User's Guide

Laser Diode Test System

LTS-9300

ILX Lightwave

Photonic Test & Measurement Instrumentation

ILX Lightwave Corporation · P. O. Box 6310 · Bozeman, MT, U.S.A. 59771 · U.S. & Canada: 1-800-459-9459 · International Inquiries: 406-586-1244 · Fax 406-586-9405
E-mail: support@ilxlightwave.com

www.ilxlightwave.com

700369_12/03_PANASONIC

SAFETY AND WARRANTY INFORMATION

The Safety and Warranty Information section provides details about cautionary symbols used in the manual, safety markings used on the instrument, and information about the Warranty including Customer Service contact information.

Safety Information and the Manual

Throughout this manual, you will see the words *Caution* and *Warning* indicating potentially dangerous or hazardous situations which, if not avoided, could result in death, serious or minor injury, or damage to the product. Specifically:

CAUTION

Caution indicates a potentially hazardous situation which can result in minor or moderate injury or damage to the product or equipment.

WARNING

Warning indicates a potentially dangerous situation which can result in serious injury or death.

WARNING

Visible and/or invisible laser radiation. Avoid direct exposure to the beam.

General Safety Considerations

If any of the following conditions exist, or are even suspected, do not use the instrument until safe operation can be verified by trained service personnel:

- Visible damage
- Severe transport stress
- Prolonged storage under adverse conditions
- Failure to perform intended measurements or functions

If necessary, return the instrument to ILX Lightwave, or authorized local ILX Lightwave distributor, for service or repair to ensure that safety features are maintained (see the contact information on page v).

All instruments returned to ILX Lightwave are required to have a Return Authorization Number assigned by an official representative of ILX Lightwave Corporation. See Returning an Instrument on page iii for more information.

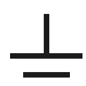
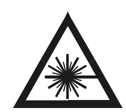
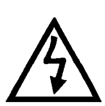
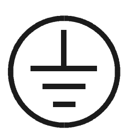
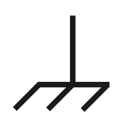
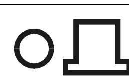
SAFETY SYMBOLS

This section describes the safety symbols and classifications. Technical specifications including electrical ratings and weight are included within the manual. See the Table of Contents to locate the specifications and other product information. The following classifications are standard across all ILX Lightwave products:

- Indoor use only
- Ordinary Protection: This product is NOT protected against the harmful ingress of moisture.
- Class I Equipment (grounded type)
- Mains supply voltage fluctuations are not to exceed ±10% of the nominal supply voltage.
- Pollution Degree II
- Installation (overvoltage) Category II for transient overvoltages
- Maximum Relative Humidity: <80% RH, non-condensing
- Operating temperature range of 0 °C to 40 °C
- Storage and transportation temperature of –40 °C to 70 °C
- Maximum altitude: 3000 m (9843 ft)
- This equipment is suitable for continuous operation.

Safety Marking Symbols

This section provides a description of the safety marking symbols that appear on the instrument. These symbols provide information about potentially dangerous situations which can result in death, injury, or damage to the instrument and other components.

 Caution, refer to manual	 Earth ground Terminal	 Alternating current	 Visible and/or invisible laser radiation
 Caution, risk of electric shock	 Protective Conductor Terminal	 Caution, hot surface	 Frame or chassis Terminal
 or (I) On: In position of a bistable push control. The slash (I) only denotes that mains are on.		 or (O) Off: Out position of a bistable push control. The circle (O) only denotes that mains are off.	

WARRANTY

ILX LIGHTWAVE CORPORATION warrants this instrument to be free from defects in material and workmanship for a period of one year from date of shipment. During the warranty period, ILX will repair or replace the unit, at our option, without charge.

Limitations

This warranty does not apply to fuses, lamps, defects caused by abuse, modifications, or to the use of the product for which it was not intended.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for any particular purpose. ILX Lightwave Corporation shall not be liable for any incidental, special, or consequential damages.

If a problem occurs, please contact ILX Lightwave Corporation with the instrument's serial number, and thoroughly describe the nature of the problem.

Returning an Instrument

If an instrument is to be shipped to ILX Lightwave for repair or service, be sure to:

1. Obtain a Return Authorization number (RA) from ILX Customer Service.
2. Attach a tag to the instrument identifying the owner and indicating the required service or repair. Include the instrument serial number from the rear panel of the instrument.
3. Attach the anti-static protective caps that were shipped with the instrument and place the instrument in a protective anti-static bag.
4. Place the instrument in the original packing container with at least 3 inches (7.5 cm) of compressible packaging material. **Shipping damage is not covered by this warranty.**
5. Secure the packing box with fiber reinforced strapping tape or metal bands.
6. Send the instrument, transportation pre-paid, to ILX Lightwave. Clearly write the return authorization number on the outside of the box and on the shipping paperwork. ILX Lightwave recommends you insure the shipment.

If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

Repairs are made and the instrument returned transportation pre-paid. Repairs are warranted for the remainder of the original warranty or for 90 days, whichever is greater.

Claims for Shipping Damage

When you receive the instrument, inspect it immediately for any damage or shortages on the packing list. If the instrument is damaged, file a claim with the carrier. The factory will supply you with a quotation for estimated costs of repair. You must negotiate and settle with the carrier for the amount of damage.

Comments, Suggestions, and Problems

To ensure that you get the most out of your ILX Lightwave product, we ask that you direct any product operation or service related questions or comments to ILX Lightwave Customer Support. You may contact us in whatever way is most convenient:

Phone . . . . (800) 459-9459 or (406) 586-1244

Fax . . . . (406) 586-9405

On the web at: . . . . www.ilxlightwave.com

Or mail to:
ILX Lightwave Corporation
P. O. Box 6310
Bozeman, Montana, U.S.A 59771

When you contact us, please have the following information:

Model Number: ______________________________

Serial Number: ______________________________

End-user Name: ______________________________

Company: ______________________________

Phone: ______________________________

Fax: ______________________________

Description of what is connected to the ILX Lightwave instrument: ______________________________

Description of the problem: ______________________________

If ILX Lightwave determines that a return to the factory is necessary, you are issued a Return Authorization (RA) number. Please mark this number on the outside of the shipping box.

You or your shipping service are responsible for any shipping damage when returning the instrument to ILX Lightwave; ILX recommends you insure the shipment. If the original shipping container is not available, place your instrument in a container with at least 3 inches (7.5 cm) of compressible packaging material on all sides.

Table of Contents

Chapter 2 System Software Reference

Chapter 4 GPIB Interface Guide

Chapter 5 Command Reference

Chapter 6 Troubleshooting

List of Figures

List of Tables

CHAPTER 1

INTRODUCTION AND SPECIFICATIONS

Chapter 1 is an introduction to the LTS-9300 Laser Diode Test System. It provides general information about the system and the manual.

WARNING

If any of the following symptoms exist, or are even suspected, remove the LTS-9300 from service. Do not use the LTS-9300 until safe operation can be verified by trained service personnel.

Visible damage

Severe transport stress

Prolonged storage under adverse conditions

Failure to perform intended measurements or functions

Potentially lethal voltages exist within the LTS-9300 Laser Diode Test System. To avoid electric shock, do not perform any maintenance on the system; only the drawers and rear panel are user-accessible. Do not attempt to remove the side-panels or other coverings.

Using Manual Conventions

The LTS-9300 User's Guide assumes you have working knowledge of basic computer operating conventions such as how to use a mouse and standard menus and commands. This manual uses the following conventions for presenting instructions and information:

- Commands that instruct usage of specific menu and screen items appear in bold. A forward arrow designates subsequent menu items or commands. For example: Select Setup>Enable Drawer (or, alternatively, select Edit and click Enable Drawer).
- The action words choose, select, double-click, and click are used as Windows® standard commands.
- Screen graphics are used throughout this manual to assist in visually confirming the software is appearing and acting as it should based on textual information. Screen illustrations appear the same regardless of what version of Windows® is used (Windows® 95, 98, ME, 2000, XP).

Overview

The LTS-9300 Laser Diode Test System is a laser diode lifetest and burn-in system. The system consists of power supplies, communication processors, DUT (device under test) drawer/electronics bays, and thermal management.

Two temperature-controlled drawers accommodate up to sixteen, 14-pin butterfly laser packages each.

Two temperature-controlled drawers accommodate up to sixteen, 2-pin OFP laser packages each.

The base system is highly configurable and up to 5 amps of laser drive current is available for butterfly device and 10 Amps for the OFP device depending on the system configuration.

Installation Requirements

This section provides information about the requirements to install the LTS-9300.

Grounding Requirements

The LTS-9300 comes with a five-conductor AC power cable. The power cord connector and power cable meet IEC safety standards. The power cable must be plugged into an approved five-contact electrical outlet, connector type L21-30.

WARNING

The system must be connected to properly earth-grounded receptacles.

AC Line Power Requirements

You can operate the mainframe from a three-phase power source delivering line voltages of 208 VAC. The system must be connected to properly earth-grounded receptacles using the L21-30 AC cable.

GPIB Connector

A total of 15 devices can be connected together on the same GPIB interface bus. The 24-pin GPIB interface connector is tapered to ensure proper orientation. Finger tighten the two screws on the cable connector.

The maximum length of the GPIB cables must not exceed 20 meters (65 feet) total, or 2 meters (6.5 feet) per device.

GPIB Address

The talk and listen addresses on the LTS-9300 are identical. The LTS-9300 comes from the factory configured with the GPIB address set to 1. You can change the GPIB address locally (via the front panel). The procedure for changing the address is found in *Reading and Changing the GPIB Address* on page *68*.

System Architecture Overview

The LTS-9300 Laser Diode Test System is a laser diode lifetest and burn-in system. The system consists of power supplies, communication processors, DUT drawer/electronics bays, and thermal management.

Refer to Chapter 3, *System Configuration and Operation* for operating fundamentals of the LTS-9300.

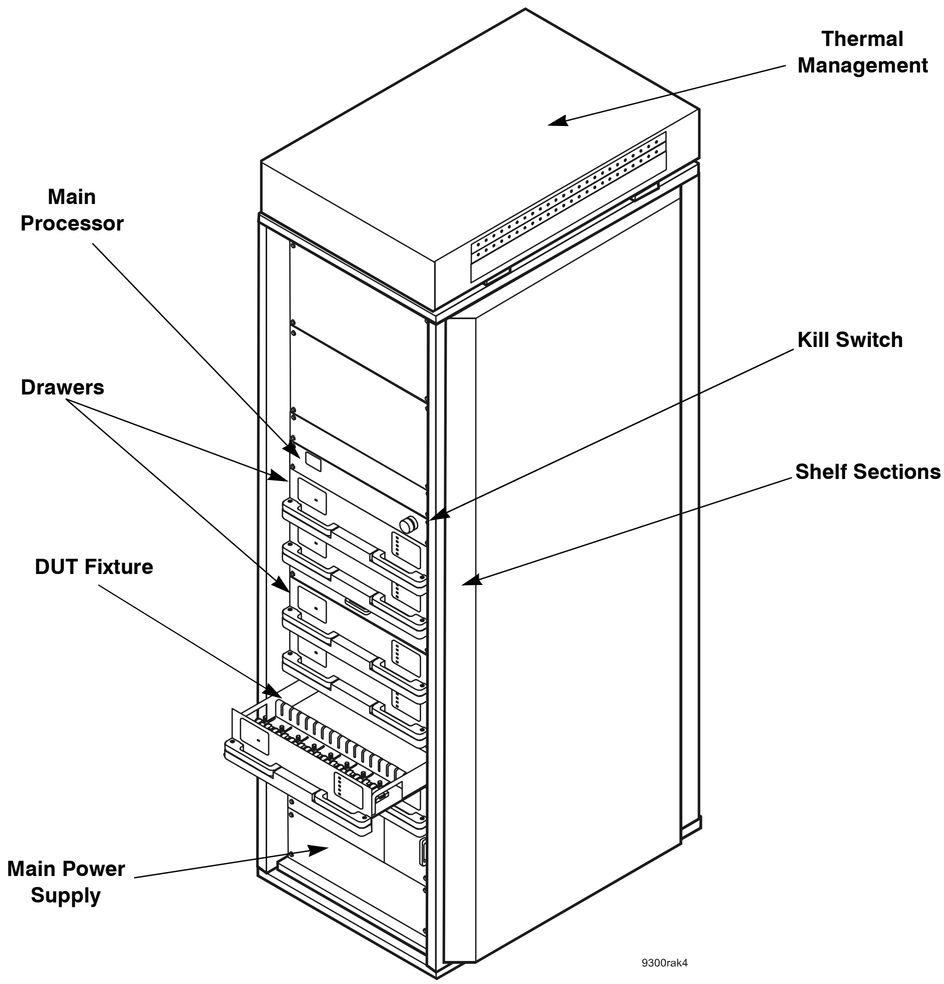


Figure 1.1 System Overview

Mainframe

The LTS-9300 mainframe contains the main processor, which acts as the interface to the user through the General Purpose Interface Bus (GPIB) and communicates with each shelf processor.

Front Panel

The LTS-9300 mainframe front panel has a power indicator and GPIB address indicator with a select button (see *GPIB Address* on page *3*). Each drawer has power, output, and status indicators as well as an enable key.

Emergency Shut-off Switch

A red emergency shut off button is located on the front panel. Pressing the emergency shut-off switch trips the main circuit breaker and immediately removes all power within the test system.

Main Power Supply

The main power supply consists of 208 VAC to 48VDC power converters. These reside in 2-U high sections. The number of power supplies depends on the total power requirements of the rack, the range of case temperature control required, and the drive ratings of the internal Peltier devices in the DUTs.

System PC

The system PC is provided as a desktop version only.

Thermal Management

The uppermost section of the test system contains two pair of centrifugal fans. One pair pressurizes one side of the rack, the other exhausts on the opposite side.

The shelf electronics sections each have a pair of axial fans to blow ambient air across the electronics and the UPS. These fans draw air from the pressurized side of the test system.

Shelves

The LTS-9300 has up to four shelves. *Shelf* is used to describe a complete assembly including the slide-out drawer where the DUTs are installed for testing, the shelf processor that handles the current source, internal TEC (ITC), case temperature (CTC), and power meter control as well as communication with the mainframe. Each shelf has its own processor, laser board, case TEC board, internal TEC board, and power supply.

The drawers configured for OFF devices have an additional current source and not ITC.

Case Temperature Controller

The case temperature controller (CTC) controls the temperature of the DUT space inside the drawer. Each shelf contains a CTC; a four-channel DSP controlled, PWM temperature controller. The case temperature control board has four separate outputs that drive four independent Peltier or resistive heaters within the drawer. Each zone has a calibrated feedback sensor to ensure the temperature is stable and consistent from DUT to DUT and zone to zone.

For chip on carrier (COC) or 14-pin butterfly devices, the Peltier devices control the temperature of an aluminum slug to which the DUTs are mounted. The drawer contains four plates, each with four slugs, to control the case temperature of the DUTs.

Current Source

The LTS-9300 provides enough slots to support four current source boards per drawer. Four boards are required to independently adjust 16 DUT current setpoints. Each current source board has four independent outputs and is optimized for a range of currents.

Internal Temperature Control

Up to four, four-channel DSP controlled, PWM temperature controller cards are accommodated by each shelf to provide a total of 16 channels. Thermistor Steinhart-Hart calibration variables can be entered into the system through the user interface.

Drawers

The LTS-9300 can have up to four drawers. Each drawer contains case temperature control TECs, fiber handling, measurement devices, and a removable DUT fixture.

DUT Fixtures

The DUT fixture is a removable assembly that allows you to load DUTs away from the LTS-9300. The DUT fixture contains DUT mounts, fiber management, measurement devices, and fiber connectors. For information about loading the DUT fixture see *Loading the Drawer* on page *40*.

The LTS-9300 accommodates 14-pin butterfly fixturing. Other packages such as DIL, Mini-DIL, Chip-on-carrier and OFP can be accommodated.

Monitor Photodiode Measurement

Each Back Facet Monitor Diode (BFMD) has a dedicated circuit. A –10 V bias is provided to each BFMD.

Light Power Measurement

The LTS-9300 supports relative light power measurements with individual detectors. Relative accuracy measurement is designed to look for changes in power output over time during the burn-in process.

Power measurement also allows monitoring of the tracking between output power and monitor diode current during burn-in.

Specifications

WARNING

Potentially lethal voltages exist within the LTS-9300 Laser Diode Test System. To avoid electric shock, do not perform any maintenance on the system; only the drawers and rear panel are user-accessible. Do not attempt to remove the side-panels or other coverings.

ILX Lightwave service personnel are required to wear protective eye wear and anti-static wrist bands while working on the LTS-9300 Laser Diode Test System. High voltage three-phase power is present at the power entry panel and in the lower part of the system. High voltage is delivered to the main power supply in the upper part of the system. Elsewhere in the system, the maximum voltage present is 48 VDC.

Table 1.1 Current Source Specifications

Specification[1]	**Butterfly**	**OFP**
Current Output (5 Amp Board)		
Output Current Range:	0 mA to 5000 mA	0 - 10 A
Set-Point Resolution:	1 mA	1 mA
Set-Point Accuracy: (% of FS)	±0.1%	±.05 %
Noise/Ripple:[4]	±0.5 mA +1% of reading	±0.5 mA +1% of reading
Compliance Voltage (Min):	3 V (non-adjustable)	2.8 V (non-adjustable)
Temperature Coefficient:	≤500 ppm/°C	≤500 ppm/°C
Short-Term Stability (1 hr):[2]	≤500 ppm	≤500 ppm
Long-Term Stability (24 hr):[3]	≤500 ppm	≤500 ppm
Current Measurement		
Current Measurement:	0 mA to 5000 mA	0 mA to 5000 mA
Resolution:	0.6 mA	0.6 mA
Accuracy:[4]	±0.5 mA +1% of reading	±0.5 mA +1% of reading

1. All values relate to a one-hour warm-up period.
2. Over any 1-hour period, half-scale output.
3. Over any 24-hour period, half-scale output.
4. +/- (fixed error +% of true value)

Table 1.2 Case Temperature Controller Specifications

Specification	Description
Control	
Temperature Control Range:	At least 25-80 °C Butterfly 25 - 85 °C OFP*
Temperature Control Accuracy:	±2 °C from setpoint at each laser seat with no laser thermal load after equalization
Set Point Resolution: (20 °C - 60 °C)	0.1 °C
Short Term Stability (1 hr.):	<0.5 °C
Long Term Stability (24 hrs.):	<0.5 °C
Number of Outputs:	4 per drawer (supports 4 independently controlled fixtures)
Maximum Heating Power:	50 Watts per output
Control Algorithm:	PID loop, implemented via digital signal processor (DSP)
Measurement	
Temperature Measurement range:	15-95 °C
Temperature Measurement resolution:	0.1 °C
Temperature Measurement accuracy:	±0.5 °C
Temperature Variability across DUTs:	+/–2 °C
Repeatability/Reproducibility	±0.2 °C

* See temperature control vs. power dissipated plot; see ΔT plot for determining case set point temperature

Table 1.3 Internal Temperature Controller Specifications

Specification	Description
Control	
Set Point Range:	At least 20-85 °C
Set Point Accuracy:	±2 °C
Set Point Resolution:	0.1 °C
Short Term Stability (1 hr.):	<0.5 °C
Long Term Stability (24 hrs.):	<0.5 °C
Number of Outputs:	16 per drawer
Current Range:	0-5000 mA
Compliance voltage:	At least 7 Volts (Non adjustable)
Control Algorithm:	PID loop, implemented via DSP
Measurement	
Temperature Measurement Range:	15-95 °C
Temperature Measurement Resolution:	0.1 °C

Table 1.3 Internal Temperature Controller Specifications

Specification	Description
Temperature measurement accuracy:	±0.5 °C
Repeatability/Reproducibility	±0.2 °C

Table 1.4 Power Meter Specifications

Specification	Butterfly	OFP
Photodetector current range[1]	0-5000 µA	0-5000 µA
Light power range	3 mW to 3000 mW	5 mW to 5000 mW
Linearity[2]	+/-0.10 dB	+/-0.10 dB
Resolution	14-bit	14-bit
Wavelength Range	400 to 1050 nm	400 to 1050 nm
Short-term repeatability	1% of FS (full scale)	1% of FS (full scale)
Monitor Diode		
Photodetector current range	0-5000 µA	NA
Resolution	14-bit	NA
Short-term repeatability	1% of FS	NA
Photodetector bias voltage	0 VDC or –10 VDC +/-10%	NA

1. Maximum output current for linear photodetector operation is nominally 2000 uA
2. Tested over a photodetector current range of 500 uA to 1600 uA

Table 1.5 General Specifications

Specification	Description
Electrical	208 VAC, three phase, ~20 amps/phase, L21-30P NEMA plug
Clearance requirements:	
Vertical	2 ft (61 cm)
Side	none
Environmental	
Operating Temperature	10 °C to 30 °C
Storage Temperature	–20 °C to 50 °C
Operating Humidity	<80% RH, non condensing
Storage Humidity	<90% RH, non conducting
General	
Size (H x W x D)	78.7" x 23.6" x 35.4" (200 cm x 60 cm x 90 cm)
Weight, not loaded	approximately 600 lbs (270 kg)

CHAPTER 2

SYSTEM SOFTWARE REFERENCE

The System Software chapter provides general information about the LTS-9300 software. Use this chapter as a reference for all the views, dialog boxes, and fields that make up the system software. The System Software chapter is organized by view, starting with the System View. Dialogs that are available in any view are listed under the System View.

System Software Overview

The LTS-9300 system software allows you to fully configure, run, record, and control burn-in and life tests using a standard PC with a simple Windows® based user interface. This starter code software is intended for performing basic life-test/burn-in testing, for verifying system functions and acceptance, troubleshooting, and providing the tools necessary to develop software based on individual needs.

Three main views allow you to control the system: the System, Drawer, and DUT views. The System View window is the main system view and allows you to see the status of all the DUTs loaded into the system. The Drawer View window displays information about DUTs in a specific drawer. The DUT View window is used to graphically view information about individual DUTs.

The system software allows you to load whole system or DUT configurations (see *Configuring the System* on page *46*).

Data recording parameters are set using the Data Recording dialog box.

If the system software experiences a catastrophic failure, contact ILX Customer Service immediately. ILX recommends you keep all system disks with the system for licensing information.

Starting the LTS-9300 System Software

Double click the LTS-9300 shortcut on the desktop or click **Start>Programs>LTS-9300>LTS-9300** to launch the System Software.

Views Overview

The system software has three modes of operation or *views*. The System View window is the main system view and allows you to see the status of all the DUTs in the system. The Drawer View window displays information about DUTs in a specific drawer. The DUT View window is used to graphically view information about individual DUTs.

The Extended View (Ctrl+Alt+E) displays register contents, script information, UPS information, and a history of commands sent to the instrument. Also access the Extended View from the View menu.

Navigating the Views

The software defaults to the System View at startup. Double clicking any of the drawers opens the Drawer View. The Drawer View is also accessible by clicking the Drawer View icon on the Navigation bar. In Drawer view, click an individual DUT to go to the DUT view, or click the DUT view icon on the navigation bar. Each view has different icons available; see each view section for information about available navigation bar icons.

Command Logging

Available in all of the views, command logging is a useful communications bus debugging and troubleshooting tool that records all GPIB bus traffic to and from the system.

Enabling Command Logging (Ctrl+Alt+L) generates log files that are stored in the \Bin directory. Only use Command Logging when troubleshooting the LTS-9300 system when requested user actions through the software are failing. Enable Command Logging and perform the action or actions that caused the failure, then disable Command Logging to avoid filling disk storage capacity.

Once the command actions are captured to log file, compress all of the log files in the Bin directory and e-mail them to ILX Customer Support (see page *v* for contact information) for a careful analysis of the files.

Scripts

The system software supports an editable, text-based script file that runs groups of commands that direct the system to turn on or off and change set-points and other values. The script provides one-hour resolution, which allows the software to direct new system commands every 60 minutes.

The script is named *AllRun.script* and it must reside in the Config directory (C:\LTS-9300\config). If you edit or create a script, the new or modified script must also be named AllRun.script and reside in C:\LTS-9300\config in order to run.

Script files use a standard INI file format for simplicity and ease of use with several editors such as Notepad®, Wordpad®, Edit®, and Emacs®.

System View

The System View window is the main system view. It allows you to quickly view the status of all the drawers and devices under test (DUTs) in the LTS-9300 system. Individual drawer (case) temperature can be controlled from the System View as well. Drawers are enabled and disabled from the System View on the Setup menu or by right-clicking a drawer.

The drawer's position in the system, a graph displaying the drawer's average case temperature measurements, the latest average case temperature measurement, a checkbox to turn on or off the case temperature controller, and a text box field to enter a new set point for the case temperature controller are displayed on the System View.

Configurable colored circles indicate the DUT status. Different colors indicate the quality of light power from a DUT.

Access the System View window by clicking the System View icon from the Navigation Bar or selecting System View from the View menu.

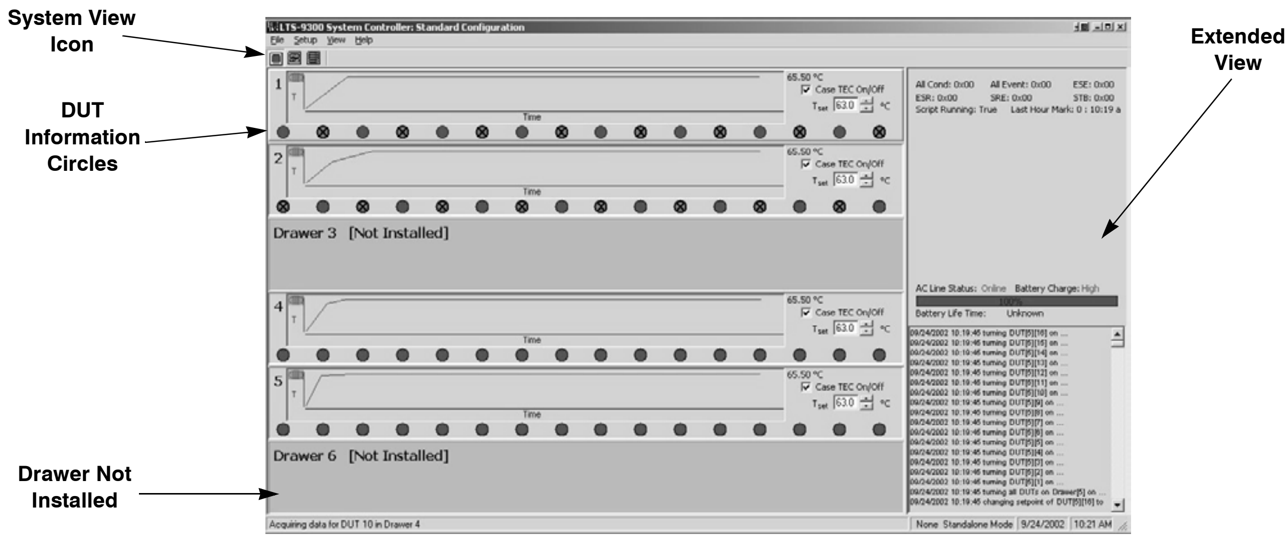


Figure 2.1 System View Window

Table 2.1 System View Window Components

Field Name	Description
DUT information circles	Each circle represents a DUT in the drawer. The color of the sphere indicates a configurable operating range (see *DUT Properties Dialog* on page *32*). A green sphere indicates a DUT that is operating within its configured light power range, an amber sphere indicates a DUT that is outside of the optimal operating light power range, and a red sphere indicates a DUT that is outside its operating light power range.
Case TEC graph	Allows you to view case temperature as a function of time. The case temperature is displayed above the Case TEC On/Off toggle
Case TEC On/Off toggle and Temperature Set field	Use the Case TEC On/Off toggle to turn on the CTC and set the desired case temperature for each drawer.
Extended View information	The Extended View displays register contents, script information, UPS information, and a history of commands sent to the instrument.

System View Icons and Hot Keys

In System View, three menu icons are available that allow you to quickly jump to another view.

Hot keys are provided for performing tasks that would otherwise require mouse clicks in two or more places. The tab key is also utilized to allow tabbing among various input controls within the view. .

Table 2.2 System View Icons

Icon		Description
	System View Icon	Displays the System View window
	Drawer View Icon	Displays the Drawer View window
	DUT View Icon	Displays the DUT View window

Table 2.3 System View Hot Keys

Hot Key	Function	Description
Ctrl+Alt+L	Command logging	Available in all of the views, command logging is a useful communications bus debugging tool that records all GPIB bus traffic to and from the system. Log files are generated and stored in the \Bin directories.
Ctrl+Alt+E	Display extended information	Displays extended information in the views including register contents, script information, and UPS information, and a history of commands sent to the system.
Ctrl+Alt+S	Starting and stopping scripts	Starts and stops the execution of the AllRun.script file. See *Scripts* on page *13* for information about running a script file.

System View Menu Descriptions

Each of the three System View windows have the same menu bar selections available: File, Setup, View, and Help.

Table 2.4 System View Menu Descriptions

Menu Item	Description
File>Exit	Used for exiting the software.
Setup	
Communications	Opens the Select an LTS-9300 dialog box. This item is available only in System view (see *Select an LTS-9300 Dialog Box* on page *16*).
Load System configuration	Opens the Select a new System Configuration dialog box (see *Select a New System Configuration Dialog* on page *17*).
LIV Option	Opens the LIV Option dialog box. Use the LIV Option dialog box to configure and run the Light (L), Current (I), and Voltage (V) sweep (see *LIV Option Dialog* on page *23*).
Data Recording	Opens the Data Recording dialog box. This item is available only in System view (see *Data Recording Dialog* on page *24*)
Disable/Enable Drawer	Disables the selected drawer. Enabling and disabling drawers is also possible by right-clicking on the drawer and selecting Enable/Disable Drawer. This item is available only in System view.
View	
Drawer View	Changes window to Drawer View.
DUT View	Changes window to DUT View.
Extended View	Displays extended information in the views including register contents, script information, and UPS information, and a history of commands sent to the system.
Help>About	Displays information about the software.

Select an LTS-9300 Dialog Box

Selecting Setup>Communications opens the Select an LTS-9300 dialog box. Use the Select an LTS-9300 dialog box to connect to the system. This dialog only needs to be opened once. Once opened, the system automatically looks for the previously selected LTS-9300.

Select a New System Configuration Dialog

The Select a new System Configuration dialog allows you to browse and open a system configuration file. System configuration files are located in the Config directory (C:\LTS-9300\config). Configuration files stored outside of the Config directory may cause unexpected results.

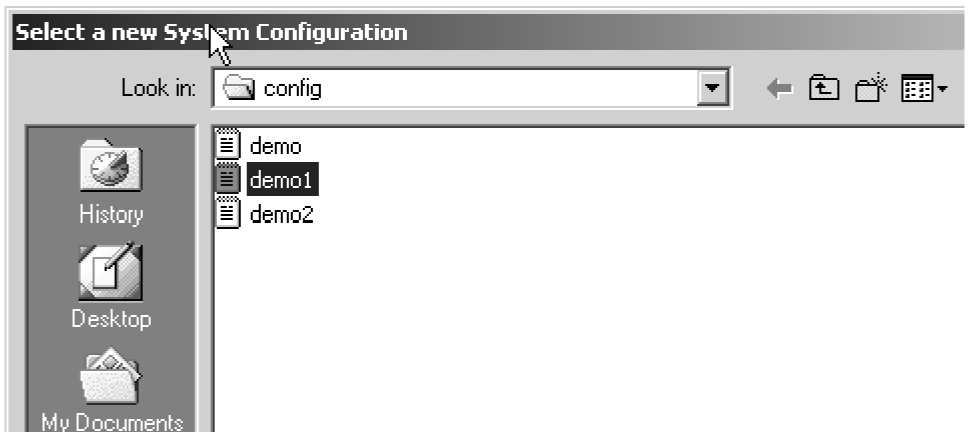


Figure 2.2 Select a new System Configuration Dialog

System Configuration Dialog

The System Configuration Dialog allows you to configure the system, drawer, and DUT from a single dialog box. Each configurable level is represented with a tab: System, Drawer, and DUT. Each level of the system is stored in its own file: System (*filename*.ssm), Drawer (*filename*.drw), and DUT (*filename*.dut). In addition, CTC and ITC are configured and stored in files. All files use a standard INI file format for simplicity and ease of use with several editors such as Notepad®, Wordpad®, Edit®, and Emacs®. Select each tab to configure each part of the LTS-9300.

System Tab

The System tab is used to indicate and configure the type and number of drawers within the LTS-9300, as well as configuring UPS support. Clicking **Save this configuration** creates a system file (*filename*.ssm) that is saved to C:\LTS-9300\config.

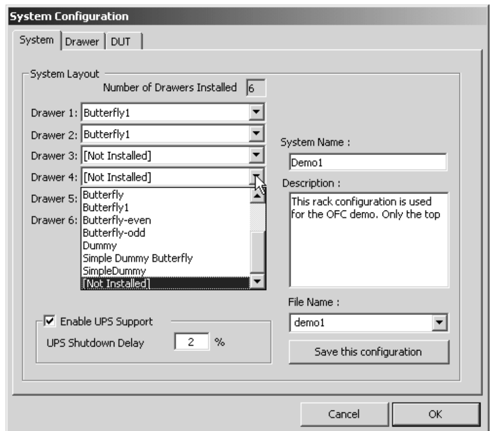


Figure 2.3 System Configuration Dialog; System Tab

Table 2.5 System Tab Components, System Configuration Dialog

Field Name	Description
Number of Drawers Installed	Indicates the number of installed drawers.
Drawer drop down lists	Allows you to select a drawer configuration for the selected drawer. The drawer is configured using the Drawer Tab. See *Drawer Tab* on page *19* and *Configuring the Drawers* on page *48* for information about drawer set-up.
Enable UPS Support check box	Click the Enable UPS Support check box to activate the uninterruptible power supply (UPS).
UPS Shutdown Delay	Allows you to enter the percentage of remaining battery power, upon UPS activation, at which all configurations, set points, and constants are saved, and the PC is shut down.
System Name	Allows you to enter or select a descriptive name for a system configuration.
File Name drop down	Allows you to enter or select a descriptive name for a system configuration.
Description	The description field allows you to view and enter a description of the current system.
Save this Configuration button	Saves the current configuration (*filename*.ssm) to C:\LTS-9300\config.

Table 2.5 System Tab Components, System Configuration Dialog

Field Name	Description
OK button	Applies any changes to the selected system and closes the dialog box. Changes are saved only with the Save this configuration button.
Cancel button	Closes the System Configuration dialog and cancels any pending changes.

Drawer Tab

The Drawer tab on the System Configuration dialog is used to configure each drawer and its parameters, as well as configure each of the DUTs in their perspective zones. Each zone represents a case TEC control loop and their parameters are specified with the Zone Types button.

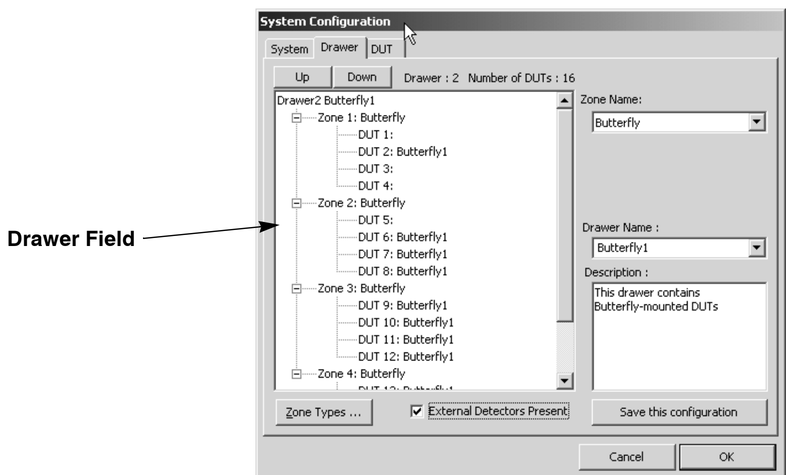


Figure 2.4 System Configuration Dialog; Drawer Tab

Table 2.6 Drawer Tab Components, System Configuration Dialog

Field Name	Description
Up/Down buttons	Selects the drawer.
Drawer field	Allows you to select and configure each zone or DUT within a drawer.
Zone Types button	Opens the Case TEC Properties dialog. See *Case TEC Properties Dialog* on page *22* for information about configuring the CTC.
External Detectors Present check box	Click the External Detectors Present check box to enable a front facet measurement system.
Zone Name/DUT Name drop down	Allows you to enter or select a descriptive name for a zone or DUT configuration. This fields alternates between Zone Name and DUT Name depending if a zone or DUT is selected in the Drawer field.
Drawer Name drop down	Allows you to enter or select a descriptive name for the drawer.
Description	The description field allows you to view and enter a description of the drawer.

Table 2.6 Drawer Tab Components, System Configuration Dialog

Field Name	Description
Save this Configuration button	Saves the drawer configuration file (*filename*.dwr) to C:\LTS-9300\config.
OK button	Applies any changes to the selected drawer and closes the dialog box. Changes are saved only with the Save this configuration button.
Cancel button	Closes the System Configuration dialog and cancels any pending changes.

DUT Tab

The DUT tab on the System Configuration dialog is used to configure each DUT and its parameters. The package type, internal TEC (see *TEC Properties Dialog* on page *34* for information about configuring the ITC), internal monitor photodiode, and operating parameters are defined with the DUT tab. The measurement ranges and corresponding indicator color are configured using the DUT Properties dialog (see *DUT information circles* on page *14*).

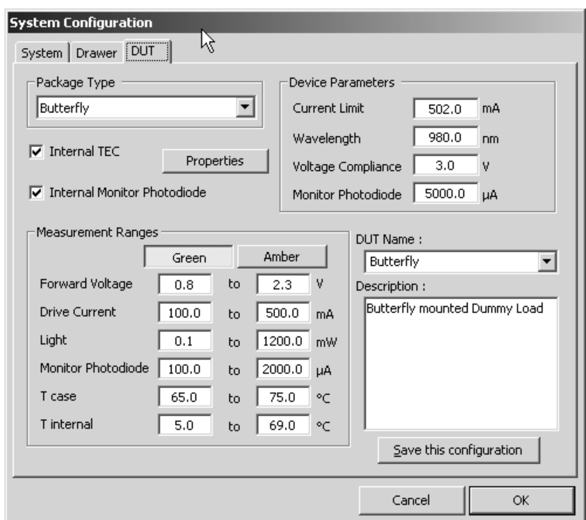


Figure 2.5 System Configuration Dialog; DUT Tab

Table 2.7 DUT Tab Components, System Configuration Dialog

Field Name	Description
Package Type	A drop down list of available laser package configurations.
Internal TEC check box	Check the Internal TEC box if the laser package includes internal temperature control. The Properties button is activated when the Internal TEC is checked. See *TEC Properties Dialog* on page *34* for information about configuring the internal TEC properties.
Internal Monitor Photodiode check box	Indicates if a laser package has an internal monitor photodiode.
Parameters Current Limit Wavelength Voltage Compliance Ipd	The parameters section allows you to configure the maximum current in mA, wavelength in nm, voltage compliance in V, and monitor photodiode current in µA for the selected laser package.
Measurement Ranges Green and Amber buttons Forward Voltage Drive Current Light Ipd T internal	The Measurement Ranges section allows you to configure the color coded indicators seen on the various windows. Clicking the Green button and entering the optimal desired operating ranges displays as green on the System and Drawer View windows when the DUT is operating at optimal levels. Clicking the Amber button allows you to configure a range that is non-optimal, but within safe limits for the DUT. Any operating range outside of the amber setting displays as red on the System and Drawer View windows. Forward voltage in V, drive current in mA, light power in W, monitor photodiode current in µA, and internal temperature ranges in °C are configurable.
DUT Name drop down	Allows you to enter or select a descriptive name for a DUT.
Description	The description field allows you to view and enter a description of the DUT.
Save this configuration button	Saves the current configuration (*filename*.dut) to C:\LTS-9300\config.
OK button	Applies any changes to the selected DUT and closes the dialog box. Changes are saved only with the Save this configuration button.
Cancel button	Closes the DUT Properties dialog and cancels any pending changes.

Case TEC Properties Dialog

The Case TEC Properties dialog box allows you to configure Case TEC (CTC) or zone properties and the operating ranges for the CTC including the PID, Sensor constants, and temperature limits.

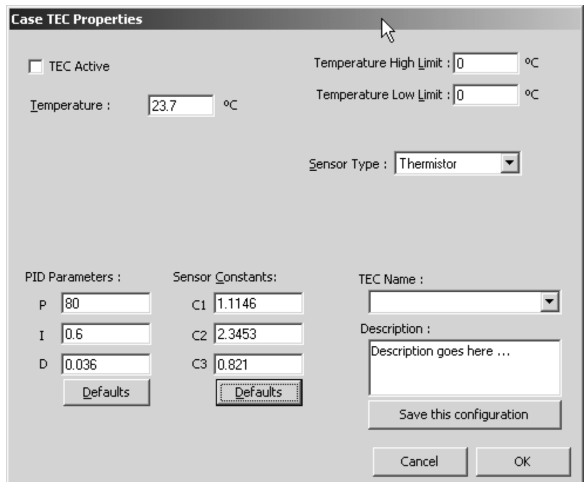


Figure 2.6 Case TEC Properties Dialog

Table 2.8 Case TEC Properties Dialog Box Field Descriptions

Field Name	Description
TEC Active check box	Allows you to turn on/off the CTC.
Temperature set field	Used to set the case TEC temperature.
Temperature High Limit field Temperature Low Limit field	Used to set the temperature high and low limits in °C.
Sensor Type drop down list	Allows you to choose from configured temperature sensor types.
PID Parameters fields P I D	Used to set the Proportional term, Integral term, and Derivative term for temperature control. See *Setting PID* on page *64*.
Sensor Constants fields C1 C2 C3	Used to enter the Steinhart-Hart temperature sensor constants (see *Guidelines for CTC Operation* on page *61*. The system uses the Steinhart-Hart equation to convert a resistance to a temperature. The equation describes the nonlinear resistance-versus-temperature characteristics of typical thermistors. Calibrating a thermistor consists of measuring its resistance at various temperatures, and fitting these measured data to the Steinhart-Hart equation. The resulting coefficients C1, C2, and C3 effectively describe the thermistor. More information about the Steinhart-Hart equation is contained in ILX Application Note #4. Contact ILX Customer Service (see page *v* for contact information) or go to www.ilxlightwave.com/library/index.html.

Table 2.8 Case TEC Properties Dialog Box Field Descriptions

Field Name	Description
Save this Configuration button	Saves the current configuration file (*CTC name*.ZON) to C:\LTS-9300\config.
OK button	Applies any changes to the selected CTC and closes the dialog box. Changes are saved only with the Save this configuration button.
Cancel button	Closes the Case TEC Properties dialog and cancels any pending changes.

LIV Option Dialog

Use the LIV Option dialog box, accessed from the Setup menu, to configure and run the light (L), current (I), and voltage (V) sweep used to characterize a laser's performance. An LIV sweep steps laser drive current from a start current to an end current. At each step, light power L (or more specifically, light detector current), laser diode current I, and laser diode voltage is recorded.

The sweep results in a data file that allows you to plot a graph relating the light, current, and voltage of a laser diode. Once an LIV sweep is run, the data file is placed in the file C:\LTS-9300\Results\ and is identified by the drawer and DUT (for example, C:\LTS-9300\Results\LIV_Drawer1_DUT1.log). The graph provides information about laser performance. See *Running an LIV Sweep* on page *56* for information about performing an LIV sweep.

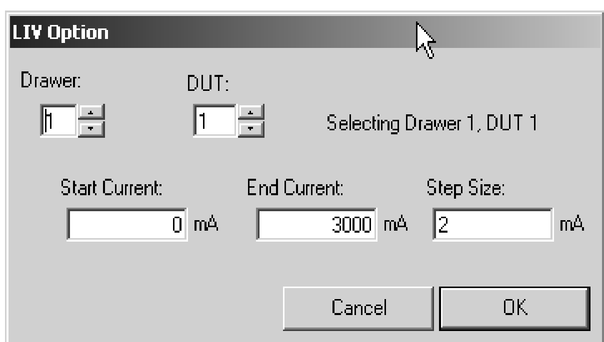


Figure 2.7 LIV Option Dialog

Table 2.9 LIV Option Dialog Box Components

Field Name	Description
Drawer	Use the drawer button to select the drawer containing the desired DUT for analysis.
DUT	Allows you to select which DUT is tested. Click the arrow buttons or enter the desired DUT number.
Start Current	Use the Start Current field to define the starting current for the LIV sweep. The current capabilities of the DUT determine the start current and end current limits.
End Current	Allows you to enter the final current value at the end of the LIV sweep. The current capabilities of the DUT determine the start current and end current limits.
Step Size	Allows you to select the current step size. At each step, a light, current, and voltage measurement is taken. Fewer steps take less time, but result in less precision. Conversely, smaller steps provide more data points, but require more time to complete the sweep. Each step takes approximately 3.50-3.60 seconds.
OK button	Saves the current configuration and starts the LIV sweep.
Cancel button	Closes the LIV Option dialog and cancels any pending changes.

Data Recording Dialog

Use the Data Recording dialog to specify the file name, delimiter type, and storage interval for data recording. Access the Data Recording dialog from the Setup menu, from any view.

The log file resides in a user-selected directory. The log file is a text file whose delimiter is selected by the user. The file can be opened by Notepad, Wordpad, Excel, or other similar programs. The log files can grow rapidly, commonly up to 1.5 MB per day, and can grow more rapidly when more data for DUT serial number, model number, and batch number are stored.

Figure 2.8 Data Recording Dialog

Table 2.10 Data Recording Dialog Components

Field Name	Description
Interval	Type the desired timing interval, in minutes, in the interval field. Once data recording has begun, each DUT appends its data to the named file for each interval. If the file does not exist, it is created and given a header to tell the reader what each column represents.
File Name	Displays the name of the data file. The data file must be selected on a mapped drive. UNC (Universal Naming Conventionality network path names are not supported. The file created is a text file that is read using Microsoft® Word® and/or Excel®.
Delimiter	Allows you to choose the delimiter between datum of information within the data file.
Clean File, Begin/Stop Now, and Close buttons	The Clean File button removes the data file. The Begin Now or Stop Now button initiates or stops data recording, The Close button saves any changes and closes Data Recording Dialog.

Drawer View

The Drawer View window is used to get detailed information about DUTs in a specific drawer. For each DUT in a drawer, the color coded numeric values for the measurements are displayed. The drawer temperature, by zone or as an average drawer temperature, is also shown.

The case temperature control settings for each drawer are configured with the Drawer View Window. Constant power and constant currents modes are selected and set using this window, which also allows you to set all DUTs to the same drive current.

Access the Drawer View window by clicking the Drawer View icon on the menu, select Drawer View from the View menu, or double click the drawer in System view.

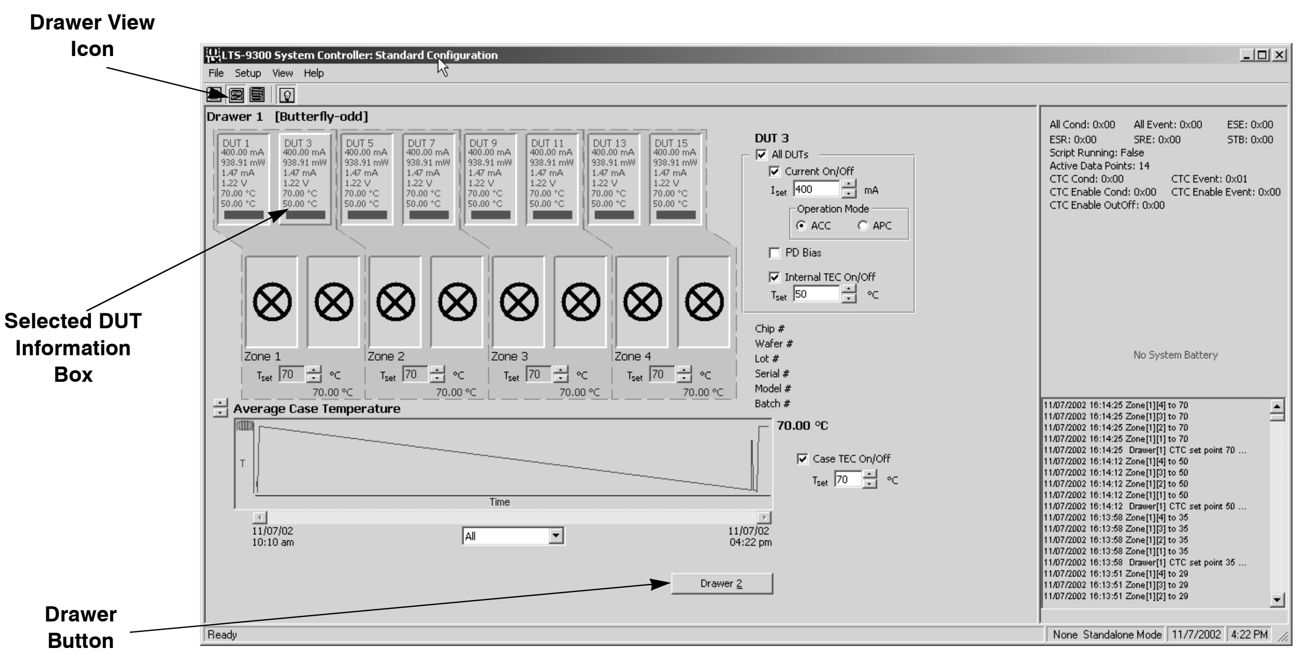


Figure 2.9 Drawer View Window

Table 2.11 Drawer View Window Components

Component	Description
Drawer buttons	Use the Drawer buttons to view different drawers.
DUT information boxes	Each DUT information box provides general information about the DUTs in the drawer. The color of each line of information indicates if it is within its operating light power range (see *DUT Properties Dialog* on page *32*). The selected DUT has a raised box; selecting the DUT allows you to turn on the current source and specify DUT information for that specific DUT.
All DUTs check box	The All DUTs check box allows you to apply current to all the DUTs in the displayed drawer.
Current On/Off check box	Use to turn on current to a selected DUT, or to all DUTs when the All DUTs check box is checked.
Current (I_{set})/Monitor Diode (Mdi_{set}) set field	Used to set the current in milli-amperes or monitor diode current in micro-amperes.
Operation Mode radio buttons	Click the radio button for the desired operation mode: ACC for constant current mode, or APC for monitor photodiode current mode.
PD Bias	Allows you to apply a 10 V reverse bias to the photodiode.
DUT Information	Information about the selected DUT is displayed. Double click the information to open the DUT Information/Serial Number dialog box (see *Serial Number Dialog* on page *32*).
Zonal Case Temperature Set fields	Allows you to set the temperature of individual zones within the drawer.
Case TEC graph	Allows you to view case temperature as a function of time.
Case Temperature Graph buttons	Use the case temperature graph buttons to view case TEC temperature graphs by zone or as an average temperature.
Time Scale drop down list	Allows you to change the time function of the Case TEC graph.
Case TEC On/Off toggle and Temperature Set field	Use the Case TEC On/Off toggle to turn on the CTC and set the desired case temperature for each drawer.

Drawer View Icons and Hot Keys

In System View, three menu icons are available that allow you to quickly jump to one of the other views.

Hot keys are provided for performing tasks that would otherwise require mouse clicks in two or more places. The tab key is also utilized to allow tabbing among various input controls within the view.

Table 2.12 Drawer View Icons

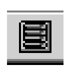
Icon		Description
	System View Icon	Displays the System View window
	Drawer View Icon	Displays the Drawer View window
	DUT View Icon	Displays the DUT View window
	Case TEC On/Off Icon	Turns on or off the Case TEC.

Table 2.13 Hot Keys

Hot Key	Function	Description
Ctrl+Alt+E	Display extended information	Displays extended information in the views including register contents, script information, and UPS information, and a history of commands sent to the system.
Ctrl+Alt+I	Display current/resistance measurements	Toggles the measurement for internal and case temperature control from current to resistance.
Ctrl+Alt+L	Command logging	Available in all of the views, command logging is a useful communications bus debugging tool that records all GPIB bus traffic to and from the system. Log files are generated and stored in the \Bin directories.
Ctrl+Alt+P	Display power measurements in current	Toggles between light power and photodiode current measurements.
Ctrl+Alt+S	Starting and stopping scripts	Starts and stops the execution of the AllRun.script file. See *Scripts* on page *13* for information about running a script file.

DUT View

Use the DUT View window to graphically view individual DUT information as a function of time and configure internal temperature controller support. Current (I), light power (L) or external photo detector current (Pdi), photodiode current (Ipd), voltage (V), and Temperature are displayed for the DUT.

Configure the DUT operation mode from the DUT View window: ACC for constant current mode, or APC for monitor photodiode current mode.

Access the DUT View window by clicking the DUT View icon on the menu, select DUT View from the View menu, or double click a DUT in Drawer view. DUT properties are accessed by double-clicking the DUT information box or clicking the DUT properties icon; in Drawer view, right-click the desired DUT and select **Properties**.

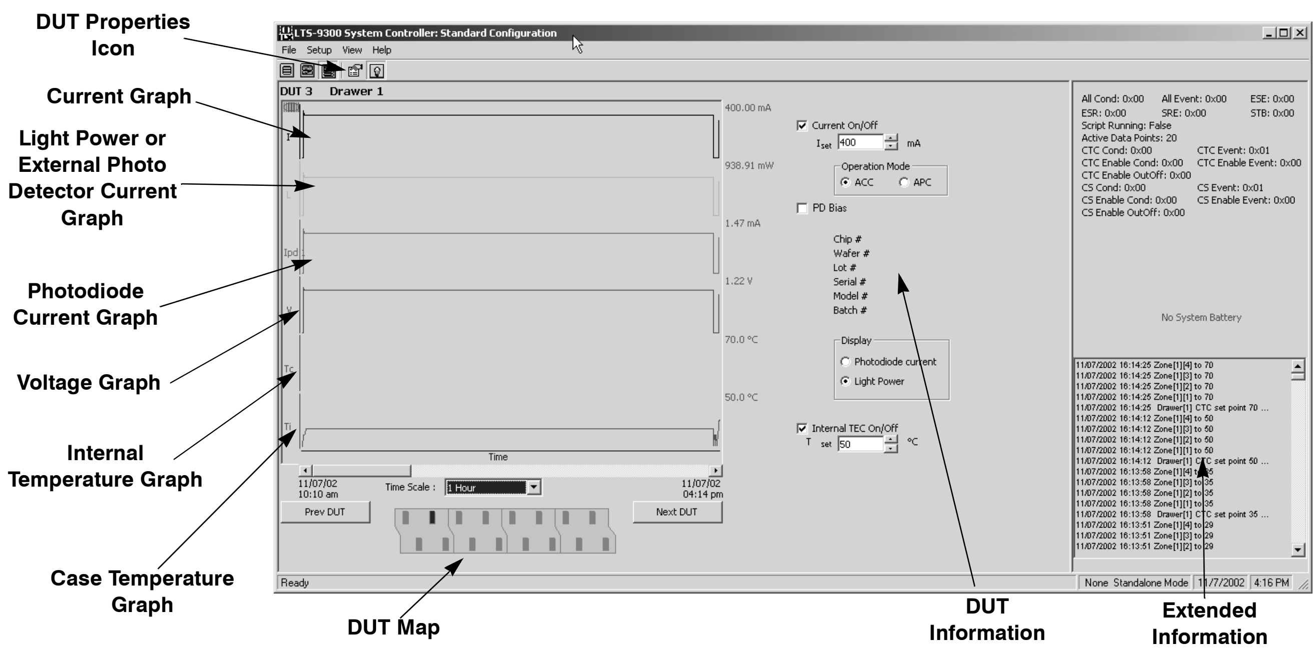


Figure 2.10 DUT View Window

Table 2.14 DUT View Window Components

Component	Description
Current (I) graph	Allows you to view current in amps as a function of time.
Light Power (L) or Photodiode Current (Pdi) graph	Allows you to view light power in Watts or photodiode current in amps as a function of time.
Photodiode Current (Ipd) graph	Allows you to view photodiode current in amps.
Voltage graph	Displays the voltage as a function of time.
Time Scale drop down list	Allows you to change the time function of the graphs.
Current On/Off toggle	Use to turn on current to the selected DUT.
Current (I_{set})/Monitor Diode (Mdi_{set}) set field	Used to set the current in amperes or monitor photodiode current in amperes.
Operation Mode radio buttons	Click the radio button for the desired operation mode: ACC for constant current mode, or APC for monitor photodiode current mode.
PD Bias	Allows you to apply a 10 V reverse bias to the photodiode.
DUT Information	Information about the selected DUT is displayed. Double click the information to open the Serial Number dialog box (see *Serial Number Dialog* on page *32*).
Display radio buttons	Allows you to switch between viewing light power or photodiode current on the graph.
DUT Map	Use to quickly identify the position in the drawer of the currently-displayed DUT.

DUT View Icons and Hot Keys

In System View, three menu icons are available that allow you to quickly jump to one of the other views. Hot keys are provided for performing tasks that would otherwise require mouse clicks in two or more places. The tab key is also utilized to allow tabbing among various input controls within the view..

Table 2.15 Dut View Icons

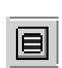
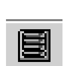
Icon	Description
 System View Icon	Displays the System View window
 Drawer View Icon	Displays the Drawer View window
 DUT View Icon	Displays the DUT View window

Table 2.15 Dut View Icons

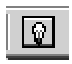
Icon		Description
	DUT Properties Icon	Opens the DUT Properties dialog box
	Current Source On/Off Icon	Turns on or off the current source

Table 2.16 Hot Keys

Hot Key	Function	Description
Ctrl+Alt+E	Display extended information	Displays extended information in the views including register contents, script information, and UPS information, and a history of commands sent to the system.
Ctrl+Alt+I	Display current/resistanc e measurements	Toggles the measurement for internal and case temperature control from current to resistance.
Ctrl+Alt+L	Command logging	Available in all of the views, command logging is a useful communications bus debugging tool that records all GPIB bus traffic to and from the system. Log files are generated and stored in the \Bin directories.
Ctrl+Alt+P	Display power measurements in current	Toggles between light power and photodiode current measurements.
Ctrl+Alt+S	Starting and stopping scripts	Starts and stops the execution of the AllRun.script file. See *Scripts* on page *13* for information about running a script file.

Serial Number Dialog

The Serial Number dialog allows you to record information about a specific DUT.

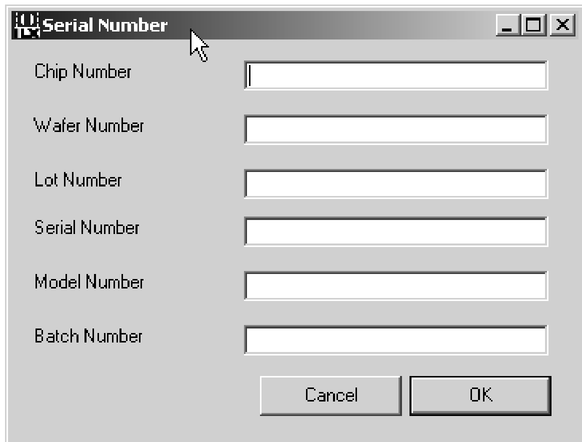


Figure 2.11 Serial Number Dialog Box

Table 2.17 Serial Number Field Descriptions

Field Name	Description
Chip Number	The user-defined chip number identifies each specific DUT being tested (not required).
Wafer Number	Used to indicate the wafer from which the chip was produced (user defined, not required).
Lot Number	User defined, not required
Serial Number	User defined, not required
Model Number	User defined, not required
Batch Number	User defined, not required

DUT Properties Dialog

The DUT Properties dialog box allows you to configure individual DUT properties and the operating ranges for the DUT. The package type, internal TEC (see *TEC Properties Dialog* on page *34* for information about configuring the ITC), internal monitor photodiode, and operating parameters are defined with the DUT Properties Dialog. The measurement ranges and corresponding indicator color is configured using the DUT Properties dialog.

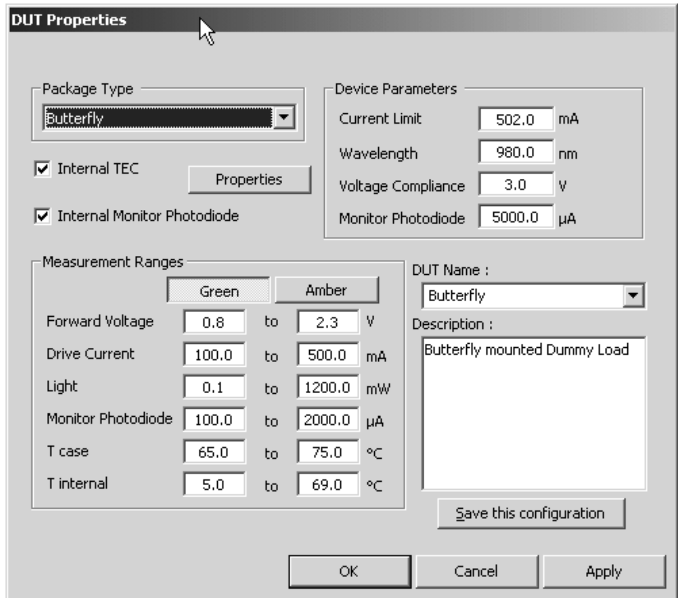


Figure 2.12 DUT Properties Dialog Box

Table 2.18 DUT Properties Dialog Field Descriptions

Field Name	Description
Package Type	A drop down list of available laser package configurations.
Internal TEC check box	Check the Internal TEC box if the laser package includes internal temperature control. The Properties button is activated when the Internal TEC is checked. See *TEC Properties Dialog* on page *34* for information about configuring the internal TEC properties.
Internal Monitor Photodiode check box	Indicates if a laser package has an internal monitor photodiode.
Parameters Current Limit Wavelength Voltage Compliance Ipd	The parameters section allows you to configure the maximum current in mA, wavelength in nm, voltage compliance in V, and maximum monitor photodiode current in µA for the selected laser package.
Measurement Ranges Green and Amber buttons Forward Voltage Drive Current Light Ipd T internal	The Measurement Ranges section allows you to configure the color coded indicators seen on the various windows. Clicking the Green button and entering the optimal desired operating ranges displays as green on the System and Drawer View windows when the DUT is operating at optimal levels. Clicking the Amber button allows you to configure a range that is non-optimal, but within safe limits for the DUT. Any operating range outside of the amber setting displays as red on the System and Drawer View windows. Forward voltage in V, drive current in mA, light power in W, monitor photodiode current in µA, and internal temperature ranges in °C are configurable.

Table 2.18 DUT Properties Dialog Field Descriptions

Field Name	Description
DUT Name drop down	Allows you to enter or select a descriptive name for a DUT.
Description	The description field allows you to view and enter a description of the DUT.
Save this configuration button	Saves the current configuration (*filename*.dut) to C:\LTS-9300\config.
Apply button	The Apply button only appears when the All DUTs check box is selected in Drawer View. By clicking Apply, all of the DUTs in the selected drawer are setup according to the dialog configuration.
OK button	Applies any changes to the selected DUT and closes the dialog box. Changes are saved only with the Save this configuration button.
Cancel button	Closes the DUT Properties dialog and cancels any pending changes.

TEC Properties Dialog

The TEC Properties dialog box allows you to configure TEC properties and the operating ranges for the TEC including the PID, Sensor constants, and temperature limits.

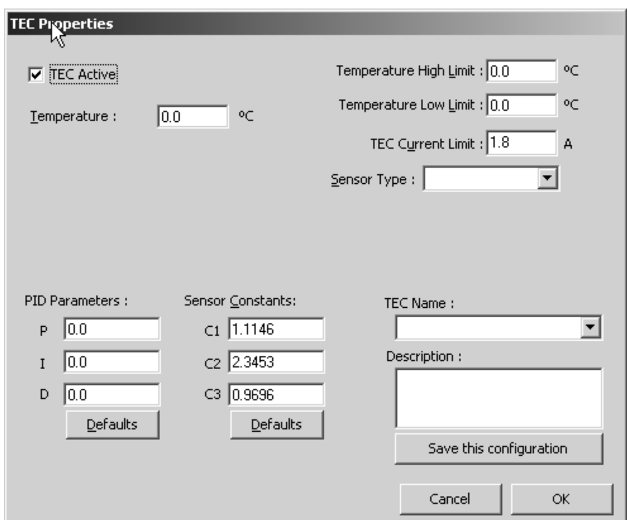


Figure 2.13 TEC (ITC) Properties Dialog

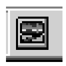
Table 2.19 TEC Properties Dialog Box Field Descriptions

Field Name	Description
Internal TEC Active check box	Allows you to turn on/off the ITC.
Temperature set field	Used to set the internal TEC temperature.
Temperature High Limit field Temperature Low Limit field	Used to set the temperature high and low limits in °C.
TEC Current Limit field	Used to set the internal TEC current limit in amps.
Sensor Type drop down list	Allows you to choose from configured temperature sensor types.
PID Parameters fields P I D	Used to set the Proportional term, Integral term, and Derivative term for temperature control. See *Setting PID* on page *64*.
Sensor Constants fields C1 C2 C3	Used to enter the Steinhart-Hart temperature sensor constants (see *Guidelines for ITC Operation* on page *63*. The system uses the Steinhart-Hart equation to convert a resistance to a temperature. The equation describes the nonlinear resistance-versus-temperature characteristics of typical thermistors. Calibrating a thermistor consists of measuring its resistance at various temperatures, and fitting these measured data to the Steinhart-Hart equation. The resulting coefficients C1, C2, and C3 effectively describe the thermistor. More information about the Steinhart-Hart equation is contained in ILX Application Note #4. Contact ILX Customer Service (see page *v* for contact information) or go to www.ilxlightwave.com/library/index.html.
Save this configuration button	Saves the current configuration (*filename*.itc) to C:\LTS-9300\config.
OK button	Applies any changes to the selected TEC and closes the dialog box. Changes are saved only with the Save this configuration button.
Cancel button	Closes the TEC Properties dialog and cancels any pending changes.

System Software Quick Reference

Icons

Table 2.20 System Icons Reference

Icon		Description
	System View Icon	Displays the System View window
	Drawer View Icon	Displays the Drawer View window
	DUT View Icon	Displays the DUT View window
	DUT Properties Icon	Opens the DUT Properties dialog box
	Current Source or Case TEC On/Off Icon	Turns on or off the current source in DUT View, or turns on or off the CTC in Drawer View

Hot Keys

Table 2.21 System Hot Key Reference

Hot Key	View	Function	Description
Ctrl+Alt+E	All	Display extended information	Displays extended information in the views including register contents, script information, and UPS information, and a history of commands sent to the system.
Ctrl+Alt+I	Drawer View DUT View	Display current/resistance measurements	Toggles the measurement for internal and case temperature control from current to resistance.
Ctrl+Alt+L	All	Command logging	Available in all of the views, command logging is a useful communications bus debugging tool that records all GPIB bus traffic to and from the system. Log files are generated and stored in the \Bin directories.
Ctrl+Alt+P	Drawer View DUT View	Display power measurements in current	Toggles between light power and photodiode current measurements.
Ctrl+Alt+S	All	Starting and stopping scripts	Starts and stops the execution of the AllRun.script file. See *Scripts* on page *13* for information about running a script file.

CHAPTER **3**

SYSTEM CONFIGURATION AND OPERATION

This chapter introduces you to the operation of the LTS-9300. It offers instructions for applying power to the system, loading the drawers, and controlling the system with ILX Lightwave software.

This chapter also provides a description of the LTS-9300 Menu Structure and has instructions about selecting each menu and performing the operations relevant to the menu selected.

Applying Power to the LTS-9300

To turn on the LTS-9300, turn the key on the Power section of the front panel to change the setting from zero (0) to one (1). This initiates the Power-on sequence. If the LTS-9300 does not appear to turn on, verify that it is connected to line power.

Power On Sequence

When power is applied to the LTS-9300, the following takes place:

- All indicators illuminate and the seven-segment GPIB address displays.
- A self test is performed to ensure that the mainframe processor is communicating with the shelf processors. After this test, the system is ready to operate.

Power On State

The LTS-9300 returns to the default configuration when power is applied. The default configuration information for each command is available in Chapter 5, Command Reference.

The set points for current source, case temperature control (CTC), and internal temperature control (ITC) output are returned to default values for power-up or reset.

Front Panel Indicators

The status of the laser, TEC, and CTC outputs are indicated with LED status indicators. The LTS-9300 main power is indicated by the power on LED located on the front panel.

The status of DUT control and drawer temperature information is displayed with LED status indicators on the front panel of each drawer.

GPIB Address

This GPIB default address is 01. Press the **ADDR SELECT** button to display the GPIB address for two seconds.

Changing the GPIB Address

Every device on the GPIB bus must have a unique address.

1. Press the **ADDR SELECT** key once to display the GPIB address.
2. Press and hold the **ADDR SELECT** key to increment the GPIB address. The address increments every 1.5 seconds.
3. Release the ADDR SELECT button when the desired GPIB address is displayed. The new GPIB address is then stored in non-volatile memory.

   The allowable address range is 0-30 for primary GPIB addressing. Extended GPIB addressing is not implemented on the LTS-9300.

Drawer Panel Indicators

The status of DUT control and drawer temperature information is displayed with LED status indicators on the front panel of each drawer.

The Enabled LED illuminates when the Enable key is turned to the on position (I).

Table 3.1 Drawer Panel LED Descriptions

Indicator	Purpose
Laser Output On	Indicates that the laser output is turned on.
Laser Status	The Laser Status indicator turns on (in a user defined color: green, red, orange) or off when a user-defined condition is met. See *LASSTATLED* on page *122* for information about configuring the illumination color.
Temperature Control On	Indicates that the case temperature controller is turned on.
Temperature Status	The Temperature Status indicator turns on (in a user defined color: green, red, orange) or off when a user-defined condition is met. See the command *TEMPSTATLED* on page *126* for information about configuring the illumination color.
Temperature Limit	Indicates that the case temperature has exceeded the user-define temperature limit.

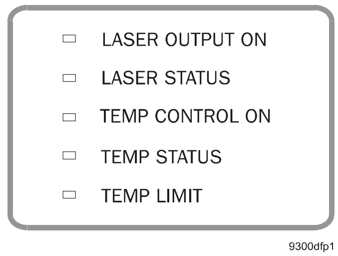


Figure 3.1 Drawer Indicators

Loading the Drawer

This section provides instructions for loading a drawer with DUTs. The DUT tray can be removed from the drawer for easier DUT fixturing.

1. Turn the enable key to the off position (O) for the desired drawer.
2. Pull both shelf release levers and slide open the drawer.
3. Open the DUT cover to expose the removable DUT fixture.
4. Loosen the four thumb screws to release the DUT fixture from the drawer.

CAUTION

ILX Lightwave recommends observing proper ESD precautions whenever a drawer is open and when a DUT tray is handled.

5. Carefully lift and remove DUT fixture and set it on a static safe surface.

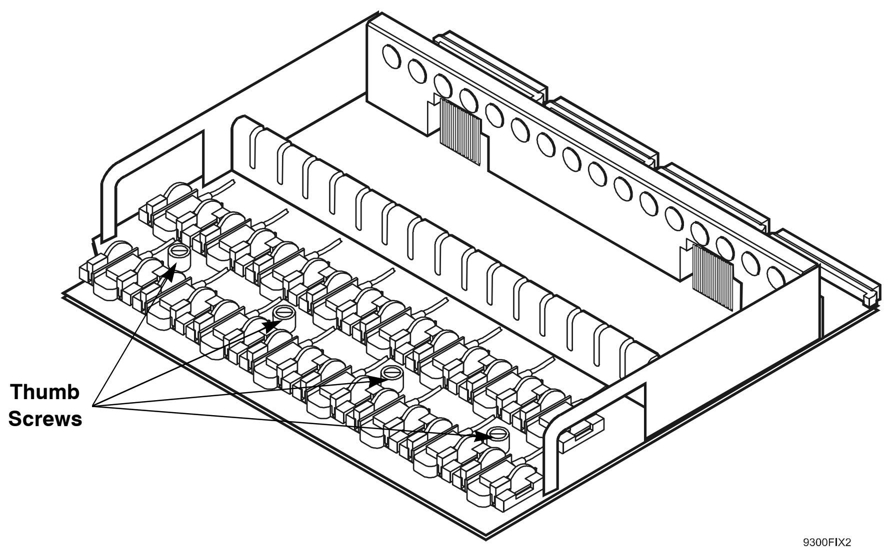


Figure 3.2 Removing the DUT Fixture

6 Install the lasers.

BUTTERFLY LASERS

6a Beginning with mount 1, open the hold down clamps (see Figure 3.5).

6b Release the hold down clips on each mount and open the lead clamps. Press down the lead clamps while opening the hold down clips to avoid damaging the clamps.

Note: With the connector side of the DUT fixture facing away from you, the first mount is top-most mount on the left side. Mount 2 is below and to the right of mount 1; while mount 3 is above and to the right of mount 2, and so on.

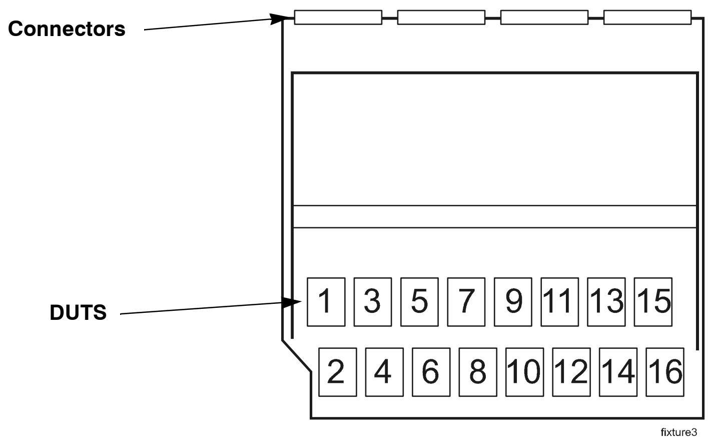


Figure 3.3 DUT Mount Position

6c With the fiber pigtails toward the fiber management bulkhead, align the laser leads with the appropriate contacts and insert the laser.

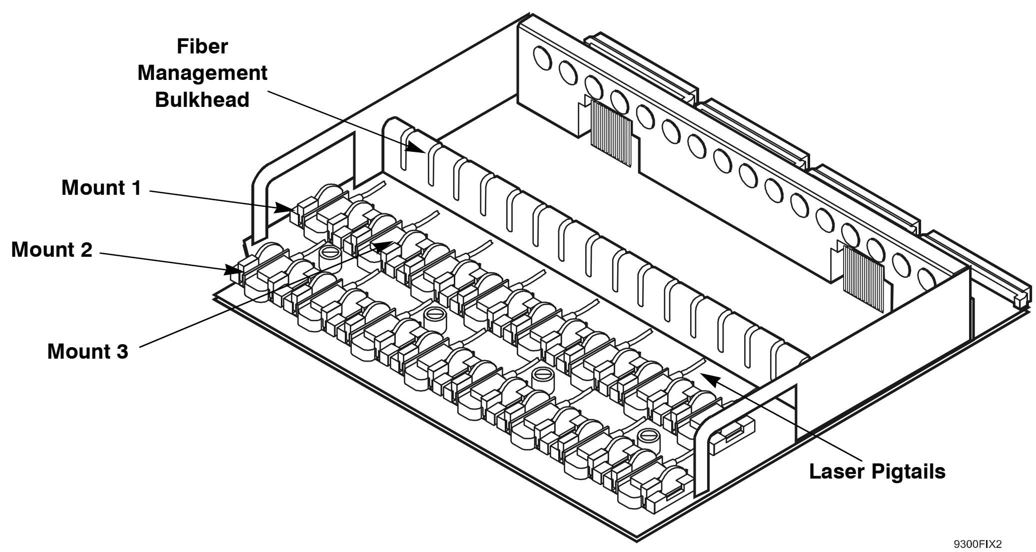


Figure 3.4 Inserting Lasers

6d Route the fiber through the fiber management bulkhead.

6e Secure the laser to the DUT fixture by closing the lead clamps and securing with the hold-down clips.

6f Secure the laser to the mount with four $2-56 screws (nominal torque spec: 2.5 in-lb) and close the DUT clamps over the end flanges on the DUT.

OFP LASERS

6g Beginning with mount 1, remove the OFP fixture from the mount. Carefully slide an OFP laser into the mount as shown below. Slide the OFP as far forward within the fixture as possible to ensure proper electrical and thermal contact.

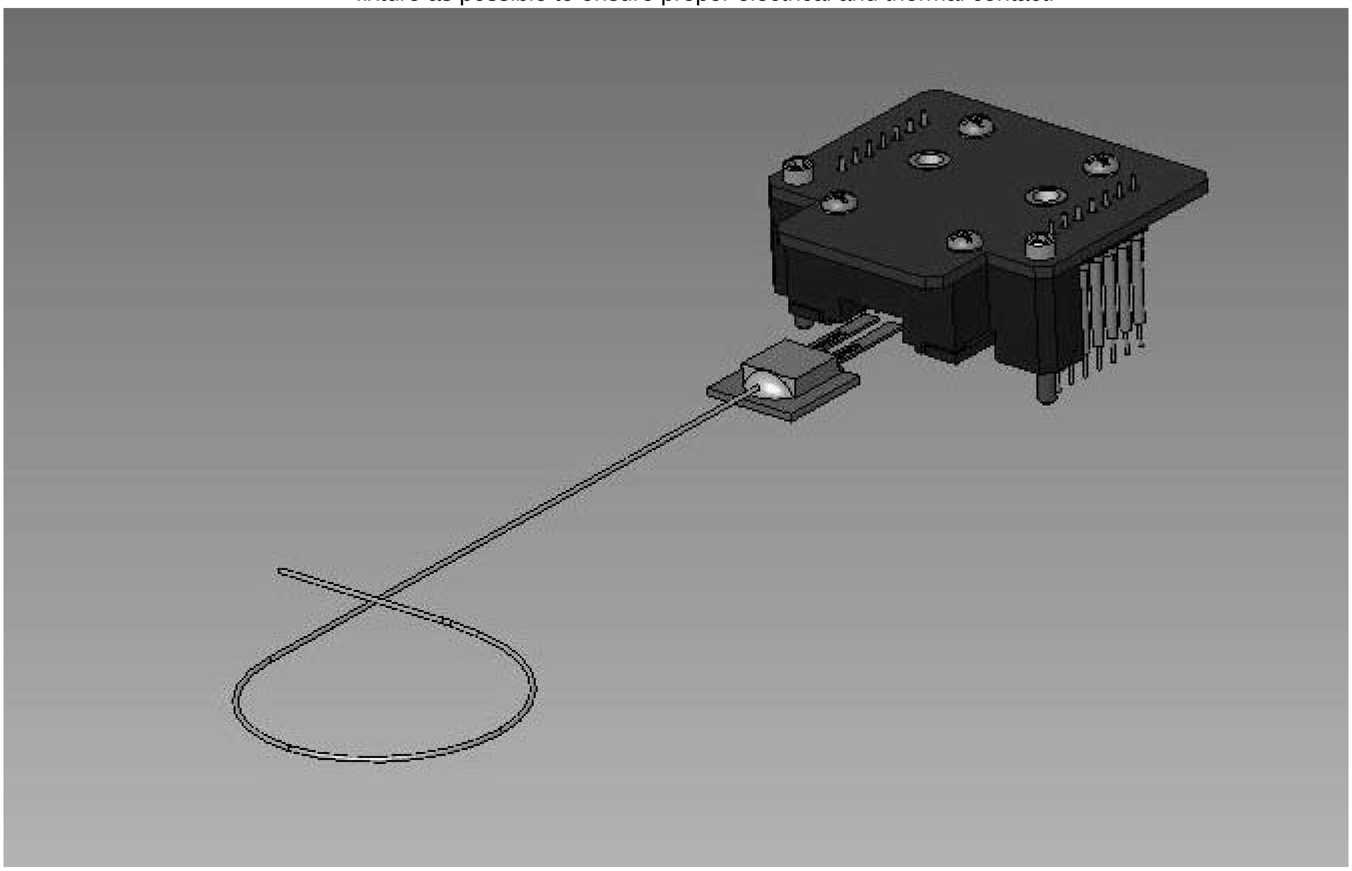


Figure 3.5 Installing an OFP into the OFP Fixture

6h Carefully align the 14 pins of the mount fixture to the mating sockets in the DUT tray and press together.

Note: The fiber should be pointed toward the fiber management bulkheads.

6i Route the fiber through the fiber management bulkhead.

6j Secure the OFP laser fixture to the mount with two $2-56 screws (nominal torque spec: 2.0 in-lb)

7 Prepare the fiber for the bare fiber adaptor.

7a Strip at least 14 mm of buffer from the fiber.

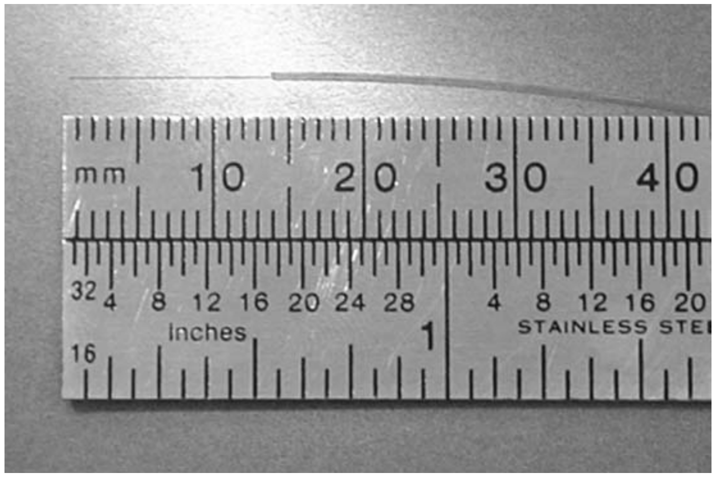


Figure 3.6 Strip the Fiber Buffer

7b Carefully clean and cleave the fiber to 6 mm using a high precision fiber cleaver.

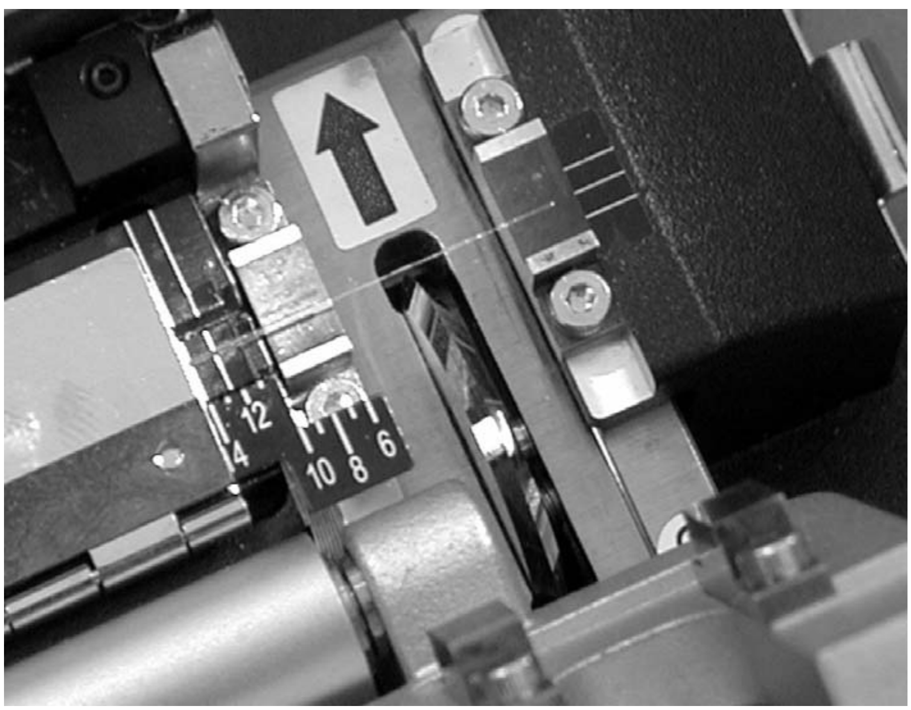


Figure 3.7 Place Edge of Buffer at 6 mm Reference and Cleave

Note: If the fiber endface touches anything after cleaving, clean it and cleave it again.

7c Open the appropriate bare fiber clamp with right index finger and hold the cleaved fiber with left hand.

Figure 3.8 Place Fiber into Bare Fiber Adapter

7d Carefully place the cleaved fiber along the edge of the adapter (opposite side of the clamp). The end of the fiber should nominally be placed using the reference line as shown. Alternatively, a mark could be made on the fiber 18 mm from the cleave. This mark could be lined up with the back edge of the bare fiber clamp..

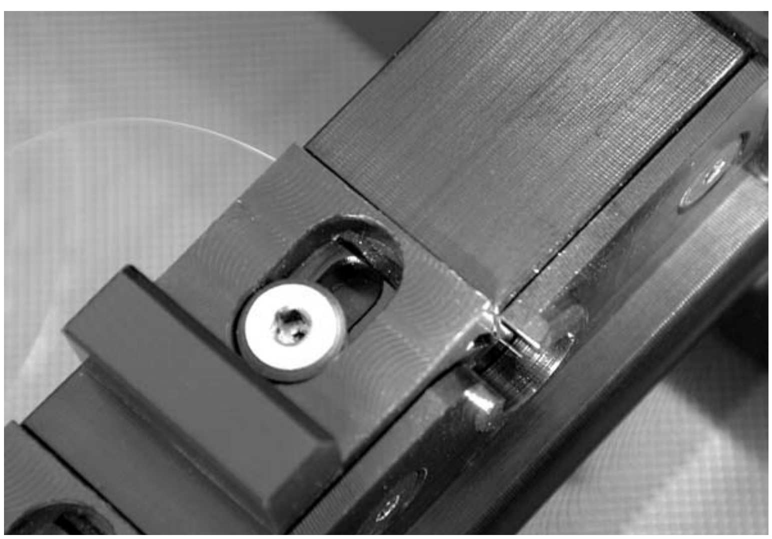


Figure 3.9 End of Fiber Placement within Adapter

7e Close the bare fiber adapter by releasing the clamp with your right index finger and gently pressing the clamp up against the fiber. Ensure the fiber is laying straight along the left edge and entering the fiber clamp at the bottom as shown below.

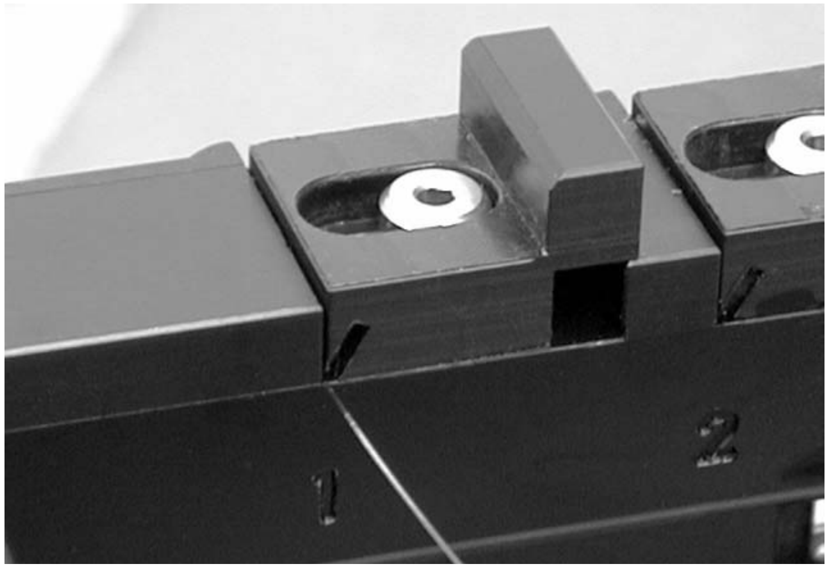


Figure 3.10 Fiber Placement within Adpater (Front View)

7f Repeat the procedure for the remaining fibers, ensuring the proper fiber is in the appropriate bare fiber holder.

8 After all lasers and fibers have been installed within a tray, clean the underside of the DUT fixture and the hot-plate surfaces within the drawer. ILX Lightwave recommends using reagent grade alcohol and lint-free wipes.

9 Place DUT fixture into drawer and tighten the four thumb screws (Torque spec: XXXXX)

10 Close the drawer cover and then push the drawer forward into the rack.

Note: To release the drawer from its mechanical stop, lift the right rail tab up and the left rail tab down, then press the drawer forward until it stops.

11 Seat the drawer connectors by closing the handles.

12 Turn the enable key switch to ON to enable the drawer.

Software Operation

The Software Operation section provides basic configuration and operation instructions for testing laser diodes. The LTS-9300 User's Guide assumes you have working knowledge of basic computer operating conventions such as how to use a mouse and standard menus and commands.

Configuring the System

The Configuring the System section provides instructions for setting up the complete system or individual components. Configuring the overall LTS-9300 system consists of four general steps: configuring internal temperature control (ITC), configuring the DUTs, the drawer, and then the system. Using the System Configuration dialog, configure and save each individual component of the system, then setup and save the whole configuration to a system configuration file (*filename*.ssm). The system file can be loaded using the Load System Configuration command (see *Loading a System Configuration* on page *52*).

Each component of the system is individually configurable; or, by following the instructions in sequence, the system can be setup as a whole. Begin by setting up the internal temperature controller for each DUT, followed by configuring the DUT. Once the DUT is configured, it is loaded into a drawer and the drawer is configured. Finally, configure the system using the System tab from the System Configuration Dialog.

Double click the LTS-9300 shortcut on the desktop or click **Start>Programs>LTS-9300>LTS-9300** to launch the System Software.

Configuring an Internal TEC (ITC)

1. From the System view, select **Setup>System Configuration** to open the System Configuration dialog.
2. Select the DUT tab from the System Configuration dialog.

   Alternatively, from the Drawer View window, right click on the desired DUT and select **Properties.** Or, click the DUT properties icon from menu on the DUT View window.
3. Click the **Internal TEC** checkbox then click **Properties** to configure an internal TEC.
4. Click the TEC Active check box and enter the desired internal temperature in degrees Celsius (°C).
5. Enter the temperature high limit, temperature low limit, and TEC current limit.
6. Select the thermistor type from the drop down list.
7. Enter the PID parameters and sensor constants. See *Setting PID* on page *64* and *Sensor Currents* on page *64* for more information.
8. Name the TEC and provide a description, then click **Save this configuration**. Clicking Save this configuration creates an ITC file (*filename*.tec) saved in the Config directory

(C:\LTS-9300\config).

9 Click **OK** to close the TEC Properties dialog or **Cancel** to abort the configuration.

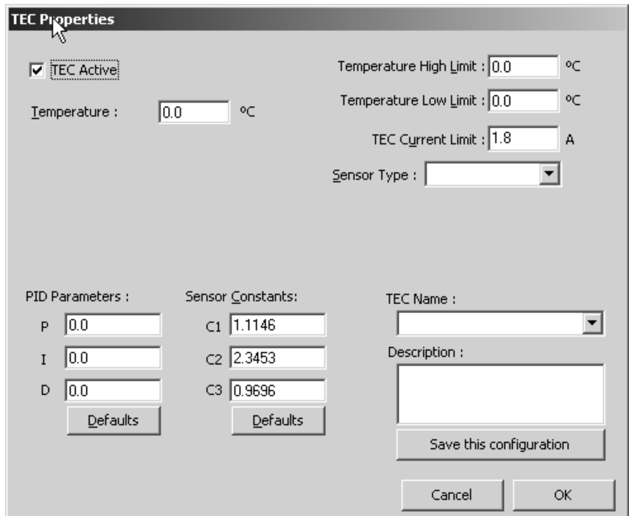


Figure 3.11 TEC Properties Dialog

Configuring the DUTs

When configuring a DUT, ILX recommends first setting up the internal TEC. See *Configuring an Internal TEC (ITC)* on page *46*. For information about specific fields and buttons see *DUT Tab* on page *20*.

1 From the System view, select **Setup>System Configuration** to open the System Configuration dialog.

2 Select the DUT tab from the System Configuration dialog.

Alternatively, from the Drawer View window, right click on the desired DUT and select **Properties.** Or, click the DUT properties icon from the tool bar on the DUT View window.

3 To configure an internal TEC, see *Configuring an Internal TEC (ITC)* on page *46*.

4 Select a laser package type from the Package Type drop down list.

5 Click the Internal Monitor Photodiode check box to configure the DUT with a monitor photodiode.

6 In the Parameters section, enter the hardware limits for the selected package type: maximum current in mA, wavelength in nm, voltage compliance in V, and monitor photodiode current limit (Ipd) in µA.

7 Select the measurement ranges for the conditional color setting. Click **Green** and enter the desired ranges for each parameter; click **Amber** and enter the ranges for each parameter.

Note: Clicking the Green button and entering the optimal desired operating ranges displays as green on the System and Drawer View window when the DUT is operating at optimal levels. Clicking the Amber button allows you to configure a range that is non-optimal, but within safe limits for the DUT. Any operating range outside of the amber setting displays as red on the System and Drawer View windows.

8 Once the DUT is configured, enter a title for the new DUT file.

9 Describe the DUT for future reference and click **Save this Configuration**. Clicking Save this configuration creates a DUT file (*filename*.dut) that is saved in the Config directory (C:\LTS-9300\config).

10 Click **OK** to close the DUT Properties dialog or **Cancel** to abort the configuration.

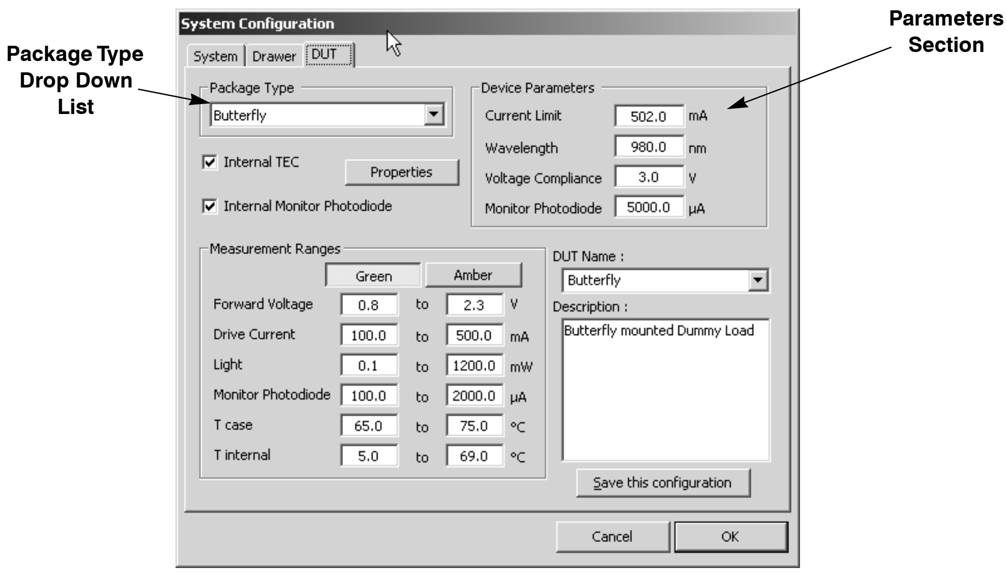


Figure 3.12 Configuring DUTs

Configuring the Drawers

When configuring a drawer, the software requires configured DUTs. See *Configuring an Internal TEC (ITC)* on page *46* and *Configuring the DUTs* on page *47* for instructions about DUT setup. For information about specific fields and buttons see *Drawer Tab* on page *19*.

1 From the System view, select **Setup>System Configuration** to open the System Configuration dialog.

2 Select the Drawer tab from the System Configuration dialog.

3 Using the Up/Down buttons, select a drawer to configure.

4 Select a zone from the drawer configuration field and enter a descriptive name using the Zone Name drop list. For information about configuring a zone and creating a zone name, see *Configuring a Case TEC (CTC)* on page *49*

5 Select each individual DUT and choose a DUT name from the DUT Name drop down list.

For more information about configuring DUTs, see *Configuring the DUTs* on page *47*.

6 Click **Zone Types** to configure the Case TEC, see *Configuring a Case TEC (CTC)* on page *49*.

7 Click the External Detectors Present check box to configure the drawer with a external monitor photodiodes.

8 Once the drawer is configured, enter or select a title for the new drawer file from the Drawer Name drop down.

9 Provide a description of the drawer in the Description field and click **Save this Configuration** to store the drawer configuration. Clicking Save this configuration creates a drawer file (*filename*.dwr) that is saved in the Config directory (C:\LTS-9300\config).

10 Click **OK** to close the System Configuration dialog or **Cancel** to abort the configuration.

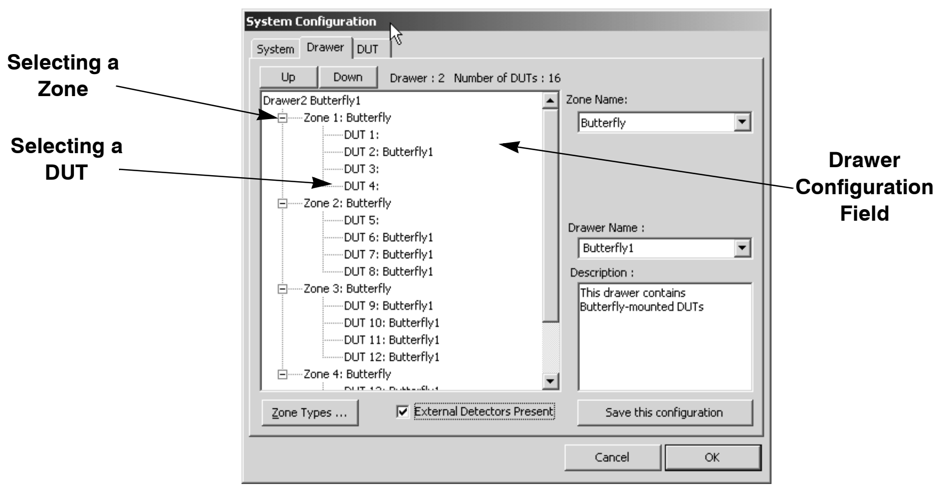


Figure 3.13 Configuring the Drawer

Configuring a Case TEC (CTC)

Configure the CTC when setting up a new drawer configuration. The LTS-9300 is shipped with the optimal CTC settings. See *Guidelines for CTC Operation* on page *61* for additional information.

1 From the System view, select **Setup>System Configuration** to open the System Configuration dialog.

2 Select the Drawer tab from the System Configuration dialog.

3 Select a zone from the drawer configuration field.

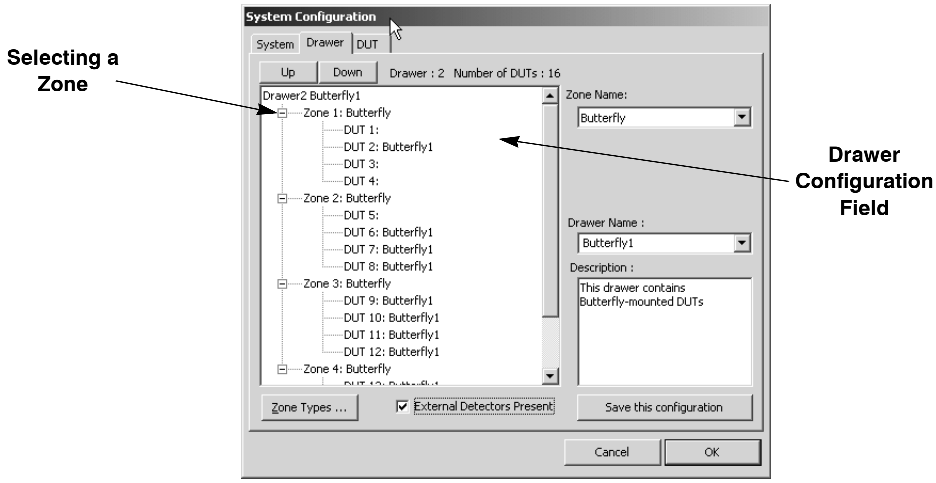


Figure 3.14 Configuring Zone Temperature Control

4 Click the **Zone Types** button to configure the CTC for the selected zone.

5 Click the TEC Active check box and enter the desired case temperature in degrees Celsius (°C).

6 Enter the temperature high and low limits and select the sensor type from the drop down list. See *Guidelines for CTC Operation* on page *61* for information about temperature limits.

7 Enter the PID parameters and sensor constants or click Defaults to set the fields to a preset value. See *Setting PID* on page *64* and *Sensor Currents* on page *64* for more information.

8 Name the CTC zone and provide a description, then click **Save this configuration**. Clicking Save this configuration creates a CTC zone file (*filename*.zon) that is saved in the Config directory (C:\LTS-9300\config).

9 Click **OK** to close the System Configuration dialog or **Cancel** to abort the configuration.

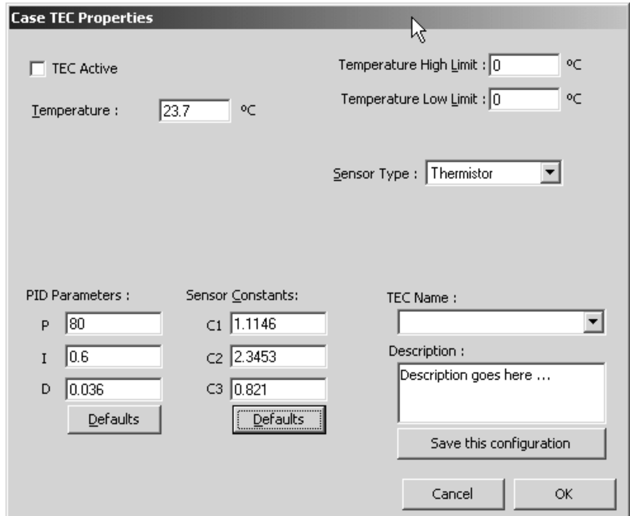


Figure 3.15 Case TEC Properties Dialog

Configuring the System

When configuring a system, the software requires configured drawers and DUTs. See *Configuring the DUTs* on page *47* and *Configuring the Drawers* on page *48* for instructions about setup. For information about specific fields and buttons see *System Tab* on page *18*.

1 From the System view, select **Setup>System Configuration** to open the System Configuration dialog.

2 Select the System tab from the System Configuration dialog.

3 Choose a drawer configuration (DUT fixture type) for each installed drawer using the Drawer drop down lists. See *Configuring the Drawers* on page *48* for information about drawer setup.

4 To activate the uninterruptible power supply (UPS), click the Enable UPS Support check box and enter the percentage of remaining battery power, upon UPS activation, at which all configurations, set points, and constants are saved.

5 Once the drawer is configured, enter or select a title for the new system file from the System Name drop down.

6 Provide a description of the system in the Description field and click **Save this Configuration**. Clicking Save this configuration creates a system file (*filename*.ssm) that is saved in the Config directory (C:\LTS-9300\config).

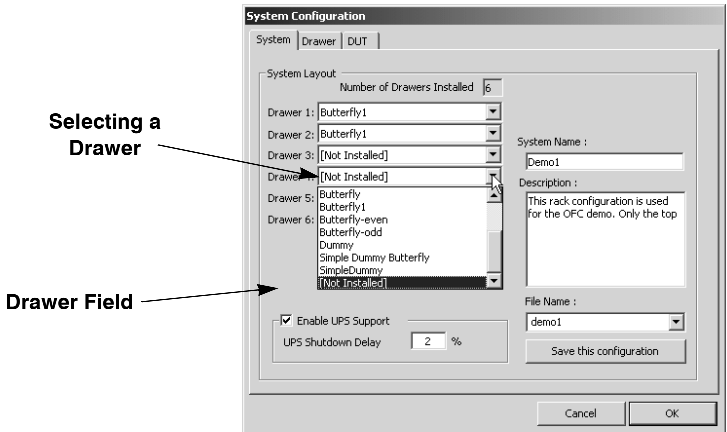


Figure 3.16 Configuring the System

Loading a System Configuration

The Select a new System Configuration dialog allows you to change and load a system configuration file (*filename*.ssm). For information about setting up a system configuration file, see *Configuring the System* on page *46*.

CAUTION

Loading a system configuration while outputs are turned on may cause unpredictable and damaging results.

1. From the System view, select **Load System Configuration** from the Setup menu to display the System Configuration window.
2. Browse to the Config directory (C:\LTS-9300\config), select the desired configuration file and click **Open**.

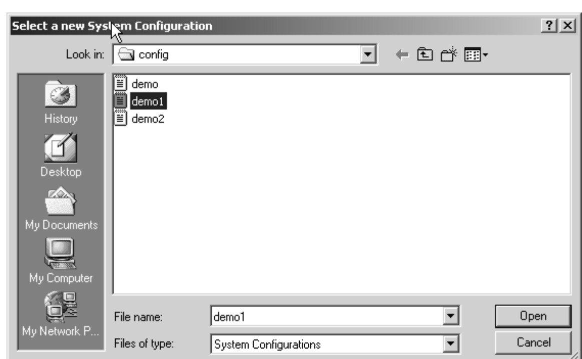


Figure 3.17 Loading a System Configuration

Configuring Data Recording

Use the Data Recording dialog to specify the file name, delimiter type, and storage interval for data recording. Access the Data Recording dialog from the Setup menu, from any view. See *Data Recording Dialog* on page *24* for more information.

1 From any view, select **Data Recording** from the Setup menu to display the Data Recording dialog.

2 To begin data recording to a log file:

2a Enter a time interval in minutes, in the Interval field.

2b From the File name field, browse and select a log file or create a log file by entering a name for the log.

2c Select the directory where the log is stored.

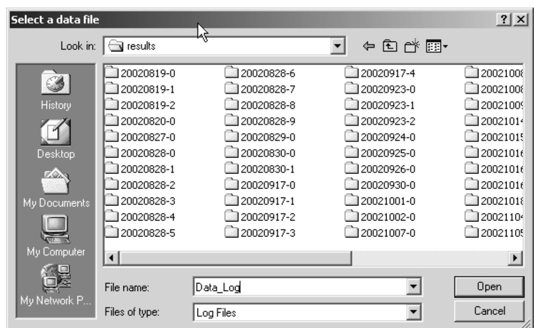


Figure 3.18 Select a Data File Dialog

2d Select a delimiter and click **Begin Now** to start recording to a log file. Alternatively, click **Stop Now** to stop data recording.

Figure 3.19 Data Recording Dialog

3 To remove an existing data file:

3a From the File name field, browse and select a log file to remove.

3b Click **Clean File** to remove the log

4 At any time, click **Close** to abort and exit the Data Recording dialog.

Operating the System

The Operating the System section provides general instructions about applying current and temperature control to the DUTs. The system must be configured and DUTs loaded before a test can be started. See *Loading the Drawer* on page *40* and *Configuring the System* on page *46* for more information.

Refer to Chapter 2, System Software Reference for information about specific fields or additional dialog boxes.

1. From the System View, enter the necessary temperature in the T_{set} field.
2. Turn on the case temperature controller for the selected drawer by clicking the **Case TEC On/Off** check box.
3. Double-click the desired drawer or select the drawer and click the Drawer View icon from the menu.
4. Select (click once) the desired DUT to turn on or select the **All DUTs** check box to apply current to all of the DUTs.
5. Select the operation mode radio button: ACC for constant current mode, or APC for photodiode current mode. See *Laser Control Modes* on page *57* for information about ACC and APC modes.
6. In the I_{set} field (in ACC mode) or MDI_{set} field (in APC mode), enter the desired current for the DUT(s).
7. Click the **Current On/Off** check box to turn on the current source.
8. Select a different drawer and repeat steps 2 through 7 to operate the remaining drawers.

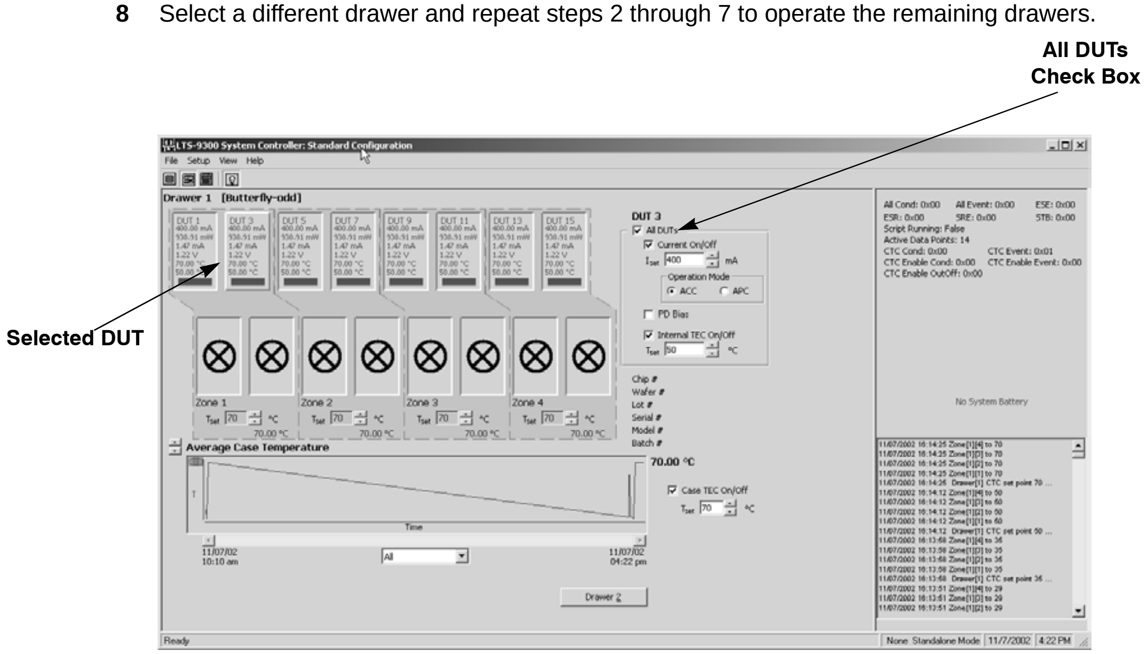


Figure 3.20 Drawer View

Running an LIV Sweep

An LIV sweep steps laser drive current from a start current to an end current. At each step, light power L (or more specifically, light detector current), laser diode current I, and laser diode voltage is recorded. The LIV sweep results in a data file that allows you to plot a graph relating the light, current, and voltage of a laser diode.

1. From the Setup menu, select **LIV Option** to open the LIV Option dialog.
2. Select the drawer and desired DUT to be tested.
3. Enter a starting current, ending current, and step size for the sweep.

   At each step, a light, current, and voltage measurement is taken. Fewer steps take less time, but result in less precision. Conversely, smaller steps provide more data points, but require more time to complete the sweep.
4. Click **OK** to run the sweep or click **Cancel** to close the LIV Option dialog.

   Once the LIV sweep is finished, a data file is placed in C:\LTS-9300\Results\ and is identified by the drawer and DUT (for example, C:\LTS-9300\Results\LIV_Drawer1_DUT1.log). See *LIV Option Dialog* on page *23* for information about the LIV Option dialog.

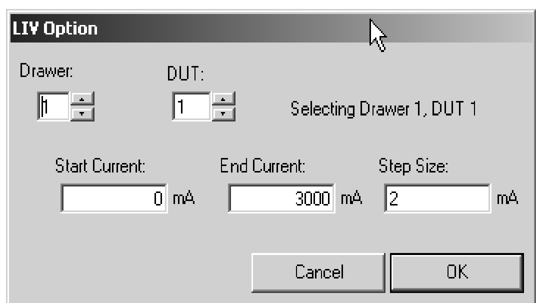


Figure 3.21 LIV Option Dialog

System Guidelines

The System Guidelines section provides general information and usage guidelines about laser operation, case temperature control, and internal temperature control.

Guidelines for Laser Operation

The Guidelines for Laser Operation section provides a resource for general information about using lasers current sources and the intended purpose of their design.

Laser Control Modes

Lasers installed in the LTS-9300 operate in constant current mode (ACC) or constant power mode (APC).

In constant current mode, the laser current source circuitry uses a closed-loop feedback circuit to maintain the laser drive current at the set point specified.

In constant power mode, the control feedback loop is based on the external photodiode current; the laser drive current is adjusted as necessary to maintain the photodiode current at the set point specified.

In constant current and constant power modes, it is critical to set the laser current limit before you operate the laser. The current limit keeps the laser from being over-driven. This is especially critical when you operate the laser in constant power mode since the control loop drives the level of current necessary to maintain the constant photodiode current.

Four-Wire Voltage Sense

The LTS-9300 has a 4-wire voltage sense feature. The laser voltage is sensed through a pair of high impedance connections that is separate from the laser current drive connections. This allows for an accurate laser voltage reading for the voltage limit feature.

Photodiode Connections

Many laser diodes contain an internal photodiode that monitors the back-facet emission of the laser.

The photodiode and laser connections to the LTS-9300 are electrically isolated from ground and each other.

Photodiode Reverse Bias

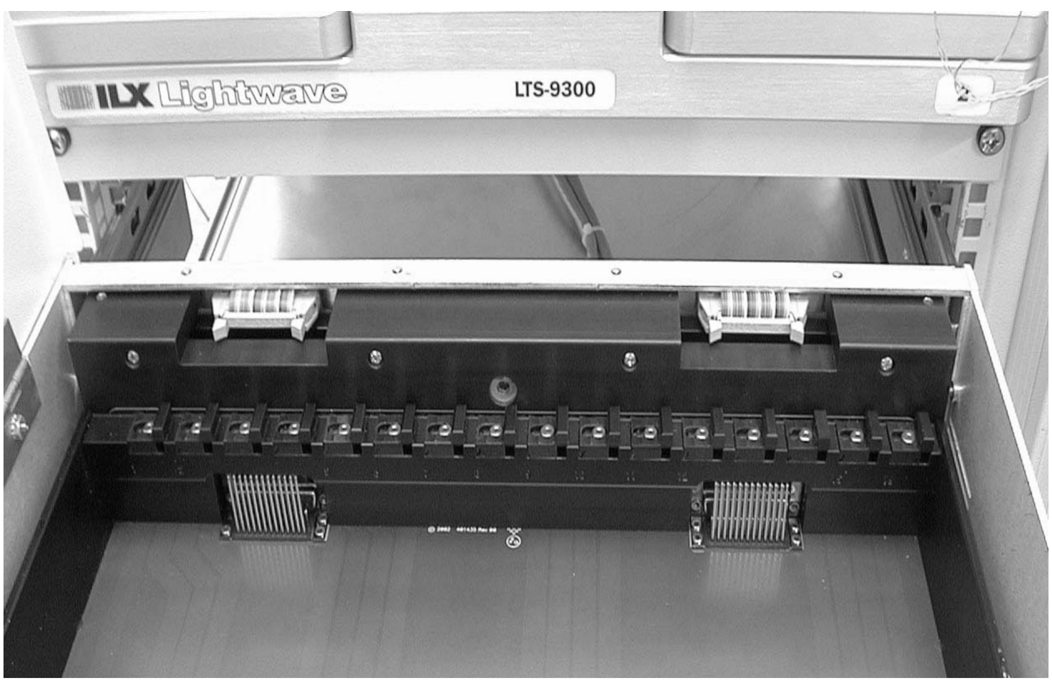
A 10 V reverse bias is applied to the back facet monitor photodiode. The bias is switched on or off through the system software.

Output Status

The status of the laser, TEC, and CTC outputs are indicated with LED status indicators on the front panel of each drawer. The LTS-9300 main power is indicated on the front panel. See *Front Panel Indicators* on page *38* for specific information about each LED status indicator.

Power Measurement Calibration

The LTS-9300 provides a power measurement circuit for each channel, consisting of a bare fiber adapter, a diffuser, a photodetector, and a current measuring circuit. The current measured from each photodetector is converted into a power reading via a calibration factor (in units of uA/mW) and is displayed just beneath the LD current for each channel. The LTS-9300 has a nominal calibration factor entered for each drawer and is dependent upon the detector to fiber spacing, the optical configuration used, and the maximum power specified for that drawer. An overall view of the bare fiber adapters and photodetector assembly is shown below.



The nominal calibration factors for the power measurement circuit are stored in a file called Calfile.ini in the CONFIG folder of the LTS-9300 software. The following nominal calibration factors are stored for your particular LTS-9300:

Table 3.2 Nominal Calibration Factors

Drawer	Cal Factor	Pmax	Detector Spacing	Fiber Extension*
1	.626	3W	14mm	17mm
2	.665	3W	12mm	17mm
3	.406	5W	19mm	17mm
4	.406	5W	19mm	17mm

* As measured from the front of the bare fiber adapter to the cleave end of the fiber

The detector spacing is factory set to meet specified maximum power requirements and is nominally measured as shown in the picture below.

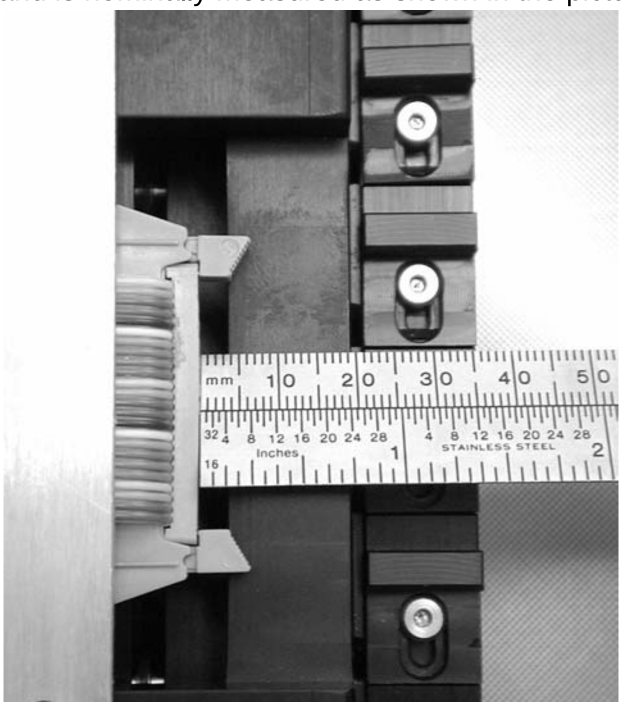


Figure 3.22 Detector Bracket Spacing

This spacing could be changed in order to improve SNR for low optical power devices. Please consult ILX Lightwave for further information on doing so.

The nominal calibration factors listed in the previous table are applied to each channel within a particular drawer. In general, the responsivity from detector to detector will vary slightly. If you want to calibrate each individual channel, or recalibrate the drawer, the following calibration procedure is provided.

Power Measurement Calibration Procedure

1. Route the fiber pigtail from the DUT to be calibrated through the fiber exit hole in the front of the drawer. (ILX Lightwave utilizes an OMH-6790B/OMM-6810B to measure up to 10W in the 800 to 1000 nm wavelength range.)
2. Carefully close and seat the drawer.
3. Enable the drawer by turning the Enable key.
4. Recleave the fiber (if necessary), install the external power meter and zero the power meter.
5. Turn on the laser to the desired internal temperature (if applicable), case temperature and nominal drive current. (Optical safety glasses should be worn to protect eyes in case of accidental fiber damage.)
6. Allow laser to stabilize and record optical power.
7. Turn laser drive control off.
8. Reopen drawer, taking care not to damage optical fiber.
9. Place optical fiber back into appropriate bare fiber adapter with cleaved end aligned with reference line (or nominally 17 mm from cleave to front end of adapter (see Chapter 3)
10. Closase and enable drawer.
11. Turn on the laser back to the exact internal temperature, case temperature and nominal drive current as previously set.
12. Press the hot keys “Ctrl, Alt, P” to switch the drawer view display from power (w) to external photodetector current (uA).
13. Once the laser has stabilized, record the external photodetector current (the entry directly below the LD current).
14. Calculate the calibration factor as follows:
    CF = External PD Current (uA) / Reference Power Reading (mW)
15. Turn laser drive control off.
16. Close the LTS-9300 application.
17. Open the Calfile.ini file (located C:/Program Files/ILX Lightwave Corporation/LTS-9300/Config)
18. Modify the appropriate drawer and channel with the new calibration factor. (The Find and Replace feature works very well for this.)
19. Save Calfile.ini.
20. Reopen LTS-9300 application.
21. Turn on the laser back to the exact internal temperature, as temperature and nominal drive current as previously set.
22. The optical power displayed (directly under the LD current) should be nominally the same as the previously measured reference power.

Guidelines for CTC Operation

Each shelf has a temperature controller to control the case temperature inside the drawer. This drawer-level temperature controller is called the Case Temperature Controller (CTC). Each CTC has four zones, each with its own temperature sensor. Each zone is controlled by an independent control loop.

CTC Control Mode

The CTC measures temperature using negative temperature coefficient (NTC) thermistors. An NTC thermistor is a device whose resistance decreases as its temperature increases. The constant sense-current that the controller provides through the thermistor results in a voltage across the thermistor. This voltage is used as a feedback signal by the CTC control loop to maintain a constant temperature.

The CTC converts the temperature setpoint to a thermistor resistance setpoint. The system uses the Steinhart-Hart equation to convert a temperature to a resistance. This equation describes the nonlinear resistance-versus-temperature characteristics of typical thermistors. Calibrating a thermistor consists of measuring its resistance at various temperatures, and fitting these measured data to the Steinhart-Hart equation. The resulting coefficients C1, C2, and C3 effectively describe the thermistor. More information about the Steinhart-Hart equation is contained in ILX Application Note #4. Contact ILX Customer Service (see page *v* for contact information) or go to www.ilxlightwave.com/library/index.html.

The thermistors used in the LTS-9300 drawers are calibrated and the calibration constants are entered into the system at calibration. For more information about sensors see *Sensor Currents* on page *64*.

Setting Case Temperature Controller PID

The case temperature control circuitry uses a software Proportional-Integrating-Derivative (PID) algorithm to quickly settle the temperature with minimum temperature overshoot. The PID constants for case temperature control system are set at the factory, but can be adjusted using the system software.

The PID control loop uses three different control signal contributions to control the peltier junctions (See *Setting PID* on page *64* for more information about the individual constants). Each control signal contributor tracks a slightly different aspect of the system's thermal performance, and all work together to reduce the difference between the temperature set point and the actual temperature. This difference is also known as the *temperature error*.

The three PID contributions work together. Changing one affects the performance of the others. The LTS-9300 is pre-programmed with PID values that give optimal performance. The default CTC PID values are P=80, I=0.6, and D=0.036.

ITC Operations

The ITC Operations section provides a resource for general information about using lasers with internal temperature control (ITC).

ITC Grounding Considerations

The TEC outputs of the LTS-9300 are isolated from chassis ground. The thermistor's Sensor (-) terminal and the TEC (-) terminals are internally connected.

Guidelines for ITC Operation

This section presents some guidelines to assist in selecting the optimal settings for an application.

ITC Control Modes

The LTS-9300 is designed to measure temperature using a negative temperature coefficient (NTC) thermistor. An NTC thermistor is a device whose resistance decreases as its temperature increases. The sense-current that the controller provides through the thermistor results in a voltage drop across the thermistor. This voltage is used as a feedback signal by the LTS-9300 control loop to maintain a constant temperature.

The system uses the Steinhart-Hart equation to convert a temperature to a resistance. The equation describes the nonlinear resistance-versus-temperature characteristics of typical thermistors. Calibrating a thermistor consists of measuring its resistance at various temperatures, and fitting these measured data to the Steinhart-Hart equation. The resulting coefficients C1, C2, and C3 effectively describe the thermistor. More information about the Steinhart-Hart equation is contained in ILX Application Note #4. Contact ILX Customer Service (see page *v* for contact information) or go to www.ilxlightwave.com/library/index.html.

To measure the precise temperature of a load, you must use a calibrated thermistor and enter its Steinhart-Hart coefficients C1, C2, and C3 through the software. If the exact temperature is not crucial (within ±1.5 °C) and you are using a 10 kΩ thermistor, use the default constants provided (C1: 1.125, C2: 2.347, C3: 0.855). However, the temperature accuracy specifications apply only to a calibrated thermistor with C1, C2, and C3 entered. For more information about calibrating your thermistor, go to www.ilxlightwave.com/support/index.html and click Technical Solutions.

Setting PID

The temperature control circuitry uses a software Proportional-Integrating-Derivative (PID) algorithm to quickly settle the temperature with minimum temperature overshoot. The PID constants for case temperature control system are set at the factory, but can be adjusted using the system software.

The PID control loop uses three different control signal contributions to control the peltier junctions. Each control signal contributor tracks a slightly different aspect of the system's thermal performance, and all work together to reduce the difference between the temperature set point and the actual temperature. This difference is also known as the *temperature error*.

Proportional Constant: the proportional contribution adjust the control signal in direct proportion to the temperature error; as the temperature error is reduced, the proportional contribution is also reduced.

Integrating Term: the integrating contribution dynamically narrows the width of the proportional control band. As the temperature error is reduced, the integrating constant focuses on the remaining temperature error and adjusts the proportional contribution to eliminate the error.

Derivative Constant: the derivative contribution controls the rate of the temperature change. If the temperature error changes very quickly, then the derivative circuit reduces its contribution to prevent temperature overshoot.

Tuning the PID Controller

The three PID contributions work together. Changing one affects the performance of the others. The LTS-9300 is pre-programmed with PID values that give optimal performance.

Sensor Currents

Thermistor resistance changes with temperature. The system supplies constant current, either
10 µA or 100 µA, through the thermistor so that a temperature change results in a voltage change across the thermistor. This voltage change is sensed by the system and fed back to the control loop. The supply current depends on the thermistor operating temperature range and the required temperature resolution. A general rule of thumb for a 10 kΩ thermistor is to use the 10 µA range for temperatures between –30 °C and +30 °C, and the 100 µA range for temperatures between 10 °C to 70 °C.

Selecting a Sensor Current

Select the thermistor sense current of 10 µA or 100 µA through the system software. Using 10 µA as the sense current allows you to use a maximum thermistor resistance of 450 kΩ. The 100 µA setting allows a 45 kΩ maximum.

To ensure proper current and thermistor selection, certain principles must be considered:

- To ensure measurement accuracy, the voltage across the thermistor must not exceed 5 V.
- To improve control responsiveness and accuracy, the thermistor voltage variations that result when the load temperature deviates from the setpoint must be as large as possible.

  The importance of maximizing voltage variation is shown in Figure 3.23, which shows resistance as a function of temperature for a thermistor. The values shown were selected for simplicity in this example, and may not reflect real thermistor values.

In the example shown in Figure 3.23, the thermistor resistance is 25 kΩ at 20 °C. Deviations of 1 °C from 20 °C cause resistance variations of about 2 kΩ. If using the 10 µA setting, there is 20 mV of feedback to the control circuit. Using the 100 µA setting provides 200 mV of feedback. The larger feedback signal means that the temperature is more precisely controlled.

Notice also that the lower slope of the curve at the higher temperatures results in a smaller feedback signal. It may be necessary, if you are controlling to higher temperatures, to use a thermistor with a different curve.

If you cannot select your thermistor and its resistance is less than 50 kΩ (at operating temperature), use the 100 µA setting. Use the 10 µA setting in all other cases.

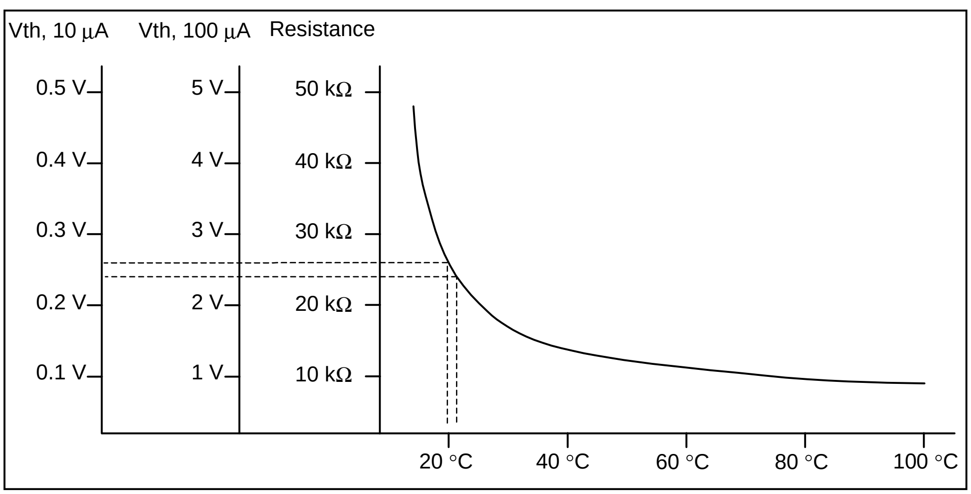


Figure 3.23 Example Thermistor Resistance vs. Temperature

Setting Safety Limits

The laser internal TEC can be damaged by excessive current; manufacturers typically specify a maximum safe operating current. The system provides a current limit feature (ILim) that allows you to set the maximum current that the controller supplies.

It is normal for the LTS-9300 to operate at the current limit, especially when the load temperature is far from the setpoint.

If the heatsink is too small for the application, the heatsink eventually becomes heat saturated—a condition where heat is being transferred to the heatsink faster than the heatsink can dissipate the heat. When the heatsink becomes saturated, the TEC current increases in an attempt to cool the load; this additional current creates more heat than can be dissipated and subsequently, more TEC current is applied. This situation is sometimes referred to as *thermal runaway*, and can cause a load and TEC to become damaged.

To help avoid thermal runaway damage, the LTS-9300 provides a high-temperature limit setting. The system can be configured to turn off the laser current and internal TEC current if the temperature limit setting is reached. See *CS:ENABLE:OUTOFF* on page *92* for more information about the register.

CHAPTER **4**

GPIB INTERFACE GUIDE

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. The following sections provide the fundamentals of operating your LTS-9300 Laser Diode Test System through the General Purpose Interface Bus (GPIB) and RS-232 interfaces.

GPIB Configuration

The following sections provide a general overview of the fundamental concepts of using the GPIB with the LTS-9300.

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.

Talkers, Listeners, and Controllers

Every GPIB system consists of one or more *talkers* and *listeners*, and 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 data logger 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 is the Controller In Charge (CIC). Control is 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 linked together (daisy-chained), allowing you to configure the system linearly or in a star configuration.

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.
- 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.

Reading and Changing the GPIB Address

1. Press the **ADDR SELECT** key once to display the GPIB address.
2. Press and hold the **ADDR SELECT** key to increment the GPIB address. The address increments every 1.5 seconds.
3. Release the ADDR SELECT button when the desired GPIB address is displayed. The

new GPIB address is then stored in non-volatile memory.

The allowable address range is 0-30 for primary GPIB addressing. Extended GPIB addressing is not implemented on the LTS-9300.

Command Structure Overview

This section contains information about the command set, command syntax, and status registers.

Command Syntax

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

Letters

Any GPIB command or query must contain all of the letters that 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 5, Command Reference). Upper or lower case does not matter, it is used in this manual to identify optional letters; although, the optional letters must be in the correct sequence. Some examples of what does, and does not, work:

Okay	Not Okay
`Meas`	`MS`
`Measu`	`MEa`
`meas`	`mesu`
`measure`	`measr`

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 use one or more white spaces before a comma, semicolon, or terminator. Since a computer normally puts the terminator at the end of each command string (line), an extra space character at the end of the command line does not affect the command string.

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

Okay	Not Okay
`TIMER?`	`TIMER ?`

Note: Too many consecutive white spaces can overflow the 80-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 a white space.

The LTS-9300 terminates its responses with <CR><NL><^END>, unless you use the TERM command to change it. See *TERM* on page *126* for more information.

If you encounter problems with GPIB communications, the terminator string can sometimes be the cause.

Command Separators

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

Note: The semicolon can be preceded by one or more spaces. Examples:

```
ITC:CHAN 1; ITC:set:t?;
ITC:MODE:t ; ITC:T 25 ; ITC:Const 1, 2, 3.5 ; ITC:OUT ON
CS:meas:ldi? ; cs:meas:ldv?
```

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

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 4.1 Substitute Parameter Names

SUBSTITUTE NAME	VALUE
ON	1
OFF	0
T	1
F	0
TRUE	1
FALSE	0
SET	1
RESET	0
I	1
O	0
YES	1
NO	0

If multiple parameters are expected, they must be separated with commas. For example, to set the Steinhart-Hart constants (C1, C2, and C3) on a CTC, the following command may be sent:

```
CTC:SHCONST 1.1, 2.2, 3.3
```

Command Sequence

All commands sent to the system must address a specified component that the command is intended. There are five different component types that can receive commands:

- Mainframe/System
- Drawer
- Current Source Control Channel
- Internal Temperature Control Channel
- Case Temperature Zone

Once the receiving component is specified, it receives all subsequent commands of the same component type until a new component is specified. For example, to specify current source 3 in drawer 4 as the receiving component, enter the command sequence:

```
DRAWER 4 ; CS:CHAN 3; <CS command>
```

All subsequent *current source* commands are routed to this current source. Commands for another component type, such as an internal temperature control command, are directed to drawer 4 unless directed elsewhere. For example, to specify ITC 3 in drawer 4, you only need to identify the ITC channel:

```
ITC:CHAN 3; <ITC command>
```

To specify ITC channel 3 in a different drawer, then a new command sequence beginning with the new drawer must be entered.

Command Tree Structure

The LTS-9300 commands require the full path notation.

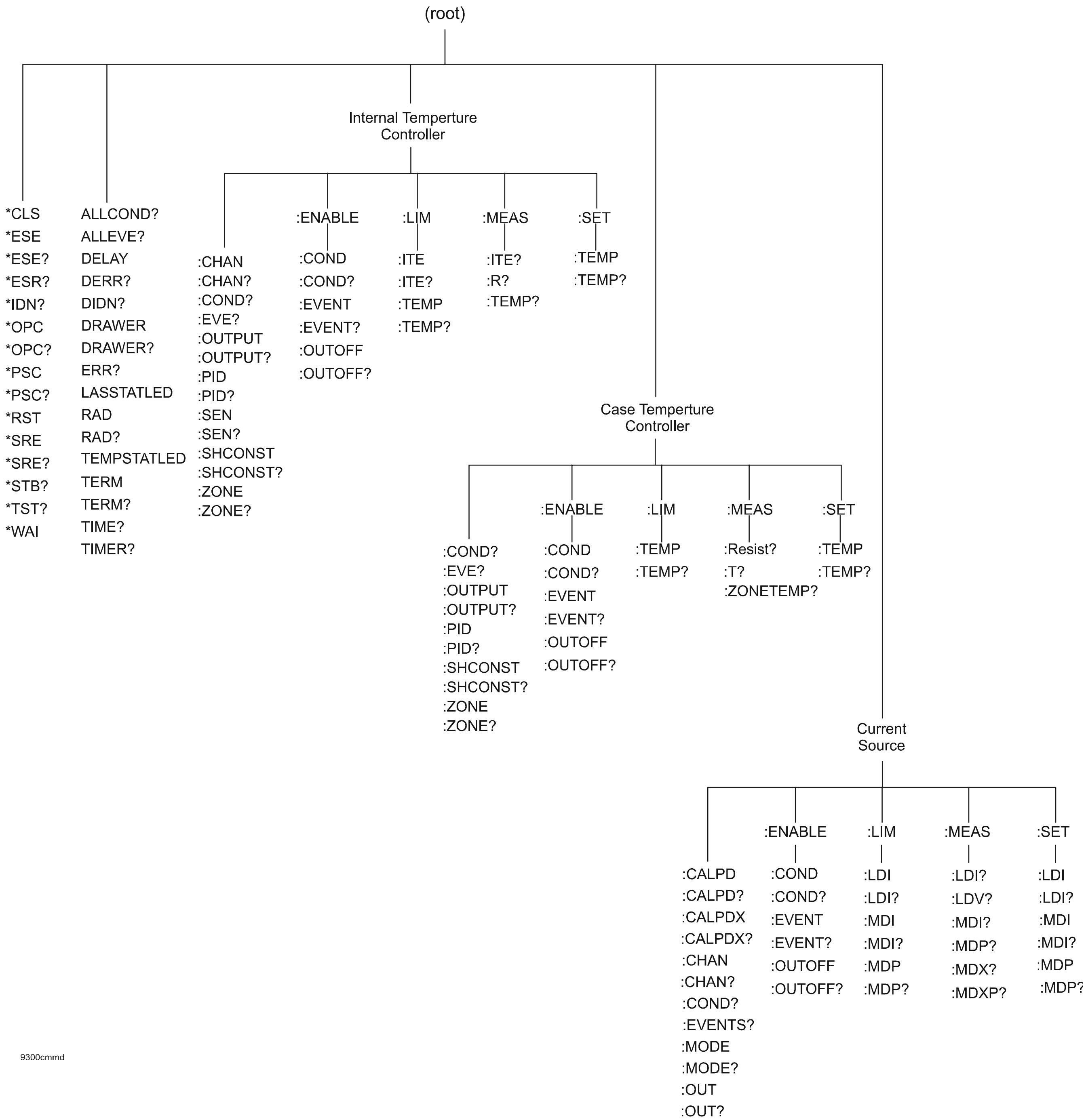


Figure 4.1 Command Path Structure

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 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.

If you encounter problems with GPIB communications, the terminator string can be the cause. Refer 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 the <CR> (Carriage Return) and treats it as white space. The LTS-9300 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.

Table 4.2 shows examples of invalid syntax command strings that produce errors:

Table 4.2 Invalid Syntax Command Strings

COMMAND	COMMENT
`CTC:MEAS T?`	Missing colon between *MEAS* and *T*
`CTC:SET:T 35.0 CS:CHAN?`	Missing semicolon between SET command and CHAN query
`CS:SET:LDI155`	Space missing between LDI and the parameter 155

IEEE 488.2 Common Commands

IEEE 488.2 Common Commands and Queries are distinguished by an asterisk (*) that begins each mnemonic. The diagrams below show the syntax structure for common commands, common command queries, and common commands with numeric data required.

Numeric data is required with *PSC (1 = on, 0 = off), *ESE (0 to 255, see Table 4.1 on page *74*), and *SRE (0 to 255, see Table 4.1 on page *74*).

The *TST? query returns *1* if all LTS-9300 drawers that are working at power-up (or at the time of the last *TST? query) have responded to the LTS-9300 mainframe within the past 15 seconds. If any drawers fail to respond to the mainframe, *TST? returns *0*, and those drawers are no longer recognized by the system.

A list of all of the IEEE 488.2 Common Commands supported by the LTS-9300:

`*CLS`	`*ESE`
`*ESE?`	`*ESR?`
`*IDN?`	`*OPC`
`*OPC?`	`*PSC`
`*PSC?`	`*RST`
`*SRE?`	`*SRE`
`*STB?`	`*TST?`
`*WAI`	

The IEEE 488.2 common commands and LTS-9300 commands are documented in Chapter 5, Command Reference.

Status Reporting

This section contains information 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 about setting some of the conditions that force a laser current source and/or temperature controller output to turn off.

The following sections describe the Event and Condition registers, Operation Complete flag, Output Off registers, and Error Messages.

Event and Condition Registers

The ALLEVE register is used to report events that occur during the operation of the LTS-9300 and that are enabled to be passed to the status byte. The ALLEVE register contains summary bits from each of the six drawers.

Likewise, the ALLCOND register is used to report conditions which exist during the operation of the LTS-9300, and are enabled to be passed on to the status byte. The ALLCOND register contains summary bits from each of the six drawers.

The bits in the ALLCOND and ALLEVE registers are logically ORed to form a summary message in the status byte for that particular register.

Events are different from conditions. Events signal one-time occurrences and are not reset until either the corresponding drawer's Event Register(s) is queried, the *CLS command is issued, or the LTS-9300 is powered off. Conditions reflect the current state of the device and therefore may change many times during operation.

Figure 4.2 on page *77* shows the status reporting scheme of the LTS-9300 Laser Diode Test System.

Operation Complete Definition

The Operation Complete (OPC) bit of the Standard Event Status Register (ESR) is not implemented in such a way that it can be used to time controller programs. Since the command set is sequential by design, the OPC bit in not set until the command execution is complete. The mainframe accepts an *OPC? query when the previous (sequential) command is complete; the same time that the OPC bit is set. Every time the OPC bit queried, it returns a *1*.

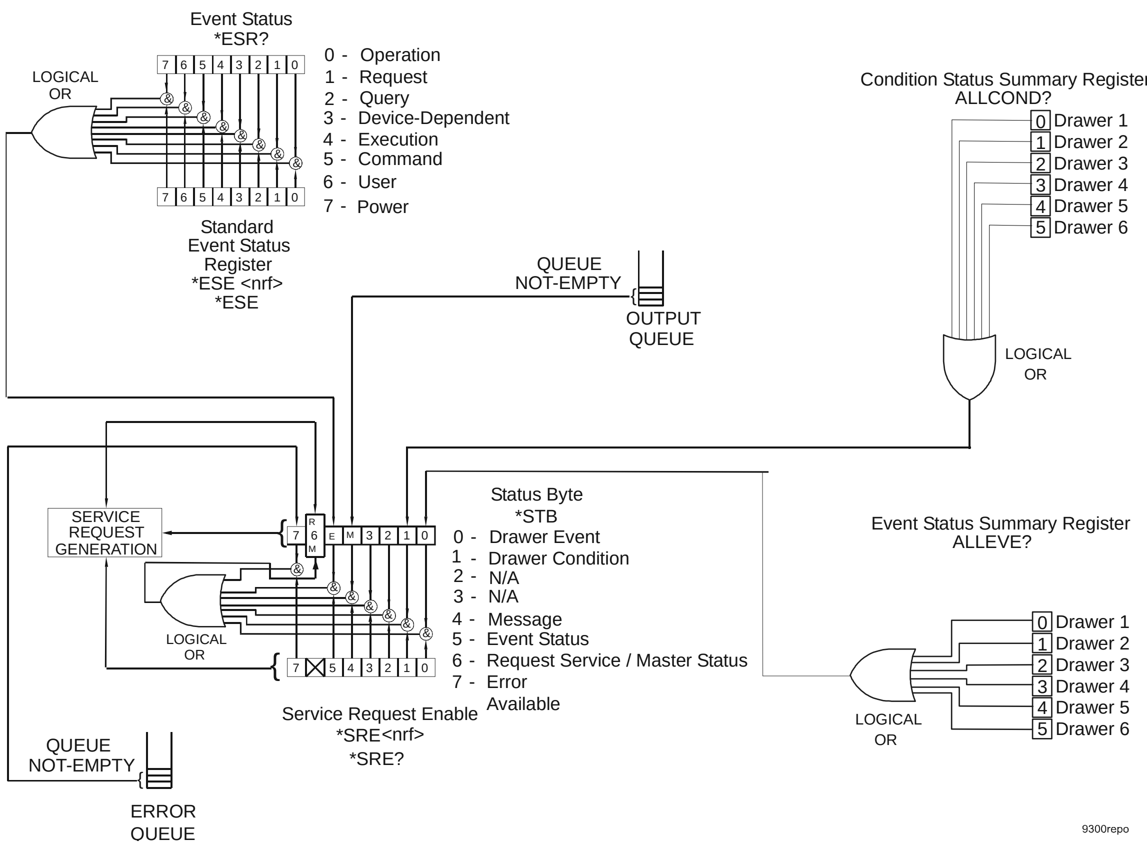


Figure 4.2 Status Reporting Schematic Diagram

If the GPIB times out while waiting for a response, either set the GPIB time-out to be longer, or use SRQ-generated interrupts in your program. See the IEEE GPIB manual for time-out configuration or SRQ programming setup.

Command Timing

All commands are sequential, although completion time of some commands may actually overlap other commands because of the complexity of the system.

See *Operation Complete Definition* on page *77* for information about setting the operation complete flag.

CHAPTER 5

COMMAND REFERENCE

This chapter is a reference for all of the commands for the LTS-9300 Laser Diode Test System. It contains an overview of the remote commands used by the system, shown in Table 5.1, as well as detailed command descriptions, listed in alphabetical order.

GPIB Commands

Table 5.1 GPIB Command Summary Reference List

Command	Param	Routing	Function
ALLCOND?	none	<command>	Returns the summary condition bits which are further summarized in the Status Byte.
ALLEVE?	none	<command>	Returns the summary of all event bits that are further summarized in the Status Byte.
*CLS	none	<command>	Resets the Standard Event Register, Status Byte and Error Queue to zero.
CS:CALPD	1	DRAWER>CS:CHAN><command>	Sets the laser photodiode feedback responsivity.
CS:CALPD?	none	DRAWER>CS:CHAN><command>	Returns the value of the laser photodiode feedback responsivity.
CS:CALPDX	1	DRAWER>CS:CHAN><command>	Sets the external photodiode feedback responsivity
CS:CALPDX?	none	DRAWER>CS:CHAN><command>	Returns the value of the external photodiode feedback responsivity setting.
CS:CHANnel	1	DRAWER><command>	Sets the current source channel that all subsequent current source commands are addressed.
CS:CHANnel?	none	DRAWER><command>	Returns the selected current source channel.
CS:COND?	none	DRAWER>CS:CHAN><command>	Returns the contents of the Laser Condition Status register.
CS:ENABLE:COND	1	DRAWER>CS:CHAN><command>	Sets the Laser Condition Status Enable register.

Table 5.1 GPIB Command Summary Reference List

Command	Param	Routing	Function
CS:ENABLE:COND?	none	DRAWER>CS:CHAN><command>	Returns the value of the Laser Condition Status Enable register.
CS:ENABLE:EVENT	1	DRAWER>CS:CHAN><command>	Sets the laser Event Status Enable register.
CS:ENABLE:EVENT?	none	DRAWER>CS:CHAN><command>	Returns the contents of the Current Source Event Status Enable register.
CS:ENABLE:OUTOFF	1	DRAWER>CS:CHAN><command>	Sets the current source Output Off Enable register.
CS:ENABLE:OUTOFF?	none	DRAWER>CS:CHAN><command>	Returns the contents of the current source Output Off Enable register.
CS:EVENTS?	none	DRAWER>CS:CHAN><command>	Returns the contents of the Laser Event Status register.
CS:LIMit:LDI	1	DRAWER>CS:CHAN><command>	Sets the laser constant-current limit.
CS:LIMit:LDI?	none	DRAWER>CS:CHAN><command>	Returns the laser constant-current limit setpoint value.
CS:LIMit:MDI	1	DRAWER>CS:CHAN><command>	Sets the monitor photodiode current limit.
CS:LIMit:MDI?	none	DRAWER>CS:CHAN><command>	Returns the monitor photodiode current limit value.
CS:LIMit:MDP	1	DRAWER>CS:CHAN><command>	Sets the laser optical power limit.
CS:LIMit:MDP?	none	DRAWER>CS:CHAN><command>	Returns the laser optical power limit setpoint.
CS:MEASure:LDI?	none	DRAWER>CS:CHAN><command>	Returns the measured laser current in mA.
CS:MEASure:LDV?	none	DRAWER>CS:CHAN><command>	Returns the measured laser voltage.
CS:MEASure:MDI?	none	DRAWER>CS:CHAN><command>	Returns the value of the laser photodetector (monitor photodiode) current measurement, in µA.
CS:MEASure:MDP?	none	DRAWER>CS:CHAN><command>	Returns the value of the laser photodetector power measurement, in mW.
CS:MEASure:MDX?	none	DRAWER>CS:CHAN><command>	Returns the external photodiode current value.
CS:MEASure:MDXP?	none	DRAWER>CS:CHAN><command>	Returns the external photodiode power value.
CS:MODE	1	DRAWER>CS:CHAN><command>	Command path used to access the laser mode selection commands.
CS:MODE?	none	DRAWER>CS:CHAN><command>	Returns the laser control mode.
CS:OUTput	1	DRAWER>CS:CHAN><command>	Turns on or off the laser output.
CS:OUTput?	none	DRAWER>CS:CHAN><command>	Returns the status of the laser output switch.
CS:SET:LDI	1	DRAWER>CS:CHAN><command>	Used to set the laser constant-current setpoint.
CS:SET:LDI?	none	DRAWER>CS:CHAN><command>	Returns the laser constant-current setpoint.
CS:SET:MDI	1	DRAWER>CS:CHAN><command>	Used to set the monitor photodiode current setpoint value.

Table 5.1 GPIB Command Summary Reference List

Command	Param	Routing	Function
CS:SET:MDI?	none	DRAWER>CS:CHAN><command>	Returns the monitor photodiode current setpoint value.
CS:SET:MDP	1	DRAWER>CS:CHAN><command>	Used to set the laser monitor PD power setpoint value.
CS:SET:MDP?	none	DRAWER>CS:CHAN><command>	Returns the laser monitor PD power setpoint value.
CTC:COND?	none	DRAWER>CS:CHAN><command>	Returns the contents (at the time of polling) of the CTC Condition Status register.
CTC:ENABLE:COND	1	DRAWER><command>	Sets the CTC Condition Status Enable register.
CTC:ENABLE:COND?	1	DRAWER><command>	Returns the value of the CTC Condition Status Enable register.
CTC:ENABLE:EVENT	1	DRAWER><command>	Sets the CTC Event Status Enable register.
CTC:ENABLE:EVENT?	1	DRAWER><command>	Returns the contents of the CTC Event Status Enable register.
CTC:ENABLE:OUTOFF	1	DRAWER><command>	Sets the CTC Output Off Enable register.
CTC:ENABLE:OUTOFF?	1	DRAWER><command>	Returns the contents of the CTC Output Off Enable register.
CTC:EVEnt?	none	DRAWER><command>	Returns the contnets of the CTC Event Status register.
CTC:LIMit:TEMP	1	DRAWER><command>	Sets the case high temperature limit value.
CTC:LIMit:TEMP?	1	DRAWER><command>	Returns the value of the CTC high temperature limit setting.
CTC:MEASure:Resist ?	none	DRAWER>CTC:ZONE><command>	Returns the value of the CTC measured thermistor resistance.
CTC:MEASure:T?	none	DRAWER><command>	Returns the value of the measured temperature.
CTC:MEASure:ZONETE MP?	none	DRAWER>CTC:ZONE><command>	Returns the value of the measured temperature of a selected case temperature zone.
CTC:OUTPUT	1	DRAWER><command>	Turns on or off the case temperature control output.
CTC:OUTPUT?	1	DRAWER><command>	Returns the on or off value indicating CTC output.
CTC:PID	3	DRAWER><command>	Sets the case temperature controller Proportional, Integral, and Derivative terms.
CTC:PID?	none	DRAWER><command>	Returns the set Proportional, Integral, and Derivative term values.
CTC:SET:TEMP	1	DRAWER><command>	Sets the constant-temperature setpoint.
CTC:SET:TEMP?	1	DRAWER><command>	Returns the CTC temperature setpoint.
CTC:SET:ZONETEMP	1	DRAWER>CTC:ZONE><command>	Sets the constant-temperature setpoint for a specified zone.
CTC:SET:ZONETEMP?	1	DRAWER>CTC:ZONE><command>	Returns the CTC temperature setpoint for a specified zone.

Table 5.1 GPIB Command Summary Reference List

Command	Param	Routing	Function
CTC:SHCONST	3	DRAWER>CTC:ZONE><command>	Sets the Steinhart-Hart coefficients for the CTC thermistor in the selected zone.
CTC:SHCONST?	none	DRAWER>CTC:ZONE><command>	Returns the values of the Steinhart-Hart coefficients.
CTC:ZONE	1	DRAWER><command>	Selects a CTC zone in a drawer.
CTC:ZONE?	none	DRAWER><command>	Returns the selected CTC zone value.
DELAY	1	<command>	Used to create a delay in the execution of further commands.
DERR?	None	DRAWER><command>	Returns a list of drawer and command errors.
DIDN?	none	<command>	Returns the drawer identification string.
DRAWER	1	<command>	Designates the drawer that all subsequent commands are addressed.
DRAWER?	none	<command>	Returns the drawer number that commands are addressed.
ERR?	none	<command>	Returns a list of system and command errors.
*ESE	1	<command>	Used to load the Standard Event Status Enable Register.
*ESE?	none	<command>	Returns the value of the Standard Event Status Enable Register
*ESR?	none	<command>	Returns the value of the Standard Event Status Register
*IDN?	none	<command>	Returns the mainframe identification string.
ITC:CHANnel	1	DRAWER><command>	Selects a internal temperature controller channel.
ITC:CHANnel?	none	DRAWER><command>	Returns the selected internal temperature controller channel number.
ITC:COND?	none	DRAWER>ITC:CHAN><command>	Returns the contents (at the time of polling) of the ITC Condition Status register.
ITC:ENABLE:COND	1	DRAWER>ITC:CHAN><command>	Sets the ITC Condition Status Enable register.
ITC:ENABLE:COND?	none	DRAWER>ITC:CHAN><command>	Returns the value of the ITC Condition Status Enable register.
ITC:ENABLE:EVENT	1	DRAWER>ITC:CHAN><command>	Sets the ITC Event Status Enable register.
ITC:ENABLE:EVENT?	none	DRAWER>ITC:CHAN><command>	Returns the contents of the ITC Event Status Enable register.
ITC:ENABLE:OUTOFF	1	DRAWER>ITC:CHAN><command>	Sets the ITC Output Off Enable register.
ITC:ENABLE:OUTOFF?	none	DRAWER>ITC:CHAN><command>	Returns the contents of the ITC Output Off Enable register.
ITC:EVEnt?	none	DRAWER>ITC:CHAN><command>	Returns the contents of the ITC Event Status register.
ITC:LIMit:ITE	1	DRAWER>ITC:CHAN><command>	Sets the ITC current limit value.

Table 5.1 GPIB Command Summary Reference List

Command	Param	Routing	Function
ITC:LIMit:ITE?	none	DRAWER>ITC:CHAN><command>	Returns the value of the ITC current limit setting.
ITC:LIMit:TEMP	1	DRAWER>ITC:CHAN><command>	Sets the ITC high temperature limit value.
ITC:LIMit:TEMP?	none	DRAWER>ITC:CHAN><command>	Returns the value of the ITC high temperature limit setting.
ITC:MEASure:ITE?	none	DRAWER>ITC:CHAN><command>	Returns the value of the measured output current.
ITC:MEASure:R?	none	DRAWER>ITC:CHAN><command>	Returns the value of the measured thermistor resistance.
ITC:MEASure:TEMP?	none	DRAWER>ITC:CHAN><command>	Returns the value of the measured temperature.
ITC:OUTPUT	1	DRAWER>ITC:CHAN><command>	Turns on or off the ITC output.
ITC:OUTPUT?	none	DRAWER>ITC:CHAN><command>	Returns the ITC output state.
ITC:PID	3	DRAWER>ITC:CHAN><command>	Sets the internal temperature controller Proportional, Integral, and Derivative terms.
ITC:PID?	none	DRAWER>ITC:CHAN><command>	Returns the set Proportional, Integral, and Derivative term values.
ITC:SENsor	1	DRAWER>ITC:CHAN><command>	Sets the ITC thermistor sense current.
ITC:SENsor?	none	DRAWER>ITC:CHAN><command>	Returns the ITC thermistor sense current.
ITC:SET:TEMP	1	DRAWER>ITC:CHAN><command>	Sets the constant-temperature setpoint.
ITC:SET:TEMP?	none	DRAWER>ITC:CHAN><command>	Returns the value of the measured temperature.
ITC:SHCONST	3	DRAWER>ITC:CHAN><command>	Sets the Steinhart-Hart coefficients for the ITC temperature sensor.
ITC:SHCONST?	none	DRAWER>ITC:CHAN><command>	Returns the values of the Steinhart-Hart coefficients.
LASSTATLED	1	DRAWER><command>	Sets the Laser Status LED color on the front panel of a selected drawer.
*OPC	none	<command>	Generates the Operation Complete message in the Standard Event Status Register.
*OPC?	none	<command>	Places an ASCII character 1 into the Output Queue when all pending operations have been finished.
*PSC	1	<command>	Used to avoid any undesirable service requests.
*PSC?	none	<command>	Queries the power-on-status-clear flag.
RAD	1	<command>	Sets the radix for integer data. Decimal, binary, octal, or hexadecimal.
RAD?	none	<command>	Returns the radix type for numerical data.
*RST	none	<command>	Performs a device reset.

Table 5.1 GPIB Command Summary Reference List

Command	Param	Routing	Function
*SRE	1	<command>	Sets the Service Request Enable Register bits to allow generation of the user-selectable service requests.
*SRE?	none	<command>	Determines the current contents of the Service Request Enable Register.
*STB?	none	<command>	Reads the Status Byte.
TEMPSTATLED	1	DRAWER><command>	Sets the Temperature Status LED color on the front panel of a selected drawer.
TERM	1	<command>	Adds a carriage return to the device terminator.
TERM?	none	<command>	Returns the status of the TERM command.
TIME?	none	<command>	Returns the elapsed time since the system was last powered up.
TIMER?	none	<command>	Returns the elapsed time since the timer was last reset.
*TST?	none	<command>	Initiates an internal self-test and returns a response when complete.
*WAI	none	<command>	Prevents executing any further commands until the No-Operation-Pending flag is true.

Command Reference

The Command Reference presents the commands for operation of the LTS-9300, listed in alphabetical order. See Chapter 4, GPIB Interface Guide for detailed instructions about using the commands.

ALLCOND?

The ALLCOND? query returns the sum of the ALLCOND register contents.

Parameters None. The response is the sum of the following:

1 - Drawer 1 conditions
2 - Drawer 2 conditions
4 - Drawer 3 conditions
8 - Drawer 4 conditions
16 - Drawer 5 conditions
32 - Drawer 6 conditions

Notes All of the *bits* of the ALLCOND register are logically ORed to set or clear bit 0 of the Status Byte Register.

Typically, the ALLCOND? query is used in conjunction with the *STB? query. For example, if you read the status byte with *STB? and find bit 0 is set, then you send the ALLCOND? to discover which drawer has an alarm condition. Finally, send queries to the offending drawer and read its status.

The value of the ALLCOND register is *not* cleared until it is read using the ALLCOND? query.

Routing <command>

Examples ALLCOND?—response: 0, means the no channels have any enabled conditions to pass to the Status Byte register.

ALLCOND?—response: 9, means that channels 1 and 4 have enabled conditions. Bit 0 of the Status Byte register is set.

ALLEVE?

The ALLEVE? query returns the status summary of enabled events from each channel.

Parameters None. The response is the sum of the following:

1 - Channel 1 events	256 - Channel 9 events
2 - Channel 2 events	512 - Channel 10 events
4 - Channel 3 events	1024 - Channel 11 events
8 - Channel 4 events	2048 - Channel 12 events
16 - Channel 5 events	4096 - Channel 13 events
32 - Channel 6 events	8192 - Channel 14 events
64 - Channel 7 events	16384 - Channel 15 events
128 - Channel 8 events	32768 - Channel 16 events

Notes All of the *bits* of the ALLEVE register are logically ORed to set or clear bit 1 of the Status Byte Register.

Typically, the ALLEVE? query is used in conjunction with the *STB? query. For example, if you read the status byte with *STB? and find bit 1 is set, then you send the ALLEVE? to discover which drawer has an alarm event. Finally, send queries to the offending drawer to read its status.

The value of the ALLEVE register is *not* cleared until it is read using the ALLEVE? query.

Routing <command>

Examples ALLEVE?—response: 0, means the no channels have any enabled events to pass to the Status Byte register.

ALLEVE?—response: 19, means that channels 1, 2, and 5 have enabled conditions. Bit 0 of the Status Byte register is set.

*CLS

Clears status event registers: Event Status, Event Status Enable, and Error Queue.

Notes Useful to clear registers before enabling service requests (SRQ).

Routing <command>

Example *CLS

CS:CALPD

The CS:CALPD command sets the laser photodiode feedback responsivity (the CAL PD parameter).

Parameters An <nrf value>, in microamps/milliwatt (µA/mW).

Notes Optical power is calibrated by dividing the monitor feedback current by its CalPD value. Photodiode (PD) responsivity is frequently provided by manufacturers of packaged lasers with built-in power monitors, and is typically called *Monitor Detector Responsivity*. The monitor produces a current when the laser illuminates it, and this current increases with increasing laser optical power. Manufacturers of laser modules with integrated monitors may specify the responsivity of the monitor in terms of the laser optical power and the resulting monitor current. For example, a responsivity may be specified as 5 µA/mW, meaning that to produce a monitor current of 5 µA, the laser optical power must be 1 mW. Typically, the specified responsivity is entered into the current source as CalPD, using the CS:CalPD command.

If this parameter is set to 0, the system does not calculate the optical power.

Routing DRAWER>CS:CHAN><command>

Examples CS:CALPD 0—action: sets the CAL PD parameter to 0.

CS:Calpd 10.0—action: sets the CAL PD parameter to 10 microamps/milliwatt. A photodiode feedback current of 10 µA will cause the measured optical power to be 1 mW.

CS:CALPD?

The CS:CALPD? query returns the value of the laser photodiode feedback responsivity (CalPD parameter).

Parameters None. The response is an <nrf value>.

Routing DRAWER>CS:CHAN><command>

Examples CS:CALPD?óresponse: 1.1, means the laser CalPD is set to 1.10 µA/mW: a photodiode feedback current of 2.2 µA represents 2 mW of optical power.

CS:CALPDX

The CS:CALPDX command sets the external photodiode feedback responsivity.

Parameters An <nrf value>, in microamps/milliwatt (µA/mW).

Notes CALPDX sets the responsivity of the front facet photodiodes on the DUT tray. If the power of the DUT is to be measured, then the CALPDX must be calculated for each front facet photodiode by switching on the laser to a known power value and measuring the front facet photodiode current (CS:MEAS:MDX?). The responsivity is calculated by dividing the photodiode current by the incident power in units of µA/mW

If this parameter is set to 0, the system does not calculate the optical power.

Routing DRAWER>CS:CHAN><command>

Examples CS:CALPDX 0—action: sets the external CAL PD parameter to 0.

CS:Calpdx 10.0—action: sets the external CAL PD parameter to 10 microamps/milliwatt. A photodiode feedback current of 10 µA causes the measured optical power to be 1 mW.

CS:CALPDX?

The CS:CALPDX? query returns the value of the external photodiode feedback responsivity (CalPDS parameter).

Parameters None. The response is an <nrf value>.

Routing DRAWER>CS:CHAN><command>

Examples CS:CALPDX?—response: 1.1, means the external CalPD is set to 1.10 µA/mW: a photodiode feedback current of 2.2 µA represents 2 mW of optical power.

CS:CHANnel

The CS:CHANnel command sets the current source channel within a drawer to which all subsequent current source commands are addressed.

Parameters An <nrf value> 1-16, that represents the selected current source from a drawer.

Notes The drawer that the current source channel resides must be selected using the Drawer command before sending the CS:CHAN command. For more information see the command *DRAWER* on page *109* and *Command Sequence* on page *72*.

Routing DRAWER><command>

Examples CS:CHAN 16—action: any subsequent commands are performed on the current source channel 16.

CS:CHANnel?

The CS:CHANnel? query returns the selected channel.

Parameters None. The response is an <nrf value> representing the current source channel selected using the CS:CHANnel command.

Notes The drawer that the current source channel resides must be selected using the Drawer command before sending the CS:CHAN command. For more information see the command *DRAWER* on page *109* and *Command Sequence* on page *72*.

Routing DRAWER><command>

Examples CS:CHAN?—response: 16; indicates that current source channel 16 was selected using the CS:CHANnel command.

CS:COND?

The CS:COND? query returns the contents of the Laser Condition Status register.

Parameters None. The response is the sum of the following:

Bit	Value	Description	Bit	Value	Description
0	1 -	Output On	8	256 -	n/a
1	2 -	In Current Limit	9	512 -	n/a
2	4 -	Internal Photodiode Current Limit	10	1024 -	n/a
3	8 -	Internal Photodiode Power Limit	11	2048 -	n/a
4	16 -	External Photodiode Current Limit	12	4096 -	n/a
5	32 -	External Photodiode Power Limit	13	8192 -	n/a
6	64 -	CTC Over Temperature	14	16384 -	n/a
7	128 -	ITC Over Temperature	15	32768 -	n/a

Notes The CS:COND? query returns the contents of the Laser Condition Status Register for the specified channel. The Condition register reports the current status of the laser controller, and is continually updated by the mainframe.

Routing DRAWER>CS:CHAN><command>

Examples CS:COND?—response: 4, means that the internal photodiode is at or above the current limit.

CS:ENABLE:COND

The CS:ENABLE:COND command sets the Laser Condition Status Enable register. The bits in this register determine which bits in the Laser Condition Status register are summarized in the Status Byte.

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

Bit	Value	Description
0	1 -	Output On
1	2 -	In Current Limit
2	4 -	Internal Photodiode Current Limit
3	8 -	Internal Photodiode Power Limit
4	16 -	External Photodiode Current Limit
5	32 -	External Photodiode Power Limit
6	64 -	CTC Over Temperature
7	128 -	ITC Over Temperature

Notes This register can be read using the CS:ENABLE:COND query.

See the Status Reporting section of the manual for more information regarding condition reporting.

Routing DRAWER>CS:CHAN><command>

Examples CS:ENABLE:COND 32—action: only the external photodiode power limit condition sets bit 0 in the Status Byte Register.

CS:ENABLE:COND?

The CS:ENABLE:COND? query returns the value of the Laser Condition Status Enable register.

Parameters None. The response is the sum of the following:

Bit	Value	Description
0	1 -	Output On
1	2 -	In Current Limit
2	4 -	Internal Photodiode Current Limit
3	8 -	Internal Photodiode Power Limit
4	16 -	External Photodiode Current Limit
5	32 -	External Photodiode Power Limit
6	64 -	CTC Over Temperature
7	128 -	ITC Over Temperature

Notes The enabled laser conditions can be set by using the CS:ENABLE:COND command.

The current source condition status can be monitored by the CS:COND? query.

Routing DRAWER>CS:CHAN><command>

Examples CS:ENAB:COND?—response: 32, means that only the external photodiode power limit condition sets bit 0 in the Status Byte Register.

CS:ENABLE:EVENT

The CS:ENABLE:EVENT command sets the Laser Event Status Enable register. The bits in this register determine which bits in the Laser Event Status register are summarized in the LTS-9300 Status Byte.

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

Bit	Value	Description	Bit	Value	Description
0	1 -	Output Went On	8	256 -	External Photodiode Current Above Limit
1	2 -	Output Went Off	9	512 -	External Photodiode Power Below Limit
2	4 -	In Current Limit	10	1024 -	External Photodiode Power Above Limit
3	8 -	Not In Current Limit	11	2048 -	External Photodiode Power Below Limit
4	16 -	Internal Photodiode Current Above Limit	12	4096 -	CTC Over Limit
5	32 -	Internal Photodiode Current Below Limit	13	8192 -	CTC Not Over Limit
6	64 -	Internal Photodiode Power Above Limit	14	16384 -	ITC Over Limit
7	128 -	Internal Photodiode Power Below Limit	15	32768 -	ITC Not Over Limit

Notes This register is read with the CS:ENABLE:EVENT query. The laser event status is monitored by the CS:ENABLE:EVENT? query.

See the Status Reporting section of the LTS-9300 manual for more information regarding condition reporting.

Routing DRAWER>CS:CHAN><command>

Examples CS:ENABLE:EVENT 20óaction: bit 1 of the Status Byte register is set if the photodiode current goes above limit or the laser current goes into limit.

CS:ENABLE:EVENT?

The CS:ENABLE:EVENT? query returns the contents of the current source event Status Enable register.

Parameters None. The response is the sum of the following:

Bit	Value	Description	Bit	Value	Description
0	1 -	Output Went On	8	256 -	External Photodiode Current Above Limit
1	2 -	Output Went Off	9	512 -	External Photodiode Power Below Limit
2	4 -	In Current Limit	10	1024 -	External Photodiode Power Above Limit
3	8 -	Not In Current Limit	11	2048 -	External Photodiode Power Below Limit
4	16 -	Internal Photodiode Current Above Limit	12	4096 -	CTC Over Limit
5	32 -	Internal Photodiode Current Below Limit	13	8192 -	CTC Not Over Limit
6	64 -	Internal Photodiode Power Above Limit	14	16384 -	ITC Over Limit
7	128 -	Internal Photodiode Power Below Limit	15	32768 -	ITC Not Over Limit

Notes This register is set using the CS:ENABLE:EVENT command. The laser event status can be monitored by the CS:ENABLE:EVENT? query.

Routing DRAWER>CS:CHAN><command>

Examples CS:ENABLE:EVENT?—response: 20, means that bit 1 of the Status Byte register is set if the photodiode current goes above limit or the laser current goes into limit.

CS:ENABLE:OUTOFF

The CS:ENABLE:OUTOFF command sets the current source Output Off Enable register. The bits in this register specify the conditions that will cause the laser current source to automatically turn off.

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

Bit	Value	Description
0	1 -	Output On
1	2 -	In Current Limit
2	4 -	Internal Photodiode Current Limit
3	8 -	Internal Photodiode Power Limit
4	16 -	External Photodiode Current Limit
5	32 -	External Photodiode Power Limit
6	64 -	CTC Over Temperature
7	128 -	ITC Over Temperature

Notes This register is read using the CS:ENABLE:OUTOFF? query.

The factory default value for this register is 192: CTC Over Temperature and ITC over Temperature shuts off the output. No settings are saved, the system returns to the default setting at power-up.

Routing DRAWER>CS:CHAN><command>

Examples CS:ENABLE:OUTOFF 9—action: sets the current source Output-Off enable register so that either a Power Limit or a Current Limit condition will cause the current source output to be turned off.

Open Circuit or Interlock Open conditions will always turn off the current source. They are not included in the Output Off Enable Register because they cannot be disabled.

CS:ENABLE:OUTOFF?

The CS:ENABLE:OUTOFF? query returns the contents of the current source Output Off Enable register.

Parameters None. The response is the sum of the following:

Bit	Value	Description
0	1 -	Output On
1	2 -	In Current Limit
2	4 -	Internal Photodiode Current Limit
3	8 -	Internal Photodiode Power Limit
4	16 -	External Photodiode Current Limit
5	32 -	External Photodiode Power Limit
6	64 -	CTC Over Temperature
7	128 -	ITC Over Temperature

Notes This register can be set by using the CS:ENABLE:OUTOFF command. The laser output status can be monitored by the LASER:EVEnt? query. No settings are saved, the system returns to the default setting at power-up.

Routing DRAWER>CS:CHAN><command>

Examples CS:ENABLE:OUTOFF?—response: 8, means that the Power Limit condition will cause the laser output to be turned off.

CS:EVENTS?

The CS:EVENTS? query returns the contents of the Laser Event Status register.

Parameters None. The response is the sum of the following:

Bit	Value	Description	Bit	Value	Description
0	1 -	Output Went On	8	256 -	External Photodiode Current Above Limit
1	2 -	Output Went Off	9	512 -	External Photodiode Power Below Limit
2	4 -	In Current Limit	10	1024 -	External Photodiode Power Above Limit
3	8 -	Not In Current Limit	11	2048 -	External Photodiode Power Below Limit
4	16 -	Internal Photodiode Current Above Limit	12	4096 -	CTC Over Limit
5	32 -	Internal Photodiode Current Below Limit	13	8192 -	CTC Not Over Limit
6	64 -	Internal Photodiode Power Above Limit	14	16384 -	ITC Over Limit
7	128 -	Internal Photodiode Power Below Limit	15	32768 -	ITC Not Over Limit

Notes The CS:EVENTS? query returns the contents of the Laser Event Status Register for the specified channel. The Event register stores information about the events that have occurred since the last time the register was queried or cleared. The register is cleared when it is queried with the CS:EVENTS? query of when the mainframe is reset with the *CLS command.

Routing DRAWER>CS:CHAN><command>

Examples CS:EVENTS?—response: 131, means that an Open Circuit Changed State event (128), a Voltage Limit Changed State event (2), and a Current Limit Changed State event (1) have occurred since the last CS;EVENTS? query.

CS:LIMIT:LDI

The CS:LIMIT:LDI command sets the laser current limit value.

Parameters An <nrf value> that represents the laser limit current, in mA.

Notes CS:LIM:LDI sets a hardware current limit forcing the instrument to only drive the LDI to the limit value. For example, if the LIM:LDI is set to 300 mA and you enter a set point of 500 mA in constant current mode, the instrument current drive cannot exceed 300 mA. Similarly, if the instrument is in constant power mode, the maximum possible current is 300 mA.

If the LDI limit is reached, bit 1 in the CS:COND register is set to 1.

Routing DRAWER>CS:CHAN><command>

Examples CS:LIMIT:LDI 50.0—action: the laser output current set point value is limited to 50.0 mA.

CS:LIMit:LDI?

The CS:LIMit:LDI? query returns the laser constant-current limit setpoint value.

Parameters None. The response is an <nrf value>.

Notes CS:lIM:LDI sets a hardware current limit forcing the instrument to only drive the LDI to the limit value. For example, if the LIM:LDI is set to 300 mA and you enter a set point of 500 mA in constant current mode, the instrument current drive cannot exceed 300 mA. Similarly, if the instrument is in constant power mode, the maximum possible current is 300 mA.

Routing DRAWER>CS:CHAN><command>

Examples CS:LIM:I?—response: 40, means the laser current limit is 40 mA.

CS:LIM:I?—response: 300, means the laser current limit is 300 mA.

CS:LIMit:MDI

The CS:LIMit:MDI command sets the monitor photodiode current limit.

Parameters An <nrf value> that represents the photodiode current setpoint limit, in µA.

Notes The monitor photodiode current is dependent on the laser optical output power.

CS:LIM:MDI sets a software limit so that if the monitor diode current limit is reached, bit 2 of CS:COND register is set to 1. If the MDI limit is reached the LDI is neither limited nor prevented from increasing. The LDI may increase once the MDI limit is reached, but LDI will not increase past the LIM:LDI value.

Routing DRAWER>CS:CHAN><command>

Examples CS:LIM:MDI 30.0—action: sets the laser monitor photodiode current limit to 30.0 mA, for use in constant MDI mode.

CS:LIMit:MDI?

The CS:LIMit:MDI? query returns the monitor photodioe current limit setpoint value.

Parameters — None. The response is an <nrf value> representing the monitor photodiode current limit in µA.

Notes — The monitor photodiode current is dependent on the laser optical output power.

CS:LIM:MDI sets a software limit so that if the monitor diode current limit is reached, bit 2 of CS:COND register is set to 1. If the MDI limit is reached, the LDI is neither limited nor prevented from increasing. The LDI may increase once the MDI limit is reached, but LDI will not increase past the LIM:LDI value.

The system can be configured to shut off the current source if the MDP limit is reached. See *CS:ENABLE:OUTOFF* on page *92*.

Routing — DRAWER>CS:CHAN><command>

Examples — CS:LIM:MDI?—response: 30.0, means the monitor photodiode current limit is 30.0 µA.

CS:LIMit:MDP

The CS:LIMit:MDP command sets the laser optical power limit. If the measured optical power exceeds this value, the current source output is shut off and a Power Limit error is generated.

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

Notes — CS:LIM:MDP sets a software limit; if the MDP limit is reached, bit 3 of the CS:COND register is set to 1. If the MDP limit is reached, the LDI is neither limited nor prevented from increasing. The LDI may increase once the MDP limit is reached, but LDI will not increase past the LIM:LDI value.

This measurement is derived from the monitor photodiode current (MDI): it is calculated by dividing the MDI by the CalPD. If CalPD is 0, this query returns a –1.0.

Routing — DRAWER>CS:CHAN><command>

Examples — CS:LIM:MDP 200—action: sets the laser monitor photodiode power (optical power) limit to 200 mW.

CS:LIMit:MDP?

The CS:LIMit:MDP? query returns the laser optical power limit setpoint.

Parameters — None. The response is an <nrf value>.

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

This measurement is derived from the monitor photodiode current (MDI): it is calculated by dividing the MDI by the CalPD. If CalPD is 0, this query returns a –1.0.

Routing — DRAWER>CS:CHAN><command>

Examples — CS:LIM:MDP?óresponse: 300.0, means the monitor PD power limit is set to 300.0 mW.

CS:MEASure:LDI?

The CS:MEASure:LDI? query returns the measured laser current in mA.

Parameters None. The response is an <nrf value>.

Notes Response is the measured laser output current, regardless of control mode. The measurement is initiated as a result of the query.

Routing DRAWER>CS:CHAN><command>

Examples CS:MEAS:LDI?—response: 30.0, means the measured laser output current is 30.0 mA.

CS:MEAS:LDI?—response: 149.6, means the measured laser output current is 149.6 mA.

CS:MEASure:LDV?

The CS:MEASure:LDV? query returns the measured laser voltage.

Parameters None. The response is an <nrf value>.

Notes Response is the measured Laser output voltage in Volts, regardless of control mode. The measurement is initiated as a result of the query.

Routing DRAWER>CS:CHAN><command>

Examples CS:MEAS:LDV?—response: 3.03, means the measured laser output voltage is 3.03 volts.

CS:MEAS:LDV?—response: 1.0, means the measured laser output voltage is 1.00 volts.

CS:MEASure:MDI?

The CS:MEASure:MDI? query returns the value of the laser photodetector (monitor photodiode) current measurement, in µA.

Parameters None. The response is an <nrf value>.

Notes The response is the measured photodiode current in µA regardless of control mode. The measurement is initiated as a result of the query.

Routing DRAWER>CS:CHAN><command>

Examples CS:MEAS:MDI?—response: 57.3, means 57.3 µA was measured on the laser monitor photodiode circuit.

CS:MEASure:MDP?

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

Parameters None. The response is an <nrf value>.

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

This measurement is derived from the monitor photodiode current (MDI) and CalPD value. If CalPD is 0, this query returns a –1.0.

The measurement is initiated as a result of the query.

Routing DRAWER>CS:CHAN><command>

Examples CS:MEAS:MDP?—response: 100.0, means Laser's optical power is calculated to be 100 mW.

CS:MEASure:MDX?

The CS:MEASure:MDX? query returns the external photodiode current value.

Parameters None. The response is an <nrf value> in µA.

Notes The measurement is initiated as a result of the query.

Routing DRAWER>CS:CHAN><command>

Examples CS:MEAS:MDX?—response: 5000; indicates the external PD value is 5000 µA.

CS:MEASure:MDXP?

The CS:MEASure:MDXP? query returns the external photodiode power value.

Parameters None. The response is an <nrf value> in mW.

Notes This measurement is derived from the external monitor photodiode current (MDX) and CALPDX value. If CalPD is 0, this query returns a -1.0.

This measurement depends on the CalPD. The measurement is initiated as a result of the query.

Routing DRAWER>CS:CHAN><command>

Examples CS:MEAS:MDXP?—response: 100; indicates the external photodiode power value measured is 100 mW.

CS:MODE

The CS:MODE: command path is used to set a select current source in constant current (ACC) or constant power (APC) mode.

Parameters An <nrf value>; LDI, MDI, or MDP.

Notes CS: MODE LDI sets the system to operate in constant laser current mode. CS:MODE MDI sets the system to operate in constant photodiode current mode. CS:MODE MDP sets the system to operate in constant power mode using the monitor photodiode.

Routing DRAWER>CS:CHAN><command>

Examples CS:MODE LDI—action: sets the system to operate in constant laser current mode.

CS:MODE?

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

Parameters None. The response is character data (which represents the operating mode).

Notes LDI is constant current mode. MDP is constant power mode. MDI is monitor photodiode current.

Routing DRAWER>CS:CHAN><command>

Examples CS:MODE?—response: LDI, means that constant current mode is in effect for the laser output.

CS:Mode?—response: MDP, means that constant optical power mode is in effect for the laser output.

CS:Mode?—response: MDI, means that constant monitor current mode is in effect for the laser

CS:OUTPUT

	The CS:OUTPUT command turns on or off the laser output.
Parameters	An <nrf value>; 1 = on, 0 = off.
Notes	After the laser output is turned on, it may be useful to wait until the output is fully on before performing further operations, but it is not necessary. When the output is turned on, there is a two second delay before the output is actually enabled. This delay is a safety requirement. When a current source output is off, an internal short is placed across the output terminals.
Routing	DRAWER>CS:CHAN><command>
Examples	CS:LDI 20; CS:out on—action: sets the laser output current to 20 mA and then turns the laser output on. CS:Out 0—action: turns off the laser current source.

CS:OUTput?

	The CS:OUTput? query returns the status of the laser output switch.
Parameters	None. The response is an <nrf value>.
Notes	Although the status of the switch is on, the output may not have reached the set point value.
Routing	DRAWER>CS:CHAN><command>
Examples	CS:OUT?—response: 0, means that the laser output switch is disabled; devices may be safely disconnected or connected at the laser output terminal. CS:OUT?—response: 1, means that the laser output switch is enabled.

CS:SET:LDI

	The CS:SET:LDI command is used to set the laser current setpoint.
Parameters	An <nrf value> that represents the current in mA.
Notes	The LDI set point is only in effect when operating in LDI mode.
Routing	DRAWER>CS:CHAN><command>
Examples	CS:SET:LDI 50.0—action: the laser output current set point value is set to 50.0 mA.

CS:SET:LDI?

	The CS:SET:LDI? query returns the laser constant-current setpoint.
Parameters	None. The response is an <nrf value> which represents the constant current set point value, in mA.
Notes	The LDI set point is only in effect when operating in LDI mode.
Routing	DRAWER>CS:CHAN><command>
Examples	CS:SET:LDI?—response: 50.0, means the laser output current set point value is 50.0 mA.

CS:SET:MDI

The CS:SET:MDI command is used to set the monitor photodiode current setpoint value.

Parameters	An <nrf value> that represents the current in µA.
Notes	The monitor photodiode current is dependent on the laser optical output power. Therefore, the MDI set point may be used to control optical output of the laser.
Routing	DRAWER>CS:CHAN><command>
Examples	CS:SET:MDI—action: 30.0, configures the laser monitor photodiode current setpoint to 30 µA, for use in constant MDI mode.

CS:SET:MDI?

The CS:SET:MDI? query returns the monitor photodiode current setpoint value.

Parameters	None. The response is an <nrf value> which represents the constant MDI set point value, in µA.
Notes	The monitor photodiode current is dependent on the laser optical output power. Therefore, the MDI set point may be used to control optical output of the laser.
Routing	DRAWER>CS:CHAN><command>
Examples	CS:SET:MDI?—response: 30.0, means the laser monitor photodiode current setpoint is 30 µA, for use in constant MDI mode.

CS:SET:MDP

The CS:SET:MDP command is used to set the laser monitor PD power setpoint value.

Parameters	An <nrf value> that represents the constant power set point, in mW.
Notes	This set point is used in constant MDP mode only. The CALPD value must be calibrated and entered.
Routing	DRAWER>CS:CHAN><command>
Examples	CS:Set:MDP 10.0—action: configures the laser monitor PD feedback set point to 10.0 mW.

CS:SET:MDP?

The CS:SET:MDP? query returns the laser monitor PD power setpoint value.

Parameters	None. The response is an <nrf value> that represents the constant power set point, in mW.
Notes	This set point is used in constant MDP mode only. The CALPD value must be calibrated and entered.
Routing	DRAWER>CS:CHAN><command>
Examples	CS:Set:MDP?—response: 10.0, means the laser monitor PD feedback set point is 10.0 mW.

CTC:COND?

The CTC:COND? query returns the contents (at the time of polling) of the CTC Condition Status register.

Parameters None. The res7ponse is the sum of the following:

Bit	Value	Description
0	1 -	CTC On
1	2 -	CTC Temperature Limit
2	4 -	CTC Short Circuit
3	8 -	CTC Output Problem
4	16 -	CTC Sensor Open
5	32 -	CTC Sensor Short
6	64 -	CTC Fan Problem
7	128 -	Interlock Not Enabled

Notes The CTC:COND? query returns the contents of the Case Temperature Status Register for the specified channel. The Condition register reports the current status of the CTC and is continually updated by the mainframe.

Routing DRAWER><command>

Examples CTC:COND?—response: 1, means that the CTC Output is On.

CTC:COND?—response: 2, means that the CTC Output is on (1) and the output is in temperature limit (1).

CTC:ENABle:COND

The CTC:ENABle:COND command sets the CTC Condition Status Enable register. The bits in this register determine the bits in the CTC Condition Status register that are summarized in the Status Byte.

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

Bit	Value	Description
0	1 -	CTC On
1	2 -	CTC Temperature Limit
2	4 -	CTC Short Circuit
3	8 -	CTC Output Problem
4	16 -	CTC Sensor Open
5	32 -	CTC Sensor Short
6	64 -	CTC Fan Problem
7	128 -	Interlock Not Enabled

Notes This register can be read using the CTC:ENABle:COND? query.

See *Status Reporting* on page *76* for more information regarding condition reporting.

Routing DRAWER><command>

Examples CTC:ENAB:COND 9—action: the only conditions from the system that are reported to the Status Byte are the Temperature Limit (8) and Current Limit (1) conditions.

CTC:ENABle:COND?

The CTC:ENABle:COND? query returns the value of the CTC Condition Status Enable register.

Parameters None. The response is the sum of the following:

Bit	Value	Description
0	1 -	CTC On
1	2 -	CTC Temperature Limit
2	4 -	CTC Short Circuit
3	8 -	CTC Output Problem
4	16 -	CTC Sensor Open
5	32 -	CTC Sensor Short
6	64 -	CTC Fan Problem
7	128 -	Interlock Not Enabled

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

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

Routing DRAWER><command>

Examples CTC:ENAB:COND?—response: 640, means that only the following two conditions will be reported (in summarized form) to the Status Byte: In Tolerance (512) and Open Circuit (128).

CTC:ENABLE:EVENT

The CTC:ENABLE:EVENT command sets the CTC Event Status Enable register. The bits in this register determine the CTC events that are summarized.

Parameters An <nrf value> whose sum represents the events that are enabled:

Bit	Value	Description	Bit	Value	Description
0	1 -	CTC Went On	8	256 -	CTC Sensor Open
1	2 -	CTC Went Off	9	512 -	CTC Sensor Not Open
2	4 -	CTC Temperature Limit	10	1024 -	CTC Sensor Shorted
3	8 -	CTC Not Temperature Limit	11	2048 -	CTC Sensor Not Shorted
4	16 -	CTC Short Circuit	12	4096 -	CTC Fan Problem
5	32 -	CTC Not Short Circuit	13	8192 -	CTC No Fan Problem
6	64 -	CTC Output Problem	14	16384 -	Interlock was Disabled
7	128 -	CTC Not Output Problem	15	32768 -	Interlock was Enabled

Notes The contents of this register are read with the CTC:ENABLE:EVENT? query.

Events can be monitored using the CTC:EVEnt? query.

See *Status Reporting* on page *76* for more information regarding event reporting.

Routing DRAWER><command>

Examples CTC:ENABLE:EVENT 136—action: only the *Open Circuit* (128) and *Temperature Limit* (8) events are reported (in summarized form) to the Status Byte.

CTC:ENABLE:EVENT?

The CTC:ENABLE:EVENT? query returns the contents of the CTC Event Status Enable register.

Parameters None. The response is the sum of the following:

Bit	Value	Description	Bit	Value	Description
0	1 -	CTC Went On	8	256 -	CTC Sensor Open
1	2 -	CTC Went Off	9	512 -	CTC Sensor Not Open
2	4 -	CTC Temperature Limit	10	1024 -	CTC Sensor Shorted
3	8 -	CTC Not Temperature Limit	11	2048 -	CTC Sensor Not Shorted
4	16 -	CTC Short Circuit	12	4096 -	CTC Fan Problem
5	32 -	CTC Not Short Circuit	13	8192 -	CTC No Fan Problem
6	64 -	CTC Output Problem	14	16384 -	Interlock was Disabled
7	128 -	CTC Not Output Problem	15	32768 -	Interlock was Enabled

Notes This register is set using the CTC:ENABLE:EVENT command. The CTC event status can be monitored by the CTC:EVEnt? query.

Routing DRAWER><command>

Examples CTC:ENABLE:EVENT?—response: 512, means that the *Tolerance Changed* event is the only event that the CTC reports to the Status Byte.

CTC:ENABle:OUTOFF

The CTC:ENABle:OUTOFF command sets the CTC Output Off Enable register. The bits in this register specify the conditions that cause CTC to automatically turn off.

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

Bit	Value	Description
0	1 -	CTC On
1	2 -	CTC Temperature Limit
2	4 -	CTC Short Circuit
3	8 -	CTC Output Problem
4	16 -	CTC Sensor Open
5	32 -	CTC Sensor Short
6	64 -	CTC Fan Problem
7	128 -	Interlock Not Enabled

Notes Read this register using the CTC:ENABle:OUTOFF? query.

The factory default value for this register is 142: the conditions that cause the output to shut off are Temperature Limit, Short Circuit, Output Problem, and Interlock disabled (2+4+8+128).

Routing DRAWER><command>

Examples CTC:ENABle:OUTOFF 72—action: sets the CTC Output-Off enable register so that either a Sensor Open (64) or Temperature Limit (8) condition causes the ITC output to be turned off.

CTC:ENABle:OUTOFF?

The CTC:ENABle:OUTOFF? query returns the contents of the CTC Output Off Enable register.

Parameters None. The response is the sum of the following:

Bit	Value	Description
0	1 -	CTC On
1	2 -	CTC Temperature Limit
2	4 -	CTC Short Circuit
3	8 -	CTC Output Problem
4	16 -	CTC Sensor Open
5	32 -	CTC Sensor Short
6	64 -	CTC Fan Problem
7	128 -	Interlock Not Enabled

Notes This register can be set by using the CTC:ENABle:OUTOFF command.

Routing DRAWER><command>

Examples CTC:ENABle:OUTOFF?—response: 8, means that the CTC output problem is the only condition that causes the CTC output to turn off.

CTC:EVEnt?

The CTC:EVEnt? query returns the contents of the CTC Event Status register.

Parameters None. The response is the sum of the following:

Bit	Value	Description	Bit	Value	Description
0	1 -	CTC Went On	8	256 -	CTC Sensor Open
1	2 -	CTC Went Off	9	512 -	CTC Sensor Not Open
2	4 -	CTC Temperature Limit	10	1024 -	CTC Sensor Shorted
3	8 -	CTC Not Temperature Limit	11	2048 -	CTC Sensor Not Shorted
4	16 -	CTC Short Circuit	12	4096 -	CTC Fan Problem
5	32 -	CTC Not Short Circuit	13	8192 -	CTC No Fan Problem
6	64 -	CTC Output Problem	14	16384 -	Interlock was Disabled
7	128 -	CTC Not Output Problem	15	32768 -	Interlock was Enabled

Notes The CTC:EVEnt? query returns the contents of the Case Temperature Controller Event Status Register for the specified channel. The Event register stores information about the events that have occurred since the last time the register was queried or cleared. The register is cleared when it is queried with the CTC:EVEnt? query of when the mainframe is reset with the *CLS command.

Routing DRAWER><command>

Examples CTC:EVEnt?—response: 131, means that an Output Circuit Opened event (128), a *Voltage Limit Occurred* event (2), and a *Current Limit Occurred* event (1) have occurred since the last CTC:EVEnt? query.

CTC:LIMit:TEMP

The CTC:LIMit:TEMP command sets the case high temperature limit value.

Parameters: An <nrf value> that represents the CTC high temperature limit, in degrees Celsius.

Notes: By default, the CTC output is turned off when the measured temperature exceeds this setting. See *CTC:ENABle:OUTOFF* on page *102* for more information. There is no low temperature limit.

The range for the temperature limit is 0 to 100 °C.

Routing: DRAWER><command>

Examples: CTC:LIM:TEMP 87.5—action: set the CTC temperature limit to 87.5 °C.

CTC:LIMit:TEMP?

The CTC:LIMit:TEMP? query returns the value of the CTC high temperature limit setting.

Parameters: None. The response is an <nrf value>.

Notes: High temperature limit is valid for all modes of operation. There is no low temperature limit.

Routing: DRAWER><command>

Examples: CTC:LIMit:TEMP?—response: 92.0, means the CTC high temperature limit is set to 92.0 °C.

CTC:MEASure:Temp?

The CTC:MEAS:Temp? query returns the value of the measured temperature in the drawer.

Parameters: None. The response is an <nrf value> representing the measured temperature, in °C.

Notes: The CTC:MEAS:Temp? query returns the average temperature value for all four zones in a selected drawer. The measurement is initiated as a result of the query.

Routing: DRAWER><command>

Examples: CTC:MEAS:Temp?—response: 13.1, means the measured CTC temperature is 13.1 °C.

CTC:MEASure:ZONETEMP?

The CTC:MEAS:ZONETEMP? query returns the value of the measured temperature for a particular zone in a drawer.

Parameters: None. The response is an <nrf value> representing the measured temperature, in °C.

Notes: The CTC:MEAS:ZONETEMP? query returns the temperature value for a zone in a selected drawer. The zone is specified using the *CTC:ZONE* command. For information about selecting a zone see *CTC:ZONE* on page *108*. The measurement is initiated as a result of the query.

Routing: DRAWER>CTC:ZONE><command>

Examples: CTC:MEAS:ZONETEMP?—response: 13.1, means the measured zonal temperature is 13.1 °C.

CTC:MEASure:Resist?

The CTC:MEAS:Resist? query returns the value of the CTC measured thermistor resistance per zone.

Parameters None. The response is an <nrf value> representing the measured thermistor resistance, in kΩ.

Notes Response is the measured thermistor resistance, regardless of control mode, for a particular zone. The zone is specified using the *CTC:ZONE* command. For information about selecting a zone see *CTC:ZONE* on page *108*. The measurement is initiated as a result of the query.

Routing DRAWER>CTC:ZONE><command>

Examples CTC:MEAS:R?—response: 16.7, means the measured CTC thermistor resistance is 16.7 kΩ.

CTC:OUTPUT

The CTC:OUTPUT command turns on or off the case temperature control output.

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

Notes After the CTC output is turned on, ILX recommends waiting until the output is stable before performing further operations.

The character strings *OFF* and *ON* may be used in place of 0 and 1.

This command turns on or off CTC output for the entire drawer.

Routing DRAWER><command>

Examples CTC:OUTPUT 1—action: turns on the CTC output.

CTC:OUTPUT OFF—action: turns off the CTC.

CTC:OUTPUT?

The CTC:OUTPUT query

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

Notes After the CTC output is turned on, ILX recommends waiting until the output is stable before performing further operations.

The character strings *OFF* and *ON* may be used in place of *0* and *1*.

Examples SHELF 1:CTC:OUTPUT 1—action: turns on the CTC output.

CTC:OUTPUT OFF—action: turns off the CTC.

CTC:PID

The CTC:PID command sets the case temperature controller Proportional, Integral, and Derivative terms.

Parameters Three floating point <nrf values> representing the Proportional, Integral, and Derivative terms.

Notes The system uses the Proportional, Integral, and Derivative terms to quickly settle the CTC temperature. The PID constants are set at the factory; the three constants work together and changing one affects the performance of the other two. ILX recommends using the default values: P=80.0, I=0.60, D=0.036Contact ILX Lightwave Customer

Service for more information about setting PID constants (see *Comments, Suggestions, and Problems* on page *v* for contact information).

Routing DRAWER><command>

Examples CTC:PID 28.0, 0.15, 0.036—action: the Proportional term is set to 28.0, the Integral term is set to 0.15, and the Derivative term is set to 0.036.

CTC:PID?

The CTC:PID query returns the set Proportional, Integral, and Derivative term values.

Parameters None. Three values representing the Proportional, Integral, and Derivative terms are returned

Notes The system uses the Proportional, Integral, and Derivative terms to quickly settle the CTC temperature. The PID constants are set at the factory; the three constants work together and changing one affects the performance of the other two. ILX recommends using the default values. Contact ILX Lightwave Customer Service for more information about setting PID constants (see *Comments, Suggestions, and Problems* on page *v* for contact information).

Routing DRAWER><command>

Examples CTC:PID?—response: 28.0, 0.15, 0.036 indicates that the Proportional term is set to 1.1, the Integral term is set to 6.5, and the Derivative term is set to 0.0.

CTC:SET:TEMP

The CTC:SET:TEMP command sets the constant-temperature setpoint for all zones in a specified drawer.

Parameters An <nrf value> representing the temperature setting, in °C.

Notes This setting is always stored when the command is valid.

This command sets the constant-temperature setpoint for the entire drawer.

Routing DRAWER><command>

Examples CTC:SET:TEMP 12—action: sets the CTC temperature setpoint to 12 °C.

CTC:SET:TEMP?

The CTC:SET:TEMP? query returns the CTC temperature setpoint.

Parameters None. The response is an <nrf value> representing the measured temperature, in °C.

Notes This setting is always stored when the command is valid.

This CTC:SET:TEMP command sets the constant-temperature setpoint for the entire drawer.

Routing DRAWER><command>

Examples CTC:SET:TEMP?óresponse: 13.1, means the measured CTC temperature is 13.1 °C.

CTC:SET:ZONETEMP

The CTC:SET:ZONETEMP command sets the constant-temperature setpoint for a specific zone in a drawer.

Parameters — An <nrf value> representing the temperature setting, in °C.

Notes — This setting is always stored when the command is valid.

This command sets the constant-temperature setpoint for the entire drawer.

Routing — DRAWER>CTC:ZONE><command>

Examples — CTC:SET:ZONETEMP 25—action: sets the CTC temperature setpoint to 25 °C for the selected zone.

CTC:SET:ZONETEMP?

The CTC:SET:TEMP? query returns the CTC temperature setpoint for a specific zone in a drawer.

Parameters — None. The response is an <nrf value> representing the measured temperature, in °C.

Notes — This setting is always stored when the command is valid.

This CTC:SET:ZONETEMP command sets the constant-temperature setpoint for the entire drawer.

Routing — DRAWER>CTC:ZONE><command>

Examples — CTC:SET:ZONETEMP?óresponse: 25.1, means the measured CTC temperature is 25.1 °C for the selected zone.

CTC:SHCONST

The CTC:SHCONST command sets the Steinhart-Hart coefficients for the CTC thermistor.

Parameters — Three <nrf values> are required. The first one represents C1, the second is C2, and the third is C3. The range for all three constants is -99.999 to 99.999. The system scales each value by an exponential value that is appropriate for that constant's part in the Steinhart-Hart equation.

Notes — If any one of the values is less than -99.999, an under-range error will be generated. Values over 99.999 will cause an over-range error. In either case, none of the constants will be modified.

A thermistor's Steinhart-Hart coefficients are typically supplied by the thermistor manufacturer.

Routing — DRAWER>CTC:ZONE><command>

Examples — CTC:CONST 0.9,1.2,2.3—action: sets the TEC Steinhart-Hart coefficients to C1=0.9, C2=1.2, C3=2.3.

CTC:SHCONST?

The CTC:SHCONST? query returns the values of the Steinhart-Hart coefficients.

Parameters None. The response data represents the values of C1, C2, and C3, in that order.

Notes These values are pre-scaled so that the exponential value is not given. The actual value of C1 is scaled by 10^3, C2 by 10^4, and C3 by 10^7.

Routing DRAWER>CTC:ZONE><command>

Examples TEC:CONST?—response: 0.9,1.1,2.2: C1, C2, and C3 are 0.9, 1.1, and 2.2.

CTC:ZONE

The CTC:ZONE command selects a CTC zone in a drawer.

Parameters An <nrf value>; 1-4 representing four CTC zones in a drawer

Notes The CTC:ZONE command must be used when querying specific zones of the CTC. Once a zone is selected, all relevant subsequent commands address the selected zone.

Use the DRAWER command to select a drawer. See the command *DRAWER* on page *109*.

Routing DRAWER><command>

Examples CTC:ZONE 1—action: zone 1 of a drawer is selected.

CTC:ZONE?

The CTC:ZONE? query returns the selected CTC zone value.

Parameters None. An <nrf value> representing one of four CTC zones in a selected drawer (1-4).

Notes The CTC:ZONE command must be used when querying specific zones of the CTC. Once a zone is selected, all relevant subsequent commands address the selected zone.

Use the DRAWER command to select a drawer. See the command *DRAWER* on page *109*.

Routing DRAWER><command>

Examples CTC:ZONE?—response: 1; indicates that zone 1 of the CTC is selected.

DELAY

The DELAY command causes the execution of commands to be delayed by a user-defined time interval.

Parameters An <nrf value> which represents the delay time, in milliseconds.

Notes Further commands are held off until the delay period elapses.

This command is useful for creating delays which do not require very much program code and do not tie up the GPIB during execution.

Routing <command>

Examples DELAY 500—action: Further commands and queries are not executed until 0.5 second has elapsed from the time this command is executed.

DERR?

The DERR? query returns a list of drawer and command errors for a specified drawer. Any drawer errors reported have occurred since the last DERR? query. The errors are notated by a number (code) that corresponds to the type of error that occurred.

Parameters None. The response consists of one or more drawer error code values, separated by commas.

Notes A response of (0) indicates that no errors were reported. The response data is sent as character data.

Routing DRAWER><command>

Examples DERR?—response: 0 means no drawer errors reported.

DERR?—response: 501, means that the drawer has a laser interlock error that is preventing the laser output from being turned on.

DIDN?

The DIDN? query returns the drawer name and serial number for the specified drawer.

Parameters None. The response consists of the model number, serial number, and version number, separated by commas.

Routing DRAWER><command>

Examples DIDN?—response: 3926374,03740001,v1.00.

DRAWER

The DRAWER command designates the drawer that all subsequent commands are addressed.

Parameters An <nrf value> 1-6, that represents the selected drawer.

Notes It is only necessary to designate a drawer once for a series of commands sent to that drawer. Once the drawer is selected, all subsequent commands are sent to that drawer until a different drawer is selected.

Routing <command>

Examples DRAWER 6—action: any subsequent commands are performed/directed to drawer six.

DRAWER?

The DRAWER? query returns the drawer number that all commands are addressed.

Parameters None.

Notes It is only necessary to designate a drawer once for a series of commands sent to that drawer. Once the drawer is selected, all subsequent commands are sent to that drawer until a different drawer is selected.

Routing <command>

Examples DRAWER?—result: 6, any commands are being sent to drawer six.

ERRors?

The ERRors? query returns a list of system and command errors, followed by a binary representation of the occurrence of system and command error. The system errors are those which have occurred since the last ERR? query. The errors are notated by a number (code) which corresponds to the type of error which occurred.

Parameters None. The response consists of one or more drawer error code values, separated by commas.

Notes A response of 0,000000 indicates that no errors were reported. The response data is sent as character data.

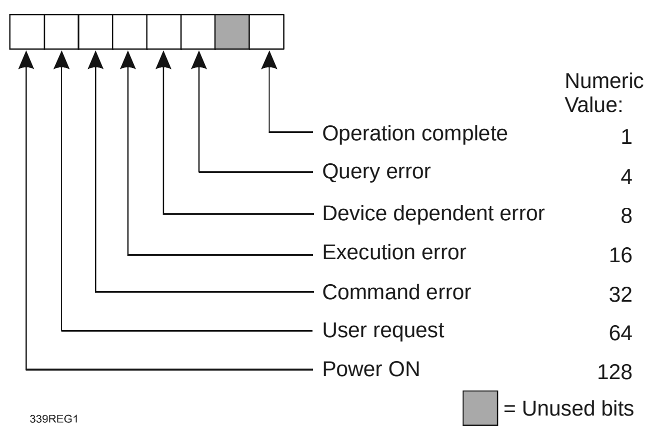
Routing <command>

Examples ERR?—response: 0,000110, the zero to the left of the comma indicates that there are no system level errors, and the binary representation to the right of the comma indicates that there are errors in drawers 2 and 3. (Drawer 6 is on the left, drawer 1 is on the right)

*ESE <nrf value>

Enables bits in the standard event status enable register.

Response The value must be between 0 and 255.



Routing <command>

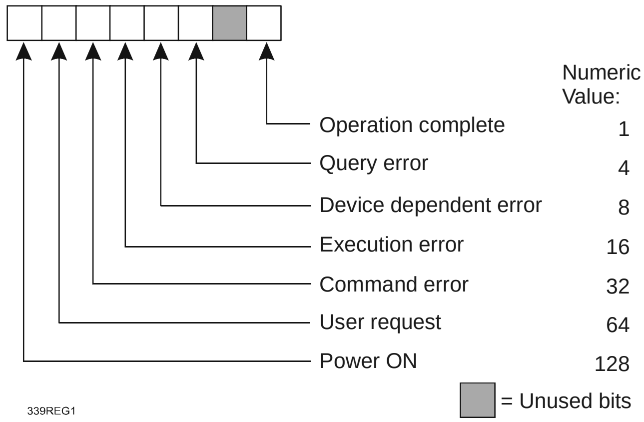
Notes Bit 5 of the status byte register is set if any enabled conditions are true.

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

*ESE?

Requests the value in the standard event status enable register.

Response The value must be between 0 and 255.



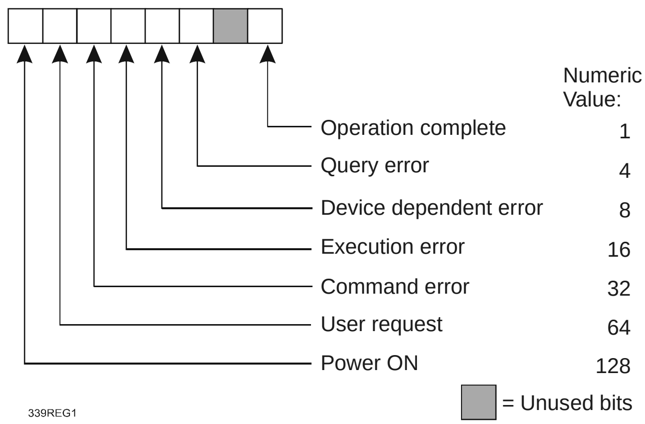
Notes Bit 5 of the status byte register is set if any enabled conditions are true. Response is the sum of the enabled bits.

Routing <command>

*ESR?

Requests the value in the standard event status register.

Response The value must be between 0 and 255.



Notes Response is the sum of the enabled bits.

This command allows you to determine which type of error has occurred.

Routing <command>

*IDN?

Requests the mainframe to identify itself.

Parameters None.

Notes There are three fields provide information about the system; the type, serial number and firmware version.

Routing <command>

Examples IDN?—Returns a comma delimited standard format ASCII identification string, from information stored in the instrument during manufacture.

ITC:CHANNel

The ITC:CHANnel command selects a internal temperature controller channel.

Parameters An <nrf value>; 1-16 representing the one of sixteen internal temperature controllers per drawer.

Notes Use the DRAWER command to select a drawer. See the command, *DRAWER* on page *109*.

Routing DRAWER><command>

Examples ITC:CHAN 16—action: internal temperature controller 16 is selected.

ITC:CHANnel?

The ITC:CHANnel? query returns the selected internal temperature controller channel number.

Parameters None. An <nrf value> indicating the channel that is selected.

Notes Use the DRAWER command to select a drawer. See the command, *DRAWER* on page *109*.

Routing DRAWER><command>

Examples ITC:CHAN?—response: 16; indicates that ITC channel 16 was selected using the ITC:CHAN command.

ITC:COND?

The ITC:COND? query returns the contents (at the time of polling) of the ITC Condition Status register.

Parameters None. The response is the sum of the following:

Bit	Value	Description
0	1 -	ITC On
1	2 -	ITC Temperature Limit
2	4 -	ITC Short Circuit
3	8 -	ITC Output Problem
4	16 -	ITC Sensor Open
5	32 -	ITC Sensor Short
6	64 -	Interlock Disabled
7	128 -	Current Limit

Notes The ITC:COND? query returns the contents of the Internal Temperature Controller Status Register for the specified channel. The Condition register reports the current status of the laser controller, and is continually updated by the mainframe.

Routing DRAWER>ITC:CHAN><command>

Examples ITC:COND?—response: 1, means that the ITC Output is On.

ITC:COND?—response: 2, means that the ITC Output is on (1) and the output is in current limit (1).

ITC:ENABle:COND

The ITC:ENABle:COND command sets the ITC Condition Status Enable register. The bits in this register determine the bits in the ITC Condition Status register that are summarized in the Status Byte.

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

Bit	Value	Description
0	1 -	ITC On
1	2 -	ITC Temperature Limit
2	4 -	ITC Short Circuit
3	8 -	ITC Output Problem
4	16 -	ITC Sensor Open
5	32 -	ITC Sensor Short
6	64 -	Interlock Disabled
7	128 -	Current Limit

Notes This register can be read using the ITC:ENABle:COND? query.

See *Status Reporting* on page *76* for more information regarding condition reporting.

Routing DRAWER>ITC:CHAN><command>

Examples ITC:ENAB:COND 9—action: the only conditions from the system that are reported to the Status Byte are the Temperature Limit (8) and Current Limit (1) conditions.

ITC:ENABle:COND?

The ITC:ENABle:COND? query returns the value of the ITC Condition Status Enable register.

Parameters None. The response is the sum of the following:

Bit	Value	Description
0	1 -	ITC On
1	2 -	ITC Temperature Limit
2	4 -	ITC Short Circuit
3	8 -	ITC Output Problem
4	16 -	ITC Sensor Open
5	32 -	ITC Sensor Short
6	64 -	Interlock Disabled
7	128 -	Current Limit

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

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

Routing DRAWER>ITC:CHAN><command>

Examples ITC:ENAB:COND?—response: 640, means that only the following two conditions will be reported (in summarized form) to the Status Byte: In Tolerance (512) and Open Circuit (128).

ITC:ENABLE:EVENT

The ITC:ENABLE:EVENT command sets the ITC Event Status Enable register. The bits in this register determine the ITC events that are summarized.

Parameters An <nrf value> whose sum represents the events that are enabled:

Bit	Value	Description	Bit	Value	Description
0	1 -	ITC Went On	8	256 -	Sensor Open
1	2 -	ITC Went Off	9	512 -	Sensor Not Open
2	4 -	Temperature Limit	10	1024 -	Sensor Shorted
3	8 -	Not Temperature Limit	11	2048 -	Sensor Not Shorted
4	16 -	Short Circuit	12	4096 -	Interlock Disabled Output
5	32 -	Not Short Circuit	13	8192 -	Interlock Enabled Output
6	64 -	Output Problem	14	16384 -	Current In Limit
7	128 -	Not Output Problem	15	32768 -	Current Out of Limit

Notes The contents of this register are read with the ITC:ENABLE:EVENT? query.

Events can be monitored using the ITC:EVEnt? query.

See *Status Reporting* on page *76* for more information regarding event reporting.

Routing DRAWER>ITC:CHAN><command>

Examples ITC:ENABLE:EVENT 136—action: only the *Open Circuit* (128) and *Temperature Limit* (8) events are reported (in summarized form) to the Status Byte.

ITC:ENABLE:EVENT?

The ITC:ENABLE:EVENT? query returns the contents of the ITC Event Status Enable register.

Parameters None. The response is the sum of the following:

Bit	Value	Description	Bit	Value	Description
0	1 -	ITC Went On	8	256 -	Sensor Open
1	2 -	ITC Went Off	9	512 -	Sensor Not Open
2	4 -	Temperature Limit	10	1024 -	Sensor Shorted
3	8 -	Not Temperature Limit	11	2048 -	Sensor Not Shorted
4	16 -	Short Circuit	12	4096 -	Interlock Disabled Output
5	32 -	Not Short Circuit	13	8192 -	Interlock Enabled Output
6	64 -	Output Problem	14	16384 -	Current In Limit
7	128 -	Not Output Problem	15	32768 -	Current Out of Limit

Notes This register is set using the ITC:ENABLE:EVENT command. The ITC event status can be monitored by the ITC:EVEnt? query.

Routing DRAWER>ITC:CHAN><command>

Examples ITC:ENABLE:EVENT?—response: 512, means that the *Tolerance Changed* event is the only event that the ITC reports to the Status Byte.

ITC:ENABle:OUTOFF

The ITC:ENABle:OUTOFF command sets the ITC Output Off Enable register. The bits in this register specify the conditions that cause ITC to automatically turn off.

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

Bit	Value	Description
0	1 -	ITC On
1	2 -	ITC Temperature Limit
2	4 -	ITC Short Circuit
3	8 -	ITC Output Problem
4	16 -	ITC Sensor Open
5	32 -	ITC Sensor Short
6	64 -	Interlock Disabled
7	128 -	Current Limit

Notes Read this register using the ITC:ENABle:OUTOFF? query.

The factory default value for this register is 142: the conditions that cause the output to shut off are Temperature Limit, Short Circuit, Output Problem, and Interlock disabled (2+4+8+128).

If you set bit 9 in this register, the output shuts off whenever the controlled temperature is out of tolerance. The tolerance conditions must include the ambient temperature to turn on the output. Make sure the temperature is within your tolerance specification before setting this bit.

Routing DRAWER>ITC:CHAN><command>

Examples ITC:ENABle:OUTOFF 72—action: sets the ITC Output-Off enable register so that either a Sensor Open (64) or Temperature Limit (8) condition causes the ITC output to be turned off.

ITC:ENABle:OUTOFF?

The ITC:ENABle:OUTOFF? query returns the contents of the ITC Output Off Enable register.

Parameters None. The response is the sum of the following:

Bit	Value	Description
0	1 -	ITC On
1	2 -	ITC Temperature Limit
2	4 -	ITC Short Circuit
3	8 -	ITC Output Problem
4	16 -	ITC Sensor Open
5	32 -	ITC Sensor Short
6	64 -	Interlock Disabled
7	128 -	Current Limit

Notes This register can be set by using the ITC:ENABle:OUTOFF command.

Routing DRAWER>ITC:CHAN><command>

Examples ITC:ENABle:OUTOFF?—response: 8, means that the ITC Temperature Limit is the only condition that causes the ITC output to turn off.

ITC:EVEnt?

The ITC:EVEnt? query returns the contents of the ITC Event Status register.

Parameters None. The response is the sum of the following:

Bit	Value	Description	Bit	Value	Description
0	1 -	ITC Went On	8	256 -	Sensor Open
1	2 -	ITC Went Off	9	512 -	Sensor Not Open
2	4 -	Temperature Limit	10	1024 -	Sensor Shorted
3	8 -	Not Temperature Limit	11	2048 -	Sensor Not Shorted
4	16 -	Short Circuit	12	4096 -	Interlock Disabled Output
5	32 -	Not Short Circuit	13	8192 -	Interlock Enabled Output
6	64 -	Output Problem	14	16384 -	Current In Limit
7	128 -	Not Output Problem	15	32768 -	Current Out of Limit

Notes The ITC:EVEnt? query returns the contents of the Internal Temperature Controller Event Status Register for the specified channel. The Event register stores information about the events that have occurred since the last time the register was queried or cleared. The register is cleared when it is queried with the ITC:EVEnt? query of when the mainframe is reset with the *CLS command.

Routing DRAWER>ITC:CHAN><command>

Examples ITC:EVEnt?—response: 131, means that an Output Circuit Opened event (128), a *Voltage Limit Occurred* event (2), and a *Current Limit Occurred* event (1) have occurred since the last ITC:EVEnt? query.

ITC:LIMit:ITE

The ITC:LIMit:ITE command sets the ITC current limit value for a selected ITC channel.

Parameters: An <nrf value> that represents the ITC limit current, in Amps.

Notes: The current limit parameter must be a positive value. It is applied to both positive and negative current drives.

You must select the ITC channel. See the command *ITC:CHANnel* on page *112*.

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:LIMit:ITE 0.8—action: the ITC current limit is set to 0.8 A.

ITC:LIMit:ITE?

The ITC:LIMit:ITE? query returns the value of the ITC current limit setting, in Amps.

Parameters: None. The response is an <nrf value>.

Notes: You must select the ITC channel. See the command *ITC:CHANnel* on page *112*

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:LIMit:ITE?—response: 0.9, means the ITC current limit is 0.9 A.

ITC:LIMit:TEMP

The ITC:LIMit:TEMP command sets the ITC high temperature limit value.

Parameters: An <nrf value> that represents the ITC high temperature limit, in degrees Celsius.

Notes: By default, the ITC output is turned off when the measured temperature exceeds this setting.

The range for the temperature limit is 0 to 199.9 °C.

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:LIMit:TEMP 87.5—action: set the ITC temperature limit to 87.5 °C.

ITC:LIMit:TEMP?

The ITC:LIMit:TEMP? query returns the value of the ITC high temperature limit setting.

Parameters: None. The response is an <nrf value>.

Notes: There is no low temperature limit.

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:LIMit:TEMP?—response: 92.0, means the ITC high temperature limit is 92.0 °C.

ITC:MEASure:ITE?

The ITC:MEASure:ITE? query returns the value of the measured measured ITC current.

Parameters: None. The response is an <nrf value> representing the measured ITE current, in Amps.

Notes: Response is the measured thermistor resistance, regardless of control mode. Make sure to select the ITC channel, before sending the ITC:MEAS:ITE? query. The measurement is initiated as a result of the query.

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:MEASure:ITE?—response: –0.7, means the measured ITC output current is –0.7 A.

ITC:MEASure:R?

The ITC:MEASure:TEMP? query returns the value measured thermistor resistance.

Parameters: None. The response is an <nrf value> representing the measured thermistor resistance, in kΩ.

Notes: Response is the measured thermistor resistance, regardless of control mode. Make sure to select the ITC channel, before sending the ITC:MEAS:ITE? query. The measurement is initiated as a result of the query.

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:MEASure:R?—response: 16.7; means the measured ITC thermistor resistance is 16.7 kΩ.

ITC:MEASure:TEMP?

The ITC:MEASure:TEMP? query returns the value of the measured temperature.

Parameters: None. The response is an <nrf value> representing the measured temperature, in °C.

Notes: The measured temperature is calculated from the measured thermistor resistance using the Steinhart-Hart equation and the Steinhart-Hart coefficients entered using the ITC:SHCONST command. The measurement is initiated as a result of the query.

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:MEASure:TEMP?—response: 13.1, means the measured ITC temperature is 13.1 °C.

ITC:OUTPUT

The ITC:OUTPUT command turns the ITC output on or off.

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

Notes: After the ITC output is turned on, it may be useful to wait until the output is stable before performing further operations, but it is not necessary.

The character strings *OFF* and *ON* may be used in place of *0* and *1*.

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:OUTPUT 1—action: turns the ITC output on.

ITC:OUTPUT OFF—action: turns off the ITC.

ITC:OUTPUT?

The ITC:OUTPUT? query returns the ITC output state.

Parameters: None. The response is an <nrf value>.

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

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:OUTPUT?—response: 0, means that the ITC is off.

ITC:OUTPUT?—response: 1, means that the ITC is turned on.

ITC:PID

The ITC:PID command sets the internal temperature controller Proportional, Integral, and Derivative terms.

Parameters: Three floating point <nrf values> representing the Proportional, Integral, and Derivative terms.

Notes: The system uses the Proportional, Integral, and Derivative terms to quickly settle the ITC temperature. The PID constants are set at the factory; the three constants work together and changing one affects the performance of the other two. ILX recommends using the default values: P=2.00, I=0.32, D=0.50. Contact ILX Lightwave Customer Service for more information about setting PID constants (see *Comments, Suggestions, and Problems* on page *v* for contact information).

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:PID 2.0, 0.32, 0.5—action: the Proportional term is set to 2.0, the Integral term is set to 0.32, and the Derivative term is set to 0.5.

ITC:PID?

The ITC:PID query returns the set Proportional, Integral, and Derivative term values.

Parameters: None. Three values representing the Proportional, Integral, and Derivative terms are returned.

Notes: The system uses the Proportional, Integral, and Derivative terms to quickly settle the ITC temperature. The PID constants are set at the factory; the three constants work together and changing one affects the performance of the other two. ILX recommends using the default values. Contact ILX Lightwave Customer Service for more information about setting PID constants (see*Comments, Suggestions, and Problems* on page *v* for contact information).

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:PID?—response: 2.0, 0.32, 0.5 indicates that the Proportional term is set to 2.0, the Integral term is set to 0.32, and the Derivative term is set to 0.5.

ITC:SENsor

The ITC:SENsor command sets the ITC thermistor sense current.

Parameters: An <nrf value> representing the desired thermistor sense current. The number 1 represents 100 μA and 2 represents 10 μA.

Notes: The sense current is applied through the thermistor, and the resulting voltage is measured by the system. The measured voltage range is 0-5V. The best sense current to use depends on the expected thermistor resistance at the setpoint. In general, use 100 μA for a resistance less than 50 kΩ, and 10 μA for larger values. The largest possible voltage swing in the vicinity of the setpoint results in the best stability.

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:SENsor 1—action: sets the ITC thermistor current to 100 μA.

ITC:SENsor?

The ITC:SENsor? query returns the ITC thermistor sense current.

Parameters: None. The response is an <nrf value> representing the sense current. The number 1 represents 100 µA and 2 represents 10 µA.

Notes: The sensor current is always applied, regardless of the control mode.

Routing: DRAWER>ITC:CHAN><command>

Examples: ITC:SENsor?—response: 1 indicates the sense current is 100 µA.

ITC:SET:TEMP

The ITC:SET:TEMP command sets the constant-temperature setpoint.

Parameters: An <nrf value> representing the constant temperature setting, in °C.

Notes: This setting is always stored when the command is valid, but it is only used when the ITC is in constant temperature mode. Make sure to select the ITC channel.

This setting is read using the ITC:SET:TEMP? query

Routing: DRAWER>ITC:CHAN><command>

Example: ITC:SET:TEMP 12—action: sets the TEC temperature setpoint to 12 °C.

ITC:SET:TEMP?

The ITC:SET:TEMP? query returns the temperature setpoint value.

Parameters: None. The response is an <nrf value> representing the measured temperature, in °C.

Notes: The measured temperature is calculated from the measured thermistor resistance using the Steinhart-Hart equation and the Steinhart-Hart coefficients entered using the ITC:SHCONST command. Make sure to select the ITC channel.

Routing: DRAWER>ITC:CHAN><command>

Example: ITC:SET:TEMP?óresponse: 13.1, means the measured ITC temperature is 13.1 °C.

ITC:SHCONST

The ITC:SHCONST command sets the Steinhart-Hart coefficients for the ITC temperature sensor.

Parameters: Three <nrf values> are required. The first one represents C1, the second is C2, and the third is C3. The range for all three constants is –99.999 to 99.999. The system scales each value by an exponential value that is appropriate for that constant's part in the Steinhart-Hart equation.

Notes: If any one of the values is less than –99.999, an under-range error will be generated. Values over 99.999 will cause an over-range error. In either case, none of the constants will be modified.

Routing: DRAWER>ITC:CHAN><command>

Example: ITC:SHCONST 0.9, 1.2, 2.3—action: sets the ITC Steinhart-Hart coefficients to C1=0.9, C2=1.2, C3=2.3.

ITC:SHCONST?

The ITC:SHCONST? query returns the values of the Steinhart-Hart coefficients.

Parameters None. The response data represents the values of C1, C2, and C3, in that order.

Notes These values are pre-scaled so that the exponential value is not given. The actual value of C1 is scaled by 10^{-3}, C2 by 10^{-4}, and C3 by 10^{-7}.

Routing DRAWER>ITC:CHAN><command>

Example ITC:SHCONST?—response: 0.9, 1.1, 2.2: C1, C2, and C3 are 0.9, 1.1, and 2.2.

LASSTATLED

The LASSTATLED command sets the Laser Status LED color on the front panel of a selected drawer.

Parameters A string: ON, OFF, RED, GREEN, or ORANGE.

Notes Setting LASSTATLED to ON defaults the LED color to green. The LASSTATLED command is useful for turning on or off the Laser Status indicator on a selected shelf when a user-defined condition is met. For example, the Laser Status LED illuminates green when a user-defined current measurement is achieved.

Routing DRAWER>LASSTATLED

Example LASSTATLED ON—action: the Laser Status LED on the drawer front panel illuminates green.

LASSTATLED RED—action: the Laser Status LED on the drawer front panel illuminates red.

*OPC

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

Parameters None.

Routing <command>

Example *OPC

*OPC?

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

Parameters None.

Routing <command>

Example *OPC?—response: 1, when all overlapped commands are complete.

*PSC

Sets automatic power-on clearing of the enable registers.

Parameters	An <nrf value>: 0, disable power-on clearing; and 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.
Routing	<command>
Examples	*PSC 0—Disable automatic power-on clearing of the enable registers. *PSC 1—Enable automatic power-on clearing of the enable registers.

*PSC?

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

Parameters	None,
Notes	Registers affected: Condition Status Enable: Service Request Enable Event Status Enable: Standard Event Status Enable See Chapter Three for more information on register structure.
Routing	<command>
Example	*PSC?—response: 0, means the enable registers are saved through power OFF/ON; and 1, means the enable registers are cleared during power ON.

RADix

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 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 (#Q).

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.

Routing — <command>

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?

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.

Parameters — None. The response will be character data. A response of DEC means decimal, BIN means binary, HEX means hexadecimal, and OCT means octal.

Notes — DEC is the default type. The System 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.

Routing — <command>

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.

*RST

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 mainframe to complete its reset process (no operations pending) before continuing with other operations.
Routing	<command>
Example	*RST

*SRE

	Enables bits in the service request enable register.
Notes	Response is the sum of the enabled bits.
Routing	<command>
Example	*SRE 136—Enable the service request enable register condition summary and error message bits (8 + 128 = 136).

*SRE?

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

*STB?

	Requests the value in the status byte register.
Notes	Response is the sum of the enabled bits.
	See *Event and Condition Registers* on page *76* for more information about register structure.
Routing	<command>
Example	*STB?—Response 200 means the status byte condition and master status summary bits, and error message bits, are enabled. (8 + 64 + 128 = 200)

TEMPSTATLED

The TEMPSTATLED command sets the Temperature Status LED color on the front panel of a selected drawer.

Parameters A string: ON, OFF, RED, GREEN, or ORANGE.

Notes Setting TEMPSTATLED to ON defaults the LED color to green. The TEMPSTATLED command is useful for illuminating the Temperature Status indicator on a selected shelf when a user-defined condition is met. For example, the Temp Status LED illuminates green when a user-defined current measurement is achieved.

Routing DRAWER>TEMPSTATLED

Example TEMPSTATLED ON—action: the Temp Status LED on the drawer front panel illuminates green.

TEMPSTATLED RED—action: the Temp Status LED on the drawer front panel illuminates red.

TERM

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, 1 = TRUE

Notes An altered terminator will be in the form <CR><NL><^END>. Technically this takes the system out of IEEE488.2 specification, but this command can be used for convenience when using non-standard GPIB controllers. This termination is sent with all output until the TERM 0 command is sent or the system is powered off.

Routing <command>

Examples TERM 1—temporarily sets <CR><NL><^END> as the output terminator.

TERM?

The TERM? query allows the programmer to determine whether the default (IEEE488.2 standard) terminator has been altered to include a carriage return.

Parameters None. The response is an <nrf value>, 1 = TRUE, 0 = FALSE.

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 system is powered off.

Routing <command>

Examples TERM?—response: 1, means that the <CR><NL><^END> terminator is temporarily being used.

TERM?—response: 0, means that the <NL><^END> terminator (IEEE 488.2 standard) is being used.

TIME?

The TIME? query allows the programmer to determine how much time has passed since the system was last powered up.

Parameters None. The response is character data in the form: hours:minutes:seconds.

Notes The TIME clock is independent of the TIMER clock.

Routing <command>

Examples TIME?—response: 00:01:02.36, means that 1 minute, 2.36 seconds have passed since the system was powered up.

TIME?—response: 00:32:00.76, means that 32 minutes, 0.76 second have passed since the system was powered up.

TIMER?

The TIMER? query allows the programmer to determine how much time has passed since the last TIMER? query was issued.

Parameters None. The response is character data in the form: hours:minutes:seconds.

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.

Routing <command>

Examples TIMER?—response: 00:02:00.31, means the system has been on for 2 minutes, 0.31 seconds since the last TIMER? query was issued.

TIMER?—response: 00:00:12.03, means the system has been on for 12.03 seconds since the last TIMER? query was issued.

*TST?

Performs internal self-test, then reports results.

Notes 0 = test completed with no errors.

Non-zero = test not completed, or was completed with errors.

Routing <command>

Example TST?

*WAI

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 controller 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.
Routing	<command>
Example	*WAI—Wait until OPC status is true.

CHAPTER 6

TROUBLESHOOTING

The Troubleshooting chapter is to help you resolve problems quickly. If you need help, contact ILX Lightwave Customer Service. See page *v* for contact information.

ILX Lightwave Corporation offers flexible service contracts for the LTS-9300. Expert help center and field support is available, night or day, seven days a week. Please contact ILX Customer Support (see *Comments, Suggestions, and Problems* on page *v* for contact information) for additional information.

For further assistance with technical solutions and troubleshooting, visit the www.ilxlightwave.com Support page (www.ilxlightwave.com/support/index.html), and the Library page (www.ilxlightwave.com/library/index.html) for Application Notes and Technical Notes.

WARNING

Potentially lethal voltages exist within the LTS-9300 Laser Diode Test System. To avoid electric shock, do not perform any maintenance on the system; only the drawers and rear panel are user-accessible. Do not attempt to remove the side-panels or other coverings.

Troubleshooting Guide

This section is a guide to troubleshooting the LTS-9300. Some of the more common symptoms are listed here, and the appropriate troubleshooting actions are given. If problems persist, contact ILX Customer Service (see page *v* for contact information).

WARNING

Potentially lethal voltages exist within the LTS-9300 Laser Diode Test System. To avoid electric shock, do not perform any maintenance on the system; only the drawers and rear panel are user-accessible. Do not attempt to remove the side-panels or other coverings.

Table 6.1 Troubleshooting

Symptom	Corrective Action
General	
Unit will not power up.	Check AC Power line voltage and power cord connection.
Power on, but outputs have been shut off. Instrument is locked up or instrument resets itself.	This may occur if the instrument loses power (AC line) briefly or line voltage drops below specification. If instrument is locked up, power it off and then on to restart.
Outputs have been shutoff, but there are no system errors.	Check for mainframe errors on the Main menu.
TE Controller	
Power on, but no TE current output.	Check the DUT tray connector (pins 1, 2, 3, 4) and operating mode for the effected channels.
Power on, but temperature is not controlled.	If there is a SENSOR OPEN indication (E402), check the DUT tray sensor connectors (pins 7,8) for the effected channels. Check that the proper sensor current range is selected. The 10 µA setting is required if the thermistor resistance is more than 50 kW. See Application note #2 at www.ilxlightwave.com/library/index.html or contact ILX Customer Service. Check that C1, C2, and C3 are the correct values for your thermistor. See Application note #4 at www.ilxlightwave.com/library/index.html or contact ILX Customer Service. Check that the GAIN setting is not too low and that the ILim value is not too low for your thermal load. See Technical Solutions on the Support page at www.ilxlightwave.com.
Unable to adjust output or parameter.	Make sure that the desired parameter is highlighted. Make sure that you are not trying to set TSet to a higher value than TLim, or ISet higher than ILim. Make sure that the operation mode allows you to set the parameter; for instance, it is impossible to set LDI with the current source in MDI mode.

Table 6.1 Troubleshooting

Symptom	Corrective Action
Output turns off or turns off intermittently.	Check that the AC power cord connection is secure. Power-line dropouts may reset the unit and when power is restored, the output will be off. Check the TE connections. A high impedance on the TE load can cause the output to exceed the compliance voltage momentarily. If enabled with GPIB, this condition will shut off the output. There are other events or conditions that will turn the output off if enabled with GPIB. See *Event and Condition Registers* on page *76* for more information. Check the sensor connections at the load. Changing control modes while the output is on will turn the output off.

Error Codes

The LTS-9300 indicates general operational error conditions through the GPIB. This section contains descriptions of the potential errors from the system as a whole, and from individual drawers.

Testing for Errors

For more information about specific GPIB commands, see Chapter 5, *Command Reference* for information about the ERR? and DERR? queries.

1 Send the query `ERR?` to read the system errors and a drawer error summary.

This allows you to error-check the LTS-9300 as a whole. If any drawer errors are present, the corresponding bit of the drawer error summary is set. For example, suppose the system responds to an ERR? query with the string 0,000110. The zero to the left of the comma indicates that there are no system level errors, and the binary representation to the right of the comma indicates that there are errors in drawers 2 and 3. (Drawer 6 is on the left, drawer 1 is on the right).

2 Send the query `DERR?` to read the drawer errors.

For example, type `DRAWER 6 ;DERR?` to return the errors in drawer 6, and `DRAWER 5;DERR?` returns any errors in drawer 5.

Table 6.2 Error Code Classifications

Error Code Range	Area of Operation
100-199	Command/Parser Errors
200-299	Execution Control Errors
300-399	GPIB Errors
400-499	Case Temperature Controller Errors
500-599	Current Source Errors
600-699	Internal Temperature Controller Errors
700-799	System Errors

Table 6.2 Error Code Classifications

Error Code Range	Area of Operation
800-899	Internal Drawer Errors
900-999	Drawer Communication Errors

Table 6.3 Error Codes[1]

Error Code	Explanation
103	Length of arbitrary block is different from expected length
104	Parameter is an undefined numeric type
105	Parameter has an invalid exponent
106	A digit was expected in the parameter but was not found
114	Specified arbitrary block length is invalid
123	Command is not found
124	An unknown command has been sent
125	Parser syntax error
126	Wrong number of parameters for command. Too few or too many program data elements
127	Invalid parameter type
130	Query not supported
131	Command not supported
133	Bad parameter type
201	Parameter value out of range
202	Error in conversion of parameter type
203	Command is a secure command, but secure commands are disabled
204	Suffix is invalid
205	Expected Boolean parameter is invalid
206	Error in conversion to signed 16-bit integer
207	Error in conversion to unsigned 16-bit integer
208	Error in conversion to signed 32-bit integer
209	Error in conversion to unsigned 32-bit integer
210	Error in conversion to floating-point number
211	Error in conversion to character pointer
212	Error in conversion to byte pointer
214	Response is too long to output
222	Set value is over range
226	Error in arbitrary block specification
227	Invalid channel selection
228	String delimiter not found

Table 6.3 Error Codes[1]

Error Code	Explanation
301	A <RESPONSE MESSAGE> was ready, but the mainframe failed to address the device to talk.
302	Device was addressed to talk, but mainframe failed to read all of the message
401	CTC was forced to turn on or off due to a problem
402	CTC calibration has failed
403	CTC reset has failed
404	CTC calibration constants are invalid
405	Invalid sensor selection
406	Output turned off; conditions matched output-off enable register
407	PID constants are invalid
408	CTC board not responding at initialization
501	A current source module is out of range
502	Change in CS control mode attempted while current source was turned on
504	Output turned off; conditions matched output-off enable register
601	ITC was forced to turn on or off due to a problem
604	ITC calibration constants are invalid
606	Output turned off; conditions matched output-off enable register
608	Temperature setpoint sent when controller is in calibration mode
710	System temperature error
711	System temperature error
712	System temperature error
713	Power Brown-out Error detected
826	Internal error: processor halted
830	Internal hardware problem
831	Internal hardware problem
832	Subsystem communication problem
833	Internal hardware problem
834	Internal hardware problem
835	Internal hardware problem
836	Internal hardware problem
837	Internal hardware problem
838	Internal hardware problem
839	Internal hardware problem
840	Internal hardware problem
841	Internal hardware problem
850	Internal firmware problem
851	Internal firmware problem

Table 6.3 Error Codes[1]

Error Code	Explanation
9XX	Drawer communication errors

1. Errors codes not listed are reserved for future design use.