tec:Out 0" -action: turns the TEC output off.

"Tec:Out OFF" -action: turns the TEC output off.

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TEC:OUTput?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:OUTput? query returns the status of the TEC output switch.

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

Examples — "Tec:Out?" -response: 0, means the TEC output switch is off, TEC output is off.

"TEC:OUT?" -response: 1, means the TEC output switch is on, TEC output is on.

TEC:R

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:R command sets the TEC's constant thermistor resistance or linear sensor reference set point.

Parameters — An <nrf value> which represents the thermistor resistance set point value, in kΤ; the AD590 current set point, in σA; or the LM335 voltage set point, in mV, depending on the selected sensor type.

Note — The R set point is used to control the TEC output in R mode only. Using the R mode, the user may also monitor the temperature of the TEC load via a remote algorithm of his/her own design.

Examples — "TEC:R 20.5" -action: sets the set point thermistor resistance to 20.5 kΤ, or sets the AD590 current to 20.5 σA, or sets the LM335 voltage to 20.5 mV.

"TEC:Mode:R; TEC:R 10" -action: sets the set point thermistor resistance to 10.0 kΤ, or the AD590 current to 10.0 σA, or the LM335 voltage to 10.0 mV. The TEC output sensor is controlled to that value, if the output is on.

TEC:R?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:R? query returns the value of the TEC thermistor resistance, or AD590 current, or LM335 voltage.

Notes — TEC load temperature is derived from the thermistor resistance or linear sensor reference measurement.

This measurement is updated approximately once every 600 msec.

Examples — "TEC:R?" -response: 10.543, means the measured TEC thermistor resistance is 10.543 kΤ, or the measured AD590 current is 10.543 σA, or the measured LM335 voltage is 10.543 mV, depending on the SENSOR SELECT switch position.

"Tec:R?" -response: 0.728, means the measured TEC thermistor resistance is 728 ohms, or the measured AD590 current is 0.728 σA, or the measured LM335 voltage is 0.728 mV, depending on the SENSOR SELECT switch position.

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TEC:SENsor?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:SENsor? query is used to read back the SENSOR SELECT switch position value. This value is a coded representation of the sensor type/thermistor sensor current.

-where the response of 1 = thermistor, at 100 σA; 2=thermistor, at 10 σA; 3=LM335 sensor; 4=AD590 sensor; 5 = RTD. Note, the RTD switch position is no longer used. However, the instru-ment will still report "5" if the SENSOR SELECT switch is in that position.

Notes
The sensor code is displayed on the TEC display, and bit 8 of the TEC event register is set, whenever the back panel SENSOR SELECT switch position is changed.

The sensor selection must be made locally at the back panel SENSOR SELECT switch.

If the response is 0, the sensor type is undetermined and a hardware error must exist.

Examples
"TEC:Sensor?" -response: 1, means the SENSOR SELECT switch is in the 100 σA thermistor posi-tion.

"Tec:SEN?" -response: 3, means the LM335 sensor is selected by the back panel SENSOR SELECT switch.

TEC:SET:ITE?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:SET:ITE? query returns the TEC constant TE current set point value.

Notes
The TEC output is controlled to this set point value only when constant ITE mode is in effect.

Examples
"TEC:SET:ITE?" -response: 3.0, means the ITE set point is 3.000 amps.

"Tec:Set:Ite?" -response: 4.0, means the ITE set point is 4.000 amps.

TEC:SET:R?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:SET:R? query returns the TEC's constant thermistor resistance or linear sensor reference set point value.

Notes
The TEC output is controlled to this set point value only when constant R mode is in effect.

Examples
"TEC:SET:R?" -response: 3.4, means the R set point is 3.400 kT, or 3.40 σA, or 3.4 mV, depending on the SENSOR SELECT switch position.

"Tec:Set:R?" -response: 4.0, means the R set point is 4.000 kT, or 4.00 σA, or 4.0 mV, depending on the SENSOR SELECT switch position.

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TEC:SET:T?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:SET:T? query returns the TEC constant temperature set point value, in ∀C.

Notes
The TEC output is controlled to this set point value only when constant T mode is in effect.

Examples
"TEC:SET:T?" -response: 33.4, means the constant T set point is 33.4∀C.
"Tec:Set:t?" -response: -4.0, means the constant T set point is -4.0 ∀C.

TEC:T

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:T command sets the TEC's constant temperature set point.

Parameters
An <nrf value> which represents the TEC temperature, in ∀C.

Notes
The TEC temperature is controlled to this set point only when the TEC is operated in T mode. If the a maximum temperature limit is set (see TEC:LIMit:THI on page 121), this limit becomes the maximum set point value as well.

Examples
"Tec:T 20" -action: sets the TEC temperature set point to 20.0∀C.
"TEC:MODE:T; TEC:T 25.3" -action: sets the TEC temperature set point to 25.3∀C. The output is controlled to this value, if the output is on.

TEC:T?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:T? query returns the value of the TEC temperature measurement.

Notes
The measured TEC temperature is valid for all modes of TEC operation. Temperature is continually updated.
This measurement is updated approximately once every 600 msec.
The response value has 6 digits of precision.

Examples
"TEC:T?" -response: 10.4231, means the measured TEC load temperature is 10.4231∀C.
"Tec:Mode:R; Tec:T?" -response: -3.0778, means the measured TEC load temperature is -3.07780∀C.

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TEC:TOLerance

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:TOLerance command allows the programmer to determine the TEC temperature tolerance, and time window for it to occur, in order that the operation complete flag be set after a "TEC:OUTput 1" command is issued or the set point is changed.

Parameters — One or two <nrf values>; the first represents the temperature tolerance, in ∀C, with a range of 0.1∀C to 10.0∀C; and the second represents the time window, in seconds, with a range of 0.001 to 50.0 seconds.

This command may be used in conjunction with the TEC:COND? to test for and delay further program activities until the TEC temperature reaches its set point to the specifications of the TEC:TOLerance command.

For example, if the set point is 10∀C, tolerance is 0.2∀C for 5 seconds, and the TEC output is turned on, the user may issue the TEC:COND? query and read back the response to ensure this set point is reached before continuing. In this case, the TEC will not set bit 9 of the TEC condition register until its TEC load temperature is within 0.2∀C of 10∀C for a period of 5 seconds.

Notes — The LDC-3700B Series Laser Diode Controller defaults to a tolerance of 0.2∀C for 5 seconds, unless changed by the TEC:TOLerance command.

In R mode the temperature and time parameters are both in effect, as in T mode.

In ITE mode, the temperature parameter is not used. A fixed value of 10 mA is used instead of the temperature parameter, and only the time window may be adjusted.

If the tolerance is set too tight it may never be achieved. This is due to the calibration of the set point and measurement values.

Examples — "Tol 0.5,10" -action: the LDC-3700B Series Laser Diode Controller's TEC controller will be in tolerance when the temperature is within 0.5∀C for a period of 10.000 seconds.

"TOLer 0.1,1.05" -action: the LDC-3700B Series Laser Diode Controller's TEC controller will be in tolerance when the temperature is within 0.1∀C for a period of 1.050 seconds.

"TEC:MODE:ITE; TOLer ,10" -action: the LDC-3700B Series Laser Diode Controller's TEC controller is set for ITE mode, and will be in tolerance when the ITE current is within 10 mA for a period of 10.000 seconds.

"Tec:Mode:R; TOLer 0.1,2.5" -action: the LDC-3700B Series Laser Diode Controller's TEC controller will be in tolerance when the temperature is within 0.1 ∀C for a period of 2.500 seconds.

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TEC:TOLerance

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:TOLerance? query allows the programmer to determine how the TEC temperature tolerance is set.

Notes
The tolerance of the LDC-3700B Series Laser Diode Controller temperature controller may be used to delay programming after an "TEC:OUTput 1" command is issued or the set point is changed.

The TEC tolerance specification is also used in the TEC status event and condition registers, and so entering or exiting TEC temperature tolerance may be used to generate service requests.

Examples
"Tec:Tol?" -response: "0.2,5", means the LDC-3700B Series Laser Diode Controller has a TEC tol-erance setting of 0.2°C with a time window of 5.000 seconds.

"TEC:TOL?" -response: "1.0,20", means the LDC-3700B Series Laser Diode Controller has a TEC tolerance setting of 1.0°C with a time window of 20.000 seconds.

TEC:V

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:V command sets the TEC voltage value for calibration mode.

Parameters
An <nrf value> which represents a TEC voltage calibration value.

Notes
If the user attempts to use this command when not in TEC voltage calibration, an error E-419 will be generated.

Examples
"TEC:V 5.4" -action: the TEC voltage calibration accepts 5.4 volts as a calibration value.

"Tec:v -3.9" -action: the TEC voltage calibration accepts -3.9 volts as a calibration value.

TEC:V?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TEC:V? returns the most recent TEC voltage measurement.

Notes
The TEC voltage measurement may only be read remotely.

The TEC voltage measurement response indicates the actual voltage at the TEC output. Even when the TEC output is off, there is a voltage present. This voltage is due to a small leakage current which flows across the high impedance TEC output circuit.

Examples
"Tec:V?" -response: "0.2", means the LDC-3700B Series Laser Diode Controller has a TEC voltage of 0.2 volts.

"TEC:v?" -response: "1.2", means the LDC-3700B Series Laser Diode Controller has a TEC voltage of 1.2 volts.

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TERM

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TERM command allows the programmer to change the default (IEEE488.2 standard) terminator to include the carriage return.

Parameters: An <nrf value>, 0 = FALSE, non-zero = TRUE

Notes: An altered terminator will be in the form <CR><NL><^END>. This technically takes the LDC-3700B Series Controller out of IEEE488.2 specification, but may be done for convenience when using non standard GPIB controllers. This termination will be sent with all output until the "TERM 0" command is sent or the 3700B Series Controller is powered off.

Examples: "Term 1" -temporarily sets <CR><NL><^END> as the output terminator.

"Term?" -response: 0, means that the <NL><^END> terminator (IEEE488.2 standard) is being used.

TERM?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TERM? query allows the programmer to determine whether the default (IEEE488.2 standard) terminator has been altered to include a carriage return.

Notes: An altered terminator will be in the form <CR><NL><^END>. This termination will be sent with all output until the "TERM 0" command is sent or the LDC-3700B Series Controller is powered off.

Examples: "Term?" -response: 1, means that the <CR><NL><^END> terminator is temporarily being used.

"Term?" -response: 0, means that the <NL><^END> terminator (IEEE488.2 standard) is being used.

TIME?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TIME? query allows the programmer to determine how much time has passed since the LDC-3700B Series Laser Diode Controller was last powered up.

Notes: The TIME clock is independent of the TIMER clock.

Examples: "Time?" -response: 1:02.36, means that 1 minute and 2.36 seconds have passed since the LDC-3700B Series Laser Diode Controller was powered up.

"TIME?" -response: 32:00:76, means that 32 minutes and 0.76 seconds have passed since the LDC-3700B Series Laser Diode Controller was powered up.

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TIMER?

COMMON
DEVICE DEPENDENT
FRONT PANEL

The TIMER? query allows the programmer to determine how much time has passed since the last TIMER? query was issued.

Notes
Each time the TIMER? query is issued, the timer is reset to 0 and the elapsed time since the last TIMER? query is returned.

The timer counter is initially set at power-up, the same as the TIME? counter. So the first time the TIMER? is issued its response will be the same as if a TIME? query's response.

Examples
"Timer?" -response: 00:02:00.31, means the LDC-3700B Series Laser Diode Controller has been on for 2 minutes and 0.31 seconds since the last TIMER? query was issued.

"TIMER?" -response: 00:00:12.03, means the LDC-3700B Series Laser Diode Controller has been on for 12.03 seconds since the last TIMER? query was issued.

*TST?

Sdrs>

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Performs internal self-test, then reports results.

Response 0 = test completed with no errors.
Non-zero = test not completed, or was completed with errors.

Example **TST?**

*WAI

V`hs sn Bnmshmtd

COMMON
DEVICE DEPENDENT
FRONT PANEL

Action Prevents the instrument from executing any further commands until OPC (operation complete) status is true.

Note This command can be used to make the instrument wait until an operation is complete before continuing.

Care should be taken to set the GPIB time-out appropriately for use with the *WAI command. After this command (or the Delay) command is sent, the 3700B may receive up to 20 more commands before the wait period is over. If more than 20 commands are sent before the delay or wait period is over, the additional commands will be ignored and an error E220 will be generated.

Example ***WAI** Wait until OPC status is true.

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CHAPTER 5

CALIBRATION AND TROUBLESHOOTING

This chapter describes calibration of your LDC-3700B Series Laser Diode Controller. Descriptions of the required test instruments, calibration conditions, and the detailed procedures for calibration of the instrument's Temperature Controller and the Laser Diode Current Source are included. A troubleshooting guide is also offered for some of the more common failure symptoms. This chapter is divided into three major sections, Local (front panel) calibration, remote (through the GPIB Interface) calibration, and a troubleshooting guide.

ILX Lightwave Corporation provides in-house and on-site calibration services for ILX instruments. Most ILX instruments require yearly calibration to ensure performance to published specifications. ILX factory calibrations employ NIST traceable measurement instrumentation, and our calibration engineers and technicians use automated test equipment to accurately and efficiently capture and record calibration data. An original certificate of calibration authenticity is provided with all instrument calibrations, and a detailed report showing any pre-calibration out-of-tolerance conditions is available upon request. Calibration turn-times are normally five business days or less. On-site calibrations can be performed around your production schedule, night or day, seven days a week. Please contact ILX Customer Support (see page xi for contact information) for additional calibration information.

Calibration Overview

There are several calibrations to completely calibrate the LDC-3700B Laser Diode Controller. The Temperature Controller calibration consists of calibrating the temperature sensors and the TE module bipolar current source and TEC voltage measurement. The TEC voltage calibration can only be done remotely. The Laser Diode Current Source calibration consists of calibrating the current source in both ranges and both modes (low and high bandwidth), calibrating the PD monitor feedback ammeter, and calibrating the forward voltage measurement.

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The current limits are calibrated internally by the instrument as part of the calibration process.

Your LDC-3700B Series Controller can be calibrated with the case closed. Calibrate the instrument every 12 months or whenever performance verification indicates that calibration is necessary, such as differences between set point and measurement display values which exceed the accuracy specification. Calibrate the instrument under laboratory conditions. ILX recommends calibration at 23 °C, ±1.0 °C. When necessary, however, the LDC-3700B Series Laser Diode Controller can be calibrated at its intended use temperature if this is within the specified operating temperature range of 0-50#C.

Finally, the LDC-3700B Series Laser Diode Controller should be allowed to warm up for at least 1 hour before calibration.

Recommended Equipment

Recommended test equipment for calibrating the LDC-3700B Series Laser Diode Controller is listed in Table 5.1. Equipment other than that shown in the table may be used if the specifications meet or exceed those listed.

Table 5.1 Recommended Test Equipment

Description	Mfg./Model	Specification
DMM	HP 3457A	DC Amps (@ 1.0 A): ±0.02 % Resistance (@ 10 W): ±0.02 % 0.1 mA or 0.1 mV resolution

You must connect various loads and circuits to the outputs of each controller for the calibration procedure. A schematic is shown in Figure 5.1 for the photodiode calibration circuit with the required components listed in Table 5.2 on page 133. Also, the devices required for other calibration loads are listed in Table 5.2.

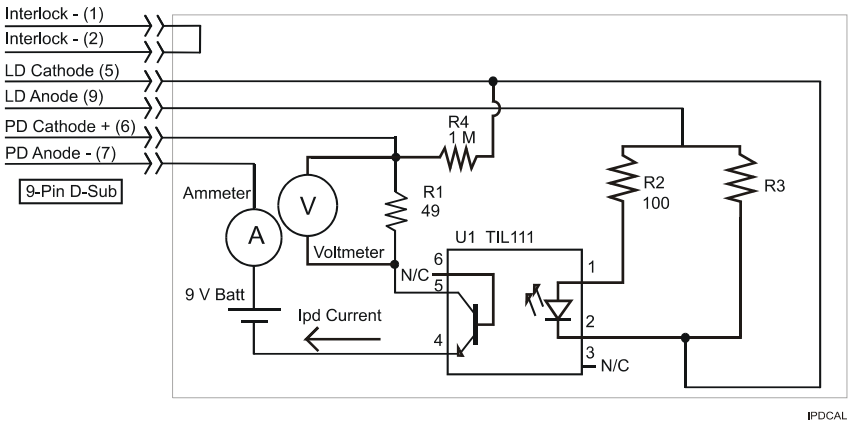


Figure 5.1 I_{PD} Calibration Circuit

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Table 5.2 Required Calibration Components

LASER CURRENT SOURCE CALIBRATION	
Current Source Calibration, all models	1T 20W resistor, low TCR
Voltage Measurement Calibration	
LDC-3714B	100T 2W resistor, low TCR
LDC-3724B	25T 5W resistor, low TCR
LDC-3744B	25T 5W resistor, low TCR
TEMPERATURE CONTROLLER CALIBRATION	
Current Source Calibration, all models	1T 20W resistor, low TCR
TEC Voltage Calibration, all models	50T 5W resistor, low TCR
Thermistor	100 kT resistor, 1% 1/4W
10 σA setting	10 kT resistor, 1% 1/4W
100 σA setting	
LM335	6.8 kT resistor, 1% 1/4W
AD590	16.8 kT resistor, 1% 1/4 W
PHOTO-DIODE MONITOR CALIBRATION (See schematic in Figure 5.1 on page 132)	
PD cal circuit	
R1	49T resistor, 1% 1/4W
R2	100T resistor, 1%, 1/4W
R4	1.0 MT resistor, 1% 1/4W
R3:	
LDC-3714B	20 T, 1%, 1 W
LDC-3724B, LDC-3744B	5 T, 1%, 10 W
U1	TIL 111 opto isolator
Battery	9 V Battery
Connector	9-pin D-sub, Male

Local Calibration of the LDC-3700B Temperature Controller

The following procedure is for calibrating the 100 σA and 10 σA thermistor current sources so that the thermistor resistance measurement for these ranges will meet the stated accuracy specifications.

Calibrating the Thermistor

1. Set the **SENSOR SELECT** switch (back panel) to the 100 mA position, the TEC display code is --01.
2. Using the multimeter, measure and record the resistance of your metal film resistors. ILX recommends a 4-point probe resistance measurement.
3. Connect the correct metal film resistor to the sensor input of the Temperature Controller 15 pin connector on the rear panel, sensor + and sensor - terminals.

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4 Enter the TEC sensor calibration mode by pushing the (**GPIB**) **LOCAL** and (**TEC DISPLAY**) **R** switches at the same time. The sensor code (**SENSOR SELECT** switch position) value displays for 2 seconds. After this, the TEC display indicates sensor resistance in kT.

5 Press and hold in the (**PARAMETER**) **SET** switch and turn the **ADJUST** knob until the **TEC** display indicates the same resistance you recorded for the metal film resistor.

6 Release the (**PARAMETER**) **SET** switch to store the new value into non-volatile memory. After the (**PARAMETER**) **SET** switch is released, the LDC-3700B Series Laser Diode Controller will return to its former state (before calibration).

7 Switch the **SENSOR SELECT** switch (back panel) to the 10 mA position, TEC display code --02, and repeat this procedure with the 100 kT resistor as the load at the Sensor + and Sensor - terminals.

AD590 Sensor Calibration

This procedure is for calibrating the AD590 sensor so that the temperature measurement is as accurate as possible.

1 Set the **SENSOR SELECT** switch (back panel) to the **AD590** position, the TEC display code is --04.

2 Connect a precision 16.8 kT (metal film) resistor and multimeter in series at the sensor input of the Temperature Controller 15 pin connector on the rear panel, Sensor + and Sensor - terminals. Configure the multimeter to measure current in σA.

3 Enter the TEC sensor calibration mode by pushing the (**GPIB**) **LOCAL** and (**TEC DISPLAY**) **R** switches at the same time. The TEC display will become blank for 2 seconds, then the sensor code (**SENSOR SELECT** switch position) value will be displayed for 2 seconds. After this, the TEC display will indicate sensor reference current in σ**A** (not enunciated)**.**

4 Press and hold in the (**PARAMETER**) **SET** switch and turn the **ADJUST** knob until the TEC display indicates the same current as shown on the multimeter.

5 Release the (**PARAMETER**) **SET** switch to store the new value into non-volatile memory. After the **SET** switch is released, the LDC-3700B Series Laser Diode Controller will return to its former state (before calibration).

LM335 Sensor Calibration

The following procedure is for calibrating the LM335 sensor so that the temperature measurement is as accurate as possible.

1 Set the **SENSOR SELECT** switch (back panel) to the **LM335** position, the **TEC** display code is --03.

2 Connect a precision 6.8 kT (metal film) resistor and the multimeter in parallel to the sensor input of the Temperature Controller 15 pin connector on the rear panel, Sensor + and Sensor - terminals. Configure the multimeter to measure voltage in mV.

3 Enter the TEC sensor calibration mode by pushing the (**GPIB**) **LOCAL** and (**TEC**

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DISPLAY) **R** switches at the same time. The sensor code (**SENSOR SELECT** switch position) value will be displayed for two seconds. After this, the TEC display will indicate sensor reference voltage in mV (not enunciated).

4 Press and hold in the (**PARAMETER**) **SET** switch and turn the **ADJUST** knob until the **TEC** display indicates the same voltage as shown on the multimeter.

5 Release the (**PARAMETER**) **SET** switch to store the new value into non-volatile memory. After the **SET** switch is released, the LDC-3700B Series Laser Diode Controller will return to its former state (before calibration).

ITE Current Calibration

This procedure is for calibrating the ITE bi-polar constant current source. This procedure calibrates the zero current set point automatically, then it automatically drives the TE current output to internally set limits of ∂2 amp. When each of these values is reached and is stable, the user enters the actual value of the current, as measured by an external DMM. The LDC-3700B Series Laser Diode Controller then automatically calibrates the TEC current source and limits.

1 With the output off, connect a 1 T, 20 W resistor across the TEC output terminals (TE Module + and TE Module -).

2 Connect a calibrated DMM across the load resistor. You will be calculating TE current in the following manner using Ohm's Law:

I = E / R

where E is the accurately measured voltage across the resistor, and R is the accurately measured load resistance. I is the calculated current in Amps. (A 4-point probe resistance measurement is recommended.)

3 Make sure that the **TEC** output is off before entering the I_{TE} calibration mode. Press the (**GPIB**) **LOCAL** and (**TEC DISPLAY**) **I_{TE}** switches at the same time to place the Controller in TEC Current Calibration mode.

The Laser display blanks and the TEC display drives the output to a value of zero (0.000) amps as the Temperature Controller calibrates itself. After 20 seconds, the TEC controller drives the output to 2.000 amps. Once stable, the temperature controller is ready to enter the actual TE current value.

4 Press and hold the (**PARAMETER**) **SET** switch and turn the Adjust Knob until the **TEC** display shows the correct value (absolute value of the I_{TE} measurement). Release the (**PARAMETER**) **SET** switch to store the new calibration value into non-volatile memory

The Controller drives the TE output current to the negative value of -2.000 Amps.

5 Repeat step 4 for the negative polarity of the TEC output current.

After the negative polarity value of the TEC output is entered, the controller automatically calibrates its current limits and set points, indicated by the flashing TE Current Limit indicator. The controller then returns to the state before calibration.

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Local Calibration of the Laser Current Source

There are three calibration adjustments required for the LASER current source of the LDC-3700B Series Laser Diode Controller. They are: calibration of the constant current source for both bandwidths and ranges, calibration of the laser voltage measurement, and calibration of the constant light power (I_{PD}) feedback circuits.

The LDC-3700B Series Laser Diode Controller implements a two-point calibration for the Laser current source. Two currents (approximately 80% and 20% of FS) are applied to a test load, and the resulting actual currents are fed back (by the user) to the Controller. The Laser Controller calibration program uses the two sets of data to calculate new calibration constants. These calibration constants are used to set the actual current output of the current source.

Current Source Calibration

The following procedure is for calibrating each range of the current source. Start with the low range. After calibration is complete in this range, switch to the high range and repeat the procedure.

Configure the Laser Controller in the following state:

Function	State
Laser Mode	I (constant current low bandwidth)
Range	low (lowest per instrument model)
Limit	90% of FS (full scale of range)
Set Point	80% of FS (90% for LDC-3744B)

1. Measure and record the resistance of a 1 Ω, 20 W resistor (a 4-point probe resistance measurement is recommended). Connect the load resistor across the LASER output terminals (Laser Anode and Laser Cathode) on the 9 pin connector of the rear panel.

2. Connect the calibrated DMM across the load resistor. Configure the multimeter to measure voltage in volts. You will be calculating the actual Laser current in the following manner using Ohm's Law.

   I = E / R

   where E is the accurately measured voltage across the resistor, and R is the accurately measured load resistance. I is the actual Laser current in Amps.

   Note: Check the current measuring range of your multimeter. You may be able to measure Laser Output current in mA by connecting the meter directly to the outputs of the Laser Current Source.

3. Press the (**LASER MODE**) **ON** switch to turn the **LASER** output on. The LASER output must be on in order to enter the LASER I calibration mode.

4. Enter the **LASER I** calibration mode by pushing the (**GPIB**) **LOCAL** and (**LASER DISPLAY**) **I** switches at the same time. The TEC display will blank and the controller will

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drive the LASER current output to the set point and the LASER display will indicate output current in mA.

5 Calculate the actual current through the load as described in step b. Press and hold in the (**PARAMETER**) **SET** switch and turn the **ADJUST** knob until the **LASER** display indicates the calculated actual current.

6 Release the (**PARAMETER**) **SET** switch. After the (**PARAMETER**) **SET** switch is released, the Controller will drive the LASER current output to about 25% of the first calibration set point.

7 Calculate the measured current again through the load resistor.

8 Press and hold in the (**PARAMETER**) **SET** switch and turn the **ADJUST** knob until the **LASER** display indicates the actual current as calculated in step 7.

9 Release the (**PARAMETER**) **SET** switch to accept the second calibration point. After the (**PARAMETER**) **SET** switch is released, the Controller will calculate the calibration constants, store them to nonvolatile memory. In low bandwidth calibration mode, the LDC-3700B Series Laser Diode Controller will also perform current limit calibrations for **I**(Constant Current) and **P**(Constant Power) modes, indicated by the **CURRENT LIMIT** LED flashing.

10 Change the Laser Mode to I_{HBW} (high bandwidth constant current mode). Repeat the calibration procedure as described above.

I_{PD} Current Calibration

The following procedure is for calibrating the LASER I_{PD} (photodiode monitor) ammeter. This procedure calibrates the feedback circuits for constant I_{PD} and constant P_{PD} modes. When these values are reached and are stable, the user enters the actual value of the monitor current, measured with a DMM. The LDC-3700B Series Laser Diode Controller then automatically calibrates the LASER feedback circuits.

Configure the Controller in the following manner for the Laser Controller calibration:

Function	State
Laser Mode	P (constant power)
Laser Range	High Range
CAL PD	set equal to zero
LASER LIMIT	90% of FS (full scale of range)
Intitial I_{PD} Set POINT	4000 σA

1 Connect a voltmeter set to autorange DCV mode between laser output pins 6 and 7. Black to pin 6 and red to pin 7. Adjust PD bias pot until voltmeter reads -3.5V.

2 With the LASER output off, connect a calibrated ammeter to the PD Anode output of the Laser Controller output connector (9 pin on rear panel), and connect the circuit of Figure 5.1 on page 132 to the LASER and PD outputs with the correct load resistor for the controller model you are calibrating (See Table 5.2 on page 133).

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Note: If a precision ammeter is not available, use a zero-Ohm jumper in place of the ammeter. Then, place a calibrated DMM (with 0.1 mV resolution) to measure the voltage across the resistor, R1, as shown in Figure 6.1. Calculate the current in the following steps by using Ohm's Law:

I = E / R

where E is the accurately measured voltage across the resistor, and R is the accurately measured load resistance. I is the actual pd current to be measured by the controller. (A 4-point resistance measurement is recommended.)

3 Press the (**LASER MODE**) **ON** switch to turn the **LASER** output on. Verify proper operation, i.e., the $\mathbf{I_{PD}}$ set point should be close, and the unit should not be in current limit.

4 Press the (**GPIB**) **LOCAL** and (**LASER DISPLAY**) $\mathbf{I_{PD}}$ switches at the same time to place the Controller in its $\mathbf{I_{PD}}$ Current Calibration mode.

After a few seconds the **LASER** display will show the I_{PD} set point value.

5 After the value on the LASER display is stable (has not changed by more than one digit for several seconds) the LDC-3700B Series Laser Diode Controller is ready for the actual I_{PD} value to be entered.

Press and hold in the (**PARAMETER**) **SET** switch and turn the **ADJUST** knob until the **LASER** display shows the actual monitor current, as shown on the calibrated ammeter (or the calculated I_{PD} value from Step 2).

6 Release the (**PARAMETER**) **SET** switch to store the first calibration value into non-volatile memory. The controller will then set the second calibration current, approximately one-fourth (1/4) of the original current. (For example, if the first calibration set point was 4000 σA, the second set point will be about 1000 σA.)

7 Press and hold in the (**PARAMETER**) **SET** switch and turn the **ADJUST** knob until the LASER display indicates the actual current as measured by the ammeter or as calculated.

8 Release the (**PARAMETER**) **SET** switch to accept the second calibration point. After the (**PARAMETER**) **SET** switch is released, the LDC-3700B Series Laser Diode Controller will calculate the calibration constants and store them to nonvolatile memory.

Laser Forward Voltage Measurement Calibration

The following procedure is for calibrating the LASER voltage measurement.

Configure the Controller in the following manner for the Laser Controller Voltage calibration:

Function	State
Laser Mode	I (constant current low bandwidth)
Range	
LDC-3714B	100 mA
LDC-3724B	500 mA
LDC-3744B	2000 mA

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Laser Limit	set to FS (full scale of range)
I Set Point	
LDC-3714B	60 mA
LDC-3724B	400 mA
LDC-3744B	400 mA

1. With the LASER output off, connect a calibrated voltmeter, in parallel with a resistor (100 Ω, 2 Watt for the LDC-3714B; 15 Ω, 5 Watt for the LDC-3724B or LDC-3744B), to the LASER output (Laser Anode and Laser Cathode) on the rear panel of the controller.
2. Press the (**LASER MODE**) **ON** switch to turn the **LASER** output on The LASER output must be on in order to enter the LDV calibration mode.
3. Enter the **LASER V** calibration mode by pushing the (**GPIB**) **LOCAL** and (**LASER DISPLAY**) **V** switches at the same time. The TEC display will blank and the controller will drive the LASER current output to the respective set point and the LASER display will indicate forward voltage in Volts.
4. Enter the measured voltage (in volts). Press and hold in the (**PARAMETER**) **SET** switch and turn the **ADJUST** knob until the **LASER** display indicates the measured voltage.
5. Once the actual voltage value is entered, the Controller will set the current to approximately one-fourth (1/4) of the original value. It will then expect the second calibration voltage point.
6. Input the second actual (measured) LASER forward voltage.
7. Once the second actual voltage value is entered, the Controller stores the new calibration constants.

Remote Calibration of the LDC-3700B Controller

The LDC-3700B Series Controllers can be calibrated remotely via the GPIB Interface. The following procedures are general guidelines for writing a program to calibrate your instrument.

The operation complete flag (bit 0 of the Standard Event Status Register) may be used to trigger a service request. This type of interrupt is enabled by setting bit 0 of the Service Request Enable register (via the *ESE command) and bit 5 of the Service Request Enable register (via the *SRE command). Service request (SRQ) handling depends on your GPIB hardware. Refer to your GPIB user's manual for details.

After a calibration value is entered, the "*OPC?" query may be used to determine when the calibration sequence is done. However, the "*OPC", or "*WAI" command, or "*OPC?" query should not be issued until after the expected calibration value is entered, or the system will "hang". This happens because the LDC-3700B Series Laser Diode Controller will wait indefinitely for an input, yet not allow any input until the calibration is finished.

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Thermistor Calibration

The following procedure is for calibrating the 100 σA and 10 σA thermistor current sources so that the thermistor resistance measurement for these ranges will meet the stated accuracy specifications.

1. Set the SENSOR SELECT switch (back panel) to the 100 σA position, the TEC display code is --01.
2. Using the multimeter, measure and record the exact resistance of your metal film resistors. (A 4-point probe resistance measurement is recommended.)
3. Connect the correct metal film resistor (See Table 5.1 on page 132) to the sensor input of the Temperature Controller 15 pin connector on the rear panel Sensor + and Sensor - terminals.
4. Enter the "TEC:CAL:SENsor" command over the GPIB. The TEC display will show the resistance value, and will then expect the actual value to be entered, in KT.

   If this calibration value is to be measured and entered remotely via a GPIB controlled DMM, for example, the actual value of the resistance should not be entered until the Controller is ready to receive it. The Controller will be ready to receive the actual (measured) resistance value when, after a "TEC:CAL:SEN?" query is sent, the response from the Controller is "1".
5. Once the "TEC:R" value is sent, the Controller will return to its former state (before calibration). The "OPC?" query may be used (after the "TEC:R" value is sent) to determine when the calibration is completed.
6. Switch the **SENSOR SELECT** switch (back panel) to the 10 mA, position, TEC display code is --02, and repeat this procedure with the 100 kT resistor as the load at the Sensor + and Sensor - terminals.

AD590 Sensor Calibration

The following procedure is for calibrating the AD590 sensor so that the temperature measurement will be as accurate as possible.

1. Set the SENSOR SELECT switch (back panel) to the AD590 position, TEC display code is --04.
2. Connect a precision 16.8 kT (metal film) resistor and multimeter in series at the sensor input of the Temperature Controller 15 pin connector on the rear panel. Configure the multimeter to measure current in σA.
3. Enter the "TEC:CAL:SENsor" command over the GPIB. The TEC display will show the current value in σA (not enunciated).
4. Input the actual current measured by the external ammeter (as an <nrf value>) via the

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"TEC:R <nrf value>" command.

If this value is to be measured and entered remotely via a GPIB controlled DMM, for example, the measured value of the current should not be entered until the LDC-3700B Series Laser Diode Controller is ready to receive it. The Controller will be ready to receive the measured value when, after a "TEC:CAL:SEN?" query is sent, the response from the Controller is "1".

5 Once the "TEC:R" value is sent, the Controller will return to its former state (before calibration). The "OPC?" query may be used (after the "TEC:R" value is sent) to determine when the calibration is completed.

LM335 Sensor Calibration

The following procedure is for calibrating the LM335 sensor so that the measured temperature will be as accurate as possible. This procedure is for remote operation through the GPIB Interface.

1 Set the SENSOR SELECT switch (back panel) to the LM335 position, TEC display code is --03.

2 Connect a precision 6.8 kΤ (metal film) resistor and the multimeter in parallel to the sensor input of the Temperature Controller 15 pin connector on the rear panel. Configure the multimeter to measure voltage in mV.

3 Enter the "TEC:CAL:SENsor" command over the GPIB. The TEC display will show the voltage in mV (not enunciated).

4 Input the actual voltage measured by the multimeter (as an <nrf value>) via the "TEC:R <nrf value>" command.

If this value is to be measured and entered remotely via a GPIB controlled DMM, for example, the measured value of the voltage should not be entered until the Controller is ready to receive it. The Controller will be ready to receive the voltage value when, after a "TEC:CAL:SEN?" query is sent, the response from the Controller is "1".

5 Once the "TEC:R" value is sent, the Controller will return to its former state (before calibration). The "OPC?" query may be used (after the "TEC:R" value is sent) to determine when the calibration is completed.

I_{TE} Current Calibration

The following procedure is for calibrating the I_{TE} bi-polar constant current source. This procedure calibrates the zero current set point, then it automatically drives the TE current output to internally set limits of ±2.000 amps. When each of these values is reached and is stable, the user enters the actual value of the current, as measured by an external DMM. The LDC-3700B Series Laser Diode Controller then automatically calibrates the TEC current source and limits.

1 With the output off, connect a 1 Τ, 20 W resistor across the TEC output terminals (TE Module + and TE Module -).

2 Connect a calibrated DMM across the load resistor. You will be calculating TE current in

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the following manner using Ohm's Law:

I = E / R

where E is the accurately measured voltage across the resistor, and R is the accurately measured load resistance. I is the calculated current in Amps. (A 4-point probe resistance measurement is recommended.)

3 The TEC output must be off in order to enter the I_{TE} calibration mode. Enter the "TEC:OUTPUT OFF" command.

4 Enter the `TEC:CAL:ITE` command to place the controller in TEC Current Calibration mode.

The TEC display indicates a small current in Amps as the temperature controller calibrates itself for a zero current level. After 20 seconds, the TEC controller drives the output to 2.000 amps. Once stable, the temperature controller is ready to enter the actual TE current value.

5 Enter the TE current value using the `TEC:ITE <nrf value>` command. The (absolute value of the) actual ITE value is the `<nrf value>`.

The controller drives the TE output current to the negative value of -2.000 Amps.

6 Repeat step 5 for the negative polarity of the TEC output current.

After the negative polarity value of the TEC output is entered, the controller automatically calibrates its current limits and set points, indicated by the flashing TE Current Limit indicator. The controller then returns to the state before calibration.

TEC Voltage Calibration

The following procedure is for calibrating the TEC voltage measurement. This procedure calibrates the positive and negative voltages in one procedure.

Note: The TEC Voltage calibration may only be performed remotely.

1 With the output off, connect a 50 Ω, 5 W resistor across the TEC output terminals (TE Module + and TE Module -).

2 Connect a calibrated DMM across the load resistor. Enter the "TEC:ITE 0" command to set the TEC current to zero for the start of this procedure.

3 Enter the "TEC:CAL:V" command to place the Controller in its TEC Voltage Calibration mode The TEC display will indicate a current of about -0.12 Amps so that the TEC voltage will be about -6.00 volts.

4 When the Controller is ready for the actual voltage value to be entered, a remote query of "TEC:CAL:V?" will return a response of "1". Allow a few seconds for the TEC current to stabilize.

When the measured value (display) is stable and the Controller is ready to proceed, enter the value by issuing the "TEC:V <nrf value>" command, where the actual TEC voltage on the DMM is the <nrf value>. Once the actual TEC voltage value is entered via the "TEC:V<nrf value>" command, the new calibration value is stored into non-volatile memory.

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Note: To ensure measurement stability of the actual TEC voltage value when the measurement is taken as a part of an automated test, the DMM measurement should be polled in a loop. When the measured value is consistent within one digit for 5 seconds (for example), the actual TEC voltage value could be considered stable.

If the "*OPC?" query is issued during TEC voltage calibration, the time out period of the GPIB driver should be at least one minute to prevent the GPIB driver from timing out and "hanging" the system. Refer to your GPIB driver instruction manual for information on setting the GPIB driver time out period.

5 The controller will drive the output current to a value of about 0.12 Amps, so that the TEC voltage will be about +6.00 volts.

6 Repeat step 4. After the value for the positive polarity of the TEC voltage is entered, the Controller will automatically store the new calibration values for TEC voltage measurement.

Current Source Calibration

There are three calibration adjustments required for the LASER current source of the LDC-3700B Series Laser Diode Controller. They are calibration of the constant current source for both bandwidths and ranges, calibration of the laser voltage measurement, and calibration of the constant light power (I_{PD}) feedback circuits.

The LDC-3700B Series Laser Diode Controller implements a two-point calibration for the Laser current source. Two currents (approximately 20% and 80% of FS) are applied to a test load, and the resulting actual currents are fed back (by the user) to the Controller. The Laser Controller calibration program uses the two sets of data to calculate new calibration constants. These calibration constants are used to set the actual current of the current source.

The following procedure is for calibrating each range of the current source. Start with the low range. After calibration is complete in this range, switch to the high range and repeat the procedure.

Configure the Controller in the following manner for the Laser Controller calibration:

FUNCTION	STATE	GPIB COMMAND
LASER MODE	I (constant current low bandwidth)	LAS:MODE:ILBW
RANGE	low (lowest per instrument model)	LAS:RAN-x
LIMIT	90% of FS (full scale of range)	LAS:LIM:Ix
SET POINT	80% of FS (90% for LDC-3744B)	LAS:LDI

1 Measure and record the resistance of a 1 Ω, 20 W resistor (a 4-point probe resistance measurement is recommended). Connect the load resistor across the LASER output terminals (Laser Anode and Laser Cathode) on the 9 pin connector of the rear panel.

2 Connect the calibrated DMM across the load resistor. Configure the multimeter to

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measure voltage in volts. You will be calculating the actual Laser current in the following manner using Ohm's Law.

I = E / R

where E is the accurately measured voltage across the resistor, and R is the accurately measured load resistance. I is the actual Laser current in Amps.

3 The LASER output must be on in order to enter the LASER I calibration mode. Enter the "LAS:OUTPUT ON" command to turn the LASER output on.

4 d.Enter the LASER I calibration mode by issuing the "LAS:CAL:LDI" command. The TEC display will blank and the LASER display will indicate a current in mA.

5 Input the first actual (measured) LASER output current (as an <nrf value>) via the "LAS:LDI <nrf value>" command.

If this value is to be measured and entered remotely via a GPIB controlled DMM, for example, the measured value of the current should not be entered until the LDC-3700B Series Laser Diode Controller is ready to receive it: The Controller will be ready to receive the new measured value when, after a "LAS:CAL:LDI?" query is sent, the response from the Controller is "1".

6 Once the newly measured I value is entered via the "LAS:LDI" command, the Controller will apply a new current equal to about 25% of the previous set current.

7 Input the second actual (measured) LASER output current (as an <nrf value>) as in Step 5.

8 Once the second actual I value is entered via the "LAS:LDI" command, the new calibration constants will be calculated and stored into non-volatile memory. In low bandwidth calibration mode, the LDC-3700B Series Laser Diode Controller will also perform current limit calibrations for I and P modes as indicated by the **CURRENT LIMIT** LED flashing. The "OPC?" query may be used (after the "LAS:LDI" value is sent) to determine when the calibration is completed.

9 Change the Laser Mode to I_{HBW} (high bandwidth constant current mode) with the LAS:IHBW command. Repeat the calibration procedure as described above.

I_{PD} Current Calibration

The following procedure is for calibrating the LASER I_{PD} constant current source. This procedure calibrates the feedback circuits for constant I_{PD} and constant P_{PD} modes. When these values are reached and are stable, the user enters the actual value of the current, as measured by an external DMM. The LDC-3700B Series Laser Diode Controller then automatically calibrates the LASER feedback circuits.

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Configure the Controller in the following manner for the Laser Controller calibration:

FUNCTION	STATE	GPIB COMMAND
PD BIAS VOLTAGE POT	>3.5V	
LASER MODE	P (constant power)	LAS:MODE:MDP
CAL PD	set equal to zero	LAS:CALMD
LASER LIMIT	90% of FS (full scale of range)	LAS:LIM:Ix
I_{PD} Set POINT	4000 σA	LAS:MDI

1. With the LASER output off, connect a calibrated ammeter to the PD Anode output of the Laser Controller output connector (9 pin on rear panel), and connect the circuit of Figure 5.1 on page 132 to the LASER and PD outputs with the correct load resistor for the controller model you are calibrating (See Table 5.2 on page 133).

2. Enter the "LAS:OUT ON" command to turn the LASER output on. Verify proper operation, i.e., the I_{PD} output should be close to the set point (read it via the "LAS:MDI?" query), and the unit should not be in current limit (read the limit status via the "LAS:COND?" query, bit 0).

3. Enter the "LAS:CAL:MDI" command to place the Controller in its LASER Current Calibration mode. The controller will increase the laser current output until the current at the PD monitor (I_{PD}) inputs equals the targeted set point.

4. After a few seconds, the Controller will be ready for the actual I_{PD} current to be entered via the "LAS:MDI <nrf value>" command. The measured value of the current should not be entered until the Controller is ready to receive it. The Controller will be ready to receive the current value when, after a "LAS:CAL:MDI?" query is sent, the response from the Controller is "1".

5. Once the actual I_{PD} value is entered via the "LAS:MDI <nrf value>" command, the Controller will store the new calibration value in non-volatile memory. It will then set the output to approximately one-fourth (1/4) of the original current. (For example, if the first calibration set point was 4000 σA, the second set point will be about 1000 σA.) Then, it will be ready to receive the second calibration value.

6. Input the second actual (measured) monitor diode current (as an <nrf value>).

7. Once the second actual I_{PD} value is entered via the "LAS:MDI" command, the new calibration constants will be calculated and stored into non-volatile memory. The "OPC?" query may be used (after the "LAS:MDI" value is sent) to determine when the calibration is completed.

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Laser Forward Voltage Measurement Calibration

The following procedure is for calibrating the LASER voltage measurement.

Configure the Controller in the following manner for the Laser Controller Voltage calibration:

FUNCTION	STATE	GPIB COMMAND
LASER MODE	I (constant current low bandwidth)	LAS:MODE:ILBW
RANGE		
LDC-3714B	100 mA	LAS:RANGE -1
LDC-3724B	500 mA	LAS:RANGE -5
LDC-3744B	2000 mA	LAS:RANGE -1
LASER LIMIT	set to FS (full scale of range)	LAS:LIM:Ix
I Set POINT		
LDC-3714B	60 mA	LAS:LDI 60
LDC-3724B	400 mA	LAS:LDI 400
LDC-3744B	400 mA	LAS:LDI 400

1. With the LASER output off, connect a calibrated voltmeter, in parallel with a resistor (100 T, 2 Watt for the LDC-3714B; 15 T, 5 Watt for the LDC-3724B or LDC-3744B), to the LASER output (Laser Anode and Laser Cathode) on the rear panel of the controller.
2. The LASER output must be on in order to enter the LDV calibration mode. Enter the "LAS:OUT ON" command to turn the LASER output on.
3. Enter the "LAS:CAL:LDV" command to place the Controller in its LASER Voltage Calibration mode.
4. Enter the measured voltage (in volts) via the "LAS:LDV <nrf value>" command. The measured value of the voltage should not be entered until the LDC-3700B Series Laser Diode Controller is ready to receive it. The Controller will be ready to receive the voltage value when, after a "LAS:CAL:LDV?" query is sent, the response from the Controller is "1".
5. Once the actual voltage value is entered via the "LAS:LDV <nrf value>" command, the Controller will set the current to approximately one-fourth (1/4) of the original value. It will then expect the second calibration voltage point.
6. Input the second actual (measured) LASER forward voltage (as an <nrf value>).
7. Once the second actual voltage value is entered via the "LAS:LDV" command, the Controller will store the new calibration constants.

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Troubleshooting

This section is a guide to troubleshooting the LDC-3700B Series Controllers. Some of the more common symptoms are listed here, and the appropriate troubleshooting actions are given. We recommend that the user start at the beginning of this guide. Read the symptom descriptions, and follow the steps for the corrective actions which apply. If you encounter problems which are beyond the scope of this guide, contact your ILX Lightwave customer service representative.

Table 5.3 Symptoms and Actions

Symptom	Corrective Actions
General	
LDC-3700B Series unit will not power up	Check AC Power line voltage and power cord connection.
Power on, but display is frozen, switches do not operate	This may occur if the instrument loses power (AC line) briefly. Turn the power switch off and on again to restart.
Laser Contoller	
Power on, but no current output	Check Interlock pins on LASER input connector on instrument rear panel. These pins must be shorted either directly or through a switch. If OPEN CIRCUIT indicator is lit check the load connections and then try again. Check the OUTPUT ON switch, the corresponding LED should be lit.
Output current at limit, cannot be lowered	If POWER mode is used, check the monitor diode (feedback) connections. Try reversing the polarity of the monitor photodiode. Check also the photodiode bias adjustment on the rear panel. If in I or I_{HBW} mode, check the current set point and I LIMIT setting. Setting the output below the limit may require several turns of the adjust knob if the set point is much greater than the desired limit setting.
Output goes off intermittently	Check the interlock circuit. An intermittent interlock will turn the output off. Check that the AC power cord connection is secure. Power-line drop-outs may reset the unit and when power is restored, the output will be off.
Unable to adjust output	Check the (ADJUST) LASER indicator, the indicator must be lit for any LASER adjustments to be made. Check the I LIMIT parameter for the output range in use, see that it is set above 0 mA.
Power Mode operation has high output current, but little or no power is measured	Check back panel PD BIAS. If set too low, may act as an open feedback loop. If in doubt, set the PD BIAS to mid range (2.5 V).

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Table 5.3 Symptoms and Actions

Symptom	Corrective Actions
Output exceeds Power Limit	The "Power Limit" is not a hardware limit. It only serves as a warning that the power measurement has exceeded the limit set point.
Open Circuit Error occurs during calibration	Check load connections. Check that measuring meter does not auto-range (use non-auto-ranging modes).
Calibration is aborted unintentionally	Calibration modes will be aborted if an open circuit is detected.
VOLTAGE LIMIT indicator blinks	This indicates a voltage limit error. Check laser connections. A high impedance may cause this condition.
Open circuit error E503 or Voltage Limit error E505 prevents output from reaching desired value.	The LDC-3700B Series instruments have an adjustable laser compliance voltage. Check to see if the LASER voltage limit setting is too low (see Chapter 2). Check laser connections.
TE Controller	
Power on, but no TE current output	If TE MODULE OPEN indicator is lit, check the load connections. Check that pins 14 and 15 of the output connector are not connected. See Boosting the TE Controller on page 41.
Power on, but temperature is not controlled	If SENSOR OPEN indicator is lit, check the sensor connections. Check that the rear panel SENSOR SWITCH position is set for the proper sensor type. Check that C1 and C2 and C3 are correct values for your temperature sensor. Check that the GAIN setting is not too low and that the LIM I_{TE} value is not too low for your thermal load.
Unable to adjust output or parameter	Check the (ADJUST)TEC indicator, the indicator must be lit for any TEC adjustments to be made. Check the MODE or DISPLAY indicators. If they do not respond to a switch, the unit may be in measurement calibration mode. Cycle the power switch to abort this mode.
Output goes off intermittently	Check that the AC power cord connection is secure. Power-line drop-outs may reset the unit and when power is restored, the output will be off. Check the TE module connections. A high impedance on the TE load may cause the output to exceed the compliance voltage momentarily, thus shutting the output off.

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Error Messages

In the event of a hardware error condition, error messages are displayed on the TEC or LASER displays. In most cases, the error message appears for three seconds. In the case of multiple error messages, the Controller will sequentially show each message for three seconds. In addition to the hardware errors, GPIB errors may be read via the"ERR?" query.

Table 5.4 lists the numerical error ranges by function. Table 5.5 contains all of the potential error messages. Not all of these messages may appear on the front panel displays; some refer to GPIB activities only. ;

In remote operation, the errors can be read by issuing the "ERR?" query. When this is done, all of the error messages which are resident in the error queue are returned (up to 10 may be stored). Reading the error queue via GPIB clears the error queue.

Table 5.4 Error Code Classifications

Error Code Range	Area of Operation
E-001 to E-099	Internal Program Errors
E-100 to E-199	Parser Errors
E-200 to E-299	Execution Control Errors
E-300 to E-399	GPIB Errors
E-400 to E-499	TEC Control Errors
E-500 to E-599	LASER Control Errors

Note: Errors codes not listed are reserved for future design use.

Table 5.5 Error Messages

Error Code	Explanation
E-001	Memory allocation failure.
E-103	<DEFINITE LENGTH ARBITRARY BLOCK PROGRAM DATA> length too long.
E-104	<NON-DECIMAL NUMERIC PROGRAM DATA> type not defined.
E-105	<DECIMAL PROGRAM DATA> exponent not valid.
E-106	<DECIMAL PROGRAM DATA> digit expected.
E-123	Generic error code for command not found
E-124	<program mnemonic> Lookup, failed because query/command type match failed.
E-126	Too few or too many program data elements.
E-201	<PROGRAM DATA> value out of range.
E-202	<PROGRAM DATA> will not convert to valid type.
E-203	Security violation, command is not available without clearance.
E-205	<PROGRAM DATA> is not a Boolean value or word.
E-207	<PROGRAM DATA> will not convert to an unsigned 16-bit value.

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Table 5.5 Error Messages

Error Code	Explanation
E-210	<PROGRAM DATA> will not convert to a floating point value.
E-211	<PROGRAM DATA> will not convert to a character value.
E-213	<PROGRAM DATA> is incorrect block data length.
E-214	<PROGRAM DATA> length exceeds maximum.
E-301	A <RESPONSE MESSAGE> was ready, but controller failed to read it. (Query error).
E-302	Query error. Device was addressed to talk, but controller failed to read all of the <RESPONSE MESSAGE>.
E-401	TEC (Temp Limit) booster interlock disabled output.
E-402	Sensor open disabled output.
E-403	TEC module open disabled output.
E-404	TEC Current limit disabled output.
E-405	TEC Voltage limit disabled output.
E-407	TEC high temperature limit disabled output.
E-408	Booster change disabled TEC output.
E-409	Sensor change disabled TEC output.
E-410	TEC out of tolerance disabled output.
E-411	TEC control error disabled output.
E-412	Analog section status is all 1's or all 0's (power down).
E-413	Serial EEPROM checksum error.
E-415	Sensor short disabled TEC output.
E-416	Incorrect Configuration for Calibration Sequence to start.
E-419	Setting a measurement is only valid during the calibration phase for that measurement. User has tried to calibrate a measurement without first entering the required calibration mode.
E-501	LASER interlock disabled output.
E-503	LASER open circuit disabled output.
E-504	LASER current limit disabled output.
E-505	LASER voltage limit disabled output.
E-507	LASER Power limit disabled output.
E-508	LASER output disabled because of TEC output off condition.
E-509	LASER output disabled because of TEC High Temperature Limit condition.
E-510	LASER out of tolerance disabled output.
E-511	LASER control error disabled output.
E-512	Analog section status is all 1's or all 0's (power down).
E-513	Serial EEPROM checksum error.
E-515	Laser Output must be off to change ranges.
E-516	Incorrect Configuration for Calibration Sequence to start.

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Table 5.5 Error Messages

Error Code	Explanation
E-517	Calibration for Laser Diode current must have the output on to start.
E-518	Calibration for the Monitor Diode must have the output on and the responsivity set to zero to start.
E-519	Setting a measurement is only valid during the calibration phase for that measurement. User has tried to calibrate a measurement without first entering the required calibration mode.
E-520	User cannot change the Laser Current set point while operating in a calibration mode for another measurement.

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