

USER'S GUIDE

LDS-7200



LASER DIODE SOURCE



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NOTICES

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SUBJECT MATER

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PSE Technology shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

PRINTING HISTORY

New editions are complete revisions of the guide reflecting alterations in the functionality of the instrument. Updates are occasionally made to the guide

between editions. The part number in the lower right hand corner on the title page changes when an updated guide is published. To find out the current revision of the guide, or to purchase an updated guide, contact your PSE Technology representative.

WARRANTY

This PSE Technology product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, PSE will, at its option, either repair or replace products that prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by PSE. Buyer shall prepay shipping charges to PSE and PSE shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to PSE from another country.

PSE warrants that its software and firmware designated by PSE for use with an instrument will execute its programming instructions when properly installed on that instrument. PSE does not warrant that the operation of the instrument, software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing,

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EXCLUSIVE REMEDY

The remedies provided herein are Buyer's sole and exclusive remedies. PSE Technology shall not be liable for any direct, indirect, special, incidental or consequential damages whether based on contract, tort, or any other legal theory.

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.

CERTIFICATION

PSE Technology certifies that this product met its published specifications at the time of shipment from the factory.

This product is produced to ISO 9001 international quality system standard as part of our objective of continually increasing customer satisfaction through improved process control.

CUSTOMER SERVICE

COMMENTS, SUGGESTIONS, AND PROBLEMS

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

Phone (970) 344-4774

Fax (970) 344-6012

E-mail support@psetech.com

Or mail to:

Customer Support
PSE Technology
1111 Jefferson Drive
Berthoud CO. U.S.A. 80513-2633
www.psetech.com

When you contact us, please have the following information:

Model Number :	_____
Firmware Version :	_____
Hardware Version :	_____
Serial Number :	_____
End-user Name :	_____
Company :	_____
Phone :	_____
Fax :	_____
Setup Description :	_____
Problem Description :	_____

We strive to provide the best photonics instrumentation available anywhere. To achieve this, we would appreciate your ideas and comments on ways we can improve our products. We invite you to contact us at any time with your suggestions. Thanks in advance for helping us improve our products and service. We look forward to serving you even better in the future!

RETURNING AN INSTRUMENT FOR SERVICE

If an instrument is to be shipped to PSE Technology for repair or service, be sure to:

1. Obtain a Return Merchandise Authorization number (RMA) from PSE Customer Service.
2. Attach a tag to the instrument identifying the owner, RMA number, list of all items being returned, short description indicating the required service or repair, and the instrument serial number (located on the rear panel of the instrument).
3. Attach the protective cap(s) 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 to avoid loss of contents during shipping.
6. Send the instrument to PSE Technology, transportation prepaid. Clearly write the return merchandise authorization number on the outside of the box and on the shipping paperwork. PSE Technology 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.

Once work is complete, the instrument will be returned transportation prepaid. Repairs are warranted for the remainder of the original warranty or for 90 days, whichever is greater.

CUSTOMER SERVICE PHILOSOPHY

Every customer service request is an opportunity for us to enhance a vital relationship; we welcome new ideas and feedback, and strive to enhance our services to exceed your needs. We listen, learn and adjust to meet your ever-evolving needs. Our customer service engineers are experienced technical professionals who are completely dedicated to ensuring your satisfaction. This is our commitment to you.

As a leading-edge innovator of products and services, we are committed to deliver advanced instruments that provide greater options than ever before. We are continuously looking for more ways to improve your experience as our customer, and we promise to strive for the highest levels of service.

This is our commitment to you.

SAFETY INFORMATION

INTRODUCTION

The Safety Information section provides details about cautionary symbols used in the manual and safety markings used on the instrument. The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. PSE Technology assumes no liability for the customer's failure to comply with these requirements.

Before operation, review the instrument and manual, including the complete Safety Information section, for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe operating condition.

SIGNS AND SYMBOLS

Throughout this manual, you will see the following signs and symbols. They indicate potentially dangerous or hazardous situations which, if ignored, could result in death, serious or minor injury, or damage to the product, and/or Device Under Test (DUT). Specifically:



The WARNING sign is used throughout the manual to denote a hazard. It calls attention to a procedure, practice or the like, which, if not correctly performed or adhered to, could damage or destroy the instrument or DUT. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.



The manual and or instrument will be marked with this symbol when it is necessary for the user to exercise extra caution in order to protect the product against damage.



The manual and or instrument will be marked with this symbol when it is necessary for the user to exercise caution to avoid visible and/or invisible laser radiation hazard. Avoid direct exposure to beam.



The manual is marked with this symbol when it is necessary for the user to exercise caution to avoid the risk of electrical shock.



The manual is marked with this symbol when it is necessary for the user to exercise caution to avoid instrument or DUT damage due to Electrostatic Sensitive Discharge.

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 PSE Technology, or authorized local PSE distributor, for service or repair to ensure that the safety features are maintained. All instruments returned to PSE Technology are required to have a Return Merchandise Authorization number assigned by an official representative of PSE Technology.

GENERAL CLASSIFICATIONS

Instrument specific 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 PSE Technology 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 $\pm 10\%$ of the nominal supply voltage.
- Pollution Degree II
- Installation (overvoltage) Category II for transient over-voltages
- Maximum Relative Humidity: $< 80\%$ RH, non-condensing
- Operating temperature range of $0\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$
- Storage and transportation temperature of $-40\text{ }^{\circ}\text{C}$ to $+70\text{ }^{\circ}\text{C}$
- Maximum altitude: 3000 m (9843 ft)
- This equipment is suitable for continuous operation.

INITIAL INSPECTION

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the PSE Technology Customer Service.



To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

ENVIRONMENTAL INFORMATION



This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste. Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product.

Do not dispose in domestic household waste.

To return unwanted products, contact PSE Technology

CHAPTER 1 – INTRODUCTION

INTRODUCTION

This chapter is intended to familiarize the user with the LDS-7200 Laser Diode Source instrument. To avoid possible injury or product damage, the operator should always perform a routine inspection before each use.



To avoid possible injury, additional instrument damage, and or DUT damage. Do not use the product if any of the following symptoms exist:

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

Return the instrument for repair by trained service personnel.

PRODUCT OVERVIEW

The LDS-7200 Laser Diode Source offers unparalleled wavelength tuning range and set point accuracy. The wavelength performance is achieved using our high performance multi-stage temperature controller configuration. This proprietary design maximizes accuracy and stability through matched ratio-metric, low temperature coefficient PID control.

In addition to the superior wavelength performance, the instrument delivers the output power required to meet your most demanding applications. This is accomplished using a low noise, closed-loop constant power laser driver. The laser driver is configurable with two modes of operation. High-bandwidth mode allows small signal modulation frequencies up to 1.5 MHz, using either the built-in waveform generator or an external modulation source. In low bandwidth mode, the source current is filtered to ensure a noise free stable optical output.

To help further safeguard your investment the instrument incorporates numerous high-speed fault detection circuits.

INITIAL INSPECTION

When you receive your instrument, inspect it for any shipping damage. The complete shipping kit should be included which contains:

- Laser Diode Source Instrument
- Power Supply
- Instruction Manual
- Calibration Certificate
- Instrument Software Drivers CD



To avoid possible injury, additional instrument damage, and or DUT damage. Do not use the product if shipping damage is evident. Return the instrument for repair by trained service personnel.

Note: When unpacking the instrument, be sure to save the packaging and the protective ESD cap(s) on the rear of the instrument in case you have to return the instrument to PSE Technology or ship it elsewhere. Shipping damage is not covered under the standard instrument warranty.

INSTALLATION

This section provides information about the requirements necessary to install the LDS-7200 Laser Diode Source and how to begin operating the instrument.

GROUNDING REQUIREMENTS

The LDS-7200 instrument comes with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with the grounding wire connected to an electrical ground (safety ground). The LDS-7200's power jack and supplied power cable meet IEC safety standards.

AC LINE POWER REQUIREMENTS

You can operate the instrument from a single-phase power source delivering nominal line voltages of 100–240 VAC (all values RMS), at 50–60 Hz. The line power voltage can vary $\pm 10\%$. Maximum power consumption is 22.0 Volt-Amps (20.0 Watts). The instrument's operational voltage is universal and need not be changed before operating the instrument.



Before connecting the instrument to an AC power source, verify it meets the requirements. To avoid electrical shock hazard, connect the instrument only to properly earth-grounded, three-prong receptacles. Failure to observe this precaution can result in severe injury or death.

USB CONNECTOR

The USB interface connector (Type "B") is located on the lower right-hand of the rear panel. See Figure 1.2. Attach the type "B" connector to the rear of the controller, which is uniquely shaped to ensure proper orientation, and the other end (Type "A") to the USB controlling hub (computer). A total of 127 devices, including the hub devices, may be connected to a single host controller. The maximum length of a standard USB cable is 5 meters (slightly more than 16 feet).

EXTERNAL COMPUTER REQUIREMENTS

Your computer must meet the following minimum requirements, or you may not be able to successfully use the LDS-7200 Instrument Software Drivers.

- Processor operating at 600 MHz or greater
- 256 MB of RAM
- Video graphics card capable of at least 800 x 600 screen resolution and 256 colors
- USB port
- Mouse
- CD ROM Drive
- Windows XP (SP1) operating system or newer

Actual requirements and product functionality may vary based on your hardware, computer system configuration, and other application software.

LDS-7200 ORIENTATION

Now that the basic requirements for LDS-7200 Laser Diode Source installation have been explained, you are prepared to learn about its operation. Figure 1.1 and Figure 1.2 show front and rear views of the instrument respectively. The figures identify such items as functional keypad groupings, connectors, and switches. Use these figures to familiarize yourself with your new instrument. Please refer to Chapter 2, Basic Operations for operating fundamentals of your laser diode source.

LDS-7200 FRONT PANEL



Figure 1.1: LDS-7200 Laser Diode Source Front Panel View

Figure 1.1 contains a photo of the LDS-7200 front panel. The front panel consists of the fiber optic bulkhead adapter and user interface.

❖ Fiber Optic Bulkhead Adapter

The fiber optic bulkhead adapter is located in the lower right-hand corner, within the OUTPUT section. Ensure all fiber optic connectors are clean and dry before connecting a fiber optic cable to the instruments bulkhead adapter on the front panel. Make sure the fiber end does not rub against any surface and do not over tighten.



Use care in handling fiber optic connectors. Always clean the fiber end prior to insertion into the connector for optimum performance and to avoid optical power errors.

To ensure accurate optical testing, it is extremely important to clean the fiber optic connector before each connection. Debris on the connector can degrade the reliability of the instrument and cause permanent damage to the connector resulting in an expensive repair.

Modern fiber optic connectors rely on a glass-to-glass contact to reduce Fresnel reflections at the connector interface. A dirty or damaged connector on the cable can damage the input connector on the front panel. Always use a good quality cable connector. If there is any question of the surface quality on the tip of the cable connector, inspect it under a microscope for scratches or debris.

Some general recommendations:

- Never use metal or other hard objects for cleaning that could scrape the connector.
- Do not use index matching gel or oils.
- Always keep connectors and the bulkhead adapter covered for protection when not in use.

❖ User Interface

The user interface consists of a touch wheel, Enter/Menu touch wheel center button, laser output On/Off button, and graphic LCD.

➤ Laser Output ON/OFF Button

The laser output button is located in the upper right-hand corner, within the OUTPUT section. When the key is not illuminated, the laser output is off. The button has a toggling action, pressing the button with the laser in the off state will initiate the laser on sequence. The laser on sequence consists of a 5 second laser safety delay before actually enabling the laser output, during this period the button will flash green. This safety delay is required to meet the CDRH US21 1040.10 laser safety requirement. After the safety delay has expired, the laser output is enabled and the button is illuminated solid green. If the instrument detects an error condition, the output will be disabled and the button will be illuminated solid red. Clearing the condition that forced the laser output to automatically turn off and turning the laser back on will clear the solid red error indicator. It is important to note that the laser output can only be

switched on when the laser enable key switch mounted on the rear of the instrument is in the on (I) position.

❖ **ENTER / MENU Button**

Located in the center of the touch wheel, is the ENTER / MENU button. As indicated in the text, this one button controls two independent actions.

- **ENTER Button** – This button is used to select a sub-menu or parameter. When a parameter is highlighted, the enter button will initiate a change to the value. When a sub-menu is highlighted, the enter button will activate the new sub-menu. If the button is selected and released within two seconds the button functions as the ENTER button.
- **MENU Button** – The user can also use this button to cycle between the two top level menus; Operations and Utility. If the button is selected and held longer than two seconds the button functions as the MENU button. If the user is anywhere within the Utility menu structure the instrument will cycle to the Operations top level menu. And conversely, if the user is in the Operations menu, the instrument will cycle to the top level Utility menu.

To help the user with the operation of this button there is an Enter key icon (↵) that is displayed in the upper right-hand corner of the LCD when this key is active.

❖ **Touch Wheel**

Similar to popular MP3 players, the instrument contains a touch wheel. The wheel functions as a standard instrument rotational adjust knob. Depending on the starting condition, rotating counterclockwise will either decrement a user configurable parameter or traverse down through the currently selected menu structure. And conversely, rotating clockwise will either increment a user configurable parameter or traverse up through the currently selected menu structure. The touch wheel also contains four keys with timed auto-repeat functionality:

- **+ (Plus Button)** – Similar to rotating clockwise, this button will either increment a user configurable parameter or traverse up through the currently selected menu structure.
- **– (Minus Button)** – Similar to rotating counterclockwise, this button will either decrement a user configurable parameter or traverse down through the currently selected menu structure.
- **|<< (Left Button)** – When a user configurable parameter is selected, the left button will move the cursor to the left, increasing the increment/decrement magnitude of the selected parameter.
- **>>| (Right Button)** – When a user configurable parameter is selected, the right button will move the cursor to the right, decreasing the increment/decrement magnitude of the selected parameter.

LDS-7200 REAR PANEL



Figure 1.2: LDS-7200 Laser Diode Controller Mount Rear Panel View

❖ Modulation Input / Output Jack

The SMA modulation connector can be configured as either an input or output.

- **Input** – With the modulation configured as an input, an externally applied source signal is summed with the set point power to produce a modulated laser output. Please reference Chapter 2 for details on configuring the depth of modulation for a specific modulation input signal.
- **Output** – With the modulation configured as an output, the instruments built-in waveform generator is available at the modulation jack. When used as an output the waveform amplitude is ~1.2 V.

❖ Trigger Input / Output Jack

The SMA trigger connector can be configured as either an input or output.

- **Input** – With the trigger configured as an input, an externally sourced TTL signal (+5V @ 10mA) will digitally modulate the laser output. When a high signal is applied the output will be off, and conversely when a low signal is applied the output will be on.
- **Output** – With the trigger configured as an output, an internally sourced TTL high signal is applied when the built-in waveform generator signal is greater than ½ the maximum and a TTL low signal otherwise.

❖ Type 'B' USB Receptacle

The instrument is equipped with a USB (Universal Serial Bus) interface. USB was designed to allow peripheral devices to be connected using a single standardized interface socket and to improve plug-and-play capabilities by allowing devices to be connected and disconnected without rebooting the computer (hot swapping). For modern instrumentation USB has become the standard connection method.

❖ Laser Key Switch

The laser key switch enables the laser output only when the key is inserted and in the ON (I) position. Note that the key can only be removed from the instrument when in the OFF (O) position. This feature is required to meet the CDRH US21 1040.10 laser safety requirements.

❖ Interlock Jack

The instrument contains an external remote interlock capability. This allows the user to connect the interlock circuit to an external switch for safety. When using the external interlock feature, the user must connect a +5V source to the jack. The optically isolated input will allow laser operation when the +5V source is present, and will disable the laser output when the source is not present.

❖ Intra-link Type 'A' USB Receptacle

The instrument is equipped with an intra-link communications bus. This is a proprietary PSE instrument communication link that allows the LDS-7200 to control auxiliary instrumentation to form a more complex system.

❖ External Power ON/OFF Rocker Switch

When the AC adapter is connected to the power input jack and this rocker switch is in the up position I (ON), the external power is applied to the instrument. When the instrument is in this state the rocker switch is illuminated green. When the external power is connected to the power input jack and the rocker switch is in the down O (OFF) position, the external power is removed from the instrument. When the instrument is in this state, the rocker switch is not illuminated.

❖ Power Input Jack

To use the instrument, the external AC/DC power adapter must be plugged into the instruments power input jack.

MAINTENANCE

FILTER CLEANING

Proper ventilation is required to maintain LDS-7200 operation, it may be necessary to periodically clean the fan intake filter. The filter can be easily accessed by removing the four #6 Phillips flat-head screws from the filter guard located on the bottom of the instrument. To remove any accumulated dust or dirt, turn the filter over and let water run through the filter in the opposite direction of the airflow. Once the filter has been sufficiently rinsed, allow it to air dry completely before reinstalling.

FIBER CLEANING

Ensure all fiber optic connectors are clean and dry before connecting a fiber optic cable to the instruments bulkhead adapter on the front panel.



Use care in handling fiber optic connectors. Always clean the fiber end prior to insertion into the connector for optimum performance and to avoid optical power errors.

Some general recommendations:

- Never use metal or other hard objects for cleaning that could scrape the connector.
- Do not use index matching gel or oils.
- Always keep connectors and the bulkhead adapter covered for protection when not in use.

To clean the end of the connector on the fiber optic cable:

1. Gently wipe the tip with a lint-free swab or lens paper dipped in isopropyl alcohol.
2. Dry it by wiping gently with a clean dry lint-free lens paper.
3. As soon as the connector is dry, insert it in the front panel or cover it for later use.

To clean the instruments bulkhead adapter:

1. Remove any fiber optic cables from the front of the instrument. Always remember to place a protective cap on both the free cable end and the instruments bulkhead adapter.
2. Remove the two #2 hex-head socket cap screws from the bulkhead adapter. The hex-head socket cap screws fasten the bulkhead adapter to the instrument. Do NOT remove the two Phillips head screws.
3. Gently pull out the fiber optic bulkhead adapter from the front of the instrument. Exercise extra caution to avoid damaging the fiber optic cable and connector that are fastened on the instruments internal side of the adapter.
4. Remove the internal side fiber optic connector from the adapter.
5. Gently wipe the tip with a lint-free swab or lens paper dipped in isopropyl alcohol.
6. Dry it by wiping gently with a clean dry lint-free lens paper.
7. As soon as the connector is dry, re-fasten the connector to the bulkhead adapter.
8. Re-install the bulkhead adapter into the instrument. Note that the adapter is keyed; insert the adapter in the same position as it was when removed.

RECOMMENDED CALIBRATION FREQUENCY

The recommended calibration frequency for this instrument is yearly to ensure performance to the published specifications. PSE factory calibrations employ NIST traceable measurement instruments, and our calibration engineers use automated test equipment to accurately and efficiently capture and record the calibration data. An original certificate of calibration authenticity is provided with all instrument calibrations, and a detailed report showing pre-calibration out-of-tolerance conditions is available upon request. We understand our customer's time is valuable therefore we endeavor to achieve calibration turn times within five business days or less.



Potentially lethal voltages exist within the instrument. To avoid electric shock, do not perform any maintenance on the instrument unless you are qualified to do so. Qualified service personnel are required to wear protective eyewear and anti-static wrist bands while working on or near the circuit boards.

LDS-7200 INSTRUMENT SPECIFICATIONS

LASER SPECIFICATIONS¹

WAVELENGTH

Wavelength:	customer specified
Tuning Range:	5.0 nm
Accuracy: ²	± 10 pm
Setpoint Resolution:	0.1 pm
Stability	
Short-term (15 Minutes): ³	± 3 pm
Long-term (24 Hours): ⁴	± 5 pm
Spectral Width	
Coherence Control Off:	< 30 MHz
Coherence Control On:	1 GHz (typical)

OUTPUT POWER

Maximum:	
1260 – 1625 nm	20 mW
1625 – 1675 nm	15 mW
Stability	
Short-term (15 Minutes): ³	< 0.005 dB rms
Long-term (24 Hours): ⁴	±0.03 dB
Attenuation	
Calibrated Range:	Maximum to 0 dB
Accuracy: ⁵	±0.1 dB
Setpoint Resolution:	0.001 mW

GENERAL

Side Mode Suppression Ratio:	> 40 dB
Signal-to-Peak Background Ratio:	> 30 dB
RIN: ⁶	-145 dB/Hz
Modulation	
Coupling:	Configurable AC or DC
Amplitude:	Digitally adjustable
Bandwidth:	1.5 MHz
Internal (Built-In)	
Frequency:	100 Hz – 1.5 MHz
Signal Types:	Sinusoidal, Triangle, Square, Coherence Control
External Input:	0 to ±5 V

¹ All values measured after 1 hour warm up period at 25 °C.

² ±10pm for first 90 days after factory calibration, < ± 25pm for one year

³ ambient temperature variation ±0.1 °C

⁴ ambient temperature variation ±1.0 °C

⁵ defined as $\Delta P_{\text{measured}} - \Delta P_{\text{actual}}$ from maximum power to 5 dB down

⁶ measured ± 100nm about center wavelength

Trigger	
Level	TTL
Input	Active High
Optical Connector: ⁷	FC/APC

Table 1.1: Laser Specifications

GENERAL INSTRUMENT SPECIFICATIONS

CONNECTORS

Modulation Input / Output:	SMA, Configurable Input Impedance
Trigger Input / Output:	SMA
Computer Communication:	Type “B” USB, USB 2.0 full speed
Instrument Intralink:	Type “A” USB
Interlock:	2.5 mm Mono Audio
Power Input Jack:	2.1 mm Center Conductor +5V @ 4A

GENERAL

Size (H x W x D):	3.0" x 8.0" x 8.0" (76.2mm x 203.2mm x 203.2mm)
Weight:	5.7 pounds (2.6 kg)
Power Requirements:	120 VAC at 60Hz, 220 VAC at 50/60 Hz, 230–240 VAC at 50/60Hz
Temperature:	15 to +35 °C operating; –40 to +70 °C storage
Humidity:	< 80% relative humidity, non-condensing.

Table 1.2: General Instrument Specifications

MINIMUM CONTROLLING COMPUTER REQUIREMENTS

MINIMUM CONTROLLING COMPUTER REQUIREMENTS

HARDWARE

Processor	≥ 600 MHz
RAM	≥ 256 MB
Video	≥ 800 x 600, 256 Color or better
Other	USB Hub, Mouse, CD ROM Drive
Processor	≥ 600 MHz
RAM	≥ 256 MB
Video	≥ 800 x 600, 256 Color or better
Other	USB Hub, Mouse, CD ROM Drive

SOFTWARE

Operating System	≥ Windows XP (SP1)
------------------	--------------------

Table 1.3: Minimum Controlling Computer Requirements

In keeping with our commitment to continuing improvement, PSE Technology reserves the right to update specifications without notice or liability for such changes.

⁷ Other connector types available, contact us with your requirements.

CHAPTER 2 – STANDARD OPERATION

INTRODUCTION

This chapter introduces you to the standard (non-computer controlled) operation of the LDS-7200 Laser Diode Source. It offers instructions for powering the instrument, navigating the menus, using the front panel buttons for standard operations, and connecting a modulation source.

TURNING THE INSTRUMENT POWER ON/OFF

As shown in figure 1.2 the power on/off rocker switch located on the rear panel is used to switch on or off the external power supply. The external power supply is connected to the 2.1mm power jack located on the left rear panel of the instrument. The rear power rocker switch enables or disables this external power supply.

The external power rocker switch has an integrated LED that provides a visual indication of the power source state. When the instrument is switched on, the LED will be illuminated red while it is initializing and performing the Power On Self Test (POST). Once the POST is complete the LED will be illuminated a solid green, indicating the instrument is operating properly and ready.

NAVIGATING THE INSTRUMENT MENU STRUCTURE

The LDS-7200 menus are structured as shown in figure 2.1 below.

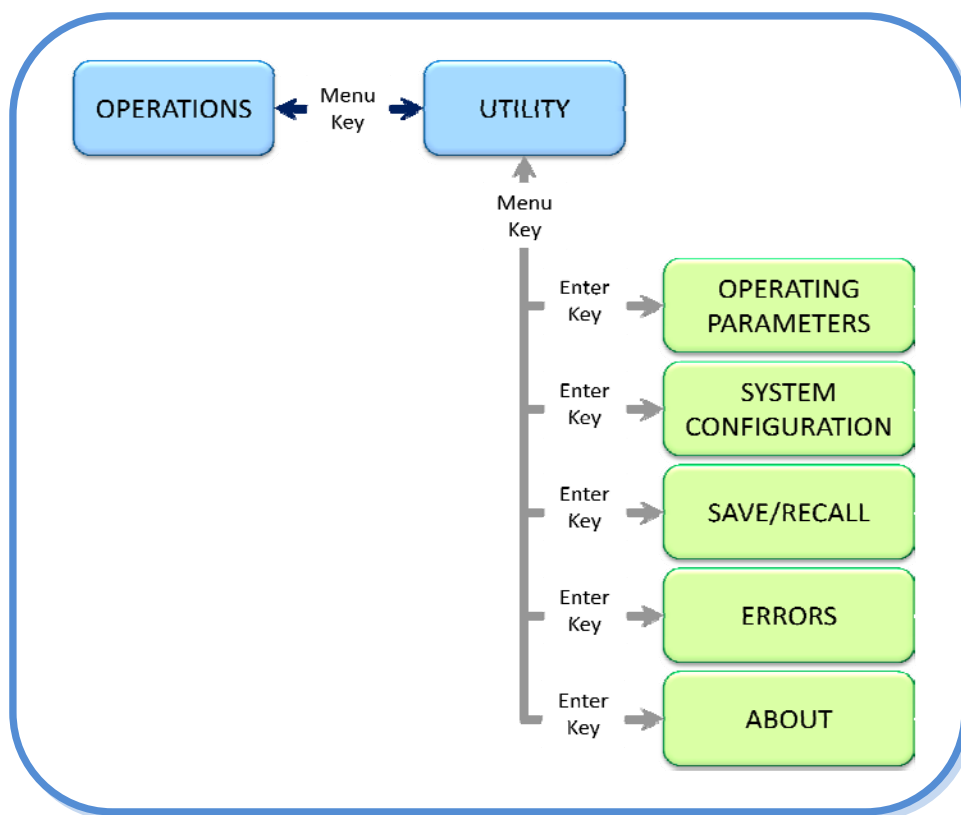


Figure 2.1: Menu Structure

Use the Menu button to cycle between the two top level menus; Operations and Utility. To initiate the Menu button, hold down the Enter/Menu button for more than two seconds. To activate one of the sub-menus beneath the Utility menu, from the Utility menu navigate to the sub-menu of interest and use the Enter button. To initiate the Enter button, hold down the Enter/Menu button for less than two seconds.

OPERATIONS MENU

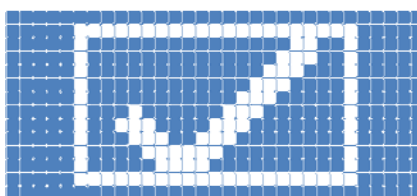
The Operations menu is shown below in figure 2.2.



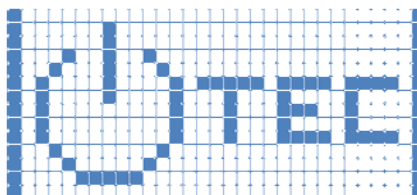
Figure 2.2: Operations Menu

This is the main menu for operating the instrument. From this menu the user can view and/or modify both the laser output power and wavelength. Located along the bottom of this menu is the operations dashboard. The operations dashboard provides an iconic view of the instruments primary operating parameters.

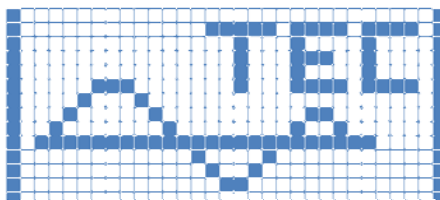
1. The first icon located at the furthest left, indicates the operating status of the instrument.
 - a. The check mark icon shown below indicates the instrument is operating properly. This requires that the following conditions be met:
 - i. All the temperature controllers are ON.
 - ii. All the temperature controllers and stabilized at their respective setpoint.
 - iii. The laser driver is NOT being clipped by the instruments current limit circuitry.



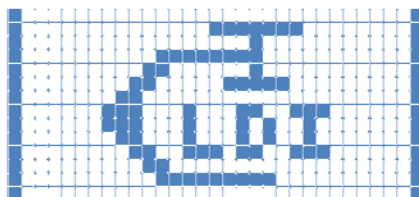
- b. If any of the instruments temperature controllers are OFF, the following icon will be displayed.



- c. If any of the instruments temperature controllers have not stabilized at their respective setpoint values, the following icon will be displayed

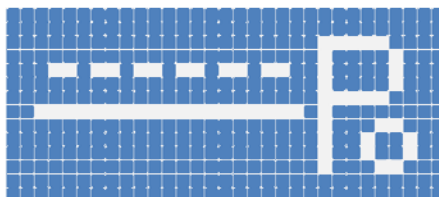


- d. If the instrument is clipping the laser driver current, the following icon will be displayed.

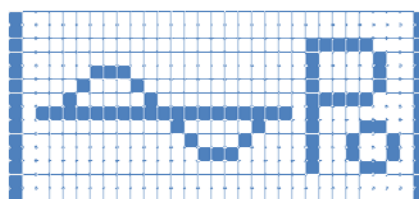


- 2. The second icon indicates how the modulation is configured.

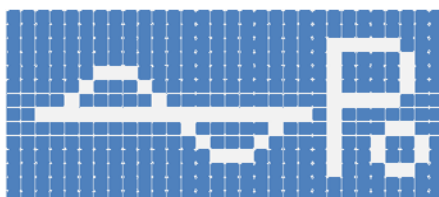
- a. If the external modulation is disabled and the internal modulation is not configured as User Set, the DC icon shown below is displayed.



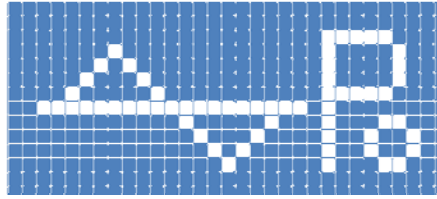
- b. When the external modulation is enabled, as shown below, the white background sinusoidal waveform icon is displayed.



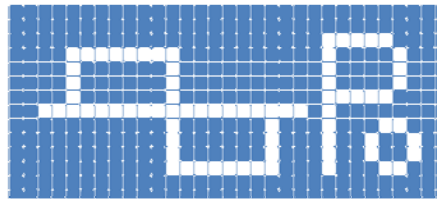
- c. When internal modulation is configured as User Set and the waveform is set to sinusoidal, as shown below, the blue background sinusoidal waveform icon is displayed.



- d. When the internal modulation is configured as User Set and the waveform is set to triangular, as shown below, the blue background triangle waveform icon is displayed.

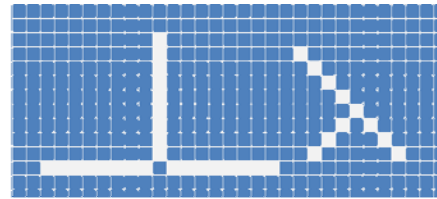


- e. When the internal modulation is configured as User Set and the waveform is set to square, as shown below, the blue background square waveform icon is displayed.

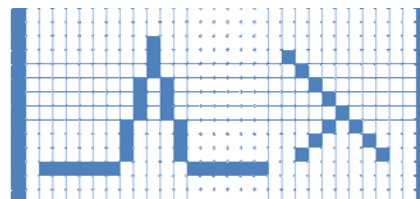


3. The third icon indicates the state of the built-in coherence control as depicted below. Note that when using coherence control the internal modulation can't be used.

- a. Coherence Control OFF

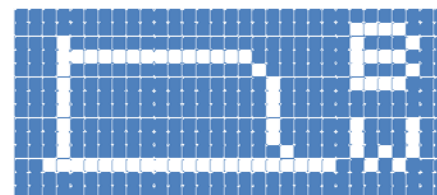


- b. Coherence Control ON.

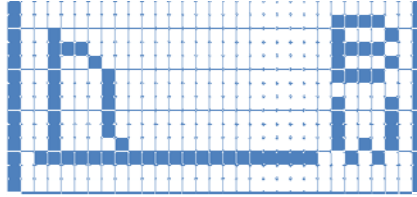


4. The fourth icon provides two independent indicators based on how the instrument is configured. When the instrument is configured to NOT use the interlock safety feature, the icon indicates the status of the laser driver bandwidth filtering.

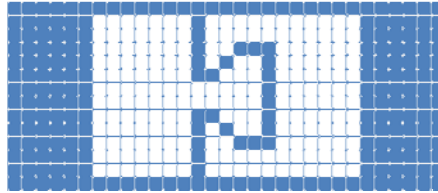
- a. High Bandwidth, the laser driver output is NOT filtered and use interlock is disabled. The high bandwidth icon is on a blue background as shown below.



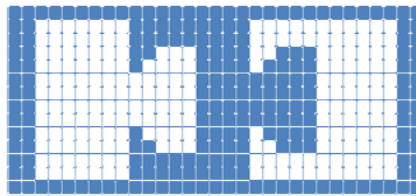
- b. Low Bandwidth, the laser driver output is filtered and use interlock is disabled. The low bandwidth icon is on a white background as shown below.



- c. Use Interlock is enabled and the interlock is closed (Enabling the laser output).

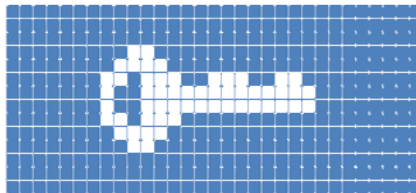


- d. Use Interlock is enabled and the interlock is open (Disabling the laser output).

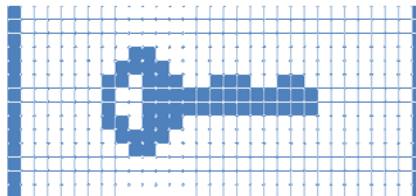


5. The fifth icon indicates the state of the rear panel key switch.

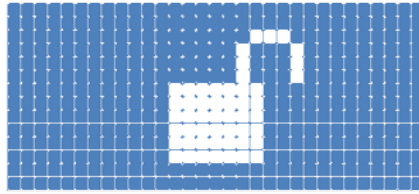
- a. Key Switch position is enabling laser output.



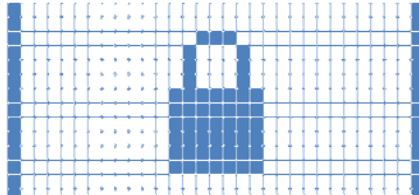
- b. Key Switch position is disabling laser output.



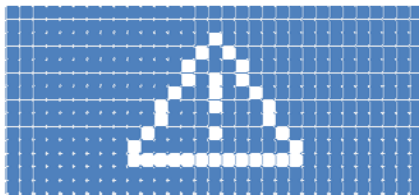
6. The sixth icon indicates the state of the lock front panel parameter changes.
- a. Unlocked (allow) front panel operating parameter changes.



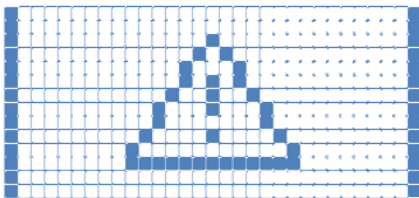
- b. Locked (prevent) front panel operating parameter changes.



7. The seventh and last icon located at the furthest right, indicates if any errors are present in the error queue.
- a. NO Errors present in the error queue.



- b. ERRORS are present in the error queue.



UTILITY MENU

The Utility menu is shown below in figure 2.3.

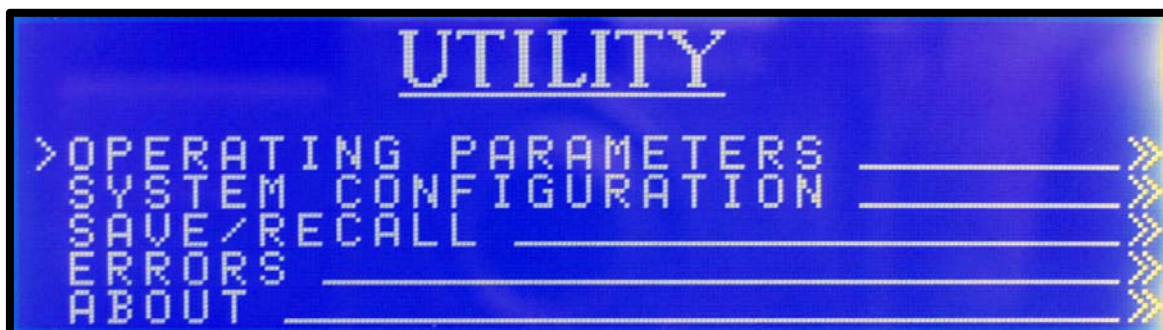


Figure 2.3: Utility Menu

This is the second of the two main menus. The Utility menu provides access to five submenus:

1. Operating Parameters – Provides access to the user configurable instruments operating parameters.
2. System Configuration – Provides access to the instruments system configuration. In addition, this menu displays the instruments internal temperature.
3. Save / Recall – Allows the user to store up to ten specific instrument configurations that can be quickly recalled. In addition, the instrument can be reset to the factory default configuration within this menu.
4. Errors – Provides access to the last ten errors in the FIFO (First In First Out) based queue. In addition, the user can also clear all errors from this submenu.
5. About – Lists the instruments maximum optical power, wavelength tuning range, serial number, firmware version, and hardware version.

OPERATING PARAMETERS SUB-MENU

The Operating Parameters sub-menu is shown below in figure 2.4.

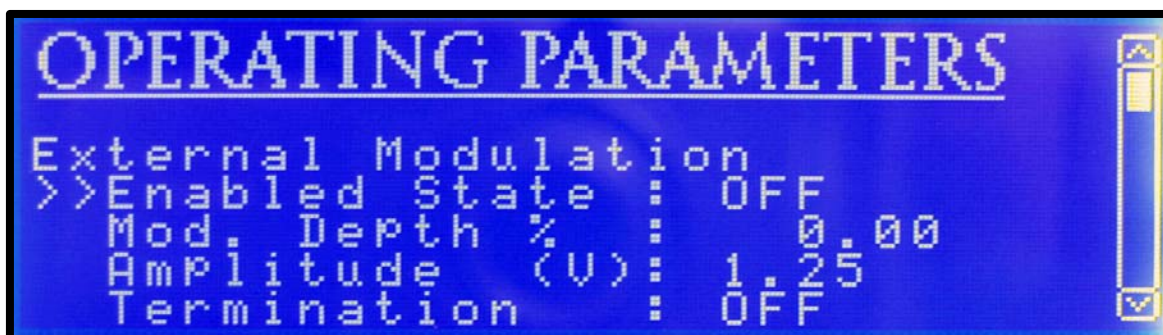


Figure 2.4: Operating Parameters Sub-Menu

This sub-menu contains more than a single screen of information. Similar to popular software programs, the scroll bar located along the right hand side of the display indicates the current position within the multi-screen menu. The Operating Parameters sub-menu provides access to the configurable instrument operating parameters as listed below:

1. External Modulation – Allows the user to configure how the external waveform generator operates.
 - a. Enabled State
 - i. ON configures the instrument to sum the signal present at the rear panel modulation connector with the laser set point.

- ii. OFF instructs the instrument to disregard signals present on the rear panel modulation connector.
 - b. Modulation Depth Percentage - Sets the depth of modulation as a percentage, for example 100% would result in an output that is modulated from zero to twice the instruments set point optical power. When the modulated signal exceeds the maximum optical power, the output will be clipped. This can result in a non-symmetrical output.
 - c. Amplitude (V) - This parameter informs the instrument of the amplitude of the external modulation source signal being applied. This value is used by the instrument to calculate an attenuation factor that is applied to the modulation signal to achieve the requested modulation depth percentage listed in the previous parameter.
 - d. Termination - This parameter instructs the instruments to configure the input impedance to either 50-Ω or high impedance.
2. Internal Modulation – Allows the user to configure how the internal waveform generator operates.
- a. Type – Configures how the internal waveform generator is used.
 - i. Coherence – The instrument applies a coherence control modulation source to the output signal.
 - ii. User Set – The instrument applies a user configured modulation signal to the output signal.
 - iii. Off – The internal modulation source is disabled.

Note: The external and internal modulation are completely independent, they can both be enabled at the same time. When both are enabled at the same time, the modulation signal is the differential summation of the internal and external modulation signals.
 - b. Modulation Depth Percentage - When operating with the Type = User Set, this parameter sets the depth of modulation as a percentage. For example 100% would result in an output that is modulated from zero to twice the instruments set point optical power. When the modulated signal exceeds the maximum optical power, the output will be clipped. This can result in a non-symmetrical output.
 - c. Frequency - When operating with the Type = User Set, this parameter sets the frequency for the internal waveform generator. The minimum modulation frequency is 100 Hz and the maximum modulation frequency is 1.5 MHz.
 - d. Waveform - When operating with the Type = User Set, this parameter sets the internal modulation waveform shape to:
 - i. Sinusoidal
 - ii. Triangular
 - iii. Square
3. General Modulation – Allows the user to configure additional modulation parameters.
- a. Trigger - Sets the rear panel trigger to an input or output. When configured as an input, an externally sourced TTL signal will digitally modulate the laser output. When a high signal is applied the output will be off, and conversely when a low signal is applied the output will be on. When configured as an output, an internally sourced TTL high signal is applied when the built-in waveform generator signal is greater than ½ the maximum and a TTL low signal otherwise.
 - b. Bandwidth - Enables or Disables the instruments laser driver filter. When configured to low bandwidth a low pass filter is active. Note that when modulating the source, the bandwidth should be set to high to avoid distorting the modulation.
 - c. Coupling - Sets how the instrument will sum the modulation source. Using AC coupling is recommended with modulation signal > 10 kHz as it does not have much effect on the modulation waveform and provides an effective method to eliminate any DC offset that may be present on the modulation signal. When setting the modulation coupling to DC it is important to note the DC offset can sum with the set point, thus resulting in an offset in the power.

4. Instrument Units – Allows the user to select the preferred instrument units used to set and report the wavelength and optical power.
 - a. Wavelength - Set the wavelength units used by the instrument to one of the following available selections:
 - nm (nanometers)
 - THz (terahertz)
 - cm-1 (wavenumber).
 - b. Optical Power - Set the optical power units used by the instrument to one of the following available selections:
 - mW (milliwatts)
 - dBm (decibels referenced to one milliwatt).

SYSTEM CONFIGURATION SUB-MENU

The System Configuration sub-menu is shown below in figure 2.5.



Figure 2.5: System Configuration Sub-Menu

This sub-menu allows the user to configure the following system parameters:

1. Audible Beep – Enables or disables the audible beep indicator for key presses.
2. Parameter Lock – When enabled this prevents users from being able to change the operating parameters from the front panel.
3. Use Interlock – Configures the instrument to use the rear panel interlock.
4. LCD Contrast – Allows the user to configure the LCD (Liquid Crystal Display) contrast.

In addition, to modifying the four system configuration settings listed above. This sub-menu displays the instruments internal operating temperature on the right-hand middle of the screen.

SAVE / RECALL SUB-MENU

The Save / Recall sub-menu is shown below in figure 2.6.



Figure 2.6: Save / Recall Sub-Menu

The purpose of this sub-menu is to provide a method for the user to store a specific instrument configuration that can be quickly recalled for later use. The instrument provides a maximum of ten memory bins that can be used for storing and recalling instrument configurations. In addition, this menu allows the user to re-set the instrument to the factory default instrument configuration.

ERRORS SUB-MENU

The Errors sub-menu is shown below in figure 2.7.



Figure 2.7: Errors Sub-Menu

This sub-menu displays up to the last ten errors in the FIFO (First In First Out) based queue. If the error queue contains more than one screen of errors, the scroll bar located along the right-hand side of the display indicates the current position within the multi-screen display. In addition, the user can also clear the error queue from this submenu. Note that the error queue is stored in non-volatile memory; therefore it will persist even after power has been cycled.

ABOUT SUB-MENU

The About sub-menu is shown below in figure 2.8.



Figure 2.8: About Sub-Menu

Similar to popular software programs, the scroll bar located along the right hand side of the display indicates the current position within the multi-screen menu. This sub-menu displays the following non-configurable instrument parameters:

1. Maximum Power – Shows the instruments maximum optical power.
2. Wavelength Min. – Shows the instruments minimum wavelength.
3. Wavelength Max. – Shows the instruments maximum wavelength.
4. Serial Number – Shows the instruments unique serial number.
5. Firmware Ver. – Shows the instruments firmware version.
6. Hardware Ver. – Shows the instruments hardware version.

TURNING THE LASER OUTPUT ON/OFF

As shown in figure 1.2 the upper right most button located on the front panel is used to enable or disable the laser output. This button contains an internal bi-color LED that is programmed to provide a visual indication of the laser state. When the button is not illuminated the laser output is disabled and was not forced off by an error condition. When the button is illuminated a continuous green, the laser drive output is enabled and functioning properly. When the button is flashing green, it indicates the laser drive output is going through the CDRH US21 CFR 1040.10 required laser safety output emission delay of 5-seconds. When the button is illuminated continuous red, the laser output was automatically disabled because of an instrument detected error condition.

The following are error conditions will automatically disable the laser drive:

- Laser enable key turned to disable output
- Laser interlock enabled and open
- Laser drive voltage limit detected
- Laser power limit detected
- TEC high temperature limit condition
- TEC current limit condition
- Instrument internal temperature sensor limit

CONNECTING A MODULATION SOURCE

The LDS-7200 Laser Diode Source is equipped with two SMA type RF connectors located on the rear of the instrument that can be configured to modulate the laser output.

- **Modulation Connector** – The modulation connector can operate as an input to modulate the laser with an external waveform generator. The external modulation must be enabled when using the modulation connector as an input. The input can also be configured as either high impedance or a 50- Ω matching impedance. In addition, the modulation signal can be either AC coupled or DC coupled to the laser drive circuitry. The advantage of AC coupling is to eliminate any DC offset on the modulation signal. However, AC coupling will distort the waveform when modulating below 10 kHz.



Do NOT apply a modulation voltage in excess of ± 15 volts. Voltages exceeding this maximum value will result in internal instrument damage that is not covered under the warranty.

- **Trigger Connector** – The trigger connector is intended for use with an externally supplied TTL source (+5V @ 10mA). A high signal applied on input turns the laser off and a low signal turns the laser on.

CHAPTER 3 – COMPUTER CONTROL

INTRODUCTION

Instrument specific software is shipped with each LDS-7200. This Instrument CD contains three important categories of software; USB Instrument Drivers, LabVIEW™ Instrument Drivers, and finally a complete LDS-7200 Application Program with source code developed in VB.NET.

USB INSTRUMENT DRIVER

The USB Instrument Drivers must be installed before any computer control is available. Installing this driver allows the controlling computer to automatically assign a unique serial port to each USB connected instrument. This unique serial port is used within the controlling programs to identify which instrument to communicate with. The assigned serial ports can be viewed within the Microsoft Windows™ Device Manager applet.

Use the following steps to install the LDS-7200 USB Instrument Driver onto your computer.

- Insert the Instrument CD into the computer's CD ROM drive
- Once the CD is in the drive it should automatically begin the installation process. If your computer is configured to block automatic installations, you can begin the process by double-clicking on the setup.exe file on the CD.
- The installation will automatically install all the driver files needed to use the LDS-7200 Laser Diode Source.
- Once the software installation process is complete, connect the instrument to a spare USB port on your PC. The computer will detect the instrument and launch the Windows Operating System - Found New Hardware Wizard.
- Follow the standard windows prompts to allow windows to automatically install and register the appropriate drivers for the LDS-7200 instrument.
- Note that if Windows is configured to warn when unsigned (non-WHQL certified) drivers are about to be installed, the screen shown in Figure 3.1 will be displayed. Click on "Continue Anyway" to continue with the installation. If Windows is configured to ignore file signature warnings, no message will appear.

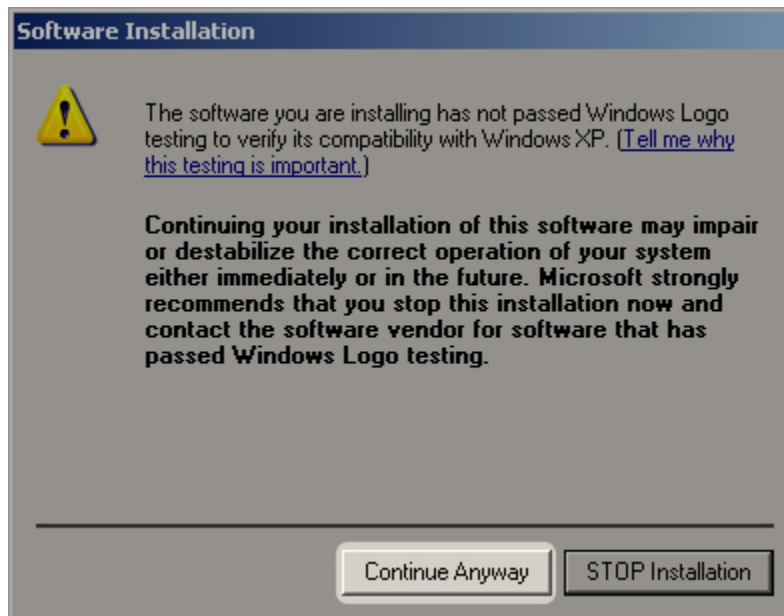


Figure 3.1: Instrument Driver Installation non-WHQL Warning Screen

LabVIEW™ INSTRUMENT DRIVERS

The LabVIEW™ Instrument Drivers are provided to assist developers in creating custom programs tailored to their specific needs. These are located on the CD in the LabVIEW directory. The VI tree is organized as shown below in figure 3.2:

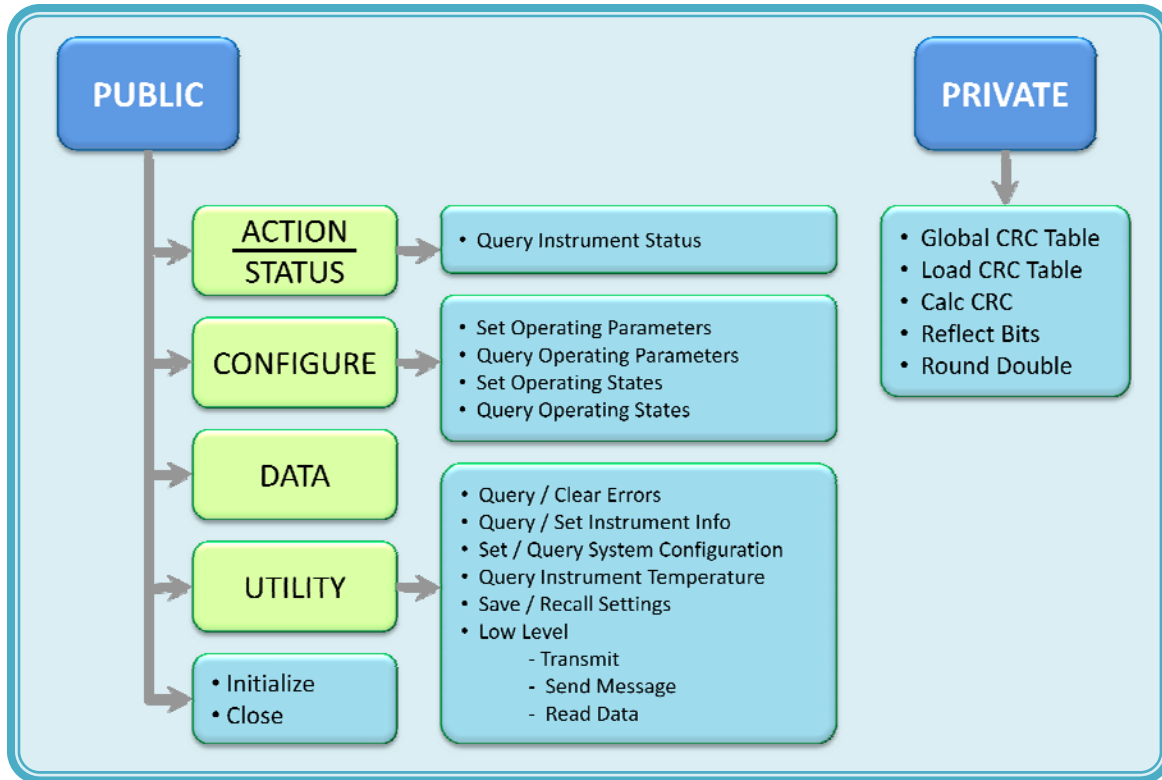


Figure 3.2: LabVIEW™ Driver VI Tree

1. Query Instrument Status – This VI is used to read the status of the instrument.
2. Set Operating Settings – This VI is used to set the instruments operating parameters.
3. Query Operating Settings – This VI is used to read the instruments operating parameters.
4. Set Operating States – This VI sets the instruments operating states.
5. Query Operating States – This VI reads the instruments operating states.
6. Query Errors – This VI reads the instruments error queue.
7. Clear Errors – This VI clears the instrument error queue.
8. Query Instrument Information – This VI reads the instruments general information.
9. Set Instrument Information – This VI sets the instrument general information.
10. Query Instrument Temperature – This VI reads the internal operating temperature sensor.
11. Save Settings – This VI stores the user set instrument parameters to a non-volatile memory location.
12. Recall Settings – This VI recalls the previously user set instrument parameters.

The low level VI's are not intended to be called directly from a user application, they are used as sub-VI's within the instrument driver VI's. The VI's listed as private provide low level instrument functionality and as such should not be modified by users.

In addition to the VI's listed in the VI Tree, we have developed a few example VI's that demonstrates the use of our LabVIEW™ Instrument Drivers. These are available in the Examples directory under the LabVIEW directory.

LDS-7200 APPLICATION PROGRAM

This section provides a description of the computer controlled instrument application program. The bulk of the chapter provides a description of the LDS-7200 Application Program menu structure. These sections provide pictures of the computer display associated with each menu. The individual menus are used to configure and operate the instrument. This section also provides instructions on how to select each menu and how to perform the operations relevant to the menu selected.

The application program has been structured to operate similar to the instruments front panel menus. The key operating parameters for the instrument can be set, adjusted, and displayed through the following menus in the LDS-7200 Application Program.

APPLICATION PROGRAM MENU TABS

The two (Operations and Utility) menu tabs located towards the top of the form provide the primary method for using the instrument. These are highlighted in the screenshot below, figure 3.3.



Figure 3.3: Tabs Screenshot

OPERATIONS TAB

Operations: As shown in the screen shot captured in figure 3.4 below. This is the first of the two tabs. Within this menu are three individual subsections, Connect, Output, and Dashboard. The Connect section allows the user to identify and connect to a specific instrument attached to one of the computers USB ports. The Output section allows the main instrument parameters (Optical Power and Wavelength) to be set, adjusted, and displayed. The last section, Dashboard graphically displays the instruments operating configuration.



Figure 3.4: Operations Tab Screenshot

1. **Connect Subsection:**

As shown in the screen shot captured in figure 3.5 below. By default the previous instrument port is automatically selected at start-up. The connect subsection allows the user to specify the port in which the instrument is connected. The assigned serial ports can be viewed within the Microsoft Windows™ Device Manager applet.



Figure 3.5: Connect Subsection Screenshot

The **Connect/Disconnect** button can be used to connect or disconnect from the USB bus. This can be used to reinitiate the communications if a problem exists.

2. Output Subsection:

As shown in the screen shot captured in figure 3.6 below. Within the output subsection, the user can configure the laser output optical power, laser operating wavelength, and turn ON/OFF the laser output. The ON/OFF button LED will be illuminated green when the output is on and not illuminated when the output is off.



Figure 3.6: Output Subsection Screenshot

3. Dashboard Subsection:

As shown in the screen shot captured in figure 3.7 below. The dashboard subsection provides a graphical representation of the instruments operations. The graphical indicators have been designed to mimic those used on the instruments operating menu dashboard. Please refer back to chapter 2 for examples of the individual icons described below. This subsection consists of the following indicators listed from left to right:

- a. Instrument Status – Indicates the state of the instrument.
 - i. A TEC OFF icon is shown if any of the instruments temperature controllers are off.
 - ii. A TEC Stabilizing icon is shown if any of the instruments temperature controllers have not stabilized at their respective setpoint temperatures.
 - iii. A LDI Clamp icon is shown if the laser diode driver current is being clipped by the current limit circuitry.
 - iv. A Check Mark icon indicates normal instrument operation. It is shown if the instrument TECs are ON and stabilized and the laser current limit is NOT active.
- b. Modulation – Indicates the state of the instruments modulation. A DC icon is shown when both the external and internal modulation is disabled. A white background sinusoidal waveform icon is shown when the external modulation is enabled. A blue background sinusoidal icon is shown when the User Set internal modulation is enabled and set to a sinusoidal waveform. A blue background triangular waveform icon is shown when the User Set internal modulation is enabled and set to a triangular waveform. A square waveform icon is shown when the User Set internal modulation is enabled and set to a square waveform.
- c. Coherence – Indicates the state of the internal coherence control generator. When the coherence control is on, a white background icon with a wide wavelength is displayed and conversely when the coherence control is disabled a blue background narrow wavelength icon is displayed.
- d. Bandwidth – Indicates the state of the laser drive filter. When the filter is enabled, a white background low bandwidth icon is displayed. When the filter is disabled, a blue background high bandwidth icon is displayed. Note that if the low bandwidth mode of operation is enabled when modulating the output, the modulated output will be severely attenuated.
- e. Key Switch – Indicates the state of the rear panel Laser Enable Key Switch. A white key on a blue background icon is displayed when the key position is enabling the laser and a blue key on a white background icon is displayed when the key is disabling the laser output.
- f. Lock Parameter Changes – Indicates the state of the front panel parameter change lockout. An open padlock on a blue background indicates the front panel parameter changes are enabled. Conversely a closed padlock on a white background indicates the front panel parameter changes are disabled.
- g. Errors – Indicates if the instrument error queue contains errors. A warning triangle with an exclamation mark in white on a blue background icon indicates the instrument contains no errors. Whereas a warning triangle with an exclamation mark in blue on a white background icon indicates the instruments error queue has at least one error.

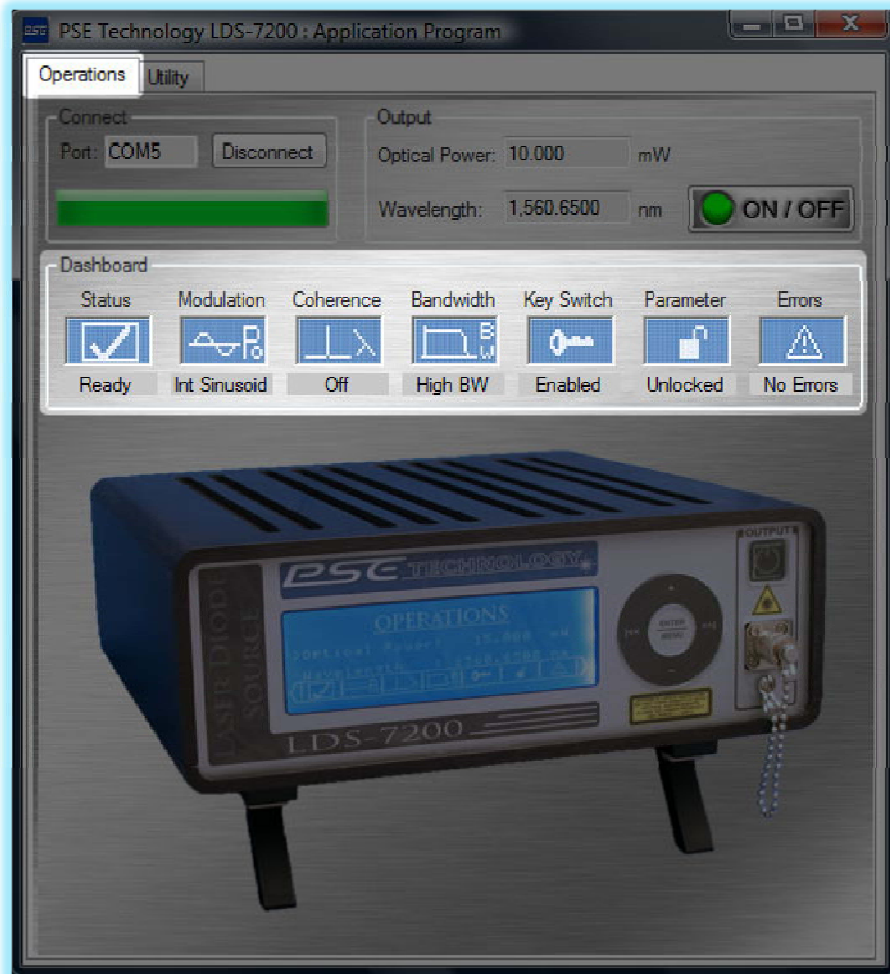


Figure 3.7: Dashboard Subsection Menu Screenshot

UTILITY TAB MENU

Utility: As shown in the screen shot captured in figure 3.8 below. This is the second of the two menu tabs. This is the menu used to both set user configurable instrument parameters and display instrument information. Within this menu are five individual subsections; Operating Parameters, System Configuration, Save/Recall, Errors, and About. Each of these individual subsections is detailed below.

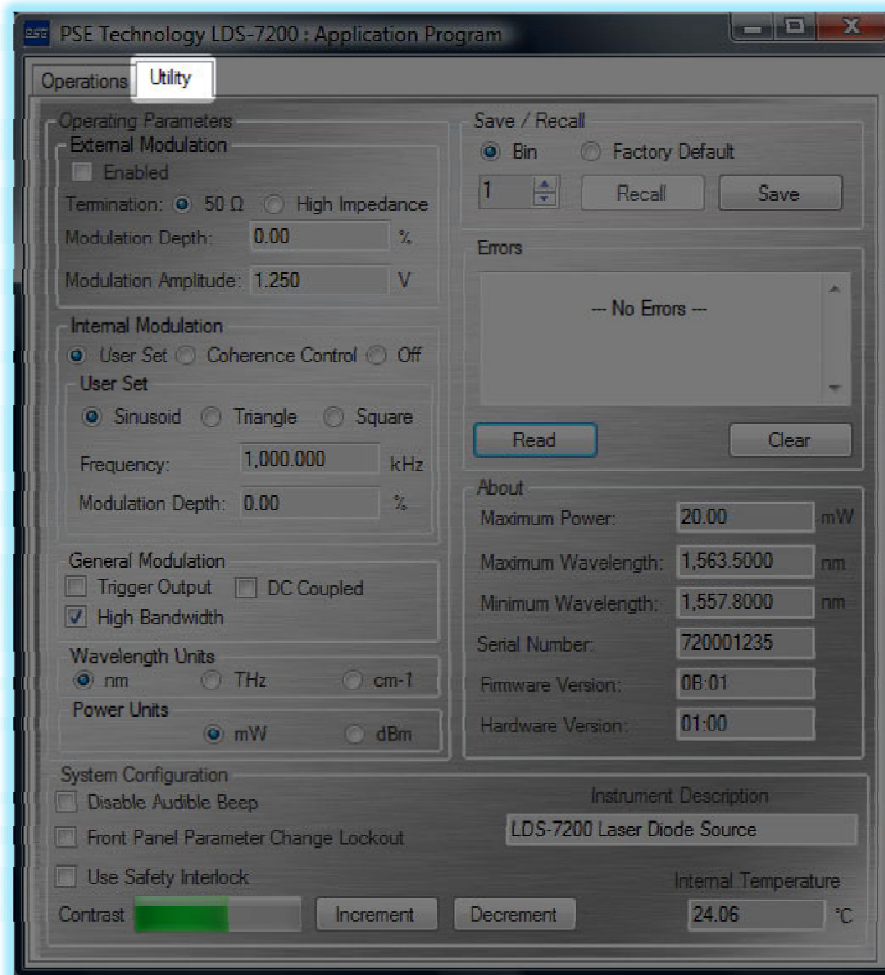


Figure 3.8: Utility Tab Menu Screenshot

1. Operating Parameters Subsection:

As shown in the screen shot captured in figure 3.9 below. This subsection located at the top left-hand side, allows the user to modify the instruments modulation characteristics and configure the instruments operating units.

- a. External Modulation – The first subsection within the Operating Parameters subsection is the external modulation subsection. This allows the user to configure the following operating parameters:
 - i. Enable / Disable the external modulation
 - ii. Set the modulation input impedance with the radio buttons. Matching the output impedance of the modulation source minimizes signal distortion due to reflections.
 - iii. Set the modulation depth percentage.
 - iv. Set the amplitude of the input modulation signal.
- b. Internal Modulation – The second subsection within the Operating Parameters subsection is the internal modulation subsection. This allows the user to configure the following operating parameters:
 - i. Set the internal modulation type using one of the three radio buttons, User Set, Coherence Control, and Off.
 - ii. Configure the User Set modulation depth percentage.
 - iii. Configure the User Set modulation waveform type; sinusoidal, triangular, or square.
- c. General Modulation – The third subsection within the Operating Parameters subsection is the general modulation subsection. This allows the user to configure the following operating parameters:
 - i. Configure the read panel Trigger connector as an input or output.
 - ii. Configure the laser driver bandwidth. Note, we recommend only using the High Bandwidth mode of operation when modulating the laser. Low Bandwidth mode will severely distort most modulation signals.
 - iii. Configure the modulation coupling as AC or DC. Using AC coupling is recommended with modulation signal > 10 kHz as it does not have much effect on the modulation waveform and provides an effective method to eliminate any DC offset that may be present on the modulation signal. When setting the modulation coupling to DC it is important to note the DC offset can sum with the set point, thus resulting in an offset in the power.
- d. Instrument Units – The fourth and last subsection within the Operating Parameters subsection is the instrument units subsection. This allows the user to configure the following operating parameters:
 - i. Wavelength Units – Using the three radio buttons, the user can select the units used for setting and reporting wavelength data.
 - ii. Power Units – Using the two radio buttons, the user can select the units used for setting and reporting optical power data.

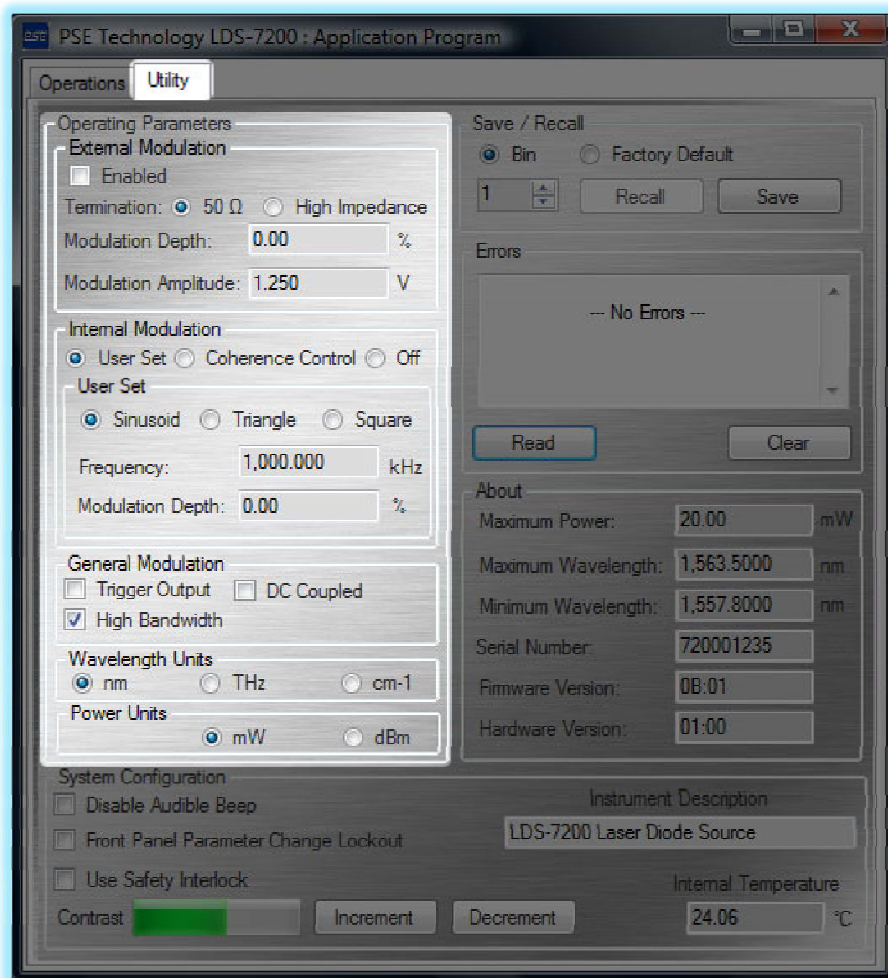


Figure 3.9: Operating Parameters Subsection Menu Screenshot

2. System Configuration Subsection:

As shown in the screen shot captured in figure 3.10 below. This subsection located at the bottom of the Utility screen, allows the user to configure the following system parameters:

- Enable / Disable the key press audible beep.
- Lock / Unlock front panel operating parameter changes.
- Enable / Disable the use instrument safety interlock.
- Increment or Decrement the instruments LCD contrast.
- Set the instrument description. To change the instrument description type in the description and hit enter. Please note that the description string is limited to a maximum of 40 characters.

In addition, this subsection periodically reads and displays the instruments internal operating temperature.

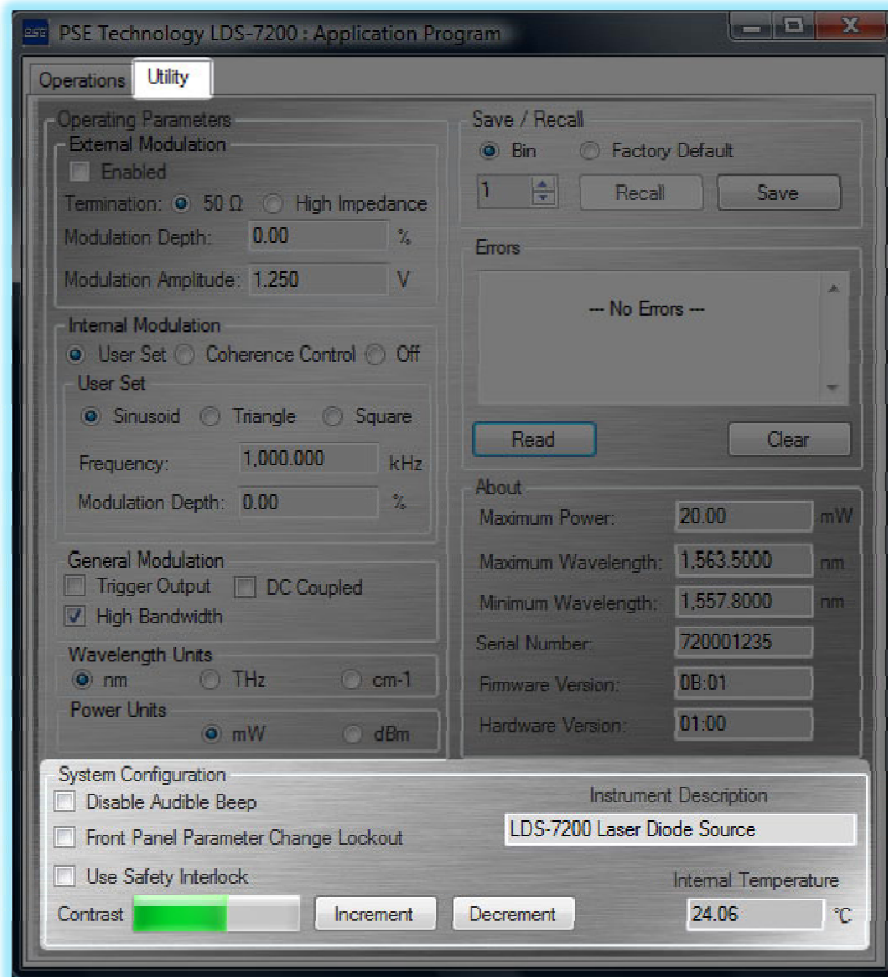


Figure 3.10: System Configuration Subsection Menu Screenshot

3. Save/Recall Subsection:

As shown in the screen shot captured in figure 3.11 below. This subsection located at the top right - hand side, provides a mechanism by which users can save or recall instrument settings. A maximum of 10 different user instrument configurations can be saved. In addition, this subsection can be used to reset the instrument to the factory default configuration. This is accomplished by activating the Factory Default radio button and pressing the recall button. Note that if the instrument does not contain any user saved instrument setting bins, the Recall button is only enabled when the Factory Default radio button is active.

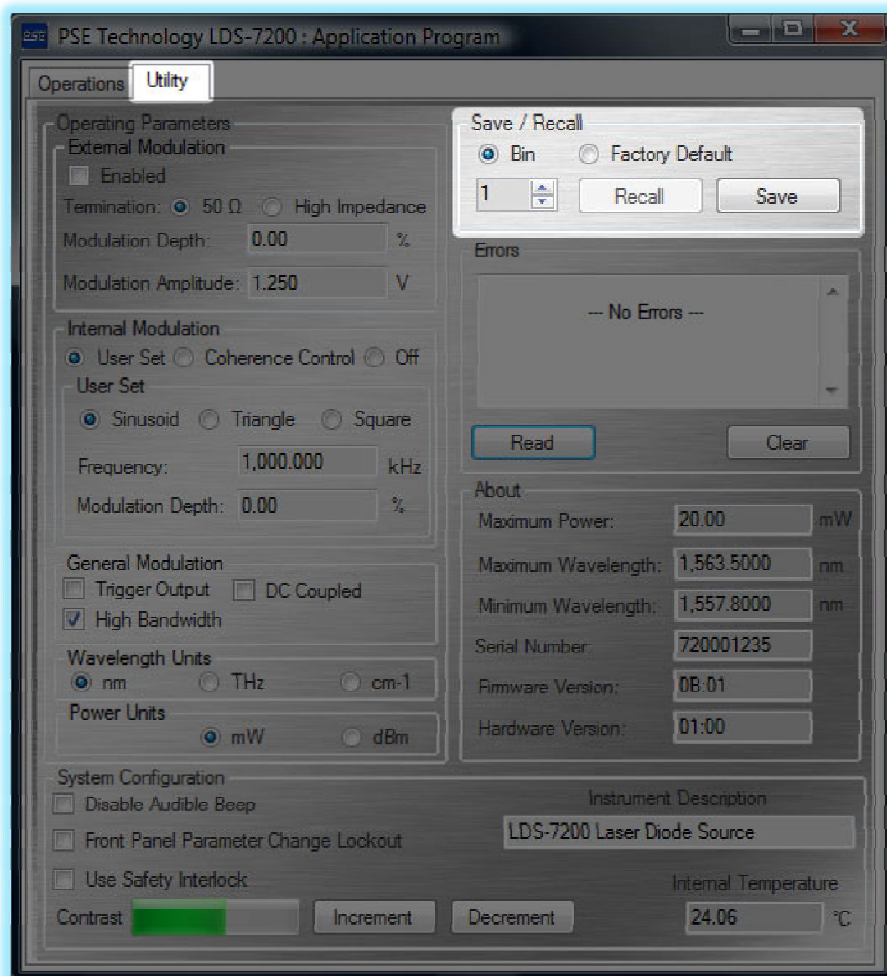


Figure 3.11: Save/Recall Subsection Menu Screenshot

4. Errors Subsection:

As shown in the screen shot captured in figure 3.12 below. This subsection located just below the Save/Recall subsection allows the user to read or clear the instruments ten deep FIFO based error queue. Note that error queue is not automatically cleared after a read; the user must explicitly clear the queue to empty the contents.

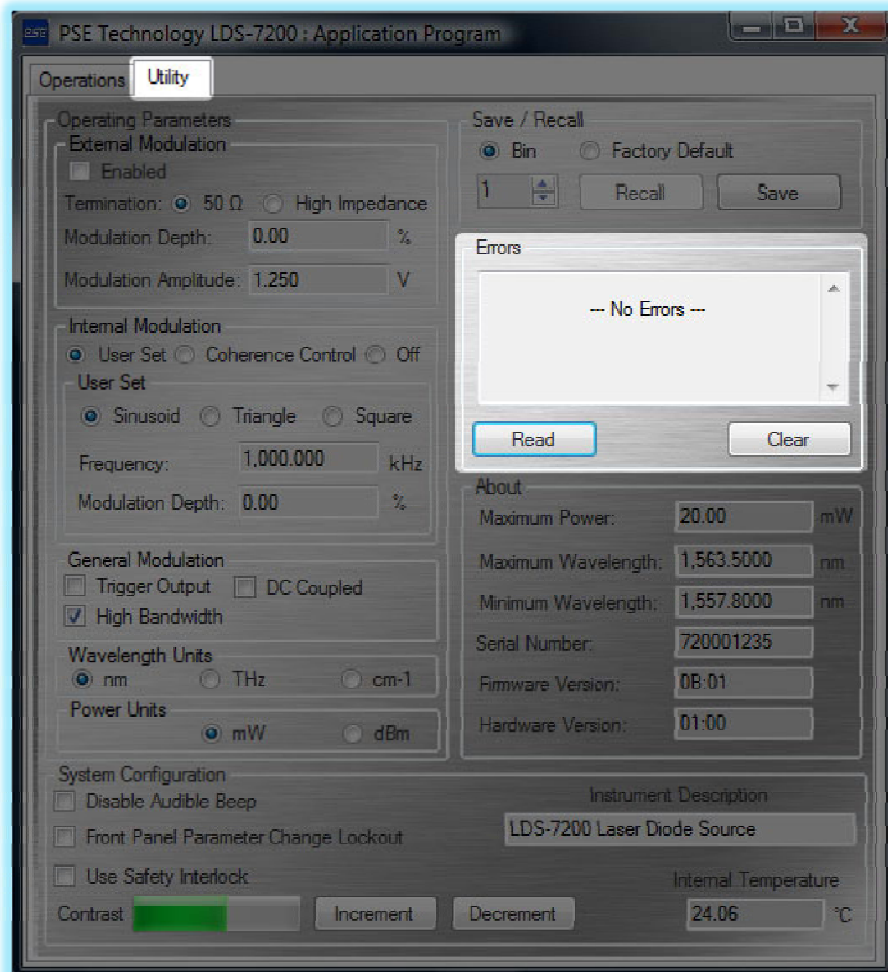


Figure 3.12: Errors Subsection Menu Screenshot

5. About Subsection:

This subsection located just below the error subsection, displays the following instrument specific information.

- a. Maximum Optical Power
- b. Maximum Wavelength
- c. Minimum Wavelength
- d. Instrument Serial Number
- e. Instrument Firmware Version
- f. Instrument Hardware Version

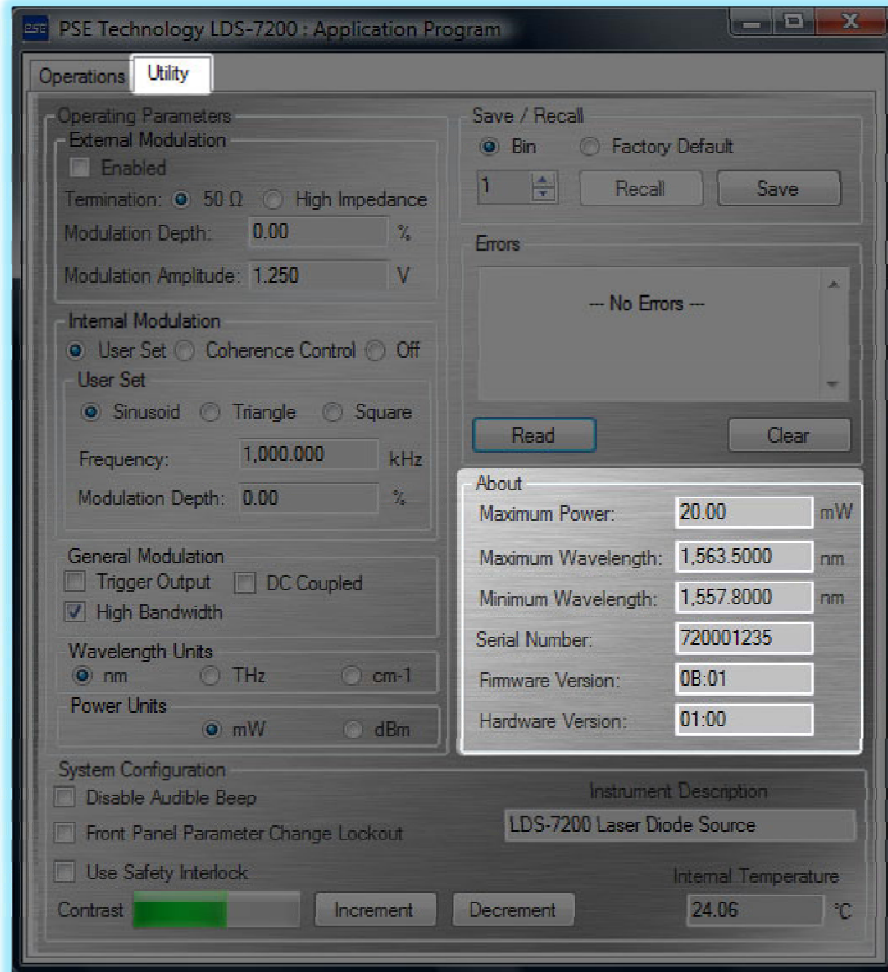


Figure 3.13: About Subsection Menu Screenshot

OPERATIONAL ERROR MESSAGES

During instrument operation the following unexpected error conditions may occur. In the event of one of these operational error conditions, the offending output will be automatically disabled and the instrument's Output On/Off button LED will be illuminated red. This automatic action by the instrument may leave the instrument in an unexpected state that confuses the user. When an output is automatically disabled the best troubleshooting technique is to determine the cause of the condition by reading the non-volatile instrument error queue. As described earlier in this section, the errors can be accessed using the Instrument Controller Program. The following list provides a summary of the operational errors that may occur.

ERROR CODE	DESCRIPTION
12	⁸ Instrument internal temperature sensor is over limit, disables all outputs
15	⁴ External interlock switch state disabled the laser output
16	⁴ Laser key switch state disabled the laser output
17	⁴ Laser Output On attempted when a TEC is off
60	^{4,5} The laser current limit automatically turned the laser output off
61	^{4,5} The laser power limit automatically turned the laser output off
62	^{4,5} The laser voltage limit automatically turned the laser output off
71	^{4,5} The TEC temperature limit automatically turned the TEC output off
74	⁴ The TEC sensor shorted
75	⁴ The TEC sensor open
80	^{4,5} The case TEC temperature limit automatically turned the case TEC off
82	⁴ The Case sensor shorted
83	⁴ The Case sensor open
100	USB Configuration EEPROM is not responding
101	Program Configuration Memory is corrupted
102	Temperature sensor data format error detected
103	Internal oscillator fault detected
104	Invalid flash memory access fault detected
105	Factory Configuration Memory is corrupted
110	Front panel UI data format error detected

Table 3.1: Instrument Operational Error Codes



The 100 series error codes, highlighted in bold, indicate that a severe hardware error condition has been detected. Service is recommended; please return the instrument for repair by trained service personnel.

⁸ These error conditions can automatically disable some or all the controller outputs

CHAPTER 4 – PROGRAMMING REFERENCE

INTRODUCTION

This chapter provides a detailed explanation for all the individual user programmable instrument commands available through the USB interface. The instrument communicates with the host computer by receiving properly formatted messages and returning appropriately formatted reply data. The messages contain device-specific information such as programming instructions, measurement results, and instrument status.

Everything you can do from the front panel or configuration program can also be done programmatically, and in some cases, with more flexibility. For instance, with programming you have access to commands for functions not found on the front panel. The following chapter describes the fundamentals of the general setup of your LDS-7200 Laser Diode Source programmatically through the USB interface. For the most efficient and effective remote control of your instrument, we recommend you study this chapter.

PROGRAMMING COMMAND SUMMARY

The following table lists all the user programmable instrument commands. The specific detail for each command is contained later in this chapter at the page number indicated in the right most column.

DESCRIPTION	HEADER	PAGE
Set Instrument User Description	1	56 Error! Reference source not found. Error! Reference source not found. Error! Reference source not found. Error! Reference source not found. Error! Reference source not found. Error! Reference source not found. Error! Reference source not found.
Query Instrument User Description	2	57
Query Instrument Serial Number	3	57
Query Firmware Version	4	58
Query Hardware Version	5	58
Query Minimum Optical Power	6	59
Query Maximum Optical Power	7	59
Query Minimum Wavelength	8	60
Query Maximum Wavelength	9	60
Set/Clear Laser Output State	10	61
Query Laser Output State	11	61
Set Laser Wavelength	12	62
Query Laser Wavelength	13	62
Set Laser Optical Power	14	63
Query Laser Optical Power	15	63
Set/Clear External Modulation State	16	64
Query External Modulation State	17	64
Set/Clear Internal Modulation State	18	65
Query Internal Modulation State	19	65

DESCRIPTION	HEADER	PAGE
Set/Clear Coherence Control State	20	66
Query Coherence State	21	66
Set/Clear 50Ω External Modulation Termination State	22	67
Query 50Ω External Modulation Termination State	23	67
Set Internal Modulation Frequency	24	68
Query Internal Modulation Frequency	25	68
Set Internal Modulation Sinusoidal Waveform	26	69
Query Internal Modulation Sinusoidal Waveform	27	69
Set Internal Depth of Modulation Percentage	28	70
Query Internal Depth of Modulation Percentage	29	70
Set Internal Modulation Attenuation DAC	30	71
Query Internal Modulation Attenuation DAC	31	71
Set External Depth of Modulation Percentage	32	72
Query External Depth of Modulation Percentage	33	72
Set External Modulation Attenuation DAC	34	73
Query External Modulation Attenuation DAC	35	73
Set External Modulation Amplitude	36	74
Query External Modulation Amplitude	37	74
Set Modulation DC Coupling State	38	75
Query Modulation DC Coupling State	39	75
Set Trigger Output State	40	76
Query Trigger Output State	41	76
Set High Bandwidth State	42	77
Query High Bandwidth State	43	77
Query Status Flag Byte	44	78
Query Laser Enable Key Switch State	45	79
Query Interlock State	46	79
Query Internal Instrument Temperature	47	80
Query Error Queue	48	80
Clear Error Queue	49	81
Set/Clear Front Panel Button Lockout State	50	81
Query Front Panel Button Lockout State	51	82
Set/Clear Use Rear Panel Interlock State	52	82
Query Use Rear Panel Interlock State	53	83
Reset Instrument To Factory Default Settings	54	84
Save User Settings to Bin	55	85
Recall User Settings from Bin	56	85
Query Number of User Bins Used	57	86
Set Wavelength Units	58	86
Query Wavelength Units	59	87
Set Optical Power Units	60	87
Query Optical Power Units	61	88
Increment/Decrement Display Contrast	62	88
Query Display Contrast	63	89
Enable Key Press Sound State	64	89
Query Key Press Sound State	65	90
Query Laser Diode Current Limit State	66	90
Query TEC Control Error State	67	91
Query Case TEC Control Error State	68	91
Query Limit States	69	92
Query TEC Output On State	70	93
Query Case TEC Output On State	71	93

Table 4.1: Programming Command Summary

PROGRAMMING GENERAL INFORMATION

DATA PACKET FORMAT

The generic communications format consists of a data packet organized as follows:

LENGTH	HEADER	PAYLOAD	CRC
1 – Byte	1 – Byte	0 to 39 Bytes	2 – Bytes
4 to 43	Unique to command	None (0 – Bytes)	CRC-16-IBM Algorithm ⁹
		Boolean or Byte (1 – Byte)	
		String (1 to 39 – Bytes)	
		Unsigned Integer (2 – Bytes)	
		Long (4 – Bytes)	
		Double (8 – Bytes)	

Table 4.2: Data Packet Format

- The length byte holds a numeric representation of the total message length. This includes the length byte, header byte, payload bytes, and CRC bytes. Valid message lengths for this instrument vary from 4 to 43 bytes.
- The header is a single byte that contains a unique value that represents each of the individual programmable commands.
- As depicted in Table 4.2 above, the payload or command parameter can consist of several different data types. The data types are further explained below:
 1. Boolean – or flag is also referred to as the logical data type, it can have one of two values: one or zero (which are equivalent to true and false, respectively). Since we use a full byte to represent the Boolean data type, a value of zero represents false and all other values are evaluated as a true.
 2. String – an array of single characters in ASCII format that denotes text.
 3. Unsigned Integer – can hold a whole number, but no fraction. Integers may be either signed (allowing negative values) or unsigned (non-negative values only). The range of a signed integer is $\pm 32,768$ and the range of an unsigned integer is 0 to 65,535.
 4. Long – identical to the standard integer type described directly above, with the exception that the range has been extended to $\pm 2,147,483,648$ for the signed version and 0 to 4,294,967,295 for the unsigned version. However, the one long implemented in this instrument is non-typical, it is a compilation of several individual Boolean flags grouped together to provide a convenient method to query all the program flags with a single command. See the general instrument command, Query Configuration for more details.
 5. Double – an extended range floating point number. A floating point number represents a real number that may have a fractional part. The range for the double floating point number is $\approx \pm 2.22507 \times 10^{-308}$. The bits are laid out as follows:

⁹ See the appendix for a detailed explanation of the CRC-16-IBM Algorithm

DOUBLE PRECISION FLOATING POINT

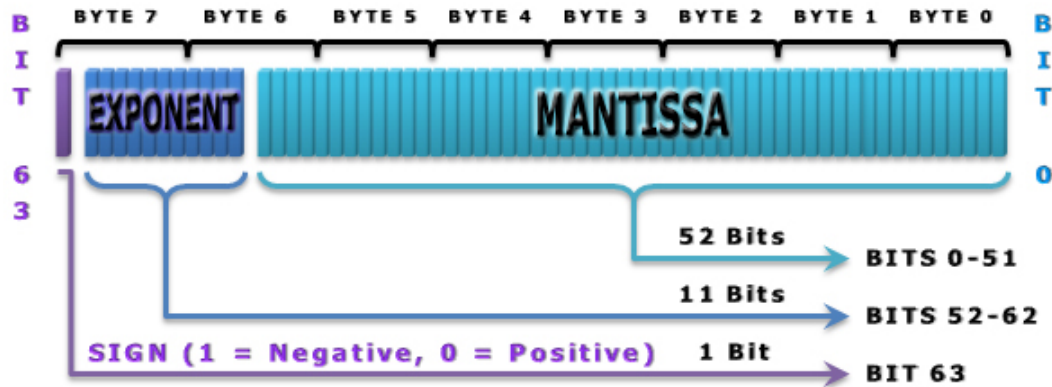


Figure 4.1: Double Number Format

- The cyclic redundancy check, CRC, is a coding technique for detecting errors in data. It is primarily used to protect data transmission. A number of check bits are appended to the message being transmitted. The receiver determines whether the check bits agree with the message to ascertain with a certain probability whether a transmission error occurred. CRC's are only used for error detection; they are not usable for error correction. Therefore, when an error occurs it is essential that the controlling program detect the condition and retransmit the corrupted data packet. Please reference the appendix for details on the CRC algorithm implementation.

PROGRAMMING RESPONSE

To ensure communications were received by the instrument, all commands will result in a response message. When data is transmitted in response to a query, the instrument will signify proper operation by returning valid data. When a command is issued that does not require response data, the instrument will signify success by returning an acknowledge character (ACK) in the payload. However, in both cases when a problem is detected the instrument will return a NOT acknowledge character (NAK) in the payload. These ACK and NAK characters are the standard communications characters defined in the ASCII code set:

- ACK (0x06, 6) = Acknowledge, valid communications
- NAK (0x15, 21) = Negative Acknowledge, invalid communications

PROGRAMMING ERROR MESSAGES

The following list of error codes can occur while programming the instrument. These indicate a problem with the instrument command issued, payload data, or the communications activity. The errors can be accessed by issuing the error query. When this is done, all of the error codes which are resident in the non-volatile error queue are returned (up to the last 10 may be stored). Reading the error queue does not clear the error queue. The error queue can only be emptied by sending the clear error queue command.

ERROR CODE	DESCRIPTION
10	Factory protected command received without proper security access
11	Invalid factory security access code detected
30	Unrecognized general type command header
31 – 36	Unrecognized factory command header
40	Invalid packet size for command
41	Indicated packet length is less than the minimum
42	Indicated packet length is greater than the maximum
43	Incomplete message packet was detected
44	Corrupted packet detected
45	Over-run error detected, new byte received before last message was processed
46	Byte framing error detected
47	Byte overflow error detected, new byte received before buffer empty
52	User requested a value greater than the maximum allowed for the parameter
53	User requested a value less than the minimum allowed for the parameter

Table 4.3: Programming Error Codes

The remaining chapter is divided into two parts. The first contains an overview of the programmable commands used by the instrument, as shown in Table 4.4. The second part describes and details each of the individual commands listed in the table, these are listed in order of the unique command header code.

COMMAND SUMMARY

HEADER	LENGTH	PARAMETER	RESPONSE	DESCRIPTION
1	44	40 x String	ACK or NAK	Set Instrument User Description
2	4	None	40 x String	Query Instrument User Description
3	4	None	9 x String	Query Instrument Serial Number
4	4	None	5 x String	Query Firmware Version
5	4	None	5 x String	Query Hardware Version
6	4	None	Double	Query Minimum Optical Power
7	4	None	Double	Query Maximum Optical Power
8	4	None	Double	Query Minimum Wavelength
9	4	None	Double	Query Maximum Wavelength
10	4	Boolean	ACK or NAK	Set/Clear Laser Output State
11	4	None	Boolean	Query Laser Output State
12	12	Double	ACK or NAK	Set Laser Wavelength
13	4	None	Double	Query Laser Wavelength
14	12	Double	ACK or NAK	Set Laser Optical Power
15	4	None	Double	Query Laser Optical Power
16	5	Boolean	ACK or NAK	Set/Clear External Modulation State
17	4	None	Boolean	Query External Modulation State
18	5	Boolean	ACK or NAK	Set/Clear Internal Modulation State
19	4	None	Boolean	Query Internal Modulation State
20	5	Boolean	ACK or NAK	Set/Clear Coherence Control State
21	4	None	Boolean	Query Coherence Control State
22	5	Boolean	ACK or NAK	Set/Clear 50Ω External Modulation
23	4	None	Boolean	Query 50Ω External Modulation Termination
24	12	Double	ACK or NAK	Set Internal Modulation Frequency
25	4	None	Double	Query Internal Modulation Frequency
26	5	Byte	ACK or NAK	Set/Clear Internal Modulation Waveform
27	4	None	Byte	Query Internal Modulation Waveform
28	12	Double	ACK or NAK	Set Internal Depth of Modulation Percentage
29	4	None	Double	Query Internal Depth of Modulation
30	6	Unsigned	ACK or NAK	Set Internal Modulation Attenuation DAC
31	4	None	Unsigned	Query Internal Modulation Attenuation DAC
32	12	Double	ACK or NAK	Set External Depth of Modulation
33	4	None	Unsigned	Query External Depth of Modulation
34	6	Unsigned	ACK or NAK	Set External Modulation Attenuation DAC
35	4	None	Unsigned	Query External Modulation Attenuation DAC
36	12	Double	ACK or NAK	Set External Modulation Amplitude
37	4	None	Double	Query External Modulation Amplitude
38	5	Boolean	ACK or NAK	Set Modulation DC Coupling State
39	4	None	Boolean	Query Modulation DC Coupling State
40	5	Boolean	ACK or NAK	Set Trigger Output State
41	4	None	Boolean	Query Trigger Output State
42	5	Boolean	ACK or NAK	Set Laser High Bandwidth State
43	4	None	Boolean	Query Laser High Bandwidth State
44	4	None	Byte	Query Status Flag Byte
45	4	None	Boolean	Query Laser Enable Key Switch State
46	4	None	Boolean	Query Interlock State
47	4	None	Double	Query Internal Instrument Temperature
48	4	None	10 x Byte	Query Error Queue
49	4	None	ACK or NAK	Clear Error Queue
50	4	None	ACK or NAK	Set/Clear Front Panel Parameter Change
51	4	None	Boolean	Query Front Panel Button Parameter
52	5	Boolean	ACK or NAK	Set/Clear Use Rear Panel Interlock State
53	4	None	Boolean	Query Use Rear Panel Interlock State
54	4	None	ACK or NAK	Reset Instrument To Factory Default
55	5	Byte	ACK or NAK	Save Settings
56	5	Byte	ACK or NAK	Recall Settings

HEADER	LENGTH	PARAMETER	RESPONSE	DESCRIPTION
57	4	None	Unsigned	Query User Bins Used
58	5	Byte	ACK or NAK	Set Wavelength Units
59	4	None	Byte	Query Wavelength Units
60	5	Byte	ACK or NAK	Set Optical Power Units
61	4	None	Byte	Query Optical Power Units
62	5	Boolean	ACK or NAK	Increment/Decrement Display Contrast
63	4	None	Unsigned	Query Display Brightness
64	5	Boolean	ACK or NAK	Set Key Sound State
65	4	None	Boolean	Query Sound State
66	4	None	Boolean	Query Laser Diode Limit State
67	4	None	Boolean	Query TEC Control Error State
68	4	None	Boolean	Query Case TEC Control Error State
69	4	None	Unsigned	Query Limit States
70	4	None	Boolean	Query TEC Output On State
71	4	None	Boolean	Query Case TEC Output On State

Table 4.4: Instrument Command Summary

GENERAL COMMAND DETAILS

ERROR! REFERENCE SOURCE NOT FOUND. SET INSTRUMENT USER DESCRIPTION

Action	Writes a user configurable ASCII formatted text string to the instruments non-volatile memory.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ ACK – indicates that the requested command operation was successfully performed. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The description string is limited to a maximum of 40 characters. The description string is useful in providing a means to uniquely identify individual instruments connected with multiple instruments on a multiport USB hub.

TRANSMIT MESSAGE FRAME

LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 to 40 Bytes)	CRC (2 Bytes)
44	1	String	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME

LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	1	ACK or NAK	Calculated

QUERY INSTRUMENT USER DESCRIPTION

Action	Reads the user configurable description stored in the instruments non-volatile memory.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a variable length character string, up to a maximum of 40 characters, is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The description string is limited to a maximum of 40 characters. The description string is useful in providing a means to uniquely identify individual instruments connected with multiple instruments on a multiport USB hub. The default description when shipped from the factory is “LDS-7200 Laser Diode Source”.

TRANSMIT MESSAGE FRAME

LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	2	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME

LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (40 Bytes)	CRC (2 Bytes)
44	2	String	Calculated
5	11	NAK	Calculated

QUERY INSTRUMENT SERIAL NUMBER

Action	Reads the instruments unique serial number identifier.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a nine digit ASCII formatted character string that represents the unique instrument serial number is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	To help ensure prompt support please provide customer service with the instrument serial number when requesting assistance.

TRANSMIT MESSAGE FRAME

LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	3	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME

LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 9 Bytes)	CRC (2 Bytes)
13	3	String	Calculated
5	3	NAK	Calculated

QUERY FIRMWARE VERSION

Action	Reads the version number of the firmware controlling the instrument.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a five character ASCII string formatted as follows XX:YY is returned. Where the digits in the XX position represent the major firmware version and the digits in the YY position represent the minor firmware version. The major and minor firmware versions are separated with the colon character. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	To help ensure accurate service please provide customer service with the full instrument firmware version when requesting assistance.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	4	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 5 Bytes)	CRC (2 Bytes)
9	4	String	Calculated
5	4	NAK	Calculated

QUERY HARDWARE VERSION

Action	Reads the version number of the hardware installed on the instrument.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a five character ASCII string formatted as follows XX:YY is returned. Where the digits in the XX position represent the analog platform hardware version and the digits in the YY position represent the digital platform hardware version. The two platform versions are separated with the colon character. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	To help ensure prompt support please provide customer service with the instrument hardware version when requesting assistance.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	5	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 5 Bytes)	CRC (2 Bytes)
9	5	String	Calculated
5	5	NAK	Calculated

QUERY MINIMUM OPTICAL POWER

Action	Reads the instruments minimum optical power setting.
Results	<p>The response message payload byte(s) indicate the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a double precision (8-Byte) real number representing the instruments minimum optical power value is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The value is scaled according to the optical power units setting.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	6	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	6	Double Precision Real Number	Calculated
5	6	NAK	Calculated

QUERY MAXIMUM OPTICAL POWER

Action	Reads the instruments maximum optical power setting.
Results	<p>The response message payload byte(s) indicate the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a double precision (8-Byte) real number representing the instruments maximum optical power value is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The value is scaled according to the optical power units setting.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	7	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	7	Double Precision Real Number	Calculated
5	7	NAK	Calculated

QUERY MINIMUM WAVELENGTH

Action	Reads the instruments minimum wavelength setting.
Results	<p>The response message payload byte(s) indicate the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a double precision (8-Byte) real number representing the instruments minimum wavelength value is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The value is scaled according to the wavelength units setting.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	8	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	8	Double Precision Real Number	Calculated
5	8	NAK	Calculated

QUERY MAXIMUM WAVELENGTH

Action	Reads the instruments maximum wavelength setting.
Results	<p>The response message payload byte(s) indicate the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a double precision (8-Byte) real number representing the instruments maximum wavelength value is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The value is scaled according to the wavelength units setting.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	9	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	9	Double Precision Real Number	Calculated
5	9	NAK	Calculated

SET/CLEAR LASER OUTPUT STATE

Action	Turns the laser diode output on or off.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	Laser safety requirements mandate that a five second safety activation delay expire prior to the laser output actually being enabled. If the laser fails to go on or quickly turns itself off, read the error queue to help determine the cause.



Whenever enabling the laser output the user should always exercise caution to avoid accidental exposure to possibly hazardous laser radiation.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Bytes)	CRC (2 Bytes)
5	10	1 = On or 0 = Off	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	10	ACK or NAK	Calculated

QUERY LASER OUTPUT STATE

Action	Reads the state of the laser diode output.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the laser output is ON and a value of 0 indicates that the laser output is OFF. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	When the state of the laser output is off and the user expects it to be on, one of the built-in laser protection features is likely automatically disabling the laser output. To determine which of the many protection features is disabling the output, check the error queue.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	11	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	11	1 = On or 0 = Off	Calculated
5	11	NAK	Calculated

SET LASER WAVELENGTH

Action	Sets the laser wavelength setpoint value.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ ACK – indicates that the requested command operation was successfully performed. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The value must be scaled according to the wavelength units setting.

<i>TRANSMIT MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (8 Bytes)	CRC (2 Bytes)
12	12	Double Precision Real Number	Calculated

<i>INSTRUMENT RESPONSE MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	12	ACK or NAK	Calculated

QUERY LASER WAVELENGTH SETPOINT

Action	Reads the laser wavelength setpoint value.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ On successful operation a double precision (8-Byte) real number wavelength value is returned. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The value is scaled according to the wavelength units setting.

<i>TRANSMIT MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	13	N/A	Calculated

<i>INSTRUMENT RESPONSE MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	13	Double Precision Real Number	Calculated
5	13	NAK	Calculated

SET LASER OPTICAL POWER

Action	Sets the laser optical power setpoint value.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ ACK – indicates that the requested command operation was successfully performed. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The value must be scaled according to the optical power units setting.

<i>TRANSMIT MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (8 Bytes)	CRC (2 Bytes)
12	14	Double Precision Real Number	Calculated

<i>INSTRUMENT RESPONSE MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	14	ACK or NAK	Calculated

QUERY LASER OPTICAL POWER SETPOINT

Action	Reads the laser optical power setpoint value.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ On successful operation a double precision (8-Byte) real number optical power value is returned. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The value is scaled according to the optical power units setting.

<i>TRANSMIT MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	15	N/A	Calculated

<i>INSTRUMENT RESPONSE MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	15	Double Precision Real Number	Calculated
5	15	NAK	Calculated

SET/CLEAR EXTERNAL MODULATION ENABLED STATE

Action	Enables or disables isolation of the external laser modulation input.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	When the external modulation input is disabled, any signal applied at the rear connector is isolated from the laser drive. This command provides a convenient method to quickly disable the modulation signal and observe the constant power laser performance (e.g. wavelength and optical power).

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	16	1 = Enabled or 0 = Disabled	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	16	ACK or NAK	Calculated

QUERY EXTERNAL LASER MODULATION ENABLED STATE

Action	Reads the external laser modulation input isolation state.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the external laser modulation input is enabled and a value of 0 indicates that the feature is disabled. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	With the modulation input disabled, the rear connector is isolated from the laser drive.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	17	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	17	1 = Enable or 0 = Disable	Calculated
5	17	NAK	Calculated

SET/CLEAR INTERNAL MODULATION ENABLED STATE

Action	Enables or disables the internal waveform generator.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	<p>This command provides a convenient method to quickly disable the internal modulation signal and observe the constant power laser performance (e.g. wavelength and optical power). Both the coherence control and internal waveform generator are derived from the same source. Therefore the user can only use either the internal waveform generator or coherence control. If both modulation and coherence control are required, enable coherence control and use an external waveform generator as the modulation source.</p>

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	18	1 = Enabled or 0 = Disabled	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	18	ACK or NAK	Calculated

QUERY INTERNAL MODULATION ENABLED STATE

Action	Reads the internal waveform generator On/Off state.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the internal waveform generator is enabled and a value of 0 indicates that the feature is disabled. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	<p>Both the coherence control and internal waveform generator are derived from the same source. Therefore the user can only use either the internal waveform generator or coherence control. If both modulation and coherence control are required, enable coherence control and use an external waveform generator as the modulation source.</p>

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	19	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	19	1 = Enable or 0 = Disable	Calculated
5	19	NAK	Calculated

SET/CLEAR COHERENCE CONTROL STATE

Action	Enables or disables the built-in coherence control.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	Both the coherence control and internal waveform generator are derived from the same source. Therefore the user can only use either the internal waveform generator or coherence control. If both modulation and coherence control are required, enable coherence control and use an external waveform generator as the modulation source.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	20	1 = Enabled or 0 = Disabled	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	20	ACK or NAK	Calculated

QUERY COHERENCE CONTROL STATE

Action	Reads the built-in coherence control state.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the built-in coherence control is enabled and a value of 0 indicates that the feature is disabled. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	Both the coherence control and internal waveform generator are derived from the same source. Therefore the user can only use either the internal waveform generator or coherence control. If both modulation and coherence control are required, enable coherence control and use an external waveform generator as the modulation source.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	21	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	21	1 = Enable or 0 = Disable	Calculated
5	21	NAK	Calculated

SET/CLEAR 50Ω EXTERNAL MODULATION TERMINATION STATE

Action	Enables or disables the 50Ω external modulation termination.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	This feature is only available when the external modulation is enabled.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	22	1 = Enabled or 0 = Disabled	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	22	ACK or NAK	Calculated

QUERY 50Ω EXTERNAL MODULATION TERMINATION STATE

Action	Reads the 50Ω external modulation termination state.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the 50Ω external modulation termination is enabled and a value of 0 indicates that the feature is disabled. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	This feature is only available when the external modulation is enabled.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	23	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	23	1 = Enable or 0 = Disable	Calculated
5	23	NAK	Calculated

SET INTERNAL MODULATION FREQUENCY

Action	Sets the frequency for the internal waveform generator.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum internal modulation frequency is 1.5 MHz and the minimum frequency is 100 Hz.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (8 Bytes)	CRC (2 Bytes)
12	24	Double Precision Real Number	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	24	ACK or NAK	Calculated

QUERY INTERNAL MODULATION FREQUENCY

Action	Reads the frequency setting for the internal waveform generator.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a double precision (8-Byte) real number frequency value is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum internal modulation frequency is 1.5 MHz and the minimum frequency is 100 Hz.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	25	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	25	Double Precision Real Number	Calculated
5	25	NAK	Calculated

SET INTERNAL MODULATION WAVEFORM

Action	Sets the internal modulation waveform.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The one byte payload sets the internal waveform type to: 0 = sinusoid, 1 = triangle, 2 = square.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	26	0 = Sinusoid 1 = Triangle 2 = Square	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	26	ACK or NAK	Calculated

QUERY INTERNAL MODULATION WAVEFORM

Action	Reads the type of the internal modulation waveform.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte value is returned. Where a value of 0 indicates that the internal waveform generator is set to produce a sinusoid, a value of 1 indicates that the waveform is set to a triangle, and a value of 2 indicates that the waveform is set to a square. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The available waveform types are 0 = sinusoid, 1 = triangle, and 2 = square.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	27	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	27	0 = Sinusoid 1 = Triangle 2 = Square	Calculated
5	27	NAK	Calculated

SET INTERNAL DEPTH OF MODULATION PERCENTAGE

Action	Sets the depth of modulation percentage for the internal waveform generator.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum depth of modulation percentage is 100.0000 and the minimum is 0.0001.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (8 Bytes)	CRC (2 Bytes)
12	28	100.0000 – 0.0001	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	28	ACK or NAK	Calculated

QUERY INTERNAL DEPTH OF MODULATION PERCENTAGE

Action	Reads the depth of modulation percentage value for the internal waveform generator.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a double precision (8-Byte) real number representing the depth of modulation percentage is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum depth of modulation percentage is 100.0000 and the minimum is 0.0001.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	29	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	29	100.0000 – 0.0001	Calculated
5	29	NAK	Calculated

SET INTERNAL MODULATION ATTENUATION DAC COUNTS

Action	Adjusts the internal modulation attenuation DAC (Digital to Analog Converter) value in counts. The attenuation DAC is 16-bits, therefore the expected value is a (2-Byte) unsigned integer.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ ACK – indicates that the requested command operation was successfully performed. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The internal modulation attenuation DAC value range is 0 to 65,535 counts. Maximum attenuation is achieved with a value of 0 and a minimum attenuation is achieved with a value of 65,535. Attempting to set a value outside of this range will generate an error and the requested setting will be ignored.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (2 Bytes)	CRC (2 Bytes)
6	30	0 – 65,535	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	30	ACK or NAK	Calculated

QUERY INTERNAL MODULATION ATTENUATION DAC COUNTS

Action	Reads the internal modulation attenuation value in DAC (Digital to Analog Converter) counts.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ On successful operation a (2-Byte) unsigned integer value representing the DAC counts for the modulation attenuation value is returned. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The DAC is 16-bits therefore valid values are 0 through 65,535. Maximum attenuation is achieved with a value of 0 and a minimum attenuation is achieved with a value of 65,535.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	31	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 2 Bytes)	CRC (2 Bytes)
6	31	0 – 65,535	Calculated
5	31	NAK	Calculated

SET EXTERNAL DEPTH OF MODULATION PERCENTAGE

Action	Sets the depth of modulation percentage for the external modulation input.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum depth of modulation percentage is 100.0000 and the minimum is 0.0001.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (8 Bytes)	CRC (2 Bytes)
12	32	100.0000 – 0.0001	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	32	ACK or NAK	Calculated

QUERY EXTERNAL DEPTH OF MODULATION PERCENTAGE

Action	Reads the depth of modulation percentage value for the external modulation input.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a double precision (8-Byte) real number representing the depth of modulation percentage is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum depth of modulation percentage is 100.0000 and the minimum is 0.0001.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	33	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	33	100.0000 – 0.0001	Calculated
5	33	NAK	Calculated

SET EXTERNAL MODULATION ATTENUATION DAC COUNTS

Action	Adjusts the external modulation attenuation DAC (Digital to Analog Converter) value in counts. The attenuation DAC is 16-bits, therefore the expected value is a (2-Byte) unsigned integer.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ ACK – indicates that the requested command operation was successfully performed. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The external modulation attenuation DAC value range is 0 to 65,535 counts. Maximum attenuation is achieved with a value of 0 and a minimum attenuation is achieved with a value of 65,535. Attempting to set a value outside of this range will generate an error and the requested setting will be ignored.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (2 Bytes)	CRC (2 Bytes)
6	34	0 – 65,535	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	34	ACK or NAK	Calculated

QUERY EXTERNAL MODULATION ATTENUATION DAC COUNTS

Action	Reads the internal modulation attenuation value in DAC (Digital to Analog Converter) counts.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ On successful operation a (2-Byte) unsigned integer value representing the DAC counts for the modulation attenuation value is returned. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The DAC is 16-bits therefore valid values are 0 through 65,535. Maximum attenuation is achieved with a value of 0 and a minimum attenuation is achieved with a value of 65,535.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	35	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 2 Bytes)	CRC (2 Bytes)
6	35	0 – 65,535	Calculated
5	35	NAK	Calculated

SET EXTERNAL MODULATION AMPLITUDE

Action	Sets the voltage amplitude of the external modulation signal being used.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ ACK – indicates that the requested command operation was successfully performed. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum voltage that can be applied to the external modulation input is ± 5 volts.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (8 Bytes)	CRC (2 Bytes)
12	36	5.0000 – 0.0001	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	36	ACK or NAK	Calculated

QUERY EXTERNAL MODULATION AMPLITUDE

Action	Reads the voltage amplitude of the external modulation signal being used.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ On successful operation a double precision (8-Byte) real number representing the voltage amplitude of the external modulation is returned. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum voltage that can be applied to the external modulation input is ± 5 volts.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	37	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	37	5.0000 – 0.0001	Calculated
5	37	NAK	Calculated

SET/CLEAR DC MODULATION COUPLING STATE

Action	Enables or disables the DC modulation coupling state.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	Using AC coupling is recommended with modulation signal > 10 kHz as it does not have much effect on the modulation waveform and provides an effective method to eliminate any DC offset that may be present on the modulation signal. When setting the modulation coupling to DC it is important to note the DC offset can sum with the set point, thus resulting in an offset in the power.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	38	1 = Enabled or 0 = Disabled	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	38	ACK or NAK	Calculated

QUERY DC MODULATION COUPLING STATE

Action	Reads the DC modulation coupling state.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the modulation signal is DC coupled and a value of 0 indicates that the modulation signal is AC coupled. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	Using AC coupling is recommended with modulation signal > 10 kHz as it does not have much effect on the modulation waveform and provides an effective method to eliminate any DC offset that may be present on the modulation signal. When setting the modulation coupling to DC it is important to note the DC offset can sum with the set point, thus resulting in an offset in the power.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	39	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	39	1 = Enabled or 0 = Disabled	Calculated
5	39	NAK	Calculated

SET/CLEAR TRIGGER OUTPUT STATE

Action	Enables or disables the trigger output state.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	When enabled the instrument will drive the trigger output with a high TTL signal when the internal modulation signal is above ½ the amplitude and a TTL low signal otherwise. When disabled the trigger connector can be used to digitally modulate the laser, a high TTL signal will turn off the laser and a low TTL signal will turn on the laser.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	40	1 = Enabled or 0 = Disabled	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	40	ACK or NAK	Calculated

QUERY TRIGGER OUTPUT STATE

Action	Reads the trigger output state.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the trigger connector is configured as an output and a value of 0 indicates that the trigger connector is configured as an input. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	When enabled the instrument will drive the trigger output with a high TTL signal when the internal modulation signal is above ½ the amplitude and a TTL low signal otherwise. When disabled the trigger connector can be used to digitally modulate the laser, a high TTL signal will turn off the laser and a low TTL signal will turn on the laser.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	41	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	41	1 = Enabled or 0 = Disabled	Calculated
5	41	NAK	Calculated

SET/CLEAR HIGH BANDWIDTH STATE

Action	Enables or disables the high bandwidth mode of operation.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	When enabled, no filtering is applied to the laser output. Whereas when disabled the laser output has a low pass filter applied. Note that operating the instrument in low bandwidth mode with a modulation signal may result in a distorted waveform.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	42	1 = Enabled or 0 = Disabled	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	42	ACK or NAK	Calculated

QUERY HIGH BANDWIDTH STATE

Action	Reads the high bandwidth mode of operation.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the instrument is configured in high bandwidth mode (no filtering) whereas a value of 0 indicates that the instrument is operating in low bandwidth mode (filtered output). NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	When enabled, no filtering is applied to the laser output. Whereas when disabled the laser output has a low pass filter applied. Note that operating the instrument in low bandwidth mode with a modulation signal may result in a distorted waveform.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	43	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	43	1 = Enabled or 0 = Disabled	Calculated
5	43	NAK	Calculated

QUERY STATUS FLAG WORD

Action	<p>Reads all the Boolean flags that indicate the state of the instrument. This consists of 6 individual Boolean flags grouped into a word as follows:</p> <ol style="list-style-type: none"> 1. BIT 0 : Interlock Active (1 = True, 0 = False) 2. BIT 1 : Key Switch Disabling Output (1 = True, 0 = False) 3. BIT 2 : Laser Output On (1 = True, 0 = False) 4. BIT 3 : TEC Output On (1 = True, 0 = False) 5. BIT 4 : Case Output On (1 = True, 0 = False) 6. BIT 5 : Front Panel Parameter Changes Locked-Out (1 = True, 0 = False) 7. BIT 6 : Factory Secure Mode Active (1 = True, 0 = False) 8. BIT 7 : Errors Present in the Queue (1 = True, 0 = False) <p>BITS 8 – 15 : Unused will be read as zero</p>
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ On successful operation a (2-bytes) unsigned integer value that represents the bit field flags listed above is returned. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The response payload is two bytes to avoid confusion between a valid status flag value and the error indicator of NAK.

<i>TRANSMIT MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	44	N/A	Calculated

<i>INSTRUMENT RESPONSE MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 2 Bytes)	CRC (2 Bytes)
6	44	0 – 255	Calculated
5	44	NAK	Calculated

QUERY LASER ENABLE KEY SWITCH STATE

Action	Reads the state of the rear panel laser enable key switch hardware.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 0 indicates that the rear panel laser key switch is enabling the laser output, and value of 1 indicates that the switch is disabling the laser output. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	When the laser output fails to go on or is being forced off unpredictably, reading the error queue may help diagnose the cause.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	45	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	45	0 = Enabled, 1 = Disabled	Calculated
5	45	NAK	Calculated

QUERY EXTERNAL LASER SAFETY INTERLOCK STATE

Action	Reads the state of the laser safety interlock hardware.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte value is returned. Where a value of 0 indicates that the rear panel laser interlock is enabling the laser output or configured as not used, a value of 1 indicates that the laser interlock is disabling the laser output. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	When the laser output fails to go on or is being forced off unpredictably, reading the error queue may help diagnose the cause.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	46	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	46	0 = Enabled, 1 = Disabled	Calculated
5	46	NAK	Calculated

QUERY INTERNAL INSTRUMENT TEMPERATURE

Action	Reads the instruments built-in temperature sensor. The measured temperature value units are in degrees Celsius.
Results	<p>The response payload message indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a double precision (8-Byte) real number temperature in Celsius is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The internal temperature sensor has been implemented in this instrument as an added laser diode protection feature. The instrument will automatically disable the laser, TEC, and case TEC output if an excessive (>80 °C) internal operational temperature is detected.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	47	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 8 Bytes)	CRC (2 Bytes)
12	47	Double Precision Real Number	Calculated
5	47	NAK	Calculated

QUERY ERROR QUEUE

Action	Reads the last ten error codes from the instruments non-volatile error queue memory.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation the last ten error codes (bytes) are returned. Each payload byte contains one of the individual error codes. When less than ten previous errors have been logged the nonexistent error code positions will be filled with zero. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The error queue can retain up to a maximum of ten previously occurring errors in the non-volatile error queue memory. Once cleared, this query will return ten zero filled bytes in the payload.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	48	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 10 Bytes)	CRC (2 Bytes)
14	48	10 Individual Error Codes	Calculated
5	48	NAK	Calculated

CLEAR ERROR QUEUE

Action	Removes all the previously generated error codes that have been logged into the instruments non-volatile error queue memory.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The error queue can retain up to a maximum of 10 previously occurring errors in the non-volatile error queue memory.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	49	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	49	ACK or NAK	Calculated

SET/CLEAR FRONT PANEL BUTTON LOCKOUT STATE

Action	Locks or unlocks the front panel parameter changes.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The button locked mode is useful when operating under computer control. This can be used to ensure that the output is not changed if a front panel button is accidentally bumped. Please be careful when operating in this mode, it can easily be confused as malfunctioning buttons.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	50	1 = Enabled or 0 = Disabled	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	50	ACK or NAK	Calculated

QUERY FRONT PANEL BUTTON LOCKOUT STATE

Action	Reads the state of the front panel button parameter change lockout feature.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the feature is enabled and a value of 0 indicates that the feature is disabled. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	It is important to always check the state of this feature when a malfunctioning button is suspected.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	51	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	51	1 = Enabled or 0 = Disabled	Calculated
5	51	NAK	Calculated

SET/CLEAR USE REAR PANEL INTERLOCK STATE

Action	Enables or Disables the use of the rear panel external interlock input.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The interlock input offers a mechanism by which users can disable the laser output when an external interlock switch is opened. For example, the external safety interlock can be tied into a rack enclosure intrusion switch that disables the laser output when the cabinet door is opened.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	52	1 = Enabled or 0 = Disabled	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	52	ACK or NAK	Calculated

QUERY USE REAR PANEL INTERLOCK STATE

Action	Reads the state of use the rear panel interlock feature.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ On successful operation a single byte Boolean value is returned. Where a value of 1 indicates that the feature is enabled and a value of 0 indicates that the feature is disabled. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	It is important to always check the state of this feature when the laser output is being disabled.

<i>TRANSMIT MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	53	N/A	Calculated

<i>INSTRUMENT RESPONSE MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	53	1 = Enabled or 0 = Disabled	Calculated
5	53	NAK	Calculated

RESET INSTRUMENT TO FACTORY DEFAULTS

Action	<p>Resets the user configurable instrument settings to their factory default values. The user configurable instrument settings and their associated default value are listed below:</p> <ol style="list-style-type: none"> 1. Laser Power Setpoint.....1.0 mW 2. Laser Wavelength Setpoint.....Mid-Point 3. Internal Depth of Modulation.....0.0 % 4. External Depth of Modulation.....0.0 % 5. External Modulation Peak-to-Peak Voltage1.25 V 6. Description LDS-7200 Laser Diode Source 7. Use Interlock..... False 8. External Modulation Enabled False 9. Internal Modulation Enabled False 10. Coherence Control Enabled..... False 11. 50Ω Termination Enabled False 12. Modulation DC Coupled False 13. Trigger Output Enabled..... False 14. High Bandwidth Enabled..... True 15. Button Sound Enabled True 16. Display Contrast..... Mid-Scale
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ○ ACK – indicates that the requested command operation was successfully performed. ○ NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	<p>This feature may be useful as an easy method to get all the instrument settings to a known state. However, please exercise caution; all the previous user configured instrument settings will be permanently discarded.</p>

TRANSMIT MESSAGE FRAME

LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	54	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME

LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	54	ACK or NAK	Calculated

SAVE USER SETTINGS TO A BIN

Action	Saves the current instrument settings to a user specified non-volatile storage bin.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum number of bins available for user storage is 10. To avoid accidentally recalling an empty bin, the user must select one of the bins already used or the next available bin for storage.

<i>TRANSMIT MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	55	1 – 10	Calculated

<i>INSTRUMENT RESPONSE MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	55	ACK or NAK	Calculated

RECALL USER SETTINGS FROM A BIN

Action	Recalls previously stored instrument settings from a bin.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum number of bins available for user storage is 10. If the user attempts to recall an empty bin, a NAK response will be returned.

<i>TRANSMIT MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	56	1 – 10	Calculated

<i>INSTRUMENT RESPONSE MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	56	ACK or NAK	Calculated

QUERY TOTAL NUMBER OF STORAGE BINS USED

Action	Reads the total number of user storage bins being used.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a two byte unsigned integer value is returned. Where the value indicates the total number of user storage bins used. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The maximum number of bins available for user storage is 10. The response payload is two bytes to avoid confusion between a valid status flag value and the error indicator of NAK.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Byte)	CRC (2 Bytes)
4	57	None	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 2 Bytes)	CRC (2 Bytes)
6	57	0 – 10	Calculated
5	57	NAK	Calculated

SET WAVELENGTH UNITS

Action	Sets the units used for setting and reporting wavelength data.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	<p>The following is the list of byte values and the corresponding unit:</p> <ol style="list-style-type: none"> 0 = nanometer (nm) 1 = terahertz (THz) 2 = wavenumbers (cm⁻¹)

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	58	0, 1, 2	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	58	ACK or NAK	Calculated

QUERY WAVELENGTH UNITS

Action	Reads the units used for setting and reporting the wavelength data.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation a (1-Byte) number representing the wavelength units is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	<p>The following is the list of byte values and the corresponding unit:</p> <ol style="list-style-type: none"> 0 = nanometer (nm) 1 = terahertz (THz) 2 = wavenumbers (cm⁻¹)

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	59	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	59	0, 1, 2	Calculated
5	59	NAK	Calculated

SET OPTICAL POWER UNITS

Action	Sets the units used for setting and reporting the optical power data.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	<p>The following is the list of byte values and the corresponding unit:</p> <ol style="list-style-type: none"> 0 = milliwatts (mW) 1 = decibals referenced to 1 milliwatt (dBm)

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	60	0 or 1	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	60	ACK or NAK	Calculated

QUERY OPTICAL POWER UNITS

Action	Reads the units used for setting and reporting the optical power data.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation (1-Byte) number representing the optical power units is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	<p>The following is the list of byte values and the corresponding unit:</p> <ol style="list-style-type: none"> 0 = milliwatts (mW) 1 = decibals referenced to 1 milliwatt (dBm)

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	61	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	61	0 or 1	Calculated
5	61	NAK	Calculated

BUMP DISPLAY CONTRAST

Action	Increment or decrement the display contrast.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	A payload Boolean value of 1 will increment the display contrast, whereas a value of 0 will decrement the display contrast.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	62	0 or 1	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	62	ACK or NAK	Calculated

QUERY DISPLAY CONTRAST

Action	Reads the display contrast setting.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation (2-Byte) number representing the display contrast setting is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	The response payload is two bytes to avoid confusion between a valid status flag value and the error indicator of NAK.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	63	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 or 2 Bytes)	CRC (2 Bytes)
5	63	0 to 63	Calculated
5	63	NAK	Calculated

SET BUTTON PRESS SOUND STATE

Action	Sets the state for using sound indicator when buttons are activated.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> ACK – indicates that the requested command operation was successfully performed. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	A Boolean value of 1 will enable the sound indicator for button presses, whereas a value of 0 will disable the sound indicator.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	64	0 or 1	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	64	ACK or NAK	Calculated

QUERY BUTTON PRESS SOUND STATE

Action	Reads the state for using sound indicator when buttons are activated.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation (1-Byte) Boolean number representing the state is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	A Boolean value of 1 indicates the button press sound indicator is enabled, whereas a value of 0 indicates the button press sound indicator is disabled.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	65	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	65	0 or 1	Calculated
5	65	NAK	Calculated

QUERY LASER DIODE CURRENT LIMIT STATE

Action	Reads the state of the laser diode current limit circuitry.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation (1-Byte) Boolean number representing the state is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	A Boolean value of 1 indicates that the laser diode current limit is active. Note that when modulating the laser the current limit protects the laser by limiting the maximum current delivered to the laser.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	66	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	66	0 or 1	Calculated
5	66	NAK	Calculated

QUERY TEC CONTROL ERROR STATE

Action	Reads the state of the TEC control loop error signal.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation (1-Byte) Boolean number representing the state is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	A Boolean value of 1 indicates that the TEC control loop has not stabilized at the setpoint temperature.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	67	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	67	0 or 1	Calculated
5	67	NAK	Calculated

QUERY CASE TEC CONTROL ERROR STATE

Action	Reads the state of the Case TEC control loop error signal.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation (1-Byte) Boolean number representing the state is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	A Boolean value of 1 indicates that the Case TEC control loop has not stabilized at the setpoint temperature.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	68	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	68	0 or 1	Calculated
5	68	NAK	Calculated

QUERY LIMIT STATES

Action	Reads the state of the limit signals.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation (2-Byte) Unsigned Integer representing the state of all the limits is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	<p>The limit byte consists of the following flags:</p> <p>Bit 0 = Laser Diode Current Limit (1 = Current Limit Active)</p> <p>Bit 1 = Laser Diode Voltage Limit (1 = Voltage Limit Active)</p> <p>Bit 2 = Laser Diode Power Limit (1 = Power Limit Active)</p> <p>Bit 3 = TEC Temperature Limit (1 = Temperature Limit Reached)</p> <p>Bit 4 = TEC Voltage Limit (1 = Voltage Limit Reached)</p> <p>Bit 5 = TEC Control Error Signal (1 = TEC Not Stabilized)</p> <p>Bit 6 = Case Temperature Limit (1 = Temperature Limit Reached)</p> <p>Bit 7 = Case Control Error Signal (1 = Case TEC Not Stabilized)</p> <p>The response payload is two bytes to avoid confusion between a valid status flag value and the error indicator of NAK.</p>

<i>TRANSMIT MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	68	N/A	Calculated

<i>INSTRUMENT RESPONSE MESSAGE FRAME</i>			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
6	68	0 – 255	Calculated
5	68	NAK	Calculated

QUERY TEC OUTPUT STATE

Action	Reads the state of the TEC output.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation (1-Byte) Boolean number representing the state is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	A Boolean value of 1 indicates that the TEC output is On, and conversely a value of 0 indicates the output is off. The laser output can't be enabled when the TEC output is off. The TEC output should never be off; the instrument will only disable the output if it detects an error condition. Please query the error queue to help diagnose why the output was disabled.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	70	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	70	0 or 1	Calculated
5	70	NAK	Calculated

QUERY CASE TEC OUTPUT STATE

Action	Reads the state of the Case TEC output.
Results	<p>The response message payload byte(s) indicates the status of the requested command operation.</p> <ul style="list-style-type: none"> On successful operation (1-Byte) Boolean number representing the state is returned. NAK – indicates that the requested command operation failed to execute. To help determine the cause of the failure, read the error queue. The first error code in the queue will indicate why the last command operation failed to execute.
Note	A Boolean value of 1 indicates that the Case TEC output is On, and conversely a value of 0 indicates the output is off. The laser output can't be enabled when the Case TEC output is off. The Case TEC output should never be off; the instrument will only disable the output if it detects an error condition. Please query the error queue to help diagnose why the output was disabled.

TRANSMIT MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (0 Bytes)	CRC (2 Bytes)
4	71	N/A	Calculated

INSTRUMENT RESPONSE MESSAGE FRAME			
LENGTH (1 Byte)	HEADER (1 Byte)	PAYLOAD (1 Byte)	CRC (2 Bytes)
5	71	0 or 1	Calculated
5	71	NAK	Calculated

APPENDIX

INTEGRATED LASER SAFETY FEATURES

In the United States, compliance with the regulations for lasers and laser products issued by the Center for Devices and Radiological Health (CDRH) of the Food and Drug Administration (FDA) is mandatory. The current CDRH regulations pertaining to laser emissions are found in 21 CFR 1040.10 and 1040.11. The following engineering design features are incorporated into the instrument to ensure class dependant compliance with most standard laser configurations, as specified in CDRH US21 CFR 1040.10.

❖ *Key Control*

- *Required for Class 3B and Class 4 laser products.*
- *The instrument has an integrated laser enable key switch located on the front panel. When switched to the laser disable position, the key should be removed and stored in a way such that untrained and unauthorized personnel cannot operate the laser.*

❖ *Remote Interlock*

- *Required for Class 3B and Class 4 laser products.*
- *The instrument has an integrated remote interlock input located on the front panel. This device, normally installed on the laser's power supply, prevents operation of the laser unless a connection is made between the terminals of the connector. This allows the user to connect door interlocks or other safety circuits in order to terminate emission when the circuit is broken (for example, when an interlocked door is opened or an emergency stop button is pressed). This can be especially useful when setting up an interlock-protected laser controlled area.*
- *While it is not required by the standard, it is nevertheless recommended as good engineering practice that, after the circuit has been broken through the operation of a remote interlock, restarting the laser should require the use of a separate, deliberate reset action unless the laser is in a safe condition when the interlock is closed. Where this is not the case then, for example, while laser emission may be terminated when an interlocked door into a laser room is inadvertently opened, laser emission will restart as soon as the door is closed, clearly not a very sensible safety arrangement if the unauthorized person who opened the door is now inside the room!*

❖ *Visual Emission Warning Device*

- *Required for Class 3B and Class 4 and also invisible-beam Class 3R laser products.*
- *The standard requires that a visual warning provide a useful indication of the laser's operating state for those not directly in control of laser emission. The instrument front panel contains a laser emission indicator LED integrated into the laser on/off button. Once switched on the laser will perform a five second delay prior to powering the laser, during this delay period the emission indicator LED will flash green. After the delay time has expired the laser will be powered up and the LED will be steady green.*

ERROR CODES

The following list of error codes can occur while operating the instrument. These may indicate a problem with the instrument, command issued, payload data, or the communications activity. The errors can be accessed with the Instrument Controller Program or by issuing the error query. When this is done, all of the error codes that are resident in the non-volatile error queue are returned (up to the last 10 may be stored). Reading the error queue does not clear the error queue. The error queue can only be emptied by sending the clear error queue command.

Error Code	Description
10	Factory protected command received without proper security access
11	Invalid factory security access code detected
12	²³ Internal instrument temperature over limit, disables all outputs
15	²³ External interlock switch state disabled the laser output
16	²³ Laser key switch state disabled the laser output
17	²³ User attempted to enable the laser output when TECs are off
30	Unrecognized system type command header
31	Unrecognized laser type command on USB message receipt
32	Unrecognized TEC type command on USB message receipt
33	Unrecognized case TEC type command on USB message receipt
34	Unrecognized factory test mode type command on USB message receipt
40	Invalid packet size for command
41	Indicated packet length is less than the minimum
42	Indicated packet length is greater than the maximum
43	Incomplete message packet was detected
44	Corrupted packet detected
45	Over-run error detected, new byte received before last message was processed
46	Byte framing error detected
47	Byte overflow error detected, new byte received before buffer empty
52	User requested a value greater than the maximum allowed for the parameter
53	User requested a value less than the minimum allowed for the parameter
60	^{23,24} The laser current limit automatically turned the laser output off
61	^{23,24} The laser power limit automatically turned the laser output off
62	^{23,24} The laser voltage limit automatically turned the laser output off
70	^{23,24} The TEC temperature limit automatically turned the TEC output off
71	^{23,24} The TEC control error limit automatically turned the TEC output off
72	²³ TEC sensor shorted
73	²³ TEC sensor open
80	^{23,27} The case TEC temperature limit automatically turned the case TEC off
81	^{10,11} The case TEC control error limit automatically turned the case TEC output off
82	²³ Case sensor shorted
83	²³ Case sensor open

Table A.1: Instrument Error Codes

¹⁰ These error conditions can disable some or all the controller outputs

¹¹ These error conditions are user configurable



The 100 series error codes indicate a severe hardware error condition has been detected. Immediate service is required; do NOT continue to operate the product. Please return the instrument for repair by trained service personnel.

Error Code	Description
100	USB Configuration EEPROM is not responding
101	Program Configuration Memory is corrupted
102	Analog PCBA temperature sensor data format error detected
103	Internal oscillator fault detected
104	Invalid memory access fault detected
105	Factory Memory EEPROM is not responding
110	Front Panel UI data format error detected
111	User Bin Storage CRC Error
121	Temperature Setpoint Corrupted

Table A.2: Instrument Severe Hardware Error Codes

LASER MODULATION ATTENUATION DAC

One of the unique features of this product is the ability to attenuate the modulation signal being delivered to multiple LDS-7200 instruments. This is critical in applications such as multiplexed spectroscopy, where multiple lasers are synchronously (from a single function generator) being scanned across absorption features of varying widths. The ability to independently tune the modulation signal ensures that the user can tweak each of the individual laser scan widths to exactly fit the unique absorption feature of interest.

The following equation demonstrates how the modulation current ($I_{\text{modulation}}$) is calculated based on the modulation voltage amplitude ($V_{\text{modulation}}$) and the DAC counts ($\text{DAC}_{\text{counts}}$).

$$I_{\text{Modulation}} = \frac{\text{DAC}_{\text{Counts}}}{2^{16} - 1} \times \frac{V_{\text{Modulation}}}{5}$$

Where:

$I_{\text{Modulation}}$ is in Amps

$V_{\text{Modulation}}$ is the maximum modulation amplitude in volts, $V_{\text{Modulation}} = V_{\text{peak-to-peak}} / 2$

$\text{DAC}_{\text{Counts}}$ is 16-bits, therefore the range is 0 – 65,535

MODULATION ATTENUATION VERSES BANDWIDTH

As shown in Figure A.1 below, the modulation attenuation is frequency dependent. For example:

Assuming zero attenuation (Digital Code = 0xFFFF), the monotonic attenuation bandwidth is 2 MHz, and gain peaking occurs between 2 MHz and 6 MHz and then rolls off at approximately 6 dB/octave.

Assuming -30 dB of attenuation (Digital Code = 0x0800), the monotonic attenuation bandwidth is 4 MHz. -30 dB of attenuation results in an attenuation factor = 0.032, as shown in the following formula:

$$= 10^{\frac{A(\text{dB})}{20}} = 10^{\frac{-30}{20}} = 0.032$$

Therefore, assuming an input peak voltage of +15 volts, the resulting output voltage would be 0.47V, as shown in the following formula:

$$+15V \times 0.032 = +0.47V$$

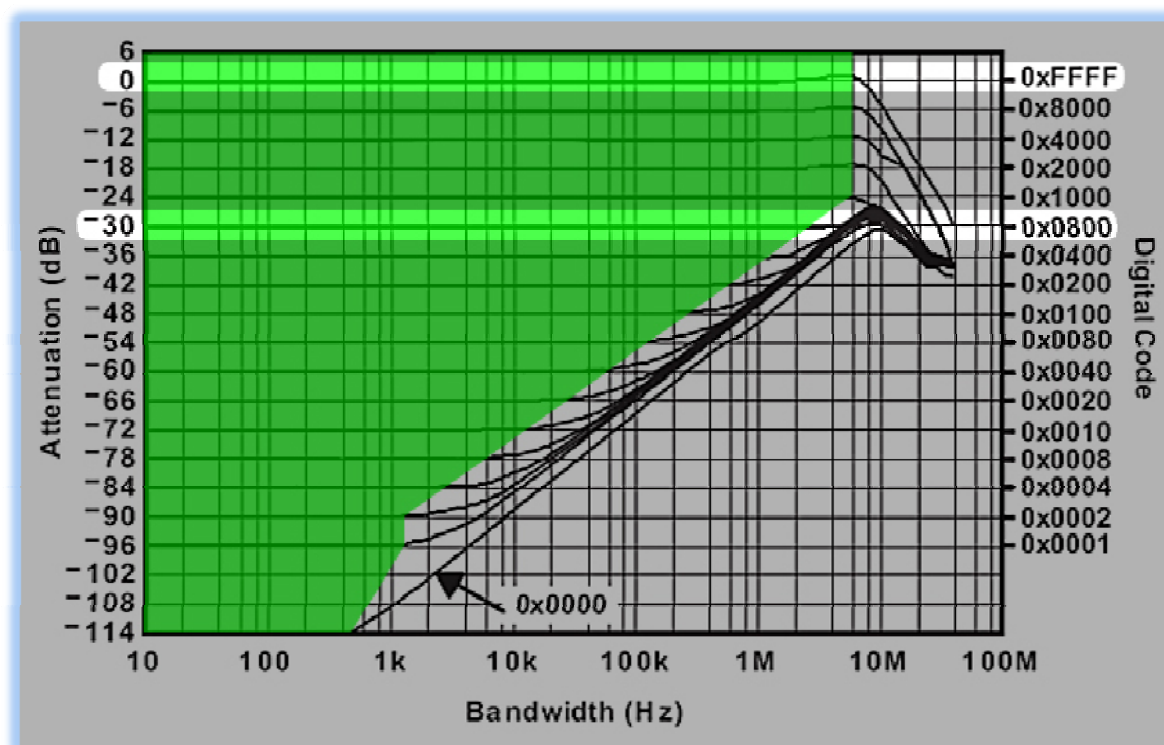


Figure A1: Modulation Bandwidth vs. Modulation Attenuation Curves

When applying attenuation to a modulated signal, the user should consult the graph in Figure A.3 to ensure the requested attenuation remains monotonic throughout the entire bandwidth, or more simply ensure that the intersection of the attenuation value (y-axis) and maximum frequency (x-axis) remain within area highlighted in green.

The following formulas are useful to convert between attenuation values and voltage output:

$$A(dB) = 20 \times \log_{10} \left(\frac{V_{out}}{V_{in}} \right)$$

$$V_{out} = V_{in} \times 10^{\frac{A(dB)}{20}}$$

To convert a modulation voltage into a modulation current apply the following formula:

$$I_{modulation} = \left(\frac{DigitalCode}{2^{16}} \right) \times \left(\frac{V_{peak-modulation}}{5} \right)$$

This instrument uses this equation to calculate the appropriate digital code that will result in the user requested modulation current given the user entered modulation peak-to-peak voltage.

IMPLEMENTING THE CRC-16-IBM ALGORITHM

The aim of an error detection technique is to enable the receiver of a message transmitted through a noisy (error-introducing) channel to determine whether the message has been corrupted. To do this, the transmitter constructs a value (called a checksum) that is a function of the message, and appends it to the message. The receiver can then use the same function to calculate the checksum of the received message and compare it with the appended checksum to see if the message was correctly received.

Note: The term "checksum" was presumably used to describe early summing formulas, but has now taken on a more general meaning encompassing more sophisticated algorithms such as the CRC ones. The CRC

algorithms to be described satisfy the second condition very well, and can be configured to operate with a variety of checksum widths.

At least two aspects are required to form a strong checksum function:

- WIDTH:

A register width wide enough to provide a low a-priori probability of failure (e.g. 16-bits gives a $1/2^{16}$ chance of detecting a failure).

- CHAOS:

A formula that gives each input byte the potential to change any number of bits in the register.

Simple addition does not provide enough chaos (randomization) to suffice as an effective checksum generator, it turns out that division does, so long as the divisor is about as wide as the checksum register.

The basic idea of CRC algorithms is simply to treat the message as an enormous binary number, to divide it by another fixed binary number, and to make the remainder from this division the checksum. Upon receipt of the message, the receiver can perform the same division and compare the remainder with the "checksum" (transmitted remainder).

The word you will hear all the time when dealing with CRC algorithms is the word "polynomial". A given CRC algorithm will be said to be using a particular polynomial, and CRC algorithms in general are said to be operating using polynomial arithmetic. What does this mean?

Instead of the divisor, dividend (message), quotient, and remainder being viewed as positive integers, they are viewed as polynomials with binary coefficients. This is done by treating each number as a bit-string whose bits are the coefficients of a polynomial. For example, the ordinary number 23 (decimal) is 17 (hex) and 10111 binary and so it corresponds to the polynomial:

$$1 \times x^4 + 0 \times x^3 + 1 \times x^2 + 1 \times x^1 + 1 \times x^0$$

or, more simply:

$$x^4 + x^2 + x^1 + x^0$$

Having defined CRC arithmetic, we can now frame a CRC calculation as simply a division, because that's all it is! This section fills in the details and gives an example.

To perform a CRC calculation, we need to choose a divisor. In math marketing speak the divisor is called the "generator polynomial", and is a key parameter of any CRC algorithm.

You can choose any generator polynomial and come up with a CRC algorithm. However, some values are better than others, and so it is wise to stick with the tried and tested ones. Developing a generating polynomial is beyond the scope of this manual, it is sufficient to just use the CRC-16-IBM generator polynomial 0x8005 or in binary 1000 0000 0000 0101.

The width (position of the highest 1 bit) of the generator polynomial is very important as it dominates the whole calculation. Typically, widths of 16 or 32 are chosen so as to simplify implementation on modern computers. The width of a generator polynomial is the actual bit position of the highest bit. For example, the width of 10011 is 4, not 5. For the purposes of example and to simplify the operation, we will chose a generator polynomial of 10011 (which has a width $W = 4$).

Having chosen a generator polynomial, we can proceed with the calculation. This is simply a division (in CRC arithmetic) of the message by the generator polynomial. The only trick is that W zero bits are appended to the message before the CRC is calculated.

Thus we have:

Original Message : 1101011011
 Generator Polynomial : 10011
 Message after appending W zeros : 11010110110000

Now we simply divide the augmented message by the generator polynomial using CRC arithmetic. This is the same division as before:

$$\begin{array}{r}
 1100001010 \\
 10011 \overline{) 1101011011 \ 0000} \\
 \underline{1001100000 \ 0000} \\
 0100111011 \ 0000 \\
 \underline{0100110000 \ 0000} \\
 0000000101 \ 1000 \\
 \underline{0000001011 \ 0000} \\
 0000000010 \ 1000 \\
 \underline{0000000010 \ 0110} \\
 0000000000 \ 1110
 \end{array}$$

The division yields the all important remainder or CHECKSUM of **1110**, and a quotient of 1100001010, which we throw away. This ends the CRC calculation example.

Usually, the checksum is then appended to the message and the result transmitted. In this case the transmission would be: **11010110111110**.

At the other end, the receiver can do one of two things:

- Separate the message and checksum. Calculate the checksum for the message (after appending W zeros) and compare the two checksums.
- Checksum the whole lot (without appending zeros) and see if it comes out as zero!

These two options are equivalent. However, option b is typically implemented because it is marginally mathematically cleaner.

A summary of the operation for calculating the CRC-16-IBM Algorithm:

1. Choose a width $W = 16$
2. Choose a generator polynomial G (of width W) = $0x8005 = 1000 \ 0000 \ 0000 \ 0101$
3. Append W zero bits to the message M . Call this M' .
4. Divide M' by G using CRC arithmetic. The remainder is the checksum.
5. Append the checksum to the original message M .

That's all there is to it. If you need additional assistance with implementing the CRC-16-IBM Algorithm, please feel free to contact us for the C functions implemented in this instrument.