COHERENT

Operator's Manual
Sapphire™ FP OEM
Optically-Pumped Semiconductor Laser System

COHERENT

Operator's Manual
Sapphire FP OEM
Optically-Pumped Semiconductor Laser System

COHERENT.
5100 Patrick Henry Drive
Santa Clara, CA 95054

Patents referenced in this Operator's manual were active as of the printing date of the manual (see last page for date). The patents referenced herein may have expired. You are advised to check to see if the patents are still active: http://portal.uspto.gov/external/portal/pair.

Every effort has been made to ensure that the data given in this document is accurate. The information, figures, tables, specifications and schematics contained herein are subject to change without notice. Coherent makes no warranty or representation, either expressed or implied with respect to this document. In no event will Coherent be liable for any direct, indirect, special, incidental or consequential damages resulting from any defects in its documentation.

The rights which customers of Coherent receive through purchase of this product are restricted, and exclude any right to use the product in the telecommunications field.

Technical Support

In the US:

Should you experience any difficulties with your laser or need any technical information, please visit our web site: www.Coherent.com. Additional support can be obtained by contacting our Technical Support Hotline at 1.800.367.7890 (1.408.764.4557 outside the U.S.) or e-mail (Product.Support@Coherent.com). Telephone coverage is available around the clock (except U.S. holidays and company shutdowns).

If you call outside our office hours, your call will be taken by our answering system and will be returned when the office reopens.

If there are technical difficulties with your laser that cannot be resolved by support mechanisms outlined above, e-mail or telephone Coherent Technical Support with a description of the problem and the corrective steps attempted. When communicating with our Technical Support Department via the web or telephone, the Support Engineer responding to your request will require the model and Laser Head serial number of your laser system.

Outside the US:

If you are located outside the U.S. visit our web site for technical assistance or contact, by phone, our local Service Representative. Representative phone numbers and addresses can be found on the Coherent web site, www.Coherent.com.

Coherent provides telephone and web technical assistance as a service to its customers and assumes no liability thereby for any injury or damage that may occur contemporaneous with such services. These support services do not affect, under any circumstances, the terms of any warranty agreement between Coherent and the buyer. Operation of any Coherent laser with any of its interlocks defeated is always at the operator's own risk.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Signal Words and Symbols in this Manual

This documentation may contain sections in which particular hazards are defined or special attention is drawn to particular conditions. These sections are indicated with signal words in accordance with ANSI Z-535.6 and safety symbols (pictorial hazard alerts) in accordance with ANSI Z-535.3 and ISO 7010.

Signal Words

Four signal words are used in this documentation: **DANGER**, **WARNING**, **CAUTION** and ***NOTICE***.

The signal words **DANGER**, **WARNING** and **CAUTION** designate the degree or level of hazard when there is the risk of injury:

DANGER!
Indicates a hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING!
Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION!
Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

The signal word "***NOTICE***" is used when there is the risk of property damage:

NOTICE!
Indicates information considered important, but not hazard-related.

Messages relating to hazards that could result in both personal injury and property damage are considered safety messages and not property damage messages.

Symbols

The signal words **DANGER**, **WARNING**, and **CAUTION** are always emphasized with a safety symbol that indicates a special hazard, regardless of the hazard level:

This symbol is intended to alert the operator to the presence of important operating and maintenance instructions.

This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.

This symbol is intended to alert the operator to the presence of dangerous voltages within the product enclosure that may be of sufficient magnitude to constitute a risk of electric shock.

This symbol is intended to alert the operator to the danger of Electro-Static Discharge (ESD) susceptibility.

This symbol is intended to alert the operator to the danger of crushing injury.

This symbol is intended to alert the operator to the danger of a lifting hazard.

Preface

This manual contains user information for the Sapphire™ FP OEM laser.

NOTICE!
Read this manual carefully before operating the laser for the first time. Pay special attention to the material in "Section One: Laser Safety" (p. 1-1) that describes the safety features built into the laser.

WARNING!
Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

U.S. Export Control Laws Compliance

It is the policy of Coherent to comply strictly with U.S. export control laws.

Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations.

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by U.S. law, clarification must be obtained from Coherent or an appropriate U.S. Government agency.

Products manufactured in the European Union, Singapore, Malaysia, Thailand: These commodities, technology, or software are subject to local export regulations and local laws. Diversion contrary to local law is prohibited. The use, sale, re-export, or re-transfer directly or indirectly in any prohibited activities are strictly prohibited.

French Translation/Traduction Française

Mots indicateurs et symboles utilisés dans ce manuel

La présente documentation peut contenir des sections dans lesquelles des dangers particuliers sont définis ou une attention spéciale est portée à des conditions spécifiques. Ces sections sont signalées par des mots indicateurs, conformément à la norme ANSI Z-535.6, ainsi que des symboles de sécurité (alertes de danger par pictogramme) conformément aux normes ANSI Z-535.3 et ISO 7010.

Mots indicateurs

Cette documentation fait usage de quatre mots indicateurs: **DANGER**, **AVERTISSEMENT**, **MISE EN GARDE** et ***AVIS***.

Les mots indicateurs **DANGER**, **AVERTISSEMENT** et **MISE EN GARDE** indiquent le degré ou niveau de danger en présence d'un risque immédiat de blessures graves :

DANGER !
Indique une situation dangereuse qui, si elle n'est pas évitée, entraînera la mort ou des blessures graves. Ce mot indicateur est réservé aux situations les plus graves.

AVERTISSEMENT !
Indique une situation dangereuse qui, si elle n'est pas évitée, peut entraîner la mort ou des blessures graves.

MISE EN GARDE !
Indique une situation dangereuse qui, si elle n'est pas évitée, pourrait entraîner des blessures légères ou modérées.

Le mot indicateur " ***AVIS*** " est utilisé lorsqu'un risque de dommages matériels existe :

AVIS !
Indique des informations considérées comme importantes, mais ne constituant pas un danger.

Les messages relatifs aux dangers pouvant entraîner à la fois des blessures et des dommages matériels sont considérés comme des messages concernant la sécurité et non comme des messages avertissant de la possibilité de dégâts matériels.

Symboles

Les mots indicateurs **DANGER**, **AVERTISSEMENT**, et **MISE EN GARDE** sont toujours mis en évidence par la présence d'un symbole de sécurité indiquant un danger spécifique, sans égard au niveau de ce danger :

Ce symbole est destiné à alerter l'opérateur de la présence d'instructions importantes concernant le fonctionnement ou l'entretien/la réparation.

Ce symbole est destiné à alerter l'opérateur de l'existence de risques d'exposition aux radiations laser, visibles ou invisibles.

Ce symbole est destiné à alerter l'opérateur de l'existence de tensions dangereuses à l'intérieur du boîtier ou carter de l'appareil, d'une importance suffisante pour constituer un risque d'électrocution.

Ce symbole est destiné à alerter l'opérateur de l'existence de décharges électrostatiques (DES).

Ce symbole est destiné à alerter l'opérateur de l'existence d'un danger d'écrasement.

Ce symbole est destiné à alerter l'opérateur de l'existence d'un risque de levage.

Préface

Ce manuel contient des informations sur le laser Sapphire FP OEM.

AVIS !
Lire ce manuel attentivement avant une première utilisation du laser. Une attention particulière devra être portée à la Section 1, Sécurité Laser, qui décrit les précautions à prendre avec le laser.

AVERTISSEMENT !
L'utilisation de procédures de contrôle ou de réglages des performances autres que celles spécifiées ci-après peut conduire à une exposition risquée aux radiations laser.

Conformité avec les lois américaines sur le contrôle des exportations

Coherent a pour politique de se conformer strictement aux lois de contrôle des exportations des États-Unis.

L'exportation et la réexportation des lasers construits par Coherent sont sujettes aux règlements d'administration des exportations des États-Unis, gérés par le département américain du commerce. En outre, les expéditions de certains composants sont réglementées par le département d'État en vertu de la réglementation visant le trafic international d'armes.

Les restrictions applicables varient selon le produit spécifique impliqué et sa destination. Dans certains cas, la loi des États-Unis exige que l'accord du gouvernement des États-Unis soit obtenu avant la revente, l'exportation ou la réexportation de certains articles. Quand il y a incertitude sur les obligations imposées par la loi des États-Unis, une clarification doit être obtenue auprès de Coherent ou d'un organisme gouvernemental compétent des États-Unis.

Produits fabriqués à l'intérieur de l'union européenne, Singapour, en Malaisie, Thaïlande: Ces marchandises, technologies ou logiciels sont sujet aux lois locales ainsi qu'aux régulations d'exportation locales. Toutes déviations contraires aux lois locales sont interdites. L'utilisation, la vente, la réexportation, ou le transfert direct ou indirect dans toutes activités illégales sont strictement interdites.

SECTION ONE: LASER SAFETY

Optical Safety

Laser light, because of its special properties, can cause safety hazards not related to light from conventional sources. The safe use of lasers requires that all laser users and all persons near the laser system understand the possible danger. The safe use of the laser depends on the user understanding the instrument and the properties of coherent, strong beams of light.

DANGER!
Direct eye contact with the output beam from the laser will cause damage and possible injury to the eyes.

Laser beams can ignite volatile substances, for example alcohol, gasoline, ether and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers, and photodiodes. Reflected beams can cause damage.The user is recommended to follow these precautions:

1. Observe all safety precautions in the operator's manual (this document).
2. Caution must be exercised when using solvents in the area of the laser.
3. Limit access to the laser to qualified users who know laser safety practices and who understand the possible danger.
4. Never look directly into the laser light source or at scattered laser light from any reflective surface. Never sight down the beam into the source.
5. Keep experimental setups at low heights to prevent accidental beam-eye encounter at eye level.

WARNING!
Laser safety glasses can be a hazard and a benefit: while they protect the eyes from possible damaging exposure, they can also block light at the laser wavelengths, which prevents the operator from seeing the beam. Use caution, even when wearing safety glasses.

6. As a precaution against accidental exposure to the output beam or its reflection, persons using the system should wear laser safety glasses as required by the wavelength being generated.
7. Use the laser in an enclosed room. Laser light remains collimated over long distances and presents a possible hazard if not confined.
8. Post warning signs in the area of the laser beam to alert individuals.
9. Tell all persons using the laser of these precautions. It is good practice to operate the laser in a room with controlled and restricted access.

Electrical Safety

The Sapphire laser does not have hazardous voltages. Do not disassemble the enclosure. There are no user-serviceable components inside. All units can be operated as assembled. Warranty is voided if the enclosure is disassembled.

Laser Safety Requirements

This laser product is to be sold to an original equipment manufacturer of electronic products for use as a component (or replacement component) in electronic products. As such, this product is exempt from DHHS performance standard for laser products in accordance with paragraph 1040.10(a)(1).

The following information is provided to help the OEM in complying with radiation safety standards.

Laser Emission and Classification

The Sapphire FP laser is classified by the United States National Center for Device and Radiological Health (CDRH) as a CLASS IIIB laser product. It emits VISIBLE AND INVISIBLE LASER RADIATION of the wavelengths (listed in Table 1-1, below) from the aperture in the front of the laser head.

Table 1-1. Emitted Wavelengths

Laser Type	Emitted Wavelengths[a]
Sapphire LP 458 nm	0.45 to 0.50 µm and 0.90 to 1.00 µm
Sapphire LP 488 nm	0.45 to 0.50 µm and 0.90 to 1.00 µm
Sapphire LP 514 nm	0.50 to 0.55 µm and 1.00 to 1.10 µm
Sapphire LP 532 nm	0.50 to 0.55 µm and 1.00 to 1.10 µm
Sapphire LP 552 nm	0.54 to 0.57 µm and 1.08 to 1.14 µm
Sapphire LP 561 nm	0.55 to 0.58 µm and 1.10 to 1.16 µm
Sapphire LP 588 nm	0.58 to 0.60 µm and 1.10 to 1.20 µm
Sapphire LP 594 nm	0.58 to 0.60 µm and 1.10 to 1.20 µm

a. Collinear radiation of 0.79 to 0.82 µm may also be present.

Laser Radiation Emission Indicator

A yellow indicator light is provided on the rear of the laser head. This light is illuminated when the laser pump diode is energized. This light may not meet the IEC-825 requirement that warning laser lights must be fail-safe or redundant. The Sapphire OEM Controller LP has is designed to accommodate a warning light that is fail-safe or redundant and meets the IEC-825 requirements. This light is part of the interlock system and must be supplied by the laser user. For more details, refer to the description of the interlock circuit under "Using a Laser Warning Light" (p. 3-15).

Interlock

A normally closed remote interlock switch can be installed on the Sapphire OEM Controller LP. For more details, refer to the description of the interlock circuit under "Using a Laser Warning Light" (p. 3-15).

DIP Switch Settings

With the DIP switches found on the Sapphire OEM Controller LP, the user can bridge the safety circuits and set the laser to Autostart mode. For more information, refer to "DIP Switch Settings" (p. 3-11).

If the DIP switch settings are changed, the user should check the safety circuits for correct functionality.

Hazardous Radiation Exposure

Use of controls or adjustments, or performance of procedures except those specified in this manual, can cause dangerous radiation exposure.

Waste Electrical and Electronic Equipment (WEEE, 2002)

The European Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) is represented by a crossed-out garbage container label (see Figure 1-1, below). The purpose of this directive is to minimize the disposal of WEEE as unsorted municipal waste and to facilitate its separate collection.

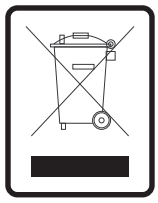


Figure 1-1. Waste Electrical and Electronic Equipment Label

RoHS Compliance

The RoHS directive restricts the use of certain hazardous substances in electrical and electronic equipment. All components of the Sapphire laser system are RoHS compliant.

China-RoHS Compliance

The China-RoHS directive restricts the use of certain hazardous substances in electrical and electronic equipment. Refer to the following table for product components that are China-RoHS compliant.

Table 1-2. China-RoHS Compliant Components

O = 小于 最高浓度值　　X = 大于 更多 最高浓度值

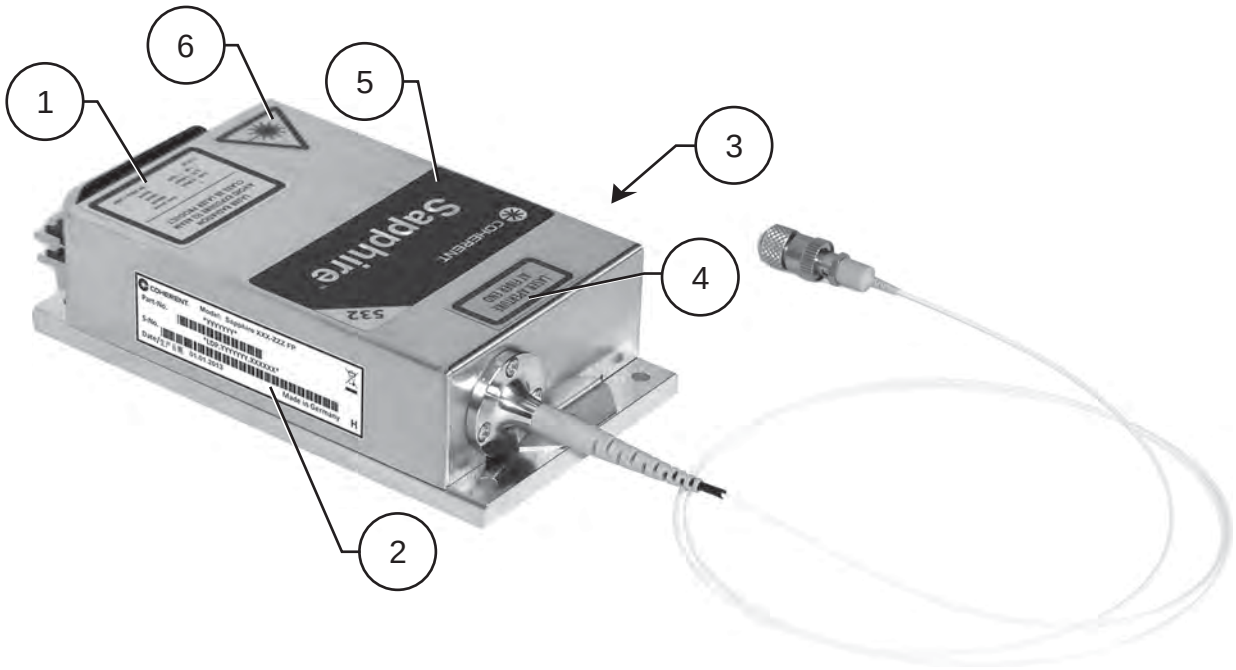
Description		铅 Pb	汞 Hg	镉 Cd	六价铬 Cr6+	多溴联苯 PBB	多溴二苯醚 PBDE
SAPPHIRE Laserhead		X	O	O	O	O	O
SAPPHIRE Powersupply		X	O	O	O	O	O
SAPPHIRE Heatsink		X	O	O	O	O	O
SAPPHIRE Controller		X	O	O	O	O	O
SAPPHIRE Headcable		X	O	O	O	O	O

CAN/CSA Compliance

This product has been tested to the requirements of CAN/CSA-C22.2 No. 61010-1, second edition, including Amendment 1, or a later version of the same standard incorporating the same level of testing requirements.

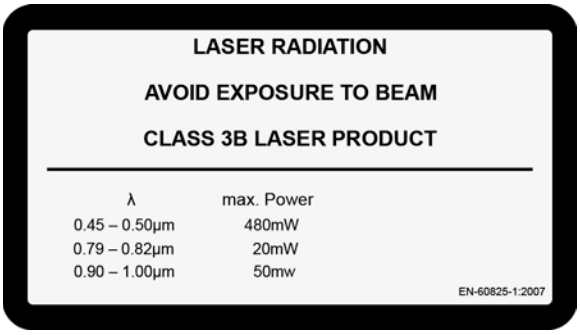
Location of Safety Labels

Refer to the following figure for the location of safety labels.

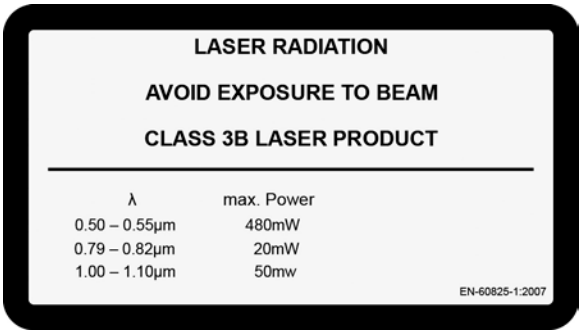


Key Starts on the Following Page

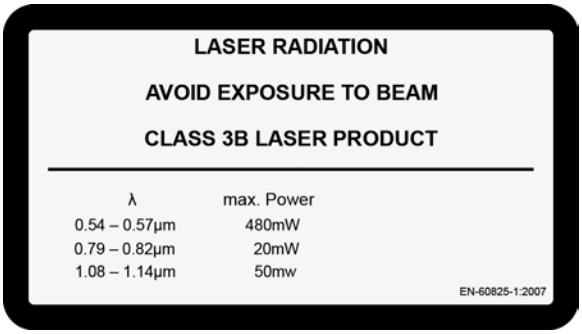
Figure 1-2. Safety Labels (Sheet 1 of 4)



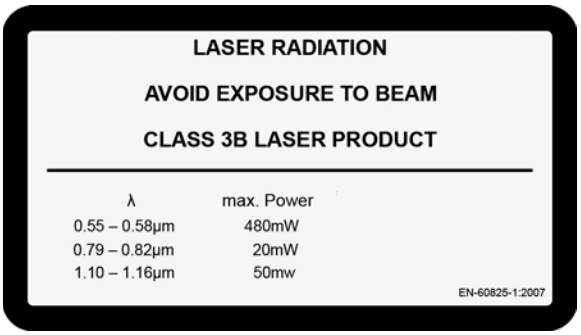
(458 nm/ 40/80 mW FP versions
488 nm/ 40/80/120/200 mW FP versions)



(514 nm/ 40/80/120 mW FP versions
532 nm/ 40/80/120/200 mW FP versions)

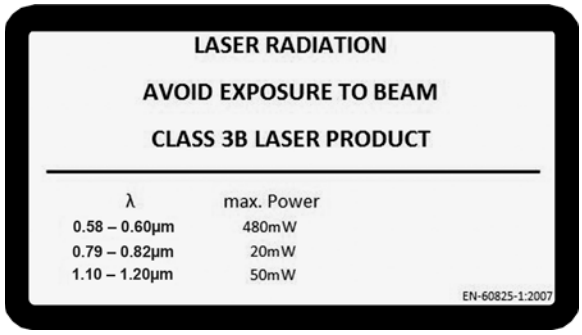


(552 nm/ 40/80/120 mW FP versions)



(561 nm/ 40/80/120/200 mW FP versions)

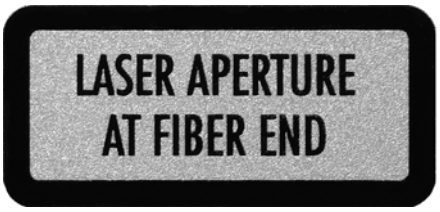
Figure 1-2. Safety Labels (Sheet 2 of 4)



(588 nm/ 40/80 mW FP versions
594 nm/ 40/80 mW FP versions)
1.

2.

3.



4.

Note: Color-coded Sapphire label indicates the wavelength (in this example, 488 nm)
5.

Figure 1-2. Safety Labels (Sheet 3 of 4)

6.

Figure 1-2. Safety Labels (Sheet 4 of 4)

Declaration of Conformity

Declaration of Conformity certificates are available upon request.

FRENCH TRANSLATION/TRADUCTION FRANÇAISE
SECTION UN : SÉCURITÉ LASER

Sécurité Optique

La lumière laser, du fait de ses propriétés particulières, ne présente pas les mêmes risques que les autres sources lumineuses traditionnels. L'utilisation sécurisée de laser requiert que tous les utilisateurs de laser, et que chaque personne proche d un système laser, connaissent les dangers inhérents à l'utilisation d'une telle source lumineuse. L'utilisation sécurisée de laser dépend de l'habitude qu'a l'utilisateur avec les instruments et les propriétés d'une lumière cohérente et intense.

DANGER!
Le contact direct avec l'œil du faisceau laser peut provoquer des lésions importantes et une possible cécité.

Les faisceaux lasers peuvent enflammer des substances volatiles comme l'alcool, l'essence, l'éther ou d'autres solvants encore, et peut endommager des éléments sensibles à la lumière comme les caméras vidéos, les photomultiplicateurs et les photodiodes. Les faisceaux réfléchis peuvent aussi induire des dommages. Pour toutes ces raisons, il est conseillé à l'utilisateur de suivre les précautions suivantes.

1. Observer toutes les précautions de sécurité du manuel utilisateur.
2. Une attention particulière doit être prise quand des solvants sont utilisés dans la même salle que le laser.
3. L'utilisation de laser doit être limitée aux personnes qualifiées et habituées à une utilisation sans risque des laser et qui en sont informées des dangers.
4. Ne jamais regarder directement le faisceau laser ou la lumière diffusée par une surface réfléchissante. Ne pas renvoyer la lumière laser dans la source laser.
5. Maintenir le montage expérimental à une faible hauteur pour éviter toute rencontre du faisceau laser avec les yeux.

ADVERTISSEMENT !
Les lunettes de sécurité laser peuvent présenter un risque aussi bien qu'un avantage ; elles protégent les yeux d'une exposition potentiellement dangereuse, elles bloquent la lumière aux longueurs d'onde du laser, ce qui empêche l'opérateur de voir le faisceau laser. Par conséquent, prendre une attention particulière même avec l'utilisation de lunettes de sécurité.

6. Afin d'éviter une exposition accidentelle au faisceau de sortie du laser ou à une de ses réflexions, les utilisateurs du système doivent porter des lunettes de sécurité imposées par la longueur d'onde générée par le laser.
7. Utiliser le laser dans une pièce fermée. La lumière laser restera collimatée sur une longue distance, et peut ainsi présenter un risque si elle n'est pas confinée.
8. Placer des panneaux d'avertissement dans la zone où se trouve le faisceau laser pour avertir les personnes y étant présentes.
9. Conseiller tous les utilisateurs de laser de ces précautions. Il est préférable de se servir du laser dans une pièce ayant un accès contrôlé et limité.

Sécurité Electrique

Le laser Sapphire LP ne présente pas de risques électriques. Ne pas démonter le boîtier. Il n'y a pas de composants utilisables à l'intérieur. Tous les boîtiers sont conçus pour être employés assemblés. La garantie sera annulée si le boîtier est démonté.

Recommandations sur la Sécurité Laser

Cet équipement laser est destiné à être vendu comme composant (ou pièce de rechange) pour un équipement électronique OEM (Original Equipement Manufacturer). Ainsi, ce produit est exempté de la norme DHHS pour les produits laser conformément au paragraphe 1040.10(a)(1). Les informations suivantes sont destinées à fournir une assistance aux OEM au niveau des normes de sécurité laser.

Émission et Classification Laser

Le laser Sapphire FP est classé par le CDRH (United States National Center for Device and Radiological Health) comme un laser de classe IIIB. Il émet une radiation laser dans le VISIBLE ET L'INVISIBLE de longueurs d'onde qui sont énumérés ci-dessous (se référer au Table 1-3), à partir de la sortie de la tête laser.

Table 1-3. Longueurs d'Onde Émise

Type de Laser	Longueurs d'Onde Émise[a]
Sapphire LP 458 nm	0.45 to 0.50 µm and 0.90 to 1.00 µm
Sapphire LP 488 nm	0.45 to 0.50 µm and 0.90 to 1.00 µm
Sapphire LP 514 nm	0.50 to 0.55 µm and 1.00 to 1.10 µm
Sapphire LP 532 nm	0.50 to 0.55 µm and 1.00 to 1.10 µm
Sapphire LP 552 nm	0.54 to 0.57 µm and 1.08 to 1.14 µm
Sapphire LP 561 nm	0.55 to 0.58 µm and 1.10 to 1.16 µm
Sapphire LP 588 nm	0.58 to 0.60 µm and 1.10 to 1.20 µm
Sapphire LP 594 nm	0.58 to 0.60 µm and 1.10 to 1.20 µm

a. Une autre radiation à 0,79 - 0,82 µm, peut également être présente dans le faisceau laser.

Radiation Laser Indicateur d'émission

Un indicateur lumineux jaune est placé sur le devant du laser. Cet indicateur est éclairé quand la diode laser est alimentée.

Interlock/Auto Start

Dans la configuration par défaut, la boucle de sécurité (interlock) est ouvert et le mode Auto Start est désactivé par des interrupteurs DIP. Pour plus d'informations se référer à la Section 3, DIP Switch Settings.

AVIS!

Le circuit intégré boucle de sécurité (interlock) ne rentre pas dans les recommandations de l IEC-825 pour laquelle les circuits boucle de sécurité (interlock) doivent être redondants, et pour laquelle le laser doit stopper si le circuit ne fonctionne pas (fail-safe). Le circuit boucle de sécurité (interlock) est conçu pour être seulement utilisé dans des applications d'OEM.

Risque Liés à Une Exposition Laser

ADVERTISSEMENT !
L'utilisation de procédures de contrôle ou de réglages des performances autres que celles spécifiées ci-après peut mener à une exposition risquée aux radiations laser.

Paramétrage du Mini Commutateurs

Avec les mini commutateurs qui sont situés sur la carte de contrôle Sapphire OEM Controller LP, l'utilisateur a la possibilité de court-circuiter la boucle de sécurité (interlock) et de régler la mode démarrage en automatique. (Référer à la section "Installation" / "DIP Switch Settings" s.v.p.)

Après une modification du paramétrage des mini commutateurs, l'utilisateur doit vérifier le bon fonctionnement du circuit de sécurité.

Waste Electrical and Electronic Equipment (WEEE, 2002)

La directive de rebut européenne de l'équipement électrique et électronique (WEEE) (2002/96/EC) est représentée par une étiquette croisée-dehors de récipient d'ordures. Le but de cette directive est réduire au minimum la disposition de WEEE en tant que déchets municipaux non triés et de faciliter sa collection séparée.

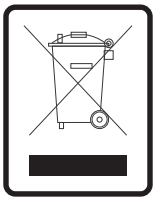


Figure 1-3. Pictogramme Concernant les Déchets d'Équipements Électriques et Électroniques

Conformité de RoHS

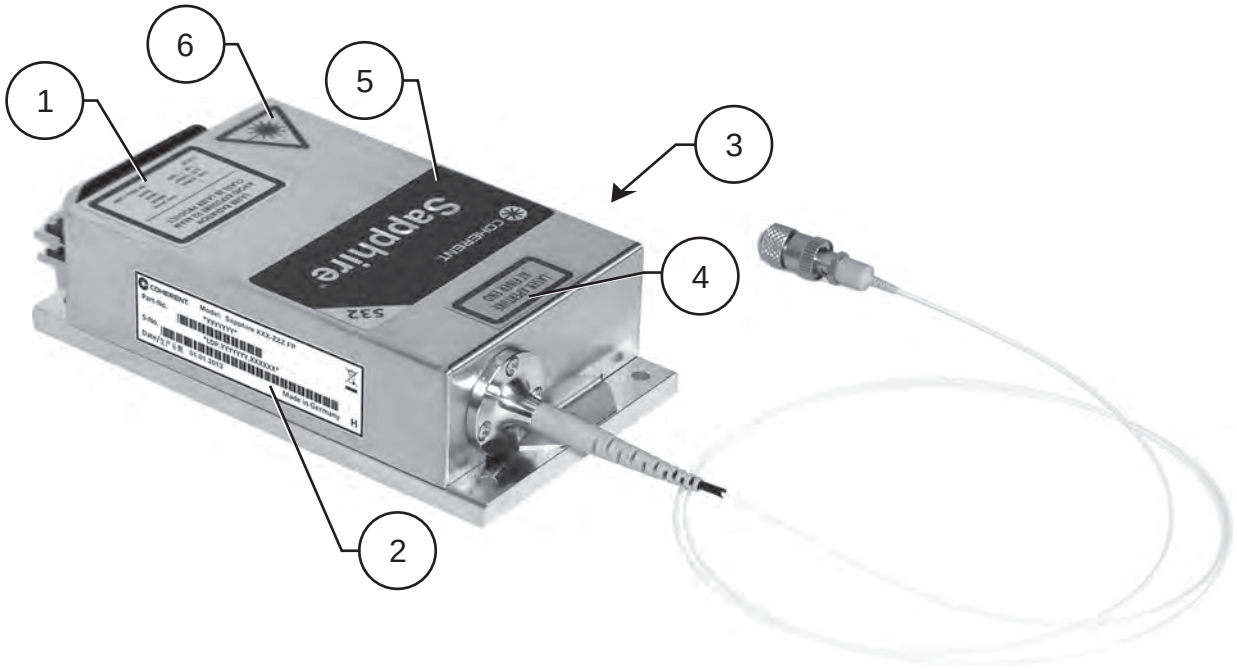
La directive de RoHS limite l'utilisation de certaines substances dangereuses dans l'équipement électrique et électronique. Tous les composants du système de laser de Sapphire LP CDRH sont RoHS conforme.

Conformité de CAN/CSA

Ce produit a été testé selon les exigences de la directive CAN/CSA-C22.2 nº 61010-1, deuxième édition, y compris l'amendement 1, ou à une version ultérieure de la même norme incorporant le même niveau d'exigence de tests.

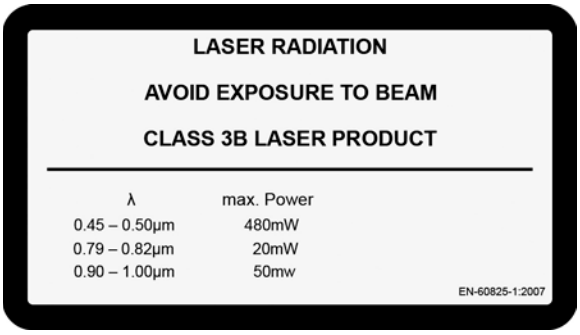
Emplacement des Étiquettes de Sécurité

Se référer à la Figure 1-4 pour l'emplacement des étiquettes de sécurité.

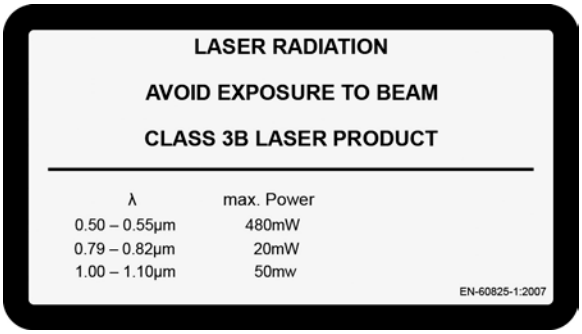


Légende sur la page suivante

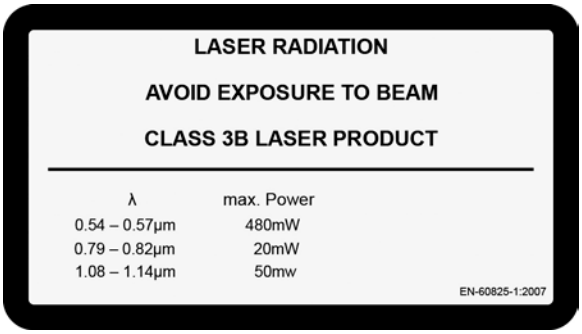
Figure 1-4. Etiquettes de Sécurité (Sheet 1 of 4)



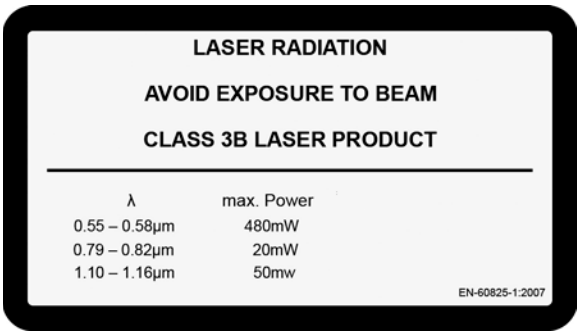
(FP versions 458 nm/ 40/80 mW
FP versions 488 nm/ 40/80/120/200 mW)



(FP versions 514 nm/ 40/80/120 mW
FP versions 532 nm/ 40/80/120 mW)

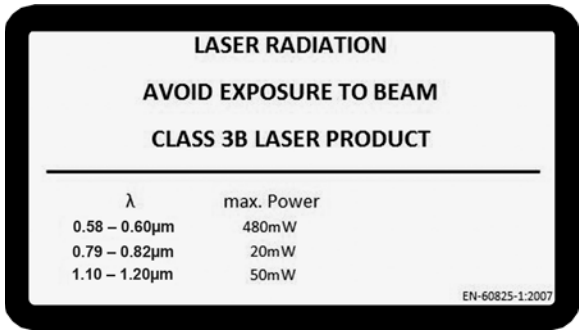


(FP version 552 nm/ 40/80/120 mW)



(FP versions 561 nm/ 40/80/120/200 mW)

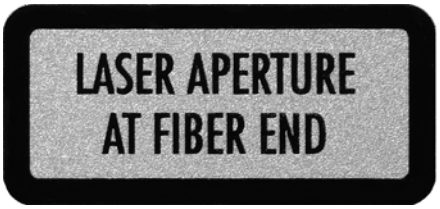
Figure 1-4. Etiquettes de Sécurité (Sheet 2 of 4)



(FP versions 588 nm/ 40/80 mW
FP versions 594 nm/ 40/80 mW)
1.

2.

3.



4.

Couleur Sapphire étiquette indiquant la longueur d'onde (488 nm exemplaire ici)
5.

Figure 1-4. Etiquettes de Sécurité (Sheet 3 of 4)

6.

Figure 1-4. Etiquettes de Sécurité (Sheet 4 of 4)

Déclaration deconformité

« Les certificats de conformité sont disponibles sur demande **»**

SECTION TWO: DESCRIPTION AND SPECIFICATIONS

System Description

The Sapphire FP OEM System is a miniature solid state diode pumped laser system for OEM and industrial use. The Sapphire is an intracavity frequency-doubled laser system which uses an optical pumped semiconductor as the gain medium and provides visible output at 458, 460, 488, 514, 532, 552, 561, or 568 nm, depending on the type. Refer to Table 2-1 (p. 2-6) for output power and wavelength of each version.

The standard Sapphire can be remotely controlled and monitored using the USB, RS-232, or analog interface.

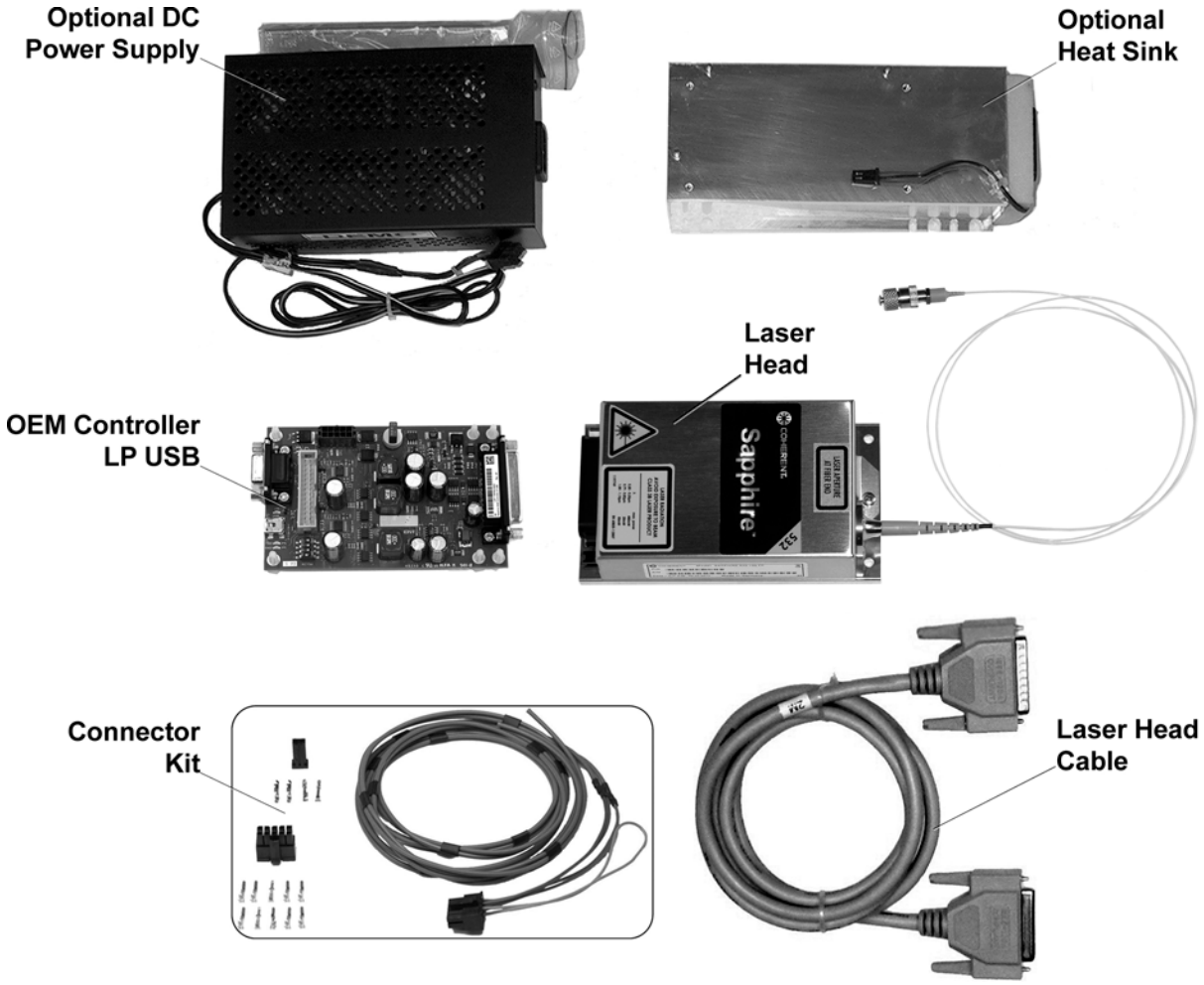


Figure 2-1. Sapphire Laser System

The Sapphire laser system—Figure 2-1 (p. 2-1)—consists of:

- Sapphire FP OEM laser head
- Sapphire OEM Controller LP USB
- Sapphire Connector kit
- Connecting cable (head to OEM Controller LP—2 m (6 feet))

The suffix "LP" distinguishes the small platform Sapphire laser from the "HP" Sapphire systems, which come in a larger package and offer up to 500 mW output power.

An optional DC power supply is available if the integrator does not supply a DC source. There is also an optional heatsink (available as an accessory), if heatsinking is not included in the OEM integration.

NOTICE!
A heatsink (not included with the Sapphire laser system) is required to dissipate the heat from the Sapphire head. The user must provide this heatsink—see "Heatsink Requirement" (p. 3-2). Incorrect heatsinking can cause a shut-off of the laser head. Exposing the laser head to excessive heat outside the specification can cause permanent damage.

Laser Head

The Sapphire is part of a class of Optically Pumped Semiconductor Lasers (OPSL™) that is similar to a conventional Vertical External Cavity Surface Emitting Laser (VECSEL), except it uses optical pumping instead of injection current to generate gain. Figure 2-2 (p. 2-3) shows the optical layout of the Sapphire.

A lens focuses the output beam of the pump diode onto the OPS chip. The OPS chip has a DBR mirror that—combined with the output coupler—forms the resonator. The resonator has the gain material (OPS chip) and a frequency-doubling crystal. The resonator mirrors are high-reflecting for the fundamental wavelength of the OPS. The electric field intensity in the resonator is high enough for generating blue light in a non-linear process in the frequency-doubling crystal. The blue beam—coupled out of the resonator—passes through collimating lenses and exits through the case window.

An integrated thermoelectric cooler stabilizes the diode laser and the resonator temperature. Excess heat dissipates via the baseplate of the laser.

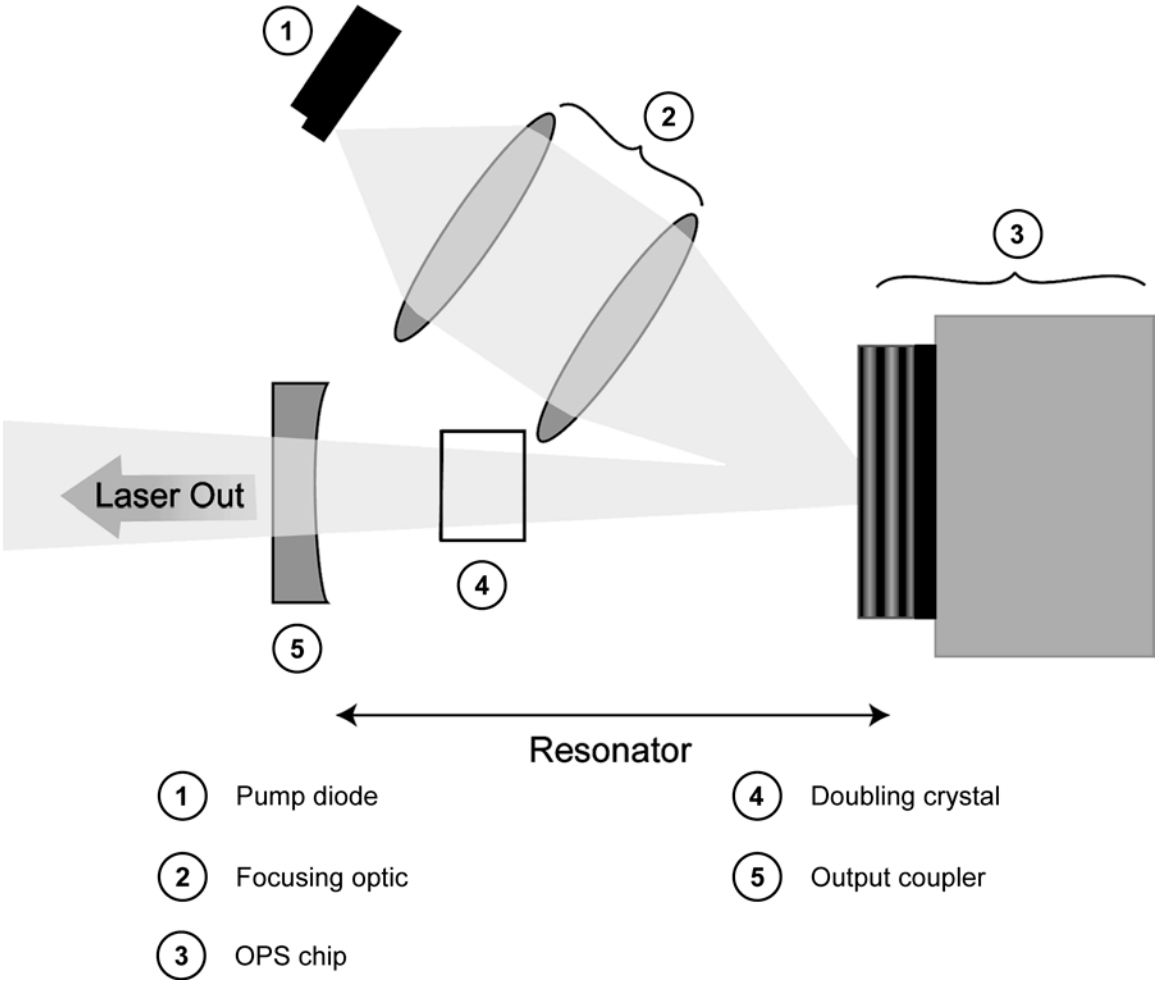


Figure 2-2. *Optical Schematic*

Optional Heatsink

An optional heatsink is available—see Figure 2-8 (p. 2-11)—if heat-sinking of the laser head is not covered by the OEM integration. This heatsink has sufficient cooling capacity for ambient temperatures up to 40ºC. Using the attached cable, the integrated fan slaves the DC power from the Sapphire laser head.

Sapphire OEM Controller LP USB

The Sapphire OEM Controller LP USB drives the pump diode, controls active resonator parameters, and monitors the laser operation. It also provides a remote interlock, control, and status monitoring over an analog interface, a RS-232 interface, and a USB interface. For more information, refer to the following tables.

Table #	Description
Table 3-3 (p. 3-17)	Describes the analog interface (26-pin IDC connector)
Table 3-4 (p. 3-19)	Describes the RS-232 interface (9-pin sub-D)
Table 3-5 (p. 3-22)	Provides a RS-232 command set

Normally within 40 seconds of power up, the OEM Controller LP USB sets all temperatures to the expected values. Light emission can be started when all temperatures are within one degree Celsius of the expected values.

Label Identification Numbers

Each Coherent Sapphire FP laser head (Figure 2-3, below) and laser OEM controller—Figure 2-4 (p. 2-5)—has a label with a unique serial number. This serial number has a part number and a production number.

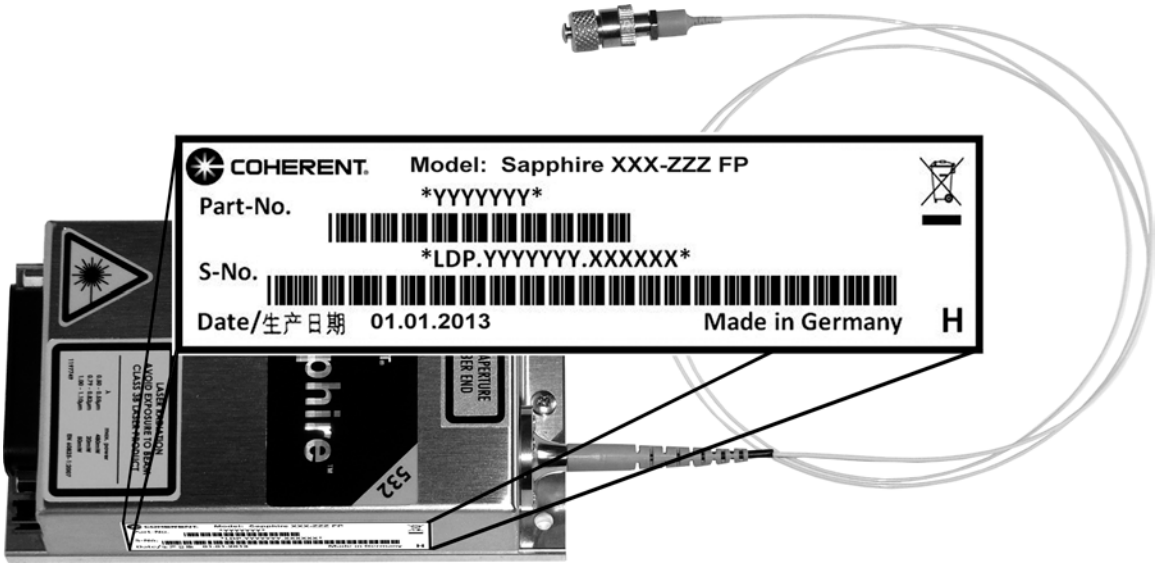


Figure 2-3. *Label Identification - Laser Head*

On the label in Figure 2-3, above:

- *XXXXXXX* = the part number
- *YYYYYY* = the production number

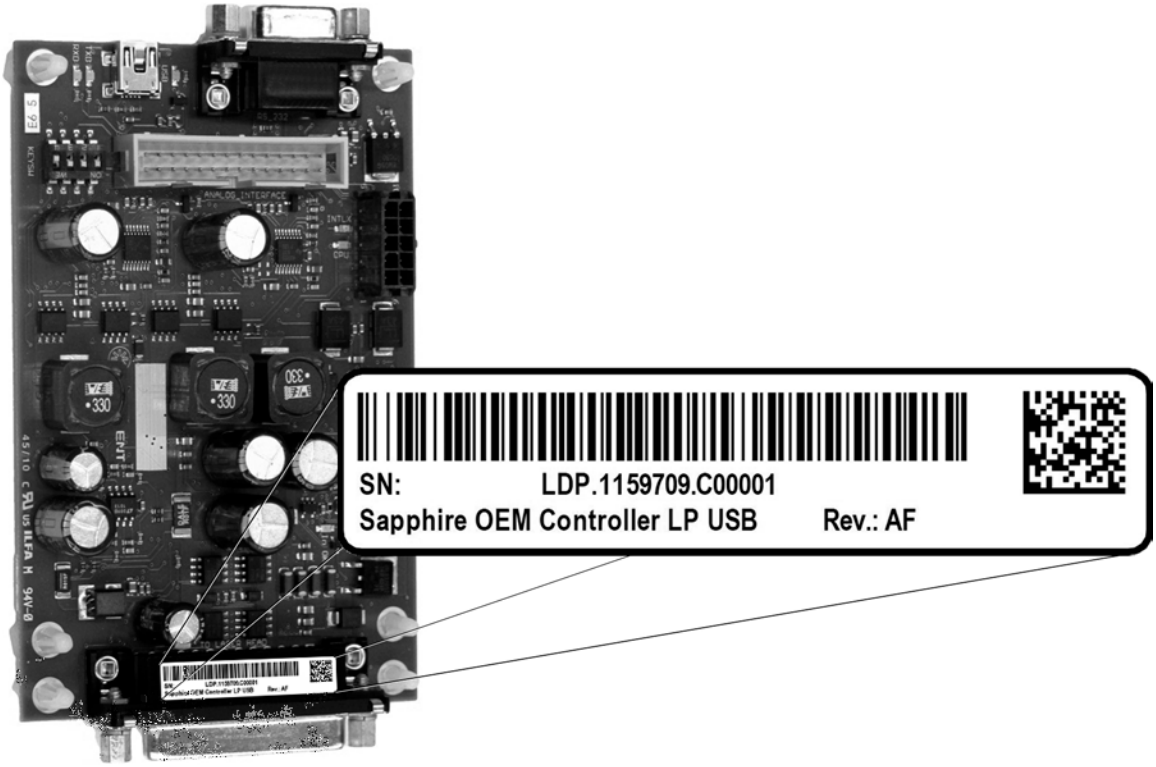


Figure 2-4. Label Identification - Laser OEM Controller LP USB

On the label shown above:

- *1159709* = the part number
- *C00001* = the production number (which is different for each controller)

Explanation of Label Numbers

A *part number* describes the type of the component—for example, Sapphire FP 488-20 Laser Head, OEM, RoHS compliant. Knowing this number makes sure that the correct product is ordered.

Laser components are consecutively numbered with a unique *production number.* A production number clearly identifies each individual component within a laser system.

Laser system part numbers and production numbers are top-level numbers. They are not shown on the labels of each components of the laser system.

Optional DC Power Supply

The optional self-contained power supply provides an output of 13.2 VDC, although any DC power supply that is in compliance with specifications listed in Table 2-1, below, can be used.

NOTICE!
Make sure to shut down the DC power supply for a minimum of ten seconds before restarting. This action prevents residual DC output voltages during restart, which can cause start-up failure or damage of the Sapphire laser system.

Specifications

Specifications for the Sapphire laser are shown in the following table.

Table 2-1. *Specifications and Requirements (Sheet 1 of 2)*

Parameter	Description
Sapphire 458/488/514/532/552/561/588/594 FP OEM	
Wavelength	458 nm ± 2 nm 488 nm ± 2 nm 514 nm ± 2 nm 532 nm ± 2 nm 552 nm ± 2 nm 561 nm ± 2 nm 588 nm ± 2 nm 594 nm ± 2 nm
Fiber output power	40/80 mW @ 458 nm 40/80/120/200 mW @ 488 nm 40/80/120 mW @ 514 nm 40/80/120 mW @ 532 nm 40/80/120 mW @ 552 nm 40/80/120/200 mW @ 561 nm 40/80 mW @ 588 nm 40/80 mW @ 594 nm
	10 to 110% adjustable. Specifications are valid for 100% power. Recommended power range is 70 to 100% power.
Noise	
P-P	20 Hz to 20 KHz: < 1%
RMS	20 Hz to 2 MHz: 0.25%
Long-term power stability: (2 hours, ±3ºC)	< 2%
Warm-up time	< 5 minutes
Fundamental beam emission	< 0.1 mW

Table 2-1. *Specifications and Requirements (Sheet 2 of 2)*

Parameter	Description	
Beam Parameters		
Beam quality	$M^2 < 1.1$	
Transverse modes	TEM_{oo}	
Fiber type	Single mode, polarization maintaining	
Fiber length	1 m	
Fiber output type	FC/APC; 8° angled	
Beam asymmetry	≤ 1:1.1	
Polarization ratio (bottom reference)	> 100:1, linear, vertical	
Maximum baseplate temperature	50ºC (122ºF)	
Maximum heat dissipation of laser head	25W (base plate at 50ºC (122ºF)	
Environmental Specifications	*Operating*	*Non-operating*
Ambient temperature	10 to 40°C (50 to 104°F)	-20 to 60°C (-4 to 140°F)
Altitude	0 to 10,000 feet	0 to 70,000 feet
Relative humidity (w/o condensation)	0 to 90%	0 to 100%
Shock tolerance (11 ms)	15 g laterally 15 g vertically	15 g laterally 15 g vertically
Input Power Requirements		
Input voltage	+10.8 to 15 VDC	
Input power	<60 W	
Ripple	< 5% peak to peak	
Load regulation	< 0.5%	

Dimensions

The dimensions of the Sapphire laser head, the Sapphire OEM Controller LP USB, the optional DC power supply, and the optional heatsink are shown in the following figures:

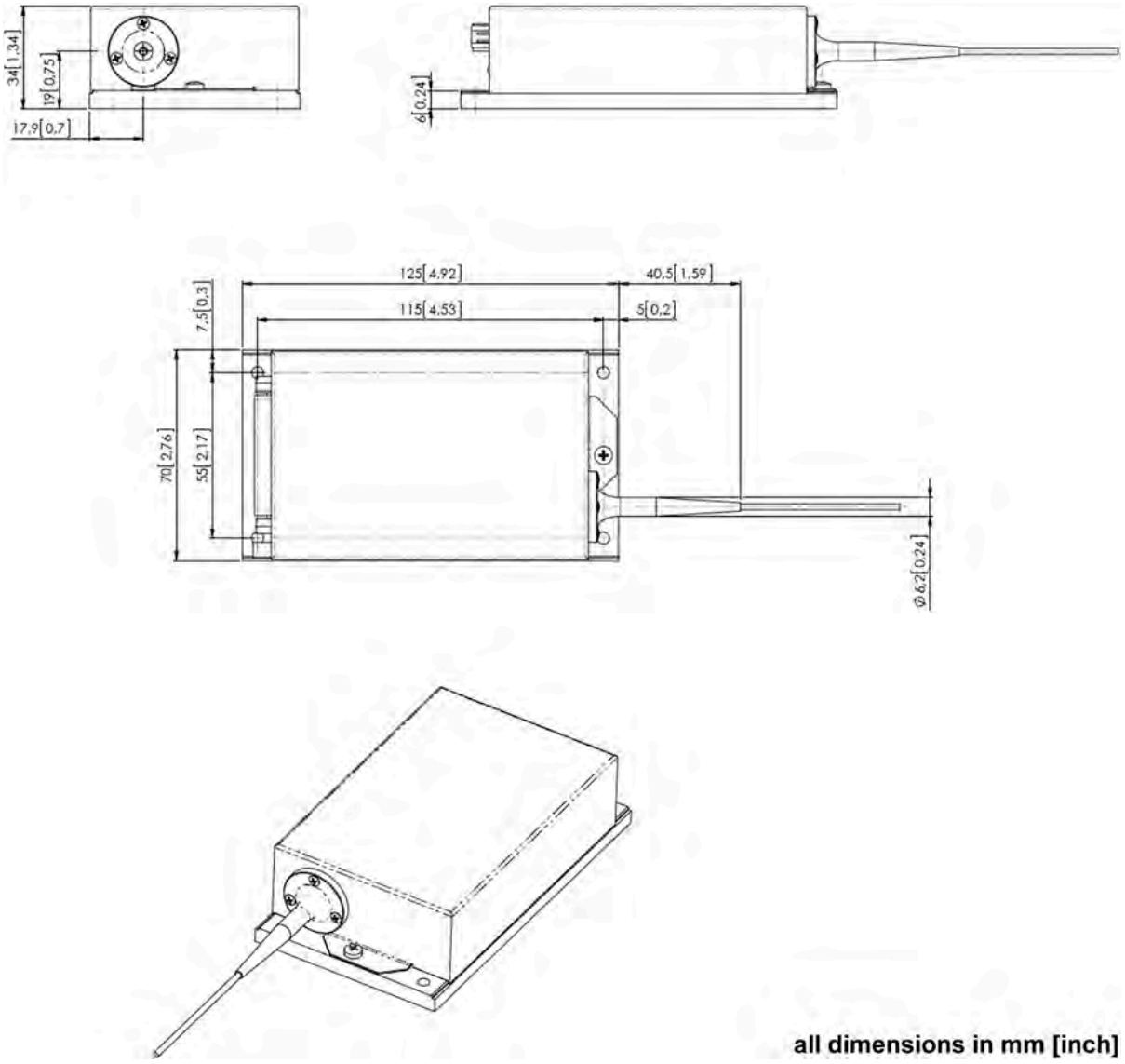


Figure 2-5. Sapphire Laser Head Dimensions

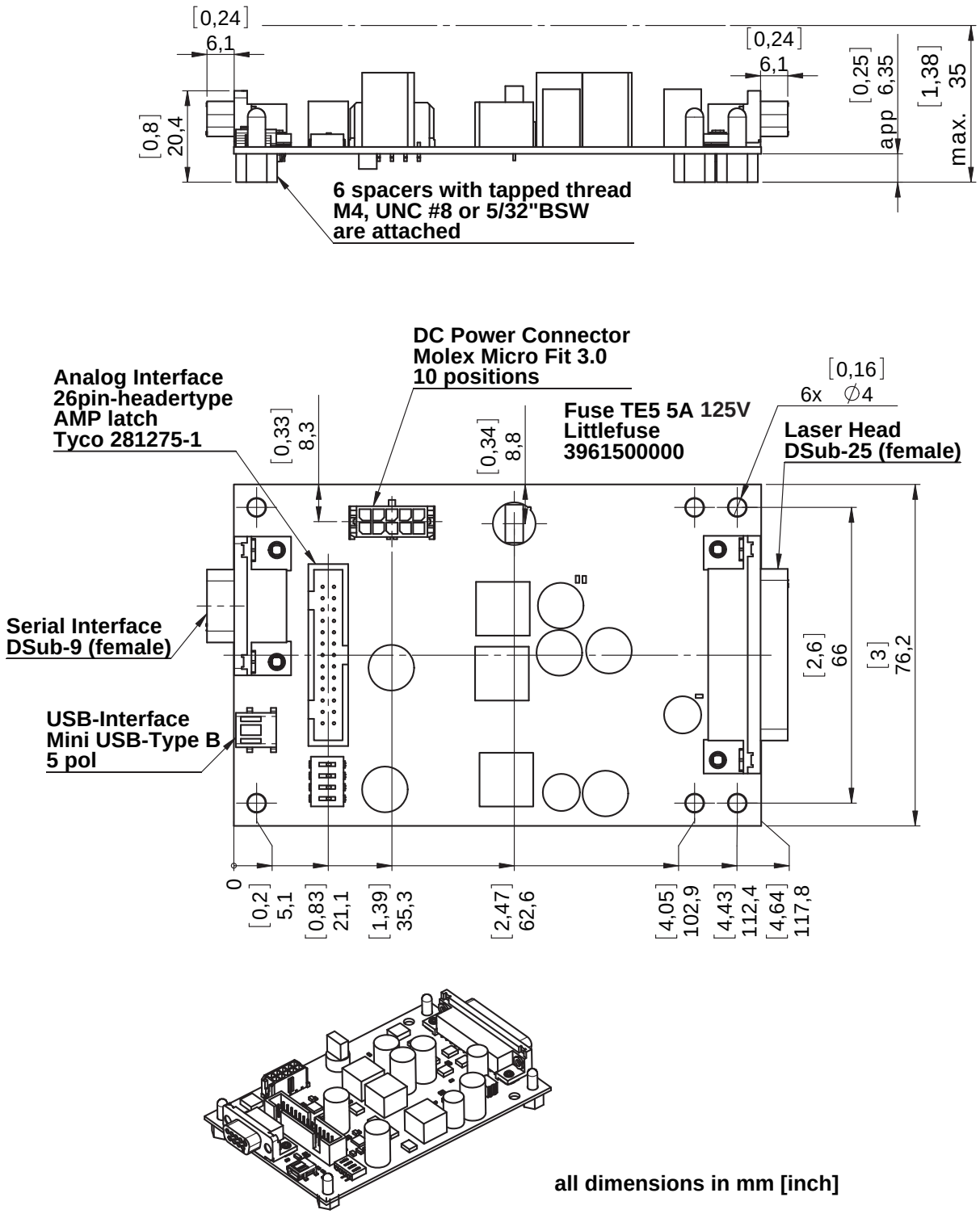


Figure 2-6. *Sapphire OEM Controller LP USB Dimensions*

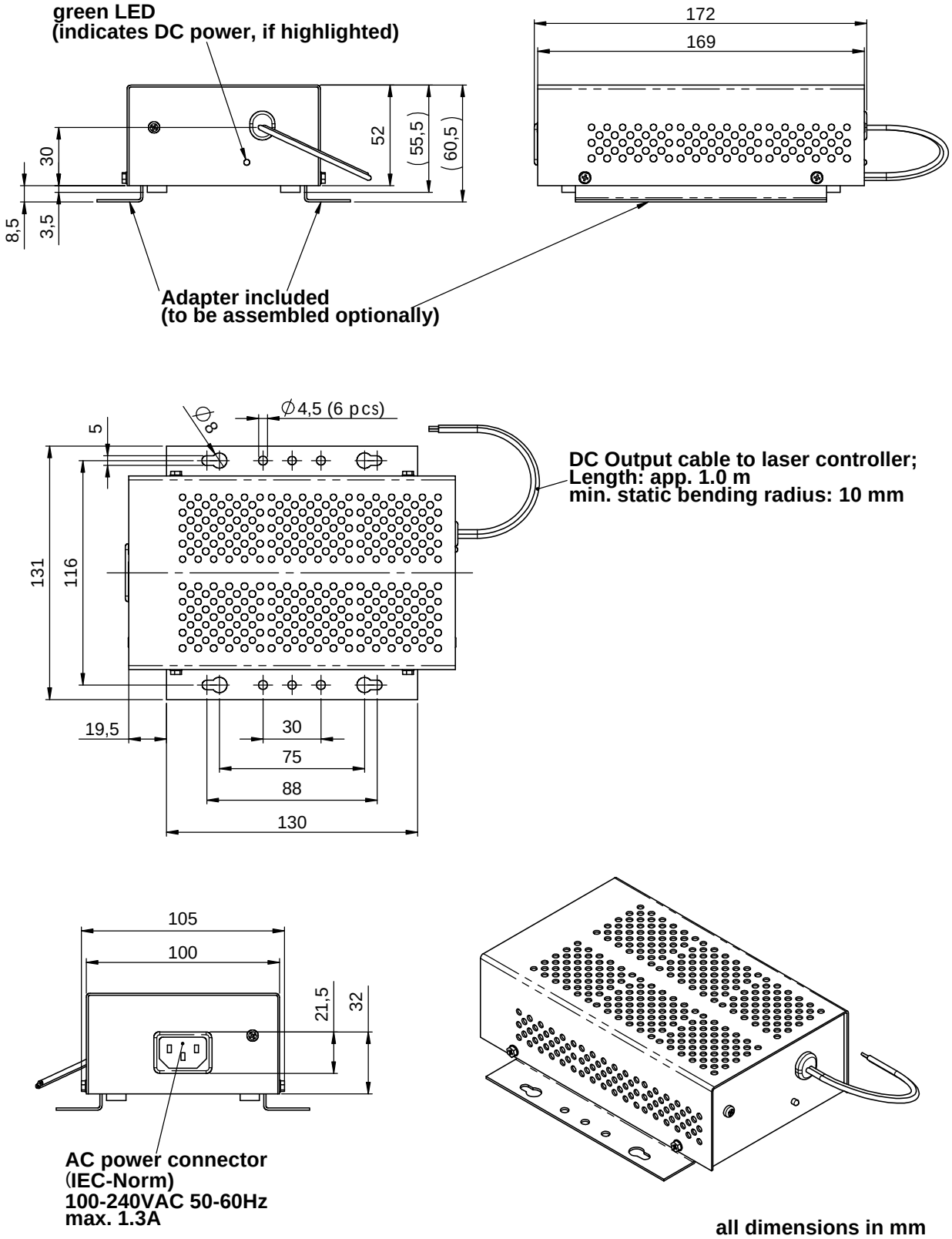


Figure 2-7. *Optional DC Power Supply Dimensions*

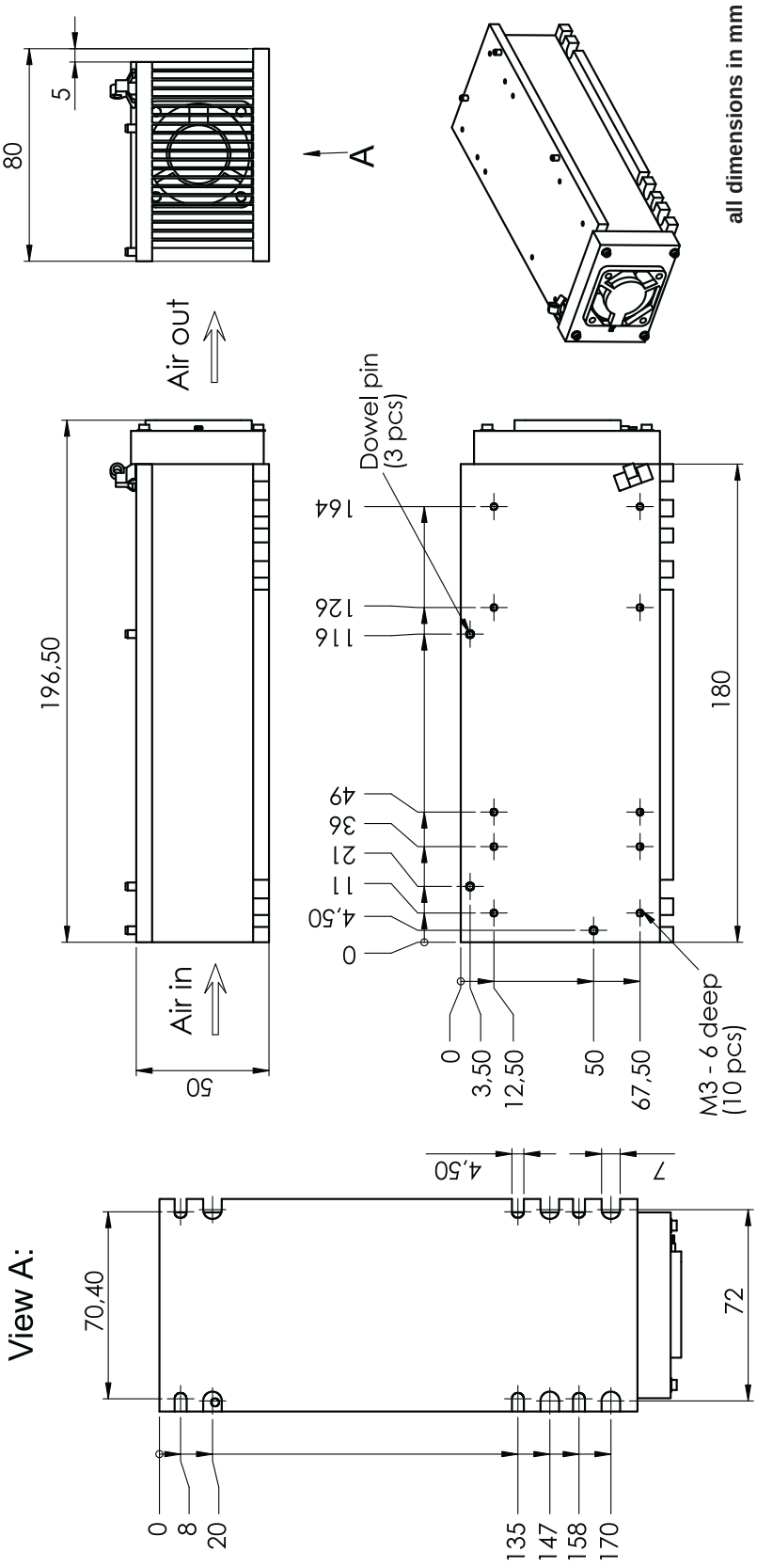


Figure 2-8. *Optional Heatsink for Laser Head Dimensions*

Type of Fiber Connector:
SM-PM / FC-APC 8° - Single Mode, Polarization Maintaining, 8-degree Angled, with End Cap

all dimensions in mm [inch]

Figure 2-9. *Dimensions and Type of Fiber Connector*

SECTION THREE: INSTALLATION

NOTICE!
After unpacking the system, keep the shipping boxes for possible later shipments—see "Section Six: Repacking Procedure" (p. 6-1).

Installation

The installation procedure includes:

- Determining heatsink requirements and install the heatsink
- Connecting the system components
- Connecting a means of controlling (and monitoring) the laser system
- Configuring the OEM Controller LP USB DIP switches for the desired mode of operation
- Connecting the system to a DC power source

The above tasks are described in the following paragraphs. After completing all of the tasks, the laser can be turned on and operated according to the description given later in this section.

NOTICE!
Do not connect or disconnect the laser head cable while the DC supply voltage is connected!

Do not connect or disconnect the Sapphire head cable when the DC supply voltage is provided to the Sapphire OEM controller LP USB. Make sure that any remaining voltage on the DC supply line is discharged before connecting or disconnecting the laser head cable.

Turning only the light emission to the off state is not sufficient. Make sure the head cable is correctly connected and the locking screws on the head cable connectors are correctly tightened before supplying DC power. Before disconnecting the head cable from the laser head or controller, make sure the DC supply voltage is disconnected and remaining voltages are correctly discharged.

NOTICE!
Do not operate the system without a heatsink installed on the laser head. Incorrect heatsinking can cause a system shutdown.

Heatsink Requirement

It is necessary that the laser head be sufficiently heatsinked; otherwise, it will overheat and shut down within seconds. Figure 3-1, below, shows the heat dissipation of the Sapphire laser head for a given baseplate temperature. The graph in Figure 3-2 (p. 3-3) allows determination of the heatsink thermal impedance requirement based on the anticipated maximum ambient temperature.

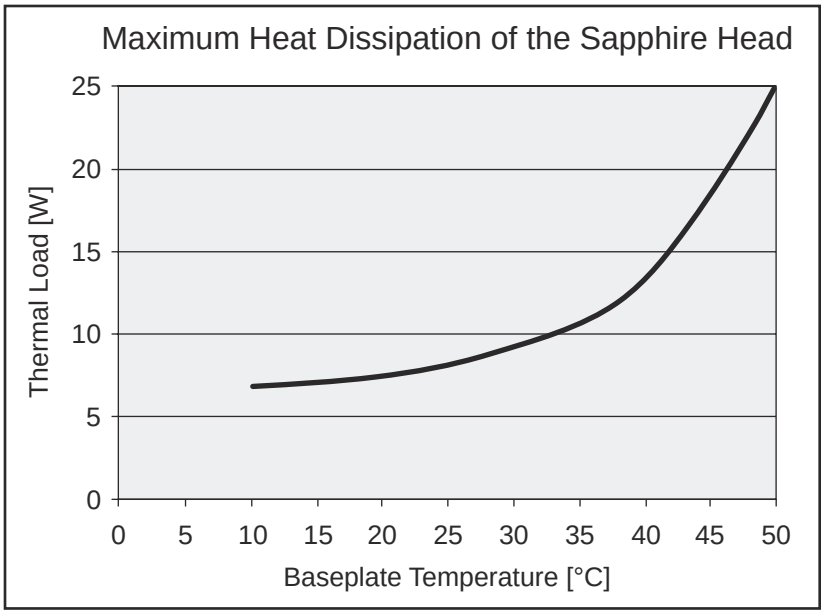


Figure 3-1. Heat Dissipation of the Sapphire Head

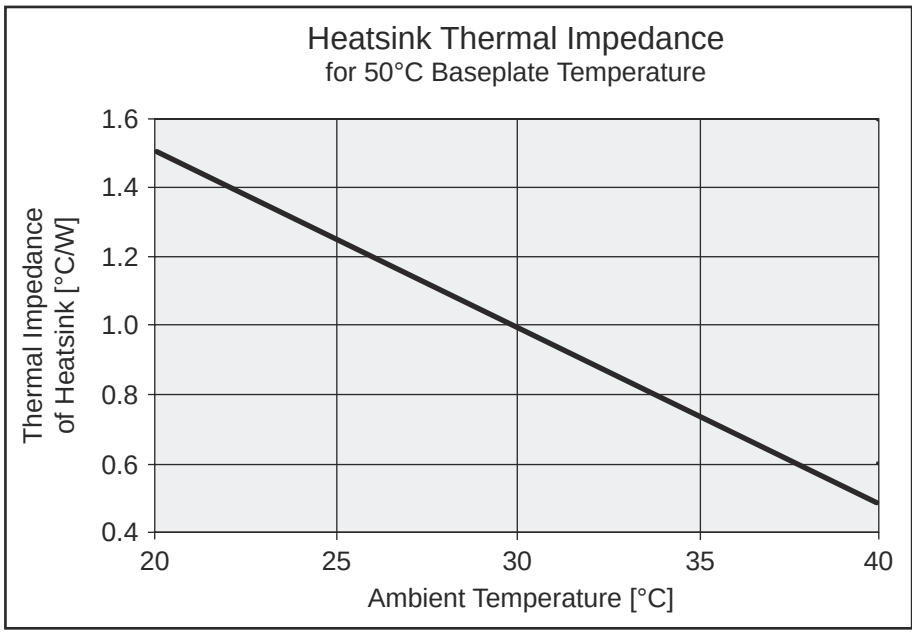


Figure 3-2. Heatsink Requirements

For example, if the maximum expected ambient temperature is 35°C, then the heatsink thermal impedance needs to be 0.8ºC/watt.

Note that the mounting surface of the heatsink must be flat to ensure good thermal contact and to prevent damage to the laser head. Many extruded heatsinks are warped and the mounting surface should thus be milled flat (to < 0.05 mm over the mounting surface). Thermal heat compound can be used between the laser head and heatsink to maximize thermal contact.

NOTICE!
No thermal compound can correct for an uneven or rough heatsink surface. For best thermal conductivity, apply a very thin layer of thermal compound on a flat milled surface with a low roughness.

For an overview of heatsink technology, refer to any standard heatsink catalog.

Mounting Specifications

Use the following procedure to mount the Sapphire laser head onto the heatsink:

1. *Lightly tighten* down the M3 metric or 4-40 UNC screws in diagonal order (refer to Figure 3-3, below). Use DIN 125 ISO 7089 washers (3.2 mm inner diameter, 7 mm outer diameter) made of A2 material.

NOTICE!
It is important to use washers to spread the pressure and ensure reliable, precise mounting.

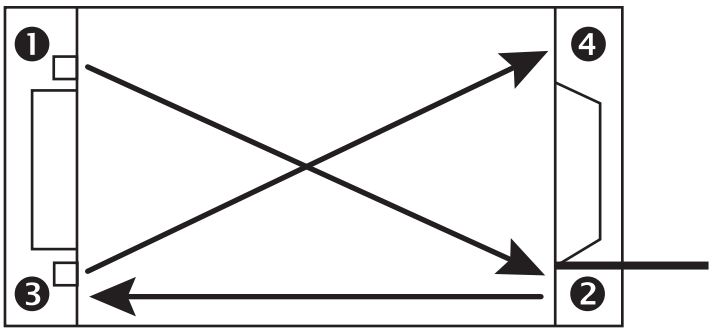


Figure 3-3. Torque and Tightening Pattern

2. Using the correct torque, tighten down the screws in diagonal order (follow the 1-2-3-4 sequence shown in Figure 3-3, above). The correct torque depends on the type of thread being used (M3 metric or 4-40 UNC) and the property class of steel used in the screw. A standard torque value for commonly-used M3 screws is 100 Ncm = 1 Nm. The overall flatness of the heatsink should be < 0.05 mm.

   To ensure the most reliable mount, torque the mounting screws twice:

   - FIRST, torque all the screws to **0.25 Nm** (2.21 lbf-in)
   - SECOND, torque all the screws to **1 Nm** (8.851 lbf-in)

NOTICE!

To take advantage of the superior static beam alignment of Sapphire—see Figure 2-5 (p. 2-8)—Coherent recommends using dowel pins or similar references in the mounting of the Sapphire head.

Changing the baseplate in any way can lead to laser damage and, thereby, void the warranty.

The standard mounting procedure for the Sapphire OEM Controller LP USB is to use threaded screws (M4, UNC No. 8 or 5/32”-32BSW) to attach the OEM Controller LP USB stack to the mounting surface, using the six spacers in the PC board.

An alternative mounting procedure is to use spacers with bush. These optional spacers are available with M4 standard bush on request and can be easily replaced.

An alternative procedure is to remove the spacers and mount the OEM Controller LP USB stack with screws via the through-holes.

NOTICE!

Use the correct isolating washers to ensure electrical isolation and prevent damaging the PC board.

Interconnections

To help establish the location of the laser system components, laser head dimensions and the analog OEM Controller LP USB are shown in Figure 2-5 (p. 2-8).

NOTICE!
Make sure that the laser head is sufficiently heatsinked, as described under "Heatsink Requirement" (p. 3-2).

NOTICE!
To prevent surge currents, do not apply power to the laser system until all connections are completed.

1. The laser head connector is protected from electrostatic discharge during shipping. Remove all materials from the connector.
2. Connect the laser system, as shown in Figure 3-4 (p. 3-7).

NOTICE!
Do NOT connect the laser system to any power source at this time.

NOTICE!
The connectors on the Sapphire OEM Controller LP do not tolerate major mechanical pressure. Ensure strain relief to cables in the integration.

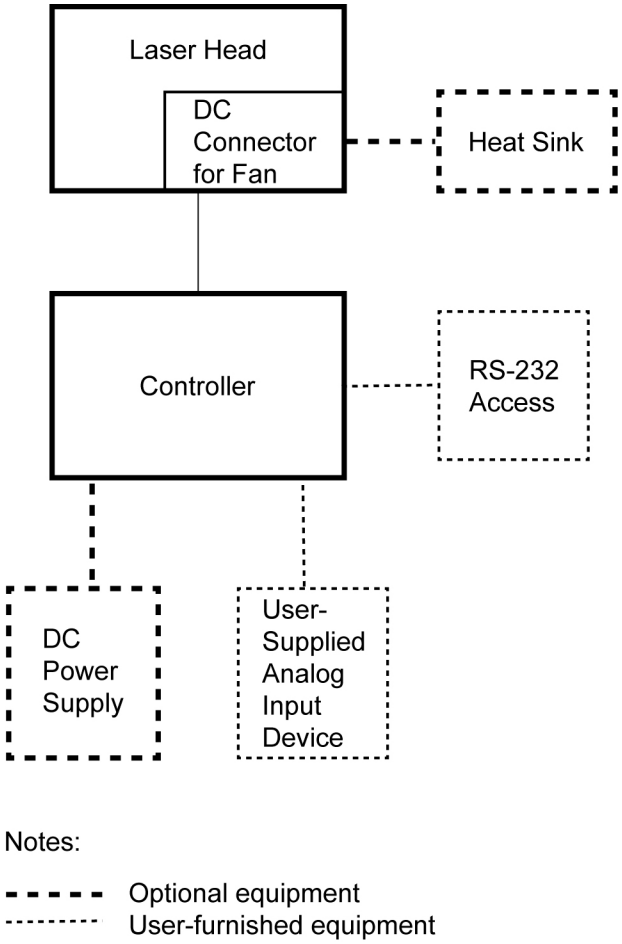
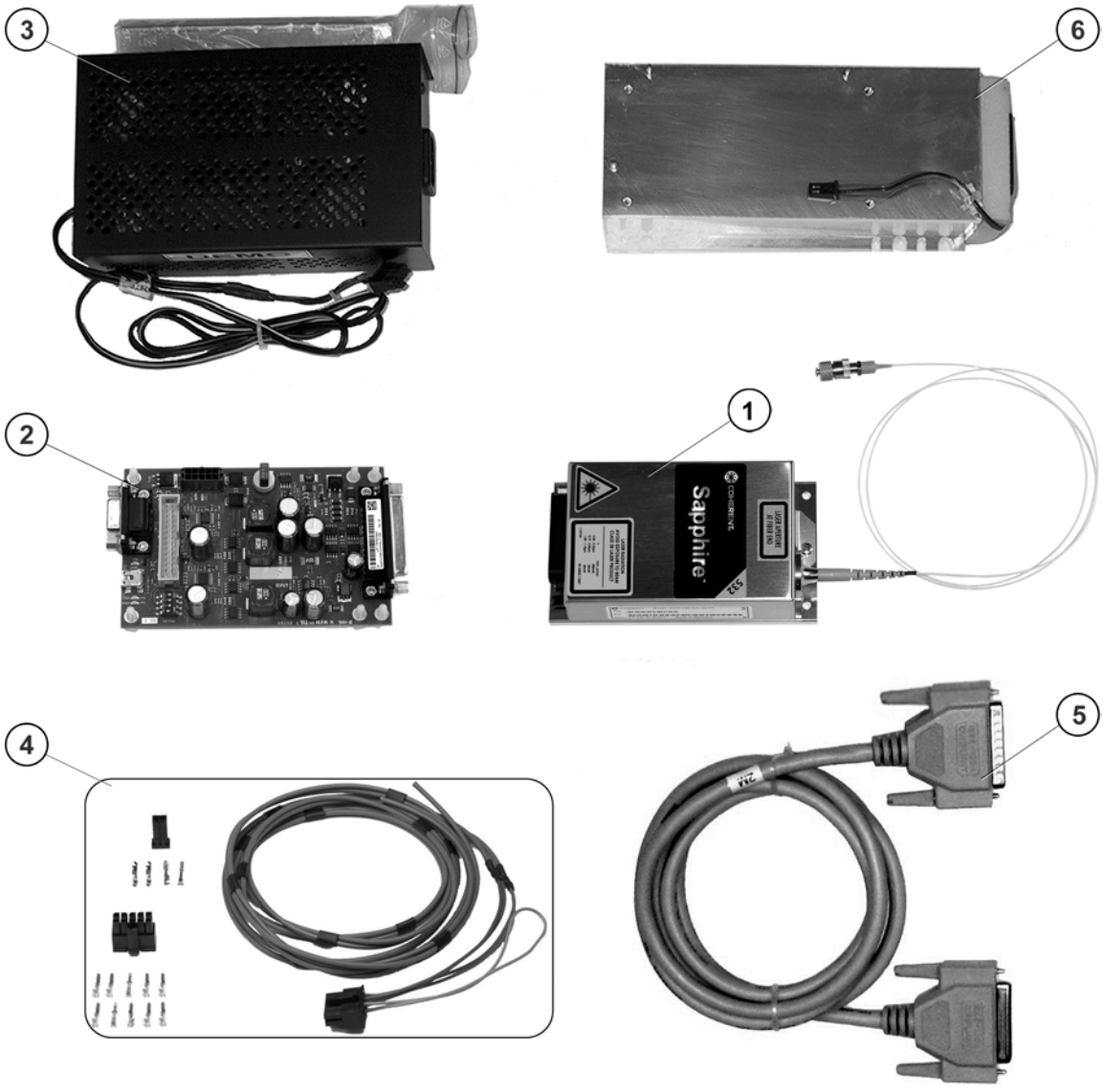


Figure 3-4. Interconnection Diagram

Table 3-1. Sapphire Laser System Components



Description of Sapphire Laser System Components

Item #	Component
1	Sapphire FP Laser Head
2	Sapphire OEM Controller LP USB
3	Sapphire LP DC Power Supply (optional)
4	Sapphire LP Connector Kit
5	Sapphire LP Head Cable
6	Sapphire LP Heatsink (optional)

Laser system part numbers are top-level numbers and are not noted on the individual components of the laser system. Each component has a label with a unique serial number and production number on it. Refer to"Label Identification Numbers" (p. 2-4) for more information.

Connecting an External Fan

The DC voltage supplied from the OEM Controller LP is available at the laser head to power an external fan (maximum current < 500 mA). For more information, refer to Figure 2-5 (p. 2-8) and Figure 3-4 (p. 3-7).

An auxiliary plug is included in the Connector kit, which is part of the system delivery volume. Figure 3-5, below, shows the AMP Connector pin assignments and part numbers.

NOTICE!
Do not connect or disconnect the fan plug while the controller is powered.

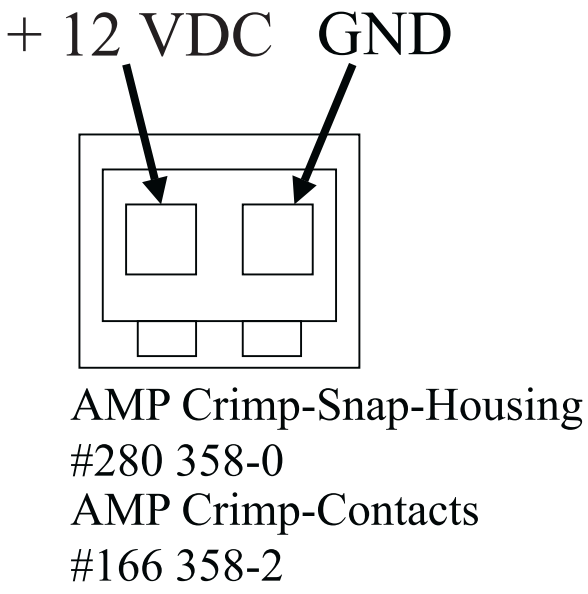
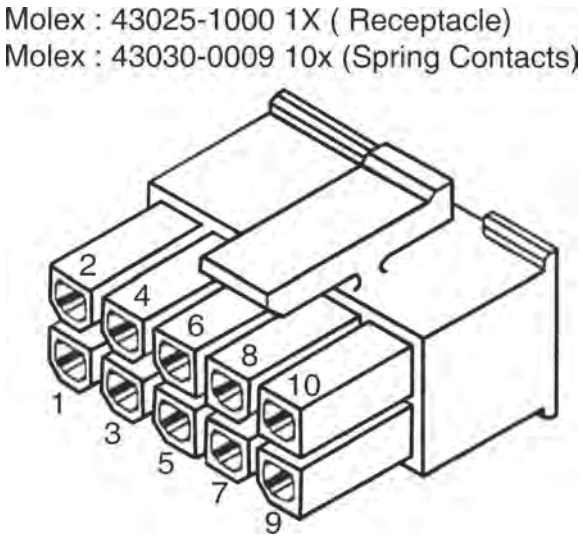


Figure 3-5. Fan Connector

Connecting a User-Furnished Power Supply

Any power supply that meets the specifications listed in Table 2-1 (p. 2-6) can be used with the laser system; we recommend using the optional power supply. When using a user-furnished power supply, a Connector kit (supplied) helps with connecting the furnished power supply to the analog OEM Controller LP. The kit offers two options:

1. Connecting a pre-assembled cable (1.5 m) with the Molex plug on one end (to fit to the OEM Controller LP) and two single wires on the other end—Red (+DC) and Black (Ground).
2. Connecting a plain Molex plug to an existing DC line cable (refer to Figure 3-6, below).



NOTE: Pin assignment is different from Molex nomenclature.

Figure 3-6. Molex Connector

+DC Input Power	Pin 1, 2	+ 10.8 to + 15 VDC Main DC power. **Use both pins due to high current.**
DC Input Power Return	Pin 3, 4	DC Power Return, separated from signal ground by EMI filter. **Use both pins due to high current.**
Interlock	Pin 5 (+) to Pin 6 (–)	<+ 15 VDC, 12.5 mA typ. Connect pins for laser on (disabled by DIP Switch SW3-2 in on position) can be used for laser warning light (LED).
Keyswitch	Pin 7 (N.O.) Pin 8 (N.C.) Pin 9 (Com.)	<+ 15 VDC, 12.5 mA typ. Connect keyswitch for laser safety circuit (disabled by DIP Switch SW3-3 in on position). The laser operates when pins 7 and 9 are connected. Connect pins 8 and 9 when the keyswitch is off.
Chassis ground	Pin 10	

DIP Switch Settings

Figure 3-7, below, shows the DIP switch locations.

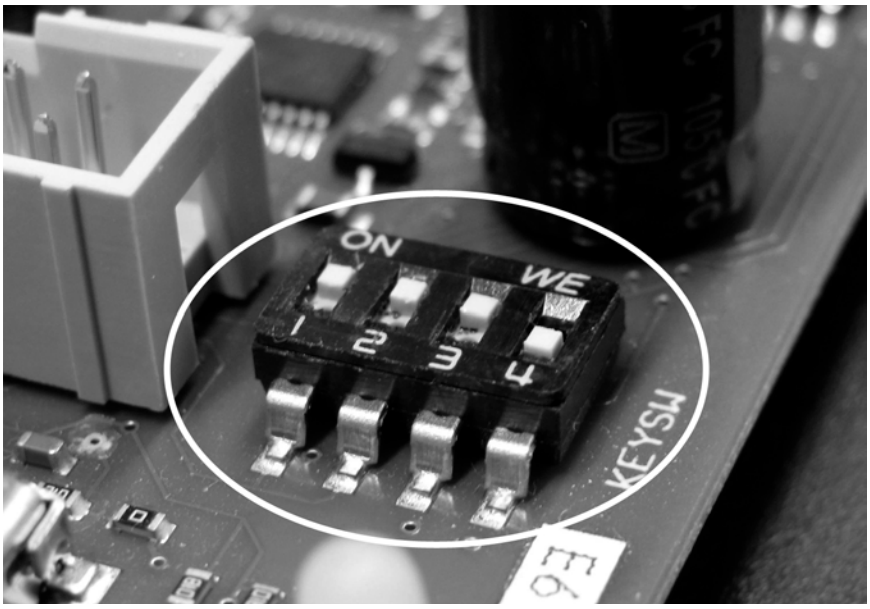


Figure 3-7. DIP Switch Location—Sapphire OEM Controller LP USB

NOTICE!
DIP switch settings should be changed only when the laser system is not powered.

Adjust the DIP switch positions carefully. Recommended tools are ball point pen or tweezers that are not too sharp. Limit operation force to less than 10N.

Do not use sharp tools such as wire cutting pliers or knifes to adjust the DIP switch.

Default Settings for the DIP Switch

The unit comes with the following default DIP switch settings:

SW 3-1	OFF	Interlock at Analog interface required
SW 3-2	OFF	Interlock at DC Power connector required
SW 3-3	OFF	Keyswitch at DC Power connector required
SW 3-4	OFF	Autostart mode disabled

These settings require the user to supply external interfacing (interlock and keyswitch closed in external circuit/wiring) to operate the Sapphire laser system.

Figure 3-9 (p. 3-15) shows an interconnect diagram for the interlock and keyswitch connecting locations.

Starting a laser with these default settings requires an active start signal via analog interface or RS-232 interface (see the following pages).

Autostart Settings for the DIP Switch

If the user does not supply this external interface, there is an auto-start setting that overrides the interlock and keyswitch safety circuits.

WARNING!
This operational mode requires the user to carefully follow all laser safety procedures. Coherent recommends taking special laser safety preparations for this mode.

NOTICE!
In this mode, the laser starts after a 40-second warm-up period.

Autostart DIP switch settings:

SW 3-1 ON Interlock at Analog interface disabled
SW 3-2 ON Interlock at DC Power connector disabled
SW 3-3 ON Keyswitch at DC Power connector disabled
SW 3-4 ON Autostart mode enabled

With Autostart engaged, the laser powers up to the previously-set power level (either factory default, specified power, or user-set).

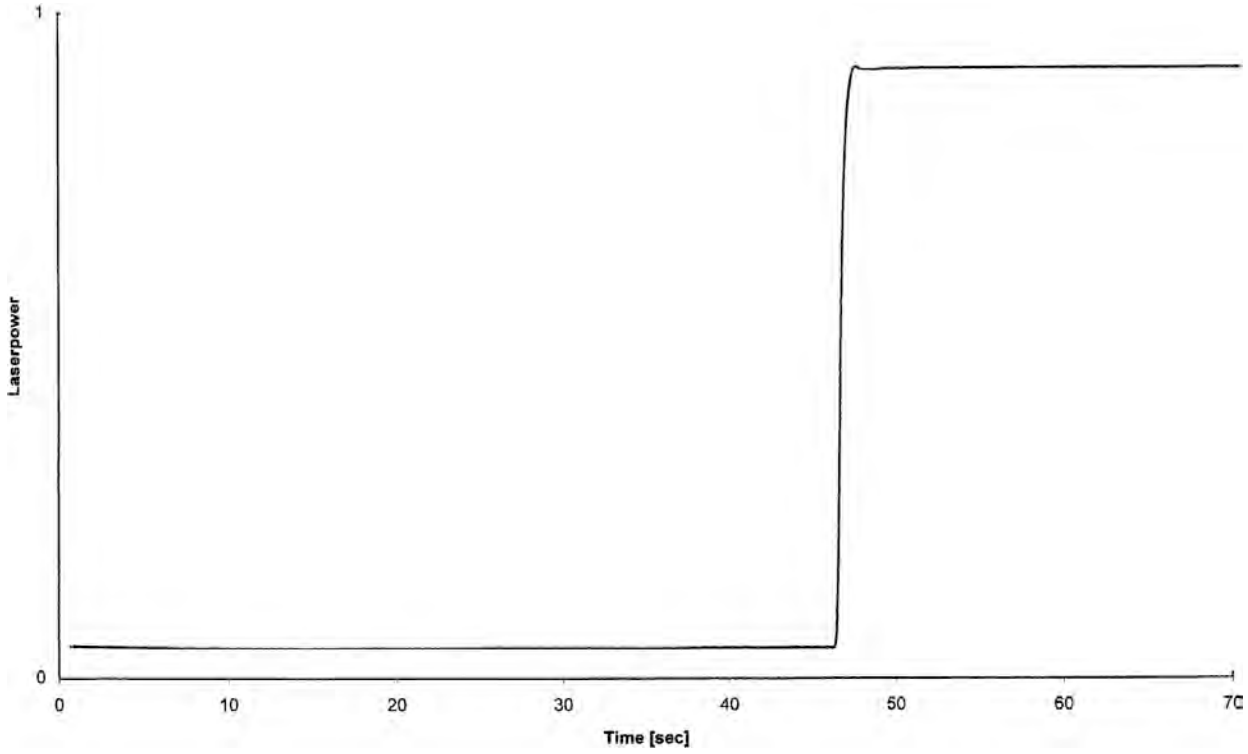


Figure 3-8. Turn On Characteristics Diagram (from cold start)

Adapting to Duty Cycles and Laser-Ready Signal

A user might want to completely shut down the laser if a laser light is not required for a longer period of time. The warm-up procedure starts with a 45-second delay and is specified with less than five minutes.

NOTICE!
If the laser is shut down via the DC power supply, be sure to let the DC power supply completely shut down before restarting. This action prevents residual DC output voltages during restart, which can cause performance failure of the Sapphire laser.

For shorter interruptions, the Sapphire laser features a Stand By mode. This mode maintains all cavity temperatures but cycles down the pump diode, thereby assuring that no optical activity takes place. From a lifetime point of view, this is basically equivalent to a completely switched-off laser. Stand By mode is recommended for application interruptions of ten minutes or longer and is set through Pin 4 of the analog interface (Run mode if no connection, Sleep mode if ground). For more information on the analog interface, refer to "Sapphire OEM Controller LP USB: Controlling the Laser via Analog Signals" (p. 3-16).

When using the RS-232 interface—see "Controlling the Laser via RS-232 or USB Command Interface" (p. 3-18)—the command "L=0" puts the laser in Stand By mode, and "L=1" resumes operation.

The typical time to resume set output power from Standby is less than five seconds.

Once the laser reaches stable output power from either cold start or Stand By mode at Pin 16, a "Laser Ready Signal" is available (TTL high).

Interlocks

Using the Interlock Loops

The Sapphire OEM Controller LP USB can connect to two different interlock loops:

1. One loop is found at the Analog connector (J1), pins 1 and 5. When this interlock is required, setting DIP switch 1 to OFF provides a closed loop at these pins.
2. The other interlock loop is found at the DC Power connector (J3), pins 5 and 6. When this interlock is required, setting DIP switch 2 to OFF provides a closed loop at these pins.

Either one or both interlock loops can be used.

Using the Keyswitch Connection

To meet CDRH and IEC-825 regulations, the user can connect a keyswitch to the Sapphire OEM Controller LP at the DC connector, pins 7, 8, and 9. Refer to Figure 3-9 (p. 3-15) for details.

To meet CDRH regulations, the user has to supply other components not listed here.

Using a Laser Warning Light

To meet CDRH and IEC-825 regulations, the user can create a warning light by connecting LED(s) in the interlock loop. This light is on when the interlock loops are closed and DC power is applied. If the voltage drop across the LED(s) is less than 5 VDC, the interlock circuit supplies 12.5 mA. Connect the LED(s) as shown in the following table.

Table 3-2. Laser Warning Light Connections

LED Location	LED Anode	LED Cathode	DIP Switch Setting
Analog Interface (J1)	J1 – 1	J1 – 5	SW3 – 1 OFF
DC Power Connector (J3)	J3 – 5	J3 – 6	SW3 – 2 OFF

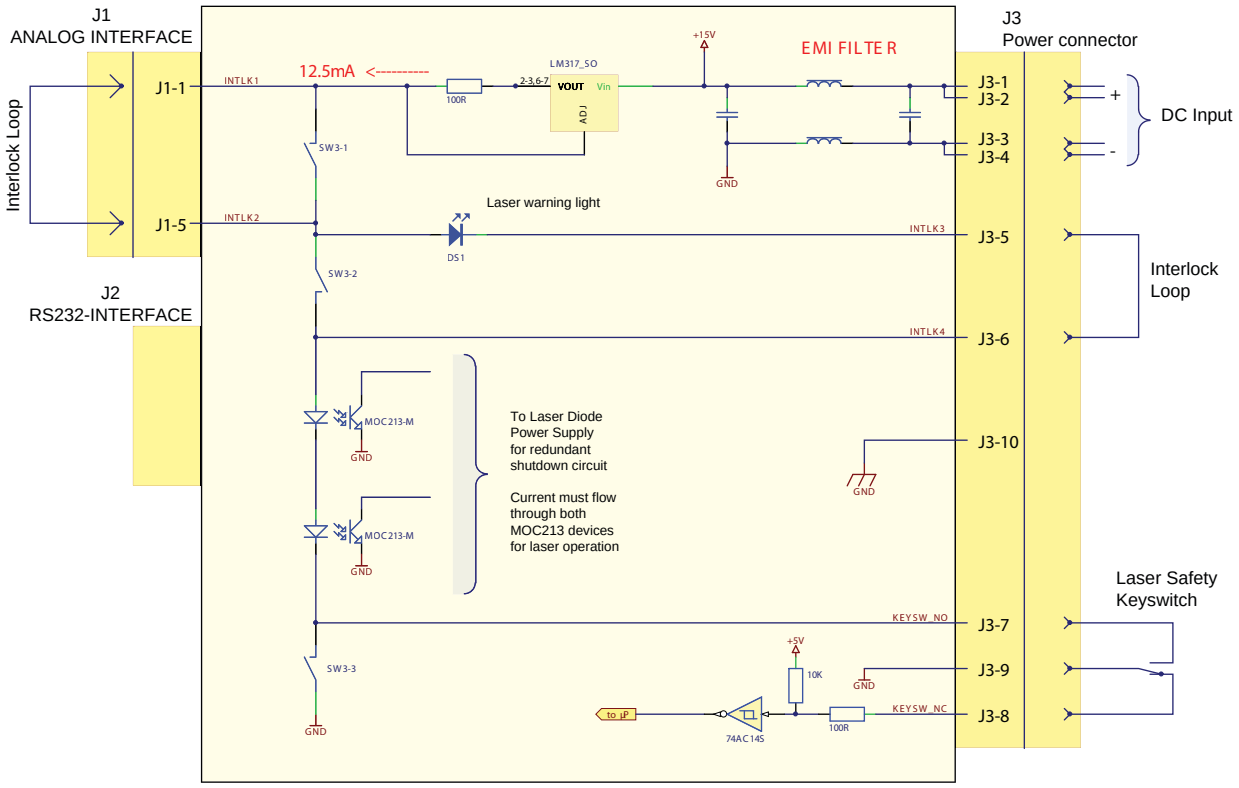


Figure 3-9. Interlock Connection Diagram

Sapphire OEM Controller LP USB: Controlling the Laser via Analog Signals

Connect all components, as described under "Interconnections" (p. 3-6). Note that the connecting cable for the analog interface is not included. The connector is a standard 26-pin IDC connector.

Provide or disable the necessary interlock connection at the Analog Interface connector. Supply the operating voltage to the DC connector and, if applicable, turn the CDRH Key switch to the ON position.

When the analog interface is active, the RS-232 interface is disabled for commands.

If Autostart mode is disabled, turn on TEC and laser by resetting Pin 3 from OFF to ON.

Figure 3-10 (p. 3-16) indicates the pinning for the Sapphire OEM Controller LP USB analog interface.

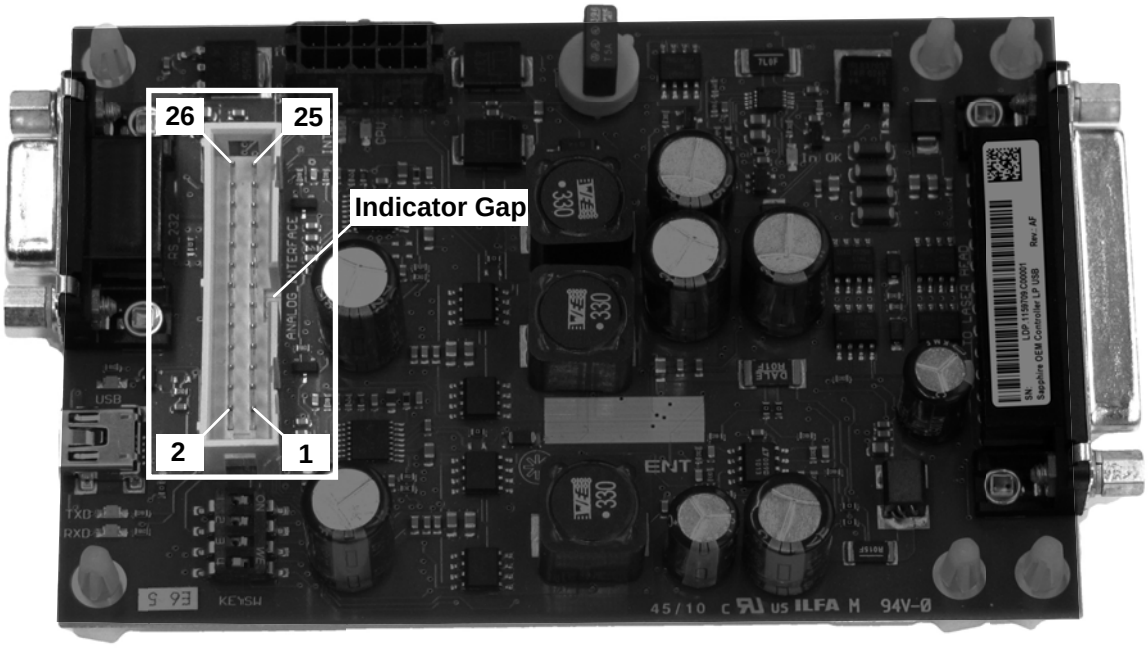


Figure 3-10. Sapphire OEM Controller LP USB Analog Interface Pinning

Table 3-3. Pin-Out for External Analog Interface Connector (26-Pin IDC) - USB Controller Version

Setting	Pin	Description
Interlock	Pin 1 (+) and Pin 5 (–)	< 15 VDC, 12.5 mA typ. connect pins for laser on (disabled by DIP switch SW3-1 in ON position) Can be used for laser warning light (LED)
ON/OFF Control	Pin 3	Turns ON/OFF TEC and Laser PIN 3 to Ground Off PIN 3 no connection On If Autostart mode is disabled, an OFF to ON reset at Pin 3 is required to turn on TEC and Laser.
Standby/Run Mode Control	Pin 7	PIN 7 to Ground Standby PIN 7 no connection Run Mode
Spare Digital Input	Pin 9	Not to be connected.
Spare Analog Input	Pin 11	Not to be connected.
Laser Output Power Control	Pin 13	Analog input 0 to + 2.048V, 7-bit resolution. Range from MINLP to MAXLP, where “MINLP” means the minimum adjustable laser power, and “MAXLP” is the maximum adjustable laser power. Refer to “Controlling the Laser via RS-232 or USB Command Interface” (p. 3-18) for further description of MINLP and MAXLP values. Minimum power if no connection. 10 Kohm input Impedance enabled by PIN 10
Power Monitor	Pin 15	Analog output, max. 10 mA drive capability. Scaling: 100% power = 2V
LD Current Monitor	Pin 17	Analog signal, 1V for 1000 mA laser diode current, max. 10 mA drive capability.
Signal/Power Return	Pin 2, 14, 16, 18, 19, 21, 22	Ground (return) for all signals and power
N/A	Pin 23	Not to be connected.
DC Output	Pin 25	+ 12 VDC, 20 mA max. (output comes directly from DC supply)
Base Temp Monitor	Pin 4	Analog output temperature monitor signal (0 to 4.096V for 0 to 100ºC)
Laser Ready	Pin 6	TTL Logic High when Output Power is Set Power ± 1 mW
N/A	Pin 8	Not to be connected.
Analog Interface Enable	Pin 10	Enables Laser Control from pins 3, 7, and 13 Pin 10 to Ground: enabled Pin 10 no connection: disabled
Spare Digital Output	Pin 12	Not to be connected.
Fault Output	Pin 20	TTL logic output, high when laser is in a fault mode
Chassis Ground	Pin 24	Connects to connector shell and mounting holes on OEM Controller LP PCB only

The circuit figure shown below describes the control of the laser diode (LD) and TEC function using Pin 3 and Pin 7:

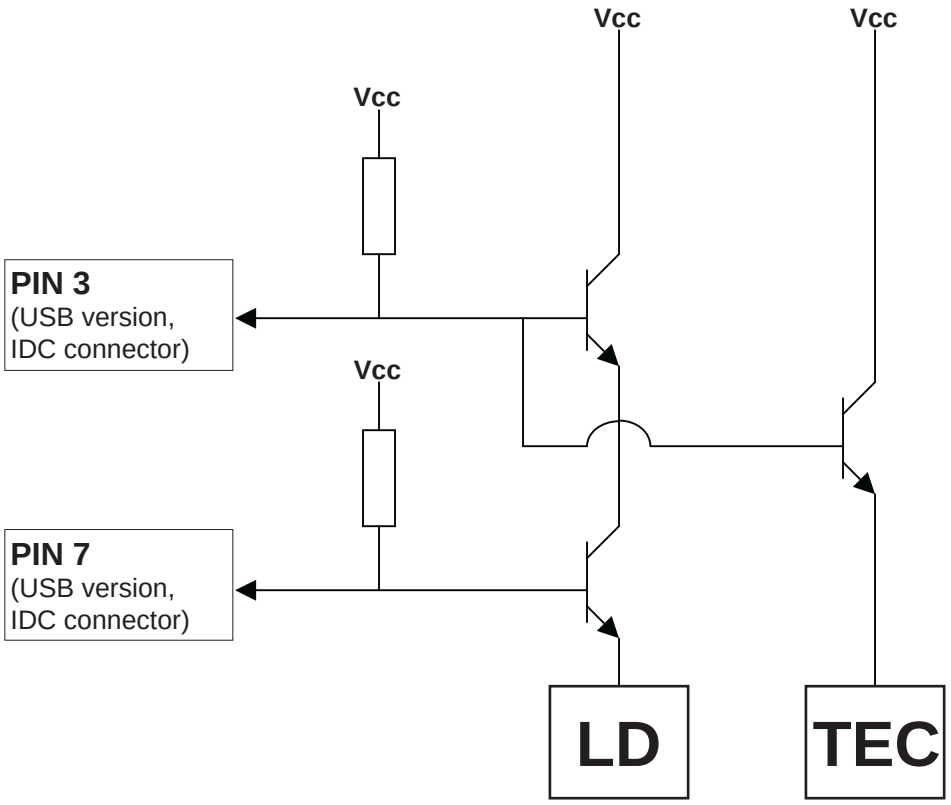


Figure 3-11. Sapphire Standby-ON-OFF

Controlling the Laser via RS-232 or USB Command Interface

Connect all components as shown in the paragraph Interconnections. Supply the necessary interlock connection at the Analog interface and/or DC power connector. Supply the operating voltage to the DC power connector. Turn the CDRH keyswitch to the ON position, if applicable. Connect a serial cable (not included) to the OEM Controller LP and make the communication to the computer. The user can use a standard terminal emulator program that is included in standard PC operation systems. For a description of the RS-232 pin assignments, refer to Table 3-4 (p. 3-19).

Settings of the OEM Controller LP USB RS-232 interface:

- 19200 baud
- no parity
- 8 data bits
- 1 stop bit
- No flow control

A cable with straight-through connections (that is, Pin 1 connects to Pin 1, Pin 2 connects to Pin 2, etc.) permits communication with the 9-pin RS-232 connector on most personal computers.

By using the commands in Table 3-5 (p. 3-22), the user can control and query different parameters. Note that the laser will go through a warm-up cycle after applying DC power. During this cycle the OEM Controller LP will not accept any commands; the user has to query the error flag until there is a zero back response. Here is a typical RS-232 startup sequence:

Sapphire:0->	{system prompt}
Sapphire:0->?FF	{checking for errors}
0	{no errors, warm-up cycle complete}
Sapphire:0->L=1	{laser on}
Sapphire:0->P=20	{output power = 20 mW}
Sapphire:0->?BT	{query baseplate temp}
35	{35ºC}
Sapphire:0->L=0	{laser off}

If the power level is not explicitly set, the laser always starts at the last power level used.

Table 3-4. RS-232 Connector (DB-9 Female on OEM Controller LP Board)

Setting	Pin	Description
DCD	Pin 1	No connection
TXD	Pin 2	RS-232 transmitter on OEM Controller LP PCB
RXD	Pin 3	RS-232 receiver on OEM Controller LP PCB
DTR	Pin 4	Connected to DSR
GND	Pin 5	Signal Ground
DSR	Pin 6	Connected to DTR
RTS	Pin 7	Connected to CTS
CTS	Pin 8	Connected to RTS
RI	Pin 9	No connection

Connecting and Installing the USB Interface

The OEM Sapphire LP USB controller supports digital USB control via a mini-USB connector. When installed, it serves as a virtual COM port and generates a new COM port at the computer. Access to this interface is then comparable to the RS-232 access.

When the USB and RS-232 interfaces are connected at the same time, USB supersedes the RS-232 interface by deactivating the RS-232 line until the supply power of the Sapphire controller is turned off and then on again.

Controlling the Laser via the USB Command Interface

The Sapphire OEM Controller LP digital interface now supports USB via a standard mini-USB connector. The following figure shows the location of the USB connector.

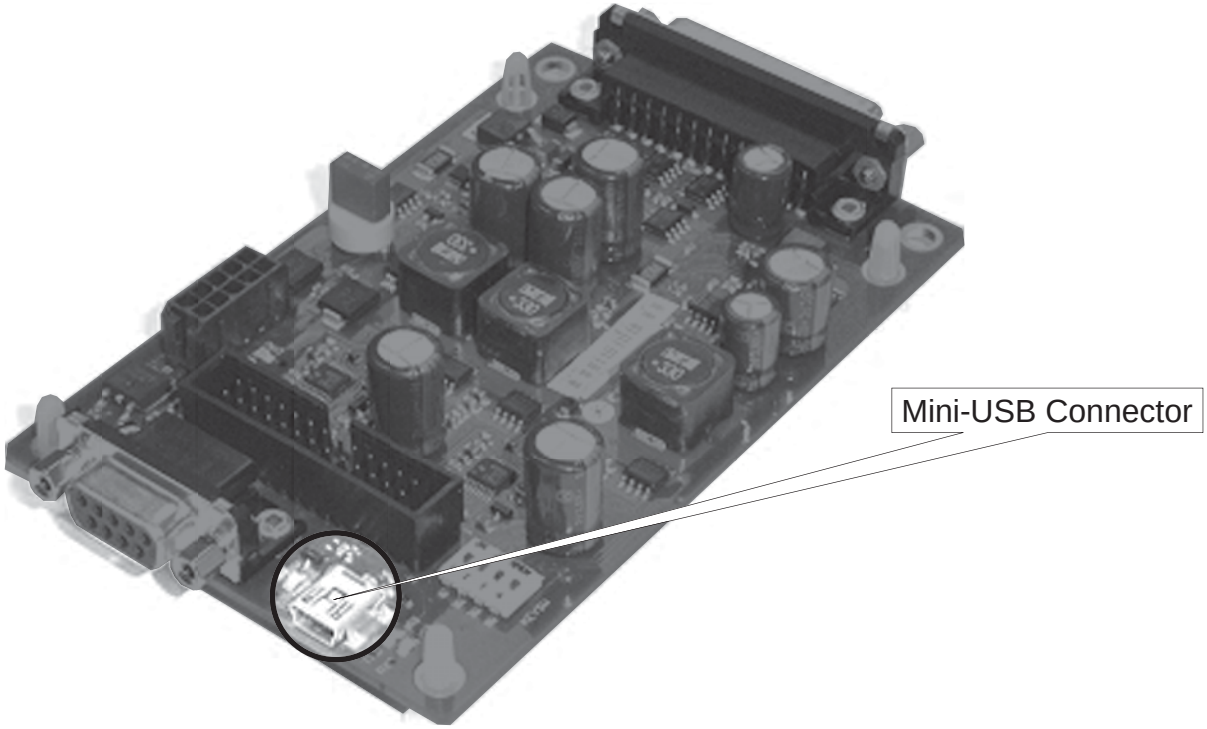


Figure 3-12. Location of the Mini-USB Connector

Hints For Software Integration

- The Sapphire firmware supports a local echo as a default setting; that is, the OEM Controller LP directly returns each character you send. To switch off the local echo, use the “E” command.
- To switch off the “Sapphire” prompt, use the “>” command.
- When working with their own software, some users find it advantageous to switch off the local echo and the system prompt.
- Don’t send more than one command at a time. After receiving a response to one command, the next command or query can then be sent.
- A command is answered by a CR LF (carriage return/line feed). If the command is wrong, an additional error message string is sent.
- A query is always answered by CR LF (carriage return/line feed) and a string. The string can also be an error message.

NOTICE!
RS-232 communication faults are frequently related to defective hardware components, for example, cables. Communication faults are also more common in rough electromagnetic interference environments. Ensure correct ground connection and shielding of the cable.

- Coherent recommends a timeout program to prevent possible faults caused by RS-232 communication. After every command or query, the response of the Sapphire controller must be completed before sending a new command or query to the controller. An interval of at least 500 ms between two commands or queries is sufficient. In case of a communication error, send a CR LF (carriage return/line feed) to clear the OEM Controller LP communication buffer.
- To handle temperature faults, etc., repeatedly use the “?FL” or the “?FF” query.
- Note that Microsoft Windows 7 is no longer equipped with the HyperTerminal program. There are other terminal programs—HTerm for example—that work.

NOTICE!
Activating the echo is recommended to confirm that the CPU and digital communications are actively working. If activated, echo lets the user check if the Sapphire laser system sends an echo as a response to a sent command or query. If the echo is missing, block the laser beam until there is verification that the CPU and digital communications are correctly working. Blocking the laser beam excludes malfunctions, including unintended laser light emission.

RS-232 Commands and Queries

Unless otherwise specified, most commands follow the "**command**=<value>" format and queries follow the "**?query**" format.

Table 3-5. Serial Commands and Queries (Sheet 1 of 3)

">"	*Type: Query and Command* Turns the command prompt ON or OFF. 1=ON 0=OFF
"BT"	Type: Query Reads the Baseplate temperature and returns the value in °C (degrees centigrade).
"C"	Type: Query Reads the laser diode current and returns the measured current value (in amps). Use the "?sc" command to read back the set current value.
"CLS"	Type: Command Clears text from a serial communication screen (only when using VT100 emulation).
"DST"	Type: Query Reads the Diode Set temperature in the system. This is a value in °C (degrees centigrade).
"DT"	Type: Query Returns the value of the measured temperature in °C (degrees centigrade). Use the "?dst" command to read back the set diode temperature value.
"E"	Type: Query and Command Sets or reads the Echo Off feature. This feature turns the serial communication terminal character echo ON or OFF and is useful if the laser is controlled by a computer script/program, rather than a person. 1=ON 0=OFF
"F"	Type: Query Checks for faults in the system and, if it finds one, returns the fault number. If there are multiple faults present in the system, it returns the first fault detected from a list of faults. See the "?FL" or "?FF" queries for different ways to receive fault status.

Table 3-5. Serial Commands and Queries (Sheet 2 of 3)

"FF"	Type: Query A reply of "8192" means that the laser is running fault-free and stable—it does not indicate a fault. Checks for faults in the system and, if it finds one, returns a two-byte result using the following format: MSB: 15 Not Implemented 14 Not Implemented 13 Laser Ready 12 EEPOT2 fault 11 EEPOT1 fault 10 OEM Controller LP EEPROM fault 9 Head EEPROM fault 8 System Warming/Waiting for TEC servo to reach target temperature. 7 Diode Temperature Fault (only Light servo turned OFF) 6 BasePlate Temperature Fault (only Light servo turned OFF) 5 Analog Interface Fault 4 Diode Current Fault 3 OEM Controller LP Temp. Fault (both TEC and Light servo's turned OFF) 2 BasePlate Temperature Fault (both TEC and Light servo's turned OFF) 1 Diode Temperature Fault (both TEC and Light servo's turned OFF) LSB: 0 External Interlock Fault
"FL"	Type: Query Checks for faults in the system and, if it finds one, returns a list of all faults present. If there are no faults in the system, it responds with "system ok." This command shows faults in text rather than in numbers. See the "?F" or "?FF" queries for different ways to receive fault status. Fault List: 0 System OK (No fault) 1 External Interlock Fault 2 Diode Temperature Fault 3 BasePlate Temperature Fault 4 OEM Controller LP Temperature Fault 5 Diode Current Fault (under current or over current) 6 Head EEPROM fault 7 OEM Controller LP EEPROM fault 8 EEpot1 fault 9 EEpot2 fault 10 ADC fault 11 Analog Interface fault
"H"	Type: Query Help - Returns a list of available queries.
"HH"	Type: Query Returns the usage hours stored in the HEAD EEPROM, using the format "?hh." Head Hours are updated every time there is at least minimum current flowing through the laser diode. See the "PSH" query to check the Power Supply usage hours.
"HID"	Type: Query Reads the Head ID. Value is numerical (floating point value). Only the integer part of the value is significant. Discarding the position after the decimal point is recommended.
"K"	Type: Query Checks the status of Key Switch (if implemented) in the hardware.

Table 3-5. Serial Commands and Queries (Sheet 3 of 3)

"L"	Type: Query and Command Reads or sets the Light Servo status. Setting L=1 closes the Light Servo and enables the automatic servo regulation. To set L=1, the TEC servo MUST be ON (T=1, automatic TEC servo regulation). Setting L=0 sets the Light Servo to an OPEN state and disables automatic servo regulation. L=0 also turns the Laser output OFF. Querying this command (?L) returns the Light Servo status.
"LT"	Type: Query Displays laser type and nominal power.
"MAXLP"	Type: Query Returns the maximum adjustable output power.
"MINLP"	Type: Query Returns the minimum adjustable output power.
"MCR"	Type: Query Returns whether the Laser Head reached the diode current limit (reply "1"), or if there is sufficient headroom (reply "0"). Note that for repeatable tests, the laser has to previously be set to maximum power (refer to the "P" command, below).
"NOMP"	Type: Query Return the nominal output power.
"P"	Type: Query and Command Sets or reads the Laser Power. To get a laser output using this command, Light Servo MUST be enabled (L=1). A query returns the actually measured Sapphire output level in a numerical and floating-point value. For queries and commands, the unit is mW.
"PSH"	Type: Query Returns the usage hours stored in the OEM Controller LP EEPROM, in the format "?psh." This value—which represents the on-time of the Sapphire unit—updates every time the Sapphire unit is turned on. See "HH" query to check the Head usage hours.
"PST"	Type: Query Returns the controller temperature.
"SP"	Type: Query Reads the set power (i.e., setpoint of the output power). The set power can be changed by using the "P" command.
"STA"	Type: Query Reads status of laser head: 1 = Start up, 2 = Warmup, 3 = Standby, 4 = Laser on, 5 = Laser ready, 6 = Error[a]
"SVPS" or "SV"	Type: Query Reads the software version stored in the Power-Supply EEPROM. The read value is numerical, and expressed in floating point.
"T"	Type: Query and Command Reads or sets the TEC Servo status. Setting T=1 closes the TEC Servo and enables the automatic servo regulation. Setting T=0 sets the TEC Servo to an OPEN state and disables automatic servo regulation. T=0 also turns the Laser output OFF. Querying this command (?T) returns the TEC Servo status.
"WAVE"	Type: Query Returns the nominal laser wavelength.

SECTION FOUR: FIBER CONNECTOR INSPECTION AND CLEANING

To avoid optical degradation and optical or mechanical damage, the fiber connector needs to be clean. Also, the connector has to be installed in a dust- and contamination-free environment when running the laser in your application; therefore, it is important that fiber connectors are inspected and cleaned prior to mating. The information in this section explains how to do that.

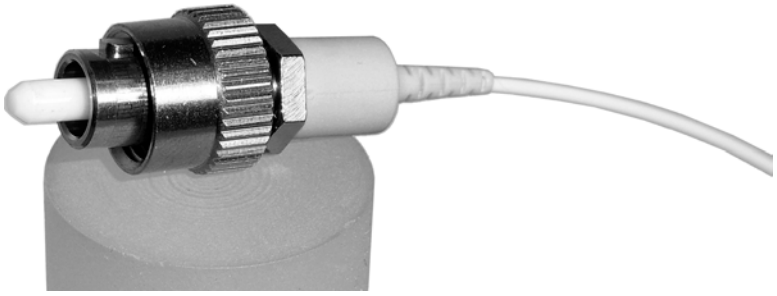


Figure 4-1. Sapphire Fiber Tip (without dust cap)

Importance of Inspection and Cleaning

A clean fiber tip is required for quality connections between fiber optic equipment. One of the most basic and important maintenance procedures of a fiber optic system is to clean the equipment.

Any contamination in the fiber connection can cause failure of either the component or the whole system. Even microscopic dust particles can cause a variety of problems for optical connections. A particle that partially or completely blocks the core can generate strong back reflections, which, in turn, can cause instability in the laser system.

In addition to dust, other types of contamination must also be cleaned off the fiber tip. Such materials include:

- Oils (for example, from human hands or lubrication of sleeves)
- Condensed vapors in the air
- Stains left after water or other solvents evaporate

These contaminants can be more difficult to remove than dust particles and, if not removed, can also damage the equipment.

The output intensity at the Sapphire fiber exit is so extreme that any contaminant can be burned into the fiber tip if it blocks the beam exit aperture while the laser is turned on. This burn might damage the optical surface enough so that it cannot be cleaned.

When fiber components are cleaned, always complete the steps carefully. The goal is to eliminate any dust or contamination and to provide a clean environment for the fiber optic connection.

Remember that inspection, cleaning, and re-inspection are critical steps which must be done before you make any fiber connections.

WARNING!
Laser safety glasses can present a hazard as well as a benefit; while they protect the eye from potentially damaging exposure, they block light at the laser wavelengths, which prevents the operator from seeing the beam. Therefore, use extreme caution even when using safety glasses.

WARNING!
Never look into a fiber while the laser is on.

WARNING!
Never connect a fiber to a fiberscope while the laser is on.

WARNING!
Always turn off the Sapphire before you inspect the fiber tip.

CAUTION!
Follow all safety instructions when using isopropyl/methanol alcohol (used for wet cleaning of the fiber tip). If you do not have a copy of the safety instructions for using alcohol, contact your vendor before following the cleaning information explained in this document.

NOTICE!
Always inspect and clean the connectors before you make a connection.

NOTICE!
Never touch the tip of the fiber connectors.

NOTICE!
Never use alcohol or wet cleaning without a way to ensure that it does not leave residue on the fiber tip.

General Cleaning Process

1. Inspect the fiber tip with a fiberscope or microscope and if the tip is dirty, use the Dry Cleaning Technique (p. 4-5) to clean it.
2. Re-inspect the fiber tip and if the connector is still dirty, repeat the Dry Cleaning Technique (p. 4-5).
3. Inspect the fiber tip and if the connector is still contaminated, clean it with the Wet Cleaning Technique (p. 4-6), followed immediately by the Dry Cleaning Technique (p. 4-5).
4. Inspect the fiber tip again and if the contaminate is still present, repeat the entire cleaning process until the fiber tip is clean.

Fiber Tip Inspection Technique

The inspection of the fiber tip is done with either a desktop video fiberscope or a handheld fiberscope. Both tools are customized microscopes used for inspecting optical fibers. The scope should provide at least 200x total magnification. A specific adapter is needed for the FC/APC (**F**iber **C**onnector/**A**ngle **P**hysical **C**ontact) to properly inspect the fiber tip.

Fiber Optic Scope

Part Number: F1MS200X

http://www.fiberinstrumentsales.com/products/fiber-optic-equipment_fis-compact-200x-fiber-optic-scope.html

Desktop Video Fiber Optic Microscope

Part Number: F1VM400USB

http://www.fiberinstrument-sales.com/products/fiber-optic-equipment_fis-destop-video-fiber-optic-microscope.html

FIS Fiber Optic Microscope Adapters

Part Number: F1VSAPC25

http://www.fiberinstrument-sales.com/products/fiber-optic-equipment_fis-fiber-optic-microscope-adapters.html

To inspect the connector:

1. Make sure that the laser is turned off before you begin the inspection.
2. Remove the dust cap and store it in a clean container.
3. Put the appropriate inspection adapter or probe on your equipment.
4. Insert the fiber connector into the fiberscope adapter and adjust the focus ring so that you see a clear fiber tip image.
5. Clean the fiber tip and re-inspect, as necessary. Refer to "General Cleaning Process" (p. 4-3).
6. Immediately plug the clean connector into the mating clean connector to reduce the risk of re-contamination.

Fiber Tip Cleaning Techniques

No known cleaning method is 100% effective; therefore, it is imperative that inspection is included as part of the cleaning process. Improper cleaning can damage the equipment.

Dry Cleaning Technique

This section describes a dry cleaning technique that uses a cartridge cleaner.

Recommended cartridge cleaning tools:

OPTIPOP R

Cord: ATC-RE-02

http://www.ntt-at.com/product/optipop/

CLETOP-S Type A

Part Number: 14110501

http://www.cletop.com/html/products.html

1. Make sure that the laser is turned off before you begin the inspection.
2. Remove the dust cap and store it in a clean container.
3. Inspect the connector with a fiberscope. Refer to the “Fiber Tip Inspection Technique” (p. 4-4).
4. If the connector is dirty, clean with a cartridge cleaner.
5. Press down and hold the thumb lever—the shutter slides back and exposes a new cleaning area.
6. Hold the fiber tip lightly against the cleaning area.
7. Pull the fiber tip lightly down the exposed cleaning area in the direction of the arrow or from top to bottom and, at the same time, rotate the fiber (90 to 180 degrees).

NOTICE!
Scrubbing the fiber against the fabric or cleaning over the same surface more than once can potentially contaminate or damage the connector.

8. Repeat steps 6 and 7 to clean the second slot.
9. Release the thumb lever to close the cleaning window.
10. Inspect the connector again with the fiberscope. Refer to "Fiber Tip Inspection Technique" (p. 4-4).
11. Repeat the inspection and cleaning processes, as necessary. If the contamination cannot be removed with the Dry Cleaning Technique, use the Wet Cleaning Technique (explained, next).

Wet Cleaning Technique

If it wasn't possible to completely remove the contamination by using the Dry Cleaning Technique:

1. Press down and hold the thumb lever of the cartridge cleaning tool. The shutter will slide back and expose a new cleaning area.
2. *Carefully* drop isopropyl/methanol on the open slots.
3. Hold the fiber tip lightly against the cleaning area.
4. Pull the fiber tip lightly down the exposed cleaning area in the direction of the arrow or from top to bottom and, at the same time, rotate the fiber (90 to 180 degrees).

NOTICE!
Scrubbing the fiber against the fabric or cleaning over the same surface more than once can potentially contaminate or damage the connector.

5. Release the thumb lever and press it down again to get an unexposed cleaning section.
6. Continue with step 6 of the "Dry Cleaning Technique" (p. 4-5).

SECTION FIVE: TROUBLESHOOTING

Use the following checklists if you are experiencing problems with the Sapphire laser system. Should the problem continue, or if you need further assistance, contact either Coherent Technical Support in the US (1-800-367-7890), or a worldwide local Coherent service representative (connect to www.Coherent.com for worldwide contact information).

LED Indicators on the OEM Controller LP USB

The Sapphire OEM Controller LP USB has a CPU LED and an Interlock LED, which are found near the DC power connector (refer to Figure 5-1, below). The Interlock LED indicates a closed interlock loop if DIP switch no. 2 is set to the OFF position. When DIP switch no. 2 is set to ON, the Interlock LED is shorted and will not emit light.

The CPU LED indicates the working microprocessor:

Slow blinking (1 sec.)	normal operation
Fast blinking	fault situation
Constant ON or OFF	microprocessor on hold

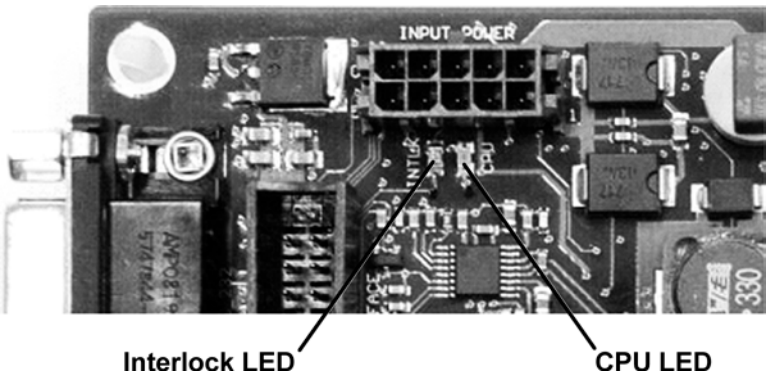


Figure 5-1. LED Indicators on the OEM Controller LP USB

Troubleshooting Procedures

The following table presents a list of possible problems, along with a reference to the associated troubleshooting checklist located in this section.

Table 5-1. Faults and Error Messages

Problem	Troubleshooting Reference
Interlock chain not closed	Checklist 1(page 5-3)
System does not turn on	Checklist 2 (page 5-4)
System shuts down (RS-232 control)	Checklist 3a (page 5-5)
System shuts down (Analog interface and Autostart)	Checklist 3b (page 5-5)
Low power (RS-232 control)	Checklist 4a (page 5-6)
Low power (Analog control)	Checklist 4b (page 5-7)
Low power (Autostart mode)	Checklist 4c (page 5-7)
Scatter light around the main beam (all operating modes)	Checklist 5 (page 5-8)
Output power not stable (all operating mode)	Checklist 6 (page 5-8)
Beam noise out of spec (all operating modes)	Checklist 7 (page 5-8)
OEM controller LP USB does not communicate with RS-232	Checklist 8 (page 5-9)
OEM Controller LP USB does not communicate with USB	Checklist 9 (page 5-10)
Transverse mode is not TEM_{oo} or polarization extinction ratio is below specification or unstable	Checklist 10 (page 5-10)
Baseplate temperature exceeds permissible temperature, causing the system to shut down	Checklist 11 (page 5-10)
If the laser system or components are being returned directly to Coherent, an RMA (Return Material Authorization) number is required. Contact Coherent or an authorized representative.	

Checklist 1: Interlock Chain Not Closed

The Interlock LED on the OEM Controller LP USB illuminates if the interlock chain is closed. Follow this checklist if the Interlock LED is not illuminated.

For a better understanding of this checklist, refer to Figure 3-9 (p. 3-15).

This checklist assumes the Interlock LED is operational. If the system activates by turning DIP switches no. 1, 2, and 3 to the ON position without the Interlock LED illuminating, then the Interlock LED is shorted.

[ ] Turn off DC power supply.

[ ] Set SW3-1, SW3-2, SW3-3 to the OFF position.

[ ] Turn on DC power after a 10-second delay.

[ ] Verify the supply voltage is stable between 10.8 and 15 VDC.

[ ] Place SW3-1, switch 1 to the ON position. If the Interlock LED on the OEM Controller LP USB turns on, check the interlock or switch at J1-1 to J1-3, then place SW3-1 back to the OFF position.

[ ] Verify there is an interlock jumper or a working LED between pins 5 and 6 of J3. Make sure the cathode of the LED is connected to J3-6.

[ ] Place SW3-3, switch 3 to the ON position. If the Interlock LED on the OEM Controller LP USB turns on, check the 2-position switch (customer provided), then place SW3-3 back to the OFF position.

[ ] If the Interlock LED on the OEM Controller LP USB still does not turn on or the system does not turn on after the start delay, return the OEM Controller LP for repairs.

Checklist 2: System Does Not Turn On

The system should last about 40 seconds after turn on.

[ ] Cycle DC power OFF/ON with a 10-second delay.

[ ] Verify the supply voltage is between 10.8 and 15 VDC and the power supply is rated at $\geq$ 60W.

[ ] Verify that the protective cap has been removed from the fiber connector.

[ ] Observe the Interlock LED on the OEM Controller LP USB. The Interlock LED is illuminated if the interlock chain is closed. Refer to "Checklist 1: Interlock Chain Not Closed" (p. 5-3) if the Interlock LED does not turn on.

[ ] Verify the Interlock LED on the OEM Controller LP USB is blinking at 1 Hz (1 blink per second).

[ ] Cycle the DC power supply OFF/ON with a minimum 10-second delay if the CPU LED on the OEM Controller LP USB does not blink at 1 Hz. Replace the OEM Controller LP if the CPU LED is still not blinking at 1 Hz.

[ ] Verify the control signals at J1 (if the Analog interface is used) or J2 (if RS-232 is used) are in accordance with Table 3-4 (p. 19). If not sure, turn off the DC power and position the SW 3 switches to autostart operation. Then re-connect the DC power supply to the system. If the system operates in autostart, check the control signals (Analog or RS-232 control).

[ ] If the control signals are good, replace the OEM Controller LP.

[ ] If the Interlock LED on the OEM Controller LP USB is ON and the CPU LED on the OEM Controller LP USB blinks at 1 Hz but the system does not turn on, replace the entire system.

Checklist 3a: System Shuts Down (RS-232 Control)

[ ] Check for proper heatsinking of the laser head.

[ ] Check the temperature of the baseplate and heatsink.

[ ] Check for proper grounding of the laser head (the laser head cover should be at earth ground).

[ ] Issue the "?FL" command

[ ] If fault #1, correct the external interlock connection

[ ] Replace the laser head if any of the following faults are ON: 2, 5, or 6 (assuming the ambient temperature is < 40ºC).

[ ] All other faults—excluding faults 3 and 1—replace the entire system.

[ ] If fault #3, measure the baseplate temperature right before shut down and, if the temperature is above the maximum-allowed baseplate temperature, check for proper heatsinking.

Checklist 3b: System Shuts Down (Analog Interface and Autostart)

[ ] Check for proper grounding of the laser head (the head cover should be at earth ground potential).

[ ] Measure the baseplate temperature at the time the system shuts down. If the baseplate temperature exceeds the permissible temperature, check for proper heatsinking of the laser head—refer to"Checklist 10: Transverse Mode is Not TEMoo or Polarization Extinction Ratio is below Specification or Unstable" (p. 5-10).

[ ] Replace the entire system.

Checklist 4a: Low Power (RS-232 Control)

Measure power (using a calibrated power meter) before the beam hits any external optics, and also use the "?P" command to obtain output power measurement from the system.

If the system does not achieve the specified maximum power level, make sure that the power level is set to the maximum level via the RS-232 command. The system will always power-up to the previously-set power level.

[ ] Verify the fiber connector tip is clean. For information about inspecting and cleaning the fiber connector tip, refer to "Section Four: Fiber Connector Inspection and Cleaning" (p. 4-1).

[ ] Verify the proper RS-232 command is issued. For example, P=10 should result in 10 mW (?P=10 mW).

[ ] If the system does not respond to the "?P" command, verify the proper RS-232 is set up and then replace the computer. Note that some portable PCs or USB-to-RS-232 converters may have weak RS-232 driver circuits which may, in turn, lead to a less robust RS-232 communication. If the problem persists, replace the OEM Controller LP USB.

[ ] For testing purpose, set the laser power to its maximum value by sending "P=XXX", whereas "XXX" represents the maximum power. Then query "?MCR". If the response is "0", the actual power should reach the set value—this can be checked by "?P", which returns the actual power. If the response to "?MCR" is "1" and the "?P" response indicates low power, then the pump diode has insufficient current head room and the laser head needs to be replaced. After the test, remember to set the laser power back to its former value.

Checklist 4b: Low Power (Analog Control)

Make sure power is measured by a calibrated power meter before it hits any external optics, or use the Analog Interface connector (J1, Pin 8+, 10-) to obtain an output power measurement. Refer to "Sapphire OEM Controller LP USB: Controlling the Laser via Analog Signals" (p. 3-16) for the correct power vs. voltage slope.

If the system does not achieve the specified maximum power level, use the RS-232 command to verify the power level is set to the maximum level. The system will always power-up to the previously-set power level.

[ ] Verify the fiber connector tip is clean. For information about inspecting and cleaning the fiber connector tip, refer to "Section Four: Fiber Connector Inspection and Cleaning" (p. 4-1).

[ ] Apply voltage at J1, Pin 7+, 10-, to 2.048V (2.048 mV corresponds to 110% of the nominal output power).

[ ] If measured power is low, the most likely cause is a defective laser head, although the OEM Controller LP USB can not be completely ruled out. First replace the laser head. If power is still low, replace the OEM Controller LP.

Checklist 4c: Low Power (Autostart Mode)

Make sure power is measured by a calibrated power meter before it hits any external optics, or use either pins 8+ and 10-, or J1 (the Analog Interface connector) to obtain the output power measurement.

If the system does not achieve the specified maximum power level, use the RS-232 command to verify the power level is set to the maximum level. The system will always power-up to the previously-set power level.

[ ] Verify the fiber connector tip is clean. For information about inspecting and cleaning the fiber connector tip, refer to "Section Four: Fiber Connector Inspection and Cleaning" (p. 4-1).

[ ] If measured power is less than maximum, the most likely cause is a defective laser head, although the OEM Controller LP can not be ruled out. Replace the laser head first.

[ ] When using Autostart mode, power is adjusted to the last setting. Systems shipped from Coherent are adjusted to nominal power. If the RS-232 or Analog interface has been used prior to autostart, reconfigure the system to operate in RS-232 or Analog mode, adjust the output power to maximum, and then reconfigure the system to operate in Autostart.

Checklist 5: Scattered Light Around the Main Beam (All Operating Modes)

- [ ] The beam is observed prior to hitting any external optics.
- [ ] Verify the fiber connector tip is clean. For information about inspecting and cleaning the fiber connector tip, refer to "Section Four: Fiber Connector Inspection and Cleaning" (p. 4-1).
- [ ] Replace the laser head.

Checklist 6: Output Power Not Stable (All Operating Modes)

- [ ] Make sure power is measured before it hits any external optics. Avoid right angles of optics in the beam path to prevent back reflections. Also, slightly tilt the detector.
- [ ] Allow the system to warm up for at least five minutes.
- [ ] Verify the fiber connector tip is clean. For information about inspecting and cleaning the fiber connector tip, refer to "Section Four: Fiber Connector Inspection and Cleaning" (p. 4-1).
- [ ] Verify all cable connections are secure.
- [ ] If the Analog Interface is used, measure the output power control signal (J1, Pin 7+, 10-) to make sure it is stable.
- [ ] If power still fluctuates, the most likely cause is a defective laser head, although the OEM Controller LP USB can not be completely ruled out.

Checklist 7: Beam Noise Out of Spec (All Operating Modes)

- [ ] Make sure beam noise is measured before the beam hits any external optics. Avoid right angles of optics in the beam path to prevent back reflections. Also, tilt the detector slightly.
- [ ] Verify the fiber connector tip is clean. For information about inspecting and cleaning the fiber connector tip, refer to "Section Four: Fiber Connector Inspection and Cleaning" (p. 4-1).
- [ ] Check for proper heatsinking.
- [ ] Verify there are no vibrations at the laser head.
- [ ] Check proper shielding and the electrical connection of the shielding with both sub-D connectors. Use a genuine Coherent head cable.
- [ ] Check for proper grounding of the head cover.
- [ ] Replace the laser head.

Checklist 8: OEM Controller LP USB Does Not Communicate With RS-232

[ ] Verify all connections are secure.

[ ] If a mini-USB cable is connected to the Sapphire OEM controller LP USB, disconnect the mini-USB connector and then turn the DC power of the Sapphire Controller off and—after a 10 second delay—on again. A connected USB cable activates the USB interface and will overrule the RS-232 interface. Note: An activated USB interface is indicated by a glowing "USB-LED," located next to the mini-USB connector on the controller pcb.

[ ] When using a USB-to-COM converter, verify that the driver for the COM port converter is properly installed. The PC operating system should correctly list the COM port in the devices list.

[ ] Verify all RS-232 or USB settings (baud rate, etc.) For a complete list of settings, refer to "Controlling the Laser via RS-232 or USB Command Interface" (p. 3-18).

[ ] Make sure a straight (1-to-1) cable is used to connect the computer to the OEM Controller LP USB. Cable length should not exceed 5 m. The cable should be properly shielded.

[ ] Use a second computer to exclude a defective RS-232 or USB port on the first computer.

[ ] Replace the OEM Controller LP USB.

Checklist 9: OEM Controller LP USB Does Not Communicate With USB

- [ ] Verify all connections are secure. An activated and properly connected USB interface is indicated by a glowing "USB-LED," located next to the mini-USB connector on the controller pcb.
- [ ] Verify that the driver for the Virtual COM port is properly installed. The PC operating system should correctly list the Virtual COM port in the devices list.
- [ ] Verify all RS-232 settings (baud rate, etc.). For a complete list of settings, refer to "Controlling the Laser via the USB Command Interface" (p. 3-20).
- [ ] Make sure that a regular mini-USB cable is used to connect the computer to the OEM Controller LP USB. Cable length should not exceed 5 m. The cable should be properly shielded.
- [ ] Use a second computer to exclude a defective USB port on the first computer.
- [ ] Replace the OEM Controller LP USB.

Checklist 10: Transverse Mode is Not TEM_{oo} or Polarization Extinction Ratio is below Specification or Unstable

- [ ] Make sure the beam is observed before it hits any external optics. Avoid right angles of optics in the beam path to prevent back reflections. Also, tilt the detector slightly.
- [ ] Verify the fiber connector tip is clean. For information about inspecting and cleaning the fiber connector tip, refer to "Section Four: Fiber Connector Inspection and Cleaning" (p. 4-1).
- [ ] Replace the laser head.

Checklist 11: Baseplate Exceeds Permissible Temperature, Causing the System to Shut Down

- [ ] Verify the proper size of the heatsink—refer to"Heatsink Requirement" (p. 3-2).
- [ ] Verify the proper operation of the heatsink (that is, if a fan is used to cool the heatsink, make sure it is operating properly).
- [ ] Verify the heatsink compound is applied evenly between the laser head and the heatsink. Ensure that any thermal conductive compound used is only *thinly* applied. No compound can properly compensate for an uneven surface.
- [ ] Verify the surface of the heatsink contacting the laser head is not bent.
- [ ] Verify the ambient temperature does not exceed 40ºC.

SECTION SIX: REPACKING PROCEDURE

This section shows the factory-recommended repacking procedure for the Sapphire laser system. This procedure should be followed when shipping the laser system to another location after initial installation, or when returning the system to the factory for service.

NOTICE!
Coherent recommends saving the shipping box and packaging materials for possible later use.

The Sapphire laser system requires one shipping box for the laser system components and a second box for the optional accessories, available as a set (part number 1037015). Table 6-1, below, lists a complete inventory of the items shipped with the Sapphire laser system.

Table 6-1. Sapphire Shipping Crate Contents

Box 1:
Sapphire FP Laser Head
OEM Controller LP
Laser Head Cable
Connector Kit
Operator’s Manual
Box 2:
Optional DC Supply
Optional Heatsink

1. Screw the protective metal cap on the fiber connector before shipping. *Do not scratch or touch the fiber connector tip*.

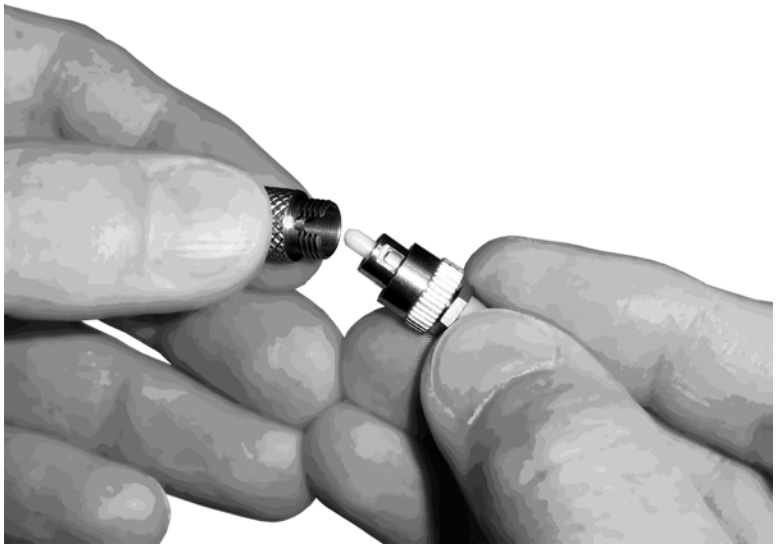


Figure 6-1. Protective Fiber Cap

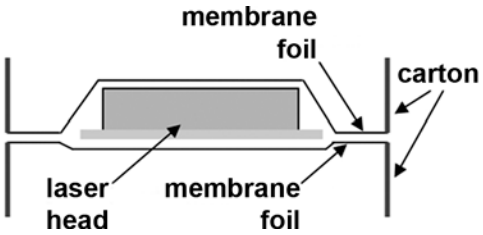
2. Put all the components into the original protective plastic bags before shipping (not shown: manual). Place the components into the shipping box, as shown below.

Figure 6-2. Sapphire FP Packing - Preparation

3. Pay special attention to the plastic foam under and above the fiber part of the Sapphire FP laser head, as shown below.

Figure 6-3. Sapphire FP Packing - Fiber Protecting Foam

4. Position the laser head and the controller between the foils. Always put the components **between** the foils and not on top or underneath. The laser head and controller are correctly positioned when the laser is pressed between the foils and fixed. The laser head *must* be flexible-mounted but not able to move between the foils.



5. Place the head cable and the connector kit in the space at the far right of the carton, as shown in the following figure.

Figure 6-4. Sapphire FP Packing - Devices Between Membrane Foils

6. Put the manual on top of the components and the flat sheet of carton on top of the manual.

7. Close the box.

8. If optional components such as the power supply and the heatsink need to be sent, use the special shipping box for accessories. The figure below shows the optional heatsink in the special shipping box. For maximum protection during ship-

ment, place the component between the foils, as described in step 4, above.

APPENDIX A: WARRANTY

Coherent, Inc. warrants Sapphire™ laser systems to the original purchaser (the Buyer) only, that the laser system, that is the subject of this sale, (a) conforms to Coherent's published specifications and (b) is free from defects in materials and workmanship.

Laser systems are warranted to conform to Coherent's published specifications and to be free from defects in materials and workmanship for a period of twelve (12+1) months. Replacement units shipped within warranty, carry the remainder warranty of the failed unit.

Responsibilities of the Buyer

The buyer is responsible for providing the appropriate utilities and an operating environment as outlined in the product literature. Damage to the laser system caused by failure of buyer's utilities or failure to maintain an appropriate operating environment, is solely the responsibility of the buyer and is specifically excluded from any warranty, warranty extension, or service agreement.

The Buyer is responsible for prompt notification to Coherent of any claims made under warranty. In no event will Coherent be responsible for warranty claims made later than seven (7) days after the expiration of warranty.

Limitations of Warranty

The foregoing warranty shall not apply to defects resulting from:

- Components and accessories manufactured by companies, other than Coherent, which have separate warranties
- Improper or inadequate maintenance by the buyer
- Buyer-supplied interfacing
- Operation outside the environmental specifications of the product
- Unauthorized modification or misuse
- Improper site preparation and maintenance
- Manipulating or opening the housing

Coherent assumes no responsibility for customer-supplied material. The obligations of Coherent are limited to repairing or replacing, without charge, equipment which proves to be defective during the warranty period. Replacement sub-assemblies may contain reconditioned parts. Repaired or replaced parts are warranted for the duration of the original warranty period only. The warranty on parts purchased after expiration of system warranty is ninety (90) days. Our warranty does not cover damage due to misuse, negligence or accidents, or damage due to installations, repairs or adjustments not specifically authorized by Coherent.

Warranty applies only to the original purchaser at the initial installation point in the country of purchase, unless otherwise specified in the sales contract. Warranty is transferable to another location or to another customer only by special agreement which will include additional inspection or installation at the new site. Coherent disclaims any responsibility to provide product warranty, technical or service support to a customer that acquires products from someone other than Coherent or an authorized representative.

THIS WARRANTY IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL OR IMPLIED, AND DOES NOT COVER INCIDENTAL OR CONSEQUENTIAL LOSS. COHERENT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

APPENDIX B: ACCESSORIES

Power Meter Accessories

Coherent offers a variety of instruments for laser test and measurement. For additional detailed information, including product selection guides, visit our web site at www.Coherent.com.

For the most common diagnostics need—measuring the output power of the Sapphire—we recommend two different types of power meters that are ideal fits to the Sapphire product family. These meters are discussed, next.

First Recommendation

We highly recommend the FieldMaxII-TO™—a full-featured power meter that supports interchangeable power sensors and offers capabilities like onboard statistical analysis and computer interfacing via USB. This meter comes with installable applications software and LabVIEW drivers.

There are two primary sensor options for this meter:

- The PS10 provides high-resolution measurements—100 uW to 1W—and is best utilized for applications such as stability monitoring. Usage of a FC/PC adapter accessory (Coherent part number 0012-3863) for the detector is recommended for stable measurements.
- The fast response time of the PM2—2 mW to 2W—makes this sensor perfectly suited for applications such as laser tuning.

FieldMaxII-TO Laser Power Meter (RoHS)	Part Number 1070873
PS10 High-Sensitive Thermopile Sensor (RoHS)	Part Number 0012-4595
PM2 Air-Cooled Thermopile Sensor (RoHS)	Part Number 0012-1350

Alternative Recommendation

LaserCheck™—a hand-held, inexpensive laser power meter that is self-contained for easy storage—is specifically designed to provide power measurements. Its compact size enables measurements in optical set-ups where a standard detector head does not fit. With its built-in attenuator, this device is ready to measure output powers from 0.5 µW to 1W.

LaserCheck Power Meter (RoHS)	Part Number 33-1553

GLOSSARY

°C	Degrees centigrade or Celsius
°F	Degrees Fahrenheit
µ	Micron(s)
µm	Micrometer(s) = 10^{-6} meters
µrad	Microradian(s) = 10^{-6} radians
µsec	Microsecond(s) = 10^{-6} seconds
$1/e^2$	Beam diameter parameter = 0.13534
AC	Alternating current
ADC	Analog-to-digital converter
Amp	Ampere(s)
CDRH	Center for Devices and Radiological Health
cm	Centimeter(s)
CPU	Central processing unit
DC	Direct current
EEPROM	Electrically erasable programmable read only memory
EMI	Electro Magnetic Interface
g	Gram(s) or earth's gravitational force (gravity)
GND	Ground
Hz	Hertz or cycles per second (frequency) (= 1/pulse period)
IR	Infrared (wavelength)
kg	Kilogram(s) = 10^3 grams
KHz	Kilohertz = 10^3 hertz
Kohm	Kilohm(s)
LD	Laser diode
LED	Light emitting diode
m	Meter(s) (length)
mA	Milliamp(s) = 10^{-3} Amperes
mAmp	Milliampere(s)
MHz	Megahertz = 10^6 hertz
mm	Millimeter(s) = 10^{-3} meters
mrad	Milliradian(s) = 10^{-3} radians (angle)
ms	Millisecond(s) = 10^{-3} seconds
mV	Millivolt(s)
mW	Milliwatt(s) = 10^{-3} Watts (power)
nm	Nanometer(s) = 10^{-9} meters (wavelength)
OEM	Original equipment manufacturer
OPS	Optically pumped semiconductor

OPSL	Optically pumped semiconductor laser
PCB	printed circuit board
rms	Root mean square (effective value of a sinusoidal wave)
RXD	Receive data
TEC	Thermo-electric cooler
TEM	Transverse electromagnetic mode (cross-sectional laser beam mode)
TTL	Transistor-to-transistor logic
TXD	Transmit data
V	Volt(s)
VAC	Volts, alternating current
VDC	Volts, direct current
VECSEL	Vertical External Cavity Surface Emitting Laser
W	Watt(s) (power)

INDEX

Sapphire™ FP OEM Operator's Manual
©Coherent Inc., 8/2014 (RoHS), printed in the USA
Part No. 1265451 Rev. AB