LF SERIES
FIBER LASER
WELDER

USER MANUAL

990-935 REV E

Printed in the United States of America

Revision Record

Revision	EO	Date	Basis of Revision
A	43885	09/15	Production release.
B	44403	09/16	Add LF1000AI, LF700AI, Type 2 Chiller. Update Technical Information
C	45441	03/19	Add Information for 8-932 Model
D	45867	05/20	Update Company Name (Amada Weld Tech), Update Model Numbers & Technical Information
E	47211	01/24	Update LF1000A Mass + Manual Title Change

This manual covers the following LF Series Laser Models:

Original Model Name	Original P/N		Current Model Name	Current P/N
LF250A-SM (6m)	8-932-ARx-xxA	→	LF-250A-AR-SM	8-932-ARx-xxB
LF250A-MM (6m)	8-932-AQx-xxA	→	LF-250A-AQ-M35	8-932-AQx-xxB
LF300AI-SM (5m)	8-932-AKx-xxA	→	LF-300A-AK-SM	8-932-AKx-xxB
LF300AI-MM (5m)	8-932-ALx-xxA	→	LF-300A-AL-M50	8-932-ALx-xxB
LF500A-SM (6m)	8-932-ABx-xxA	→	LF-500A-AB-SM	8-932-ABx-xxB
LF500A-SM (10m)	8-932-AMx-xxA	→	LF-500A-AM-SM	8-932-AMx-xxB
LF500AI-SM (5m)	8-932-AHx-xxA	→	LF-500A-AH-SM	8-932-AHx-xxB
LF500AI-MM (5m)	8-932-AJx-xxA	→	LF-500A-AJ-M50	8-932-AJx-xxB
LF500A-MM (6m/100µm)	8-932-ACx-xxA	→	LF-500A-AC-M100	8-932-ACx-xxB
LF500A-MM (10m/100µm)	8-932-ANx-xxA	→	LF-500A-AN-M100	8-932-ANx-xxB
LF500A-MM (10m/50µm)	8-932-ASx-xxxA	→	LF-500A-AS-M50	8-932-ASx-xxxB
LF700AI-SM	8-932-AUx-xxA	→	LF-700A-AU-SM	8-932-AUx-xxB
LF700AI-MM	8-932-AVx-xxA	→	LF-700A-AV-M50	8-932-AVx-xxB
LF1000AI-SM	8-932-ATx-xxA	→	LF-1000A-AT-SM	8-932-ATx-xxB
LF1000AI-MM	8-932-APx-xxA	→	LF-1000A-AP-M50	8-932-APx-xxB

FOREWORD

Thank you for purchasing an Amada Weld Tech LF Series Fiber Laser. Upon receipt of the laser, please thoroughly inspect it for shipping damage ***before*** you install it. If there is any damage, contact the shipping company immediately to file a claim, and notify Amada Weld Tech at:

Amada Weld Tech Inc.
1820 South Myrtle Ave.
Monrovia, California 91016
Phone: (626) 303-5676
FAX: (626) 358-8048
E-Mail: info@amadaweldtech.com

The purpose of this manual is to supply operating and maintenance personnel with the information needed to properly and safely operate and maintain the LF Series Fiber Laser Welder. We have made every effort to ensure the information in this manual is accurate and adequate. If you have any questions, or find any errors or omissions in this manual, please contact us. The contents of this manual are subject to change without notice.

Amada Weld Tech is not responsible for any loss or injury due to improper use of this product.

CDRH COMPLIANCE STATEMENT

The Amada Weld Tech LF SERIES FIBER LASER is certified to be fully compliant with all applicable standards and regulations as set forth by the United States of America's Health and Human Services (HHS), Food and Drug Administration (FDA), Center for Devices and Radiological Health (CDRH), title 21 Code of Federal Regulations (CFR) sections 1002, 1010, and 1040 for Class IV laser devices except for deviations pursuant to Laser Notice 56 dated May 8, 2019.

Reference CDRH Accession number is available upon request.

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SAFETY PRECAUTIONS

General

This Operator's Manual describes the Operation and Maintenance for all models of the LF Series Fiber Laser Welder, and provides instructions relating to its SAFE use. Procedures described in this manual ***must*** be performed as detailed by ***qualified*** and ***trained*** personnel.

NOTE: For the rest of this manual, all models of LF Series Fiber Laser Welder will simply be referred to as "***the Laser,***" except in specific instances where unique descriptions are required such as specifications, connections, etc.

For SAFETY, and to effectively take advantage of the full capabilities of the Laser, please read this instruction manual and the Laser Safety Manual (Part Number 990-502) thoroughly ***before*** attempting to use the Laser.

After reading this manual, retain it for future reference when any questions arise regarding the proper and SAFE operation of the Laser.

Operation

When operating or servicing the Laser, ***always*** wear Protective Goggles having an optical density of at least 7^{+} at a wavelength of 1060-1150 nanometers for the operation of the Laser.

Appoint a Laser Safety Officer. The Laser Safety Officer (LSO) must provide personnel with sufficient training so that personnel can operate, maintain and service the Laser safely. The LSO must take charge of the key to the Key Switch to ensure that ***only*** qualified and authorized personnel operate the Laser.

Establish and control a dedicated Laser Operation Area. The Laser Safety Officer must isolate the Laser Operation Area from other work areas and display signs warning that the Laser Operation Area is off-limits to unauthorized personnel.

Maintenance/Service

Before performing any maintenance on the Laser, read *Chapter 4, Maintenance* thoroughly. Use the appropriate tools for terminating the connecting cables, being careful not to nick the wire conductors.

Procedures other than those described in this manual or not performed as prescribed in this manual, may expose personnel to electrical and/or laser radiation hazards.

Do ***not*** modify the Laser without prior written approval from Amada Weld Tech.

Before using this equipment, read the **Safety Precautions** carefully to understand the correct usage of the equipment.

- These precautions are given for the safe use of the Laser and for prevention of injury to operators or others.
- Be sure to read ***each*** of the instructions, as they are all important for safe operation.
- The meaning of the words and symbols are as follows:

CAUTION
Denotes operations and practices that may result in personal injury or damage to the equipment if not correctly followed.

WARNING
Denotes operations and practices that may result in serious injury or loss of life if not correctly followed.

DANGER
Denotes operations and practices that may imminently result in serious injury or loss of life if not correctly followed.

These symbols denote **PROHIBITION**. They are warnings about actions that should ***not*** be performed because they can damage the equipment and will void the warranty.

These symbols denote actions which operators ***must*** take.

Each symbol with a triangle denotes that the contents gives notice of **DANGER**, **WARNING**, or **CAUTION** to the operator.

DANGER

Do *not* touch the interior of the Laser when it is turned ON.
Doing so may result in electric shock.

Never **attempt to disassemble, repair, or modify the Laser.**
Doing so may result in electric shock or fire.
Refrain from any mechanical adjustment other than the maintenance procedures specifically described in the operation manual.

Never **expose eyes or skin to laser irradiation.**
Exposure to direct or scattered laser light is extremely hazardous.
Direct exposure of the eye to laser beams may result in blindness.

WARNING

Wear protective glasses.

Be sure to wear protective glasses while using the Laser. Even with eye protection, you may lose your sight if you look directly at the laser beam.

Do *not* expose your skin to the laser beam.

Your skin may be severely burned.

Do *not* touch any processed part during, or immediately after processing.

Welded parts are ***very hot***.

Use only specified cables.

A cable with insufficient capacity or loose connections can cause electric shock or fire.

Do *not* use a damaged power cable, connecting cables, or plugs.

Do ***not*** step on, twist, or tense any power cable. The power cable and connecting cables may be damaged which can cause electric shock, short circuit, or fire. If any part needs to be repaired or replaced, consult Amada Weld Tech or your distributor.

Stop operation if any trouble occurs.

If you detect a burning smell, abnormal sounds, abnormal heat, smoke, etc. from the Laser, turn the power OFF ***immediately*** to prevent fire or electric shock. Contact Amada Weld Tech or your distributor for help.

Ground the Laser.

If the Laser is not grounded, you may get an electric shock when there is trouble or if electricity leaks through the protective insulation.

Use a stopper plug.

Laser beams are dangerous to the human body. Prevent accidental leakage of the laser beam by using a stopper (a heat-resistant, laser beam absorbing material).

People with pacemakers *MUST* stay away from the Laser.

When the Laser is operating, it generates a magnetic field, which adversely affects pacemakers. People who use a pacemaker must ***not*** approach the Laser, or walk around the laser shop while the Laser is operating, ***unless*** their medical doctor has deemed it safe to do so.

Keep water and water containers away from the Laser.

Water spilled on the Laser can cause a short circuit, electrical shock, or fire.

CAUTION

Use proper tools (wire strippers, pressure wire connectors, etc.) for terminations of the connecting cables.

Do not nick the wire conductor. Doing so can cause a short circuit, electric shock, or fire.

Install the Laser on a firm, level surface.

Injury may result if the Laser falls over or drops from an uneven surface.

Keep combustible matter away from the Laser.

Laser spatter can ignite combustible materials. If you cannot remove all combustible materials, cover them with a non-combustible material.

NEVER apply the laser beam to combustible materials.

To avoid the risk of fire, never apply the laser to flammable or combustible materials.

When operating the Laser, do not cover it with a blanket, cloth, etc.

Heat generated by the operating Laser may ignite a blanket or cover.

Do *NOT* use the Laser for purposes other than processing metal.

Use of the Laser on other materials, or in a manner other than specified may cause fire or electrical shock.

Wear protective gear when operating the Laser.

Wear protective gear such as protective gloves, long-sleeved jacket, leather apron, etc. so that Laser spatter will not burn the skin. Do not breathe fumes generated by laser processing.

Keep a fire extinguisher nearby.

Make sure there is a fire extinguisher in or near the Laser shop in case of fire.

Regularly inspect and maintain the Laser.

Regular inspection and maintenance is essential for safe operation and long life of the Laser. If you see ***any*** damage, make necessary repairs before operating the Laser.

Guidelines for Normal Use

1. Appoint a Laser Safety Officer (LSO). Ensure that the LSO has as much expertise and experience with lasers and laser equipment as possible.

   The LSO, who will be in charge of the laser key switch, is responsible for familiarizing users with safety issues and for coordinating laser welding.

2. Partition off all areas that may be exposed to laser light.

   The LSO is responsible for posting signs to keep unauthorized personnel out of the laser area.

3. Install the Laser on a solid, level surface.

4. To prevent errant laser processing, place workpieces on the same stand as the Laser Head so that the workpieces do ***not*** vibrate during laser processing.

5. To ensure optimal welding quality, use the Laser in a location where ambient temperatures are 41ºF to 105ºF (5°C to 40°C), free of sudden temperature fluctuations and a relative humidity less than 85% (non-condensing). Do ***not*** use the laser in any of the following locations:
   - Locations with excessive dirt or oil mist
   - Locations in which the Laser may be subject to vibration or impact
   - Locations in which the Laser may be exposed to chemicals
   - Locations near sources of high-frequency noise, or
   - Locations in which condensation may form on the Laser's surface.

6. If the room temperature changes quickly (as when a heater is turned ON in cold weather), moisture may condense on the optical components, resulting in fogging or collection of dust.

   Avoid sudden changes in temperature. Under the conditions in which condensation may occur, wait for a period of time after turning the Laser ON before beginning operations.

7. If the exterior of the Laser becomes soiled, wipe it with a soft dry or lightly moistened cloth.

   Clean heavily soiled areas with a cloth moistened with diluted neutral detergent or alcohol. Do ***not*** use paint thinner, acetone, benzene, or similar chemicals, which may discolor or damage the Laser.

8. Never place screws or other foreign objects inside the Laser. Such objects can damage the Laser.

9. Operate the switches and buttons gently by hand.

   Applying excessive force or using the tip of a screwdriver, pen, or other instrument may damage the Laser.

10. Operate only one switch or button at a time.

    Attempting to operate several at a time may damage the Laser.

11. Properly handle fumes generated by laser processing according to local regulations. Many materials are harmful and protection is required.

WARNING

Always wear protective goggles when maintaining the Laser. Goggles must have an optical density of at least 7+, at a wavelength of 1060 - 1150 nanometers for the operation of the Laser.

12. For more consistent performance, allow the Laser to thermally stabilize for approximately 10 to 30 minutes before use (the appropriate warm-up time will depend on the ambient temperature and workpiece material.)

    Refer to the following standards for more information on managing laser equipment:

    - **IEC60825-1 Edition1.2** "Safety of laser products Part1: Equipment Classifications, requirements and user's guide."
    - **Amada Weld Tech Laser Safety Manual** (Part Number 990-502)

Warning Labels

The Laser Welder carries the following labels. Read and follow the label instructions to ensure correct use. Data on the warning labels may be different depending on model number characteristics.

WARNING

DO NOT PLUG OR UNPLUG CABLES WHEN AC POWER IS TURNED ON

4-66-534-01 Rev A

DANGER
HIGH VOLTAGE

DISCONNECT POWER AND WAIT 5 MIN. BEFORE SERVICING.

VISIBLE AND INVISIBLE
LASER RADIATION
AVOID EYE OR SKIN
EXPOSURE TO DIRECT OR
SCATTERED RADIATION
CLASS 4 LASER PRODUCT

CAUTION

DO *NOT* ATTEMPT TO REMOVE THE FIBER UNDER ANY CIRCUMSTANCES. DOING SO WILL *DESTROY* THE FIBER AND VOID THE WARRANTY.

AMADA

AMADA WELD TECH

MANUFACTURED BY:
AMADA WELD TECH INC.
1820 SOUTH MYRTLE AVE
MONROVIA, CA 91016 U.S.A.

CATALOG NO.	SEE I.D LABEL BEHIND FRONT DOOR FOR MODEL AND SERIAL INFORMATION
MODEL NO.	
SERIAL NO.	

INPUT POWER: SINGLE PHASE AC
VOLTS: 200~240 Hz: 50/60
MAXIMUM RMS AMPS: 35

LASER OUTPUT:	Yb FIBER	AIMING:
MAXIMUM:	2000 W	< 5mW
OSCILLATION:	PULSED/CW	CW
WAVE LENGTH:	900-1250nm	630-680nm

CENTRAL EMISSION WAVELENGTH: 1070nm

PULSE OUTPUT FREQUENCY 0-100 kHz

COMPLIES WITH 21 CFR 1040.10
CLASS IV LASER PRODUCT

466121-01 REV A

EC Declaration of Incorporation
For Incomplete Machinery

In accordance with EN ISO 17050-1: 2004

We, Amada Weld Tech Inc.
of 1820 S Myrtle Avenue
Monrovia, CA 91016

In accordance with the following Directive(s):

2004/30/EU	**The Electromagnetic Compatibility Directive**
2014/35/EU	**Low Voltage Directive**
2011/65/EU	**EU RoHS Directive**

hereby declare that:

Equipment Function:	LF Series Fiber Laser Welder
Model Number:	8-930-xxx- or 8-931-xxx- or 8-932-xxx- where x is configurable per unit specification
Serial Number:	See Individual Unit Label

is in conformity with the applicable requirements of the following documents

Ref No:
EN61326-1, EN61010-1, EN55011 Class A Group 1, EN61000-4-2, EN61000-4-3, EN61000-4-4, EN6100-4-5, EN61000-4-6, EN61000-4-8, EN50581:2012

We hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications and is in accordance with the requirements of the Directive(s)

In accordance with the following Directive for the same equipment:

2006/42/EC **The Machinery Directive**

we hereby declare that the basic requirements (appendix 1) of the above directive are conformed:

1.5.1, 1.5.11, 1.5.12, 1.6.1-1.6.3, 1.7.2, 1.7.3

we hereby declare that the following EHSRs have been complied with:

EN11553-1: Safety of Machinery – Laser Processing Machines
EN60204-1: Safety of Machinery – Electrical Equipment of Machines
EN60825-1: Safety of laser products – 1 Equipment Classification and Requirements
EN60825-4: Safety of Laser Products – Laser Guards
IEC13849-1: Safety of machinery – Safety Related Parts of Control Systems

and the technical documentation is compiled in accordance with Annex VII (B of the Directive).

We undertake to transmit, in response to a reasoned request by the appropriate national authorities, relevant information on the partly completed machinery identified above. The method of transmission shall be at the discretion of Amada Weld Tech.

The machinery is incomplete and must not be put into service until the machinery into which it is to be incorporated has been declared in conformity with the provisions of the Directive.

Signed by: Thomas Houy

Name: Thomas Houy
Position: Manager, Sustaining Engineering
Done at: 1820 S. Myrtle Ave
Monrovia, CA 91016
On: 04/2019

The technical documentation for the machinery is available from:

Name: Dieter Kemmerer-Fleckenstein
Amada Weld Tech GmbH
Lindberghstrasse 1; DE-82178 Puchheim, Germany

LIMITED WARRANTY

GENERAL TERMS AND CONDITIONS FOR THE SALE OF GOODS

1. Applicability.

(a) These terms and conditions of sale (these "**Terms**") are the only terms which govern the sale of the goods ("**Goods**") by Amada Weld Tech Inc. ("**Seller**") to the buyer identified in the Sales Quotation and/or Acknowledgment (as each defined below) to which these Terms are attached or incorporated by reference ("**Buyer**"). Notwithstanding anything herein to the contrary, if a written contract signed by authorized representatives of both parties is in existence covering the sale of the Goods covered hereby, the terms and conditions of said contract shall prevail to the extent they are inconsistent with these Terms.

(b) The accompanying quotation of sale (the "**Sales Quotation**") provided to Buyer, and/or sales order acknowledgement ("**Acknowledgement**") and these Terms (collectively, this "**Agreement**") comprise the entire agreement between the parties, and supersede all prior or contemporaneous understandings, agreements, negotiations, representations and warranties, and communications, both written and oral. For clarification, after the Acknowledgement is received by Buyer, the order for Goods is binding and cannot be cancelled by Buyer for any reason and the full purchase price amount set forth in the Acknowledgement shall be due and payable by Buyer to Seller pursuant to the payment schedule set forth in the Acknowledgement unless otherwise agreed to in writing by Seller. All terms and conditions contained in any prior or contemporaneous oral or written communication which are different from, or in addition to, the terms and conditions in this Agreement are hereby rejected and shall not be binding on Seller, whether or not they would materially alter this Agreement. These Terms prevail over any of Buyer's terms and conditions of purchase regardless whether or when Buyer has submitted its purchase order or such terms. Fulfillment of Buyer's order does not constitute acceptance of any of Buyer's terms and conditions and does not serve to modify or amend these Terms. Notwithstanding anything herein to the contrary, all orders for Goods must be for a minimum purchase price of $100 or such orders will be rejected by Seller.

2. Delivery.

(a) The Goods will be delivered within a reasonable time after Seller provides Buyer the Acknowledgment, subject to availability of finished Goods. Seller will endeavor to meet delivery schedules requested by Buyer, but in no event shall Seller incur any liability, consequential or otherwise, for any delays or failure to deliver as a result of ceasing to manufacture any product or any Force Majeure Event. Delivery schedules set forth in the Acknowledgment are Seller's good faith estimate on the basis of current schedules. In no event shall Seller be liable for special or consequential damages resulting from failure to meet requested delivery schedules.

(b) Unless otherwise agreed in writing by the parties in the Acknowledgement, Seller shall deliver the Goods to Seller's plant in Monrovia, CA, USA (the "**Shipping Point**") using Seller's standard methods for packaging and shipping such Goods. Buyer shall take delivery of the Goods within three (3) days of Seller's written notice that the Goods have been delivered to the Shipping Point. Buyer shall be responsible for all loading costs (including freight and insurance costs) and provide equipment and labor reasonably suited for receipt of the Goods at the Shipping Point. Seller shall not be liable for any delays, loss or damage in transit.

(c) Seller may, in its sole discretion, without liability or penalty, make partial shipments of Goods to Buyer, if applicable. Each shipment will constitute a separate sale, and Buyer shall pay for the units shipped whether such shipment is in whole or partial fulfillment of Buyer's purchase order.

(d) If for any reason Buyer fails to accept delivery of any of the Goods on the date fixed pursuant to Seller's notice that the Goods have been delivered at the Shipping Point, or if Seller is unable to deliver the Goods at the Shipping Point on such date because Buyer has not provided appropriate instructions, documents, licenses or authorizations: (i) risk of loss to the Goods shall pass to Buyer; (ii) the Goods shall be deemed to have been delivered; and (iii) Seller, at its option, may store the Goods until Buyer picks them up, whereupon Buyer shall be liable for all related costs and expenses (including, without limitation, storage and insurance).

3. Non-delivery.

(a) The quantity of any installment of Goods as recorded by Seller on dispatch from Seller's place of business is conclusive evidence of the quantity received by Buyer on delivery unless Buyer can provide conclusive evidence proving the contrary.

(b) Seller shall not be liable for any non-delivery of Goods (even if caused by Seller's negligence) unless Buyer gives written notice to Seller of the non-delivery within three (3) days of the date when the Goods would in the ordinary course of events have been received.

(c) Any liability of Seller for non-delivery of the Goods shall be limited to (in Seller's sole discretion) replacing the Goods within a reasonable time or adjusting the invoice respecting such Goods to reflect the actual quantity delivered.

4. Shipping Terms. Unless indicated otherwise in the Acknowledgment, Delivery shall be made EXW (Incoterms 2010), Shipping Point, including without limitation, freight and insurance costs. If no delivery terms are specified on the Acknowledgement, the method of shipping will be in the sole discretion of Seller. Unless directed in writing otherwise by Buyer, full invoice value will be declared for all shipments.

5. Title and Risk of Loss. Title and risk of loss passes to Buyer upon delivery of the Goods at the Shipping Point. As collateral security for the payment of the purchase price of the Goods, Buyer hereby grants to Seller a lien on and security interest in and to all of the right, title and interest of Buyer in, to and under the Goods, wherever located, and whether now existing or hereafter arising or acquired from time to time, and in all accessions thereto and replacements or modifications thereof, as well as all proceeds (including insurance proceeds) of the foregoing. The security interest granted under this provision constitutes a purchase money security interest under the California Commercial Code.

6. Amendment and Modification. These Terms may only be amended or modified in a writing which specifically states that it amends these Terms and is signed by an authorized representative of each party.

7. Inspection and Rejection of Nonconforming Goods.

(a) Buyer shall inspect the Goods within two (2) days of receipt ("**Inspection Period**"). Buyer will be deemed to have accepted the Goods unless it notifies Seller in writing of any Nonconforming Goods during the Inspection Period and furnishes such written evidence or other documentation as required by Seller. "**Nonconforming Goods**" means only the following: (i) product shipped is different than identified in Buyer's Acknowledgement; or (ii) product's label or packaging incorrectly identifies its contents. Notwithstanding the foregoing, for shipped Goods that require field installation, the "re-verification" terms in the Acknowledgement shall apply and for custom installations, the inspection and verification shall take place at Buyer's site immediately after the installation is completed.

(b) Seller will only accept Nonconforming Goods that are returned under Seller's Return Material Authorization procedures then in effect ("**RMA**"). Buyer shall obtain a RMA number from Seller prior to returning any Nonconforming Goods and return the Nonconforming Goods prepaid and insured to Seller at 1820 South Myrtle Avenue, Monrovia, CA 91016 or to such other location as designated in writing by Seller for the examination to take place there. If Seller reasonably verifies Buyer's claim that the Goods are Nonconforming Goods and that the nonconformance did not developed by use from Buyer, Seller shall, in its sole discretion, (i) replace such Nonconforming Goods with conforming Goods, or (ii) credit or refund the Price for such Nonconforming Goods pursuant to the terms set forth herein. Notwithstanding the foregoing, the only remedy for Nonconforming Goods that are custom systems is repair (not refund or replacement). No returns for Nonconforming Goods are allowed after thirty (30) days from the original shipping date.

(c) Buyer acknowledges and agrees that the remedies set forth in Section 7(a) are Buyer's exclusive remedies for the delivery of Nonconforming Goods. Except as provided under Section 7(a) and Section 14, all sales of Goods to Buyer are made on a one-way basis and Buyer has no right to return Goods purchased under this Agreement to Seller.

8. Price.

(a) Buyer shall purchase the Goods from Seller at the prices (the "**Prices**") set forth in Seller's published catalogue literature in force as of the date of the Sales Quotation. However, the Prices shown in such catalogue literature or any other publication are subject to change without notice. Unless specifically stated to the contrary in the Sales Quotation, quoted Prices and discounts are firm for thirty (30) days from the date of the Sales Quotation. Unless otherwise stated, prices are quoted EXW (Incoterms 2010), Shipping Point. Unless otherwise stated in the Acknowledgement, if the Prices should be increased by Seller before delivery of the Goods to a carrier for shipment to Buyer, then these Terms shall be construed as if the increased prices were originally inserted herein, and Buyer shall be billed by Seller on the basis of such increased prices.

(b) All Prices are exclusive of all sales, use and excise taxes, and any other similar taxes, duties and charges of any kind imposed by any governmental authority on any amounts payable by Buyer. Buyer shall be responsible for all such charges, costs and taxes (present or future); provided, that, Buyer shall not be responsible for any taxes imposed on, or with respect to, Seller's income, revenues, gross receipts, personnel or real or personal property or other assets.

9. Payment Terms.

(a) Unless otherwise provided in the Acknowledgement, if Buyer has approved credit with Seller, Buyer shall pay all invoiced amounts due to Seller within thirty (30) days from the date of Seller's invoice. If Seller does not have Buyer's financial information and has not provided pre-approved credit terms for Buyer, the payment must be made in cash with order or C.O.D. in US dollars. If Buyer has approved credit terms, the payment may be made by cash with order, wire transfer of immediately available funds, or check in US dollars. Certain products require a down payment. Any payment terms other than set forth above will be identified in the Acknowledgement. Notwithstanding anything herein to the contrary, all prepaid deposits and down payments are non-refundable. If a deposit is not received when due, Seller reserves the right to postpone manufacturing of Goods until payment is received. Seller will not be responsible for shipment delays due to deposit payment delays.

(b) In Seller's sole discretion, Seller may access Buyer interest on all late payments at the lesser of the rate of 1.5% per month or the highest rate permissible under applicable law, calculated daily and compounded monthly. Buyer shall reimburse Seller for all costs incurred in collecting any late payments, including, without limitation, attorneys' fees. In addition to all other remedies available under these Terms or at law (which Seller does not waive by the exercise of any rights hereunder), Seller shall be entitled to suspend the delivery of any Goods if Buyer fails to pay any amounts when due hereunder and such failure continues for ten (10) days following written notice thereof.

(c) Buyer shall not withhold payment of any amounts due and payable by reason of any set-off of any claim or dispute with Seller, whether relating to Seller's breach, bankruptcy or otherwise.

10. Intellectual Property; Software License.

(a) To the extent that any Goods provided under this Agreement contains software, whether pre-installed, embedded, in read only memory, or found on any other media or other form ("**Software**"), such Software and accompanying documentation are licensed to Buyer, not sold and shall remain the sole and exclusive property of Seller or third party licensors of Seller. Seller grants Buyer a non-exclusive license to use the Software solely as provided in and in connection with the use of the Goods in which such Software is contained and in accordance with any applicable user documentation provided with such Goods and subject to the provisions of this Agreement. Certain of Seller's Goods may include third party software such as computer operating systems. Licenses to such third party software are subject to the terms and conditions of any applicable third party software license agreements. Unless identified in the Acknowledgement, no license is granted by Seller with respect to such third party software products that may be provided with the Goods (if any). Seller makes no warranties regarding any third party software that may accompany the Goods or otherwise and such software is explicitly included in the definition of Third Party Products below.

(b) Buyer shall not copy, modify, or disassemble, or permit others to copy, modify, or disassemble, the Software, nor may Buyer modify, adapt, translate, reverse assemble, decompile, or otherwise attempt to derive source code from the Software. Buyer shall not transfer possession of the Software except as part of, or with, the Goods, and each such transfer shall be subject to the restrictions contained herein. Buyer may not sublicense, rent, loan, assign or otherwise transfer the Software or documentation, and Buyer shall retain on all copies of the Software and documentation all copyright and other proprietary notices or legends appearing therein or thereon. Seller may terminate this license upon written notice for any violation of any of the terms of this license or any material breach of any provision of this Agreement. Buyer shall immediately discontinue use of the Software upon any termination of this license or Agreement. This license shall terminate upon any termination of the Agreement.

(c) All patents, trademarks, copyrights or other intellectual property rights embodied in the Goods, including without limitation the Software, are owned by Seller and its licensors. Seller and its licensors retain all right, title and interest in such intellectual property rights. Except as expressly set forth herein, no license rights or ownership in or to any of the foregoing is granted or transferred hereunder, either directly or by implication. ALL RIGHTS RESERVED.

(d) If Buyer is the United States Government or any agency thereof, each of the components of the Software and user documentation are a "commercial item," and "computer software" as those terms are defined at 48 C.F.R. 2.101, consisting of "commercial computer software" and "commercial computer software documentation," as such terms are used in 48 C.F.R. 12.212. Consistent with 48 C.F.R. 12.212 and 48 C.F.R. 227.7202-1 through 227.7202-4, all United States government Buyers acquire only those rights in the Software and user documentation that are specified in this Agreement.

11. Installation and Other Services. Seller shall provide installation services ("**Installation Services**") to Buyer if set forth in the Acknowledgment. If Installation Services are provided for in the Acknowledgement, Buyer will prepare the location for the installation consistent with Buyer's written specifications and Buyer will install necessary system cable and assemble any necessary equipment or hardware not provided by Seller, unless agreed otherwise in writing by the parties. For Goods that will be operated on or in connection with Buyer supplied hardware or software, Buyer is responsible for ensuring that its hardware and software conform with Seller minimum hardware and software requirements as made available to Buyer. Seller shall provide other field services, such as maintenance visits and field repairs (the "**Other Services**" and together with the Installation Services, the "**Services**") if set forth in the Acknowledgement.

12. Limited Warranty.

(a) Subject to the exceptions and upon the conditions set forth herein, Seller warrants to Buyer that for a period of one (1) year from the date of shipment ("**Warranty Period**"), that such Goods will be free from material defects in material and workmanship.

(b) Notwithstanding the foregoing and anything herein to the contrary, the warranty set forth in this Section 12 shall be superseded and replaced in its entirety with the warranty set forth on **Exhibit A** hereto if the Goods being purchased are specialty products, which include, without limitation, laser products, fiber markers, custom systems, workstations, Seller-installed products, non-catalogue products and other custom-made items (each a "**Specialty Product**").

(c) **EXCEPT FOR THE WARRANTY SET FORTH IN SECTION 12(A), SELLER MAKES NO WARRANTY WHATSOEVER WITH RESPECT TO THE GOODS (INCLUDING ANY SOFTWARE) OR SERVICES, INCLUDING ANY (a) WARRANTY OF MERCHANTABILITY; (b) WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE; (c) WARRANTY OF TITLE; OR (d) WARRANTY AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF A THIRD PARTY; WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE.**

(d) Products manufactured by a third party and third party software ("**Third Party Product**") may constitute, contain, be contained in, incorporated into, attached to or packaged together with, the Goods. Third Party Products are not covered by the warranty in Section 12(a). For the avoidance of doubt, **SELLER MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO ANY THIRD PARTY PRODUCT, INCLUDING ANY (a) WARRANTY OF MERCHANTABILITY; (b) WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE; (c) WARRANTY OF TITLE; OR (d) WARRANTY AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF A THIRD PARTY; WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE.** Notwithstanding the foregoing, in the event of the failure of any Third Party Product, Seller will assist (within reason) Buyer (at Buyer's sole expense) in obtaining, from the respective third party, any (if any) adjustment that is available under such third party's warranty.

(e) Seller shall not be liable for a breach of the warranty set forth in Section 12(a) unless: (i) Buyer gives written notice of the defect, reasonably described, to Seller within five (5) days of the time when Buyer discovers or ought to have discovered the defect and such notice is received by Seller during the Warranty Period; (ii) Seller is given a reasonable opportunity after receiving the notice to examine such Goods; (iii) Buyer (if requested to do so by Seller) returns such Goods (prepaid and insured to Seller at 1820 South Myrtle Avenue, Monrovia, CA 91016or to such other location as designated in writing by Seller) to Seller pursuant to Seller's RMA procedures and Buyer obtains a RMA number from Seller prior to returning such Goods for the examination to take place; and (iii) Seller reasonably verifies Buyer's claim that the Goods are defective and that the defect developed under normal and proper use.

(f) Seller shall not be liable for a breach of the warranty set forth in Section 12(a) if: (i) Buyer makes any further use of such Goods after giving such notice; (ii) the defect arises because Buyer failed to follow Seller's oral or written instructions as to the storage, installation, commissioning, use or maintenance of the Goods; (iii) Buyer alters or repairs such Goods without the prior written consent of Seller; or (iv) repairs or modifications are made by persons other than Seller's own service personnel, or an authorized representative's personnel, unless such repairs are made with the written consent of Seller in accordance with procedures outlined by Seller.

(g) All expendables such as electrodes are warranted only for defect in material and workmanship which are apparent upon receipt by Buyer. The foregoing warranty is negated after the initial use.

(h) Subject to Section 12(e) and Section 12(f) above, with respect to any such Goods during the Warranty Period, Seller shall, in its sole discretion, either: (i) repair or replace such Goods (or the defective part) or (ii) credit or refund the price of such Goods at the pro rata contract rate, provided that, if Seller so requests, Buyer shall, at Buyer's expense, return such Goods to Seller.

(i) **THE REMEDIES SET FORTH IN SECTION 12(H) SHALL BE BUYER'S SOLE AND EXCLUSIVE REMEDY AND SELLER'S ENTIRE LIABILITY FOR ANY BREACH OF THE LIMITED WARRANTY SET FORTH IN SECTION 12(A).** Representations and warranties made by any person, including representatives of Seller, which are inconsistent or in conflict with the terms of this warranty, as set forth above, shall not be binding upon Seller.

13. Limitation of Liability.

(a) **IN NO EVENT SHALL SELLER BE LIABLE FOR ANY CONSEQUENTIAL, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR PUNITIVE DAMAGES, LOST PROFITS OR REVENUES OR DIMINUTION IN VALUE, LOSS OF INFORMATION OR DATA, OR PERSONAL INJURY OR DEATH ARISING IN ANY WAY OUT OF THE MANUFACTURE, SALE, USE, OR INABILITY TO USE ANY GOODS, SOFTWARE OR SERVICE, ORARISING OUT OF OR RELATING TO ANY BREACH OF THESE TERMS, WHETHER OR NOT THE POSSIBILITY OF SUCH DAMAGES HAS BEEN DISCLOSED IN ADVANCE BY BUYER OR COULD HAVE BEEN REASONABLY FORESEEN BY BUYER, REGARDLESS OF THE LEGAL OR EQUITABLE THEORY (CONTRACT, TORT OR OTHERWISE) UPON WHICH THE CLAIM IS BASED, AND NOTWITHSTANDING THE FAILURE OF ANY AGREED OR OTHER REMEDY OF ITS ESSENTIAL PURPOSE.**

(b) **IN NO EVENT SHALL SELLER'S AGGREGATE LIABILITY ARISING OUT OF OR RELATED TO THIS AGREEMENT, WHETHER ARISING OUT OF OR RELATED TO BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, EXCEED THE TOTAL OF THE AMOUNTS PAID TO SELLER FOR THE GOODS SOLD HEREUNDER.**

(c) **ALL WARRANTIES SET FORTH HEREIN, DIRECT OR IMPLIED, ARE VOIDED IF THE INITIAL INSTALLATION AND START-UP OF THE SUBJECT GOOD IS NOT SUPERVISED BY AN AUTHORIZED REPRESENTATIVE OF SELLER. AFTER INSTALLATION, ANY RE-ALIGNMENT, RE-CLEANING, OR RE-CALIBRATION, PROVIDED THEY ARE NOT RELATED TO A PROVEN DEFECT IN MATERIALS OR WORKMANSHIP, SHALL BE PERFORMED BY AN AUTHORIZED REPRESENTATIVE OF SELLERAT THE CURRENT SERVICE RATES.**

(d) **WHERE GOODS ARE SUBJECT TO A MOVE TO ANOTHER LOCATION AFTER THE ORIGINAL INSTALLATION HAS BEEN MADE, THE WARRANTY MAY BE MAINTAINED ONLY IF SUPERVISED BY AN AUTHORIZED REPRESENTATIVE OF SELLER. SELLER, FOR A SERVICE CHARGE, WILL ARRANGE FOR AND SUPERVISE THE DISCONNECTION, TRANSPORTATION, REINSTALLATION AND START-UP OF THE EQUIPMENT. CLAIMS FOR DAMAGE IN SHIPMENT ARE THE RESPONSIBILITY OF BUYER AND SHALL BE FILED PROMPTLY WITH THE TRANSPORTATION COMPANY.**

14. Return Goods Policy. Seller's products may be returned to Seller for credit within sixty (60) days of shipment subject to the following conditions.

(a) In order to return products for credit, Buyer must obtain a RMA number from Seller. Upon receipt, it must be executed by an authorized person and then returned with the Goods. Goods returned to Seller without a RMA will be returned at Buyer's expense.

(b) Goods are to be returned to Seller at 1820 South Myrtle Avenue, Monrovia, CA 91016 with Freight Prepaid. Seller will not accept collect shipments.

(c) Restocking fees will be assessed in accordance with the following schedules: (i) Goods returned within the first thirty (30) days from shipment date will be restocked less twenty percent (20%) of the amount billed on the original invoice. (ii) Goods returned over thirty (30) days of shipment but less than sixty (60) days will be restocked less thirty percent (30%) of the amount billed on the original invoice. (iii) No returns are allowed after sixty (60) days from the original shipping date.

(d) The restocking fees set forth above are the minimum fees. If a returned Good requires rework to restore it to a saleable condition, further charges will be assessed. Seller's quality assurance department will document the condition of the Goods when received by Seller and report their findings to Buyer.

(e) **Notwithstanding the foregoing provisions of this Section 14, the following Goods cannot be returned, are not eligible for any credit and cannot be restocked: (i) custom or modified products and (ii) any expendable product(s) that have been used.**

15. Compliance with Law and Indemnification. Buyer shall comply with all applicable laws, regulations and ordinances. Buyer shall maintain in effect all the licenses, permissions, authorizations, consents and permits that it needs to carry out its obligations under this Agreement. Buyer shall comply with all export and import laws of all countries involved in the sale of the Goods under this Agreement or any resale of the Goods by Buyer. Goods, Services and technical data delivered by Seller shall be subject to U.S. export controls. Buyer shall, and shall cause its customers to, obtain all licenses, permits and approvals required by any government and shall comply with all applicable laws, rules, policies and procedures of the applicable government and other competent authorities. Buyer will indemnify and hold Seller harmless for any violation or alleged violation by Buyer of such laws, rules, policies or procedures. Buyer shall not transmit, export or re-export, directly or indirectly, separately or as part of any system, the Goods or any technical data (including processes and Services) received from Seller, without first obtaining any license required by the applicable government, including without limitation, the U.S. government. Buyer also certifies that none of the Goods or technical data supplied by Seller under this Agreement will be sold or otherwise transferred to, or made available for use by or for, any entity that is engaged in the design, development, production or use of nuclear, biological or chemical weapons or missile technology. No Buyer information will be deemed "technical data" unless Buyer specifically identifies it to Seller as such. Buyer assumes all responsibility for shipments of Goods requiring any government import clearance. Seller may terminate this Agreement if any governmental authority imposes antidumping or countervailing duties or any other penalties on Goods. For all international shipments, Seller requires that all required Export Control documentations, including Form BIS-711 Statement by Ultimate Consignee and Purchases, are submitted by Buyer along with the purchase order. Seller reserves the right to postpone shipment until all documentations are completed and submitted to Seller. Seller will not be responsible for shipment delays due to non-compliance by Buyer of the foregoing two sentences.

16. Termination. In addition to any remedies that may be provided under these Terms, Seller may terminate this Agreement with immediate effect upon written notice to Buyer, if Buyer: (i) fails to pay any amount when due under this Agreement and such failure continues for ten (10) days after Buyer's receipt of written notice of nonpayment; (ii) has not otherwise performed or complied with any of these Terms, in whole or in part; or (iii) becomes insolvent, files a petition for bankruptcy or commences or has commenced against it proceedings relating to bankruptcy, receivership, reorganization or assignment for the benefit of creditors.

17. Waiver. No waiver by Seller of any of the provisions of this Agreement is effective unless explicitly set forth in writing and signed by Seller. No failure to exercise, or delay in exercising, any rights, remedy, power or privilege arising from this Agreement operates or may be construed as a waiver thereof. No single or partial exercise of any right, remedy, power or privilege hereunder precludes any other or further exercise thereof or the exercise of any other right, remedy, power or privilege.

18. Confidential Information. All non-public, confidential or proprietary information of Seller, including, but not limited to, specifications, samples, patterns, designs, plans, drawings, documents, data, business operations, customer lists, pricing, discounts or rebates, disclosed by Seller to Buyer, whether disclosed orally or disclosed or accessed in written, electronic or other form or media, and whether or not marked, designated or otherwise identified as "confidential," in connection with this Agreement is confidential, solely for the use of performing this Agreement and may not be disclosed or copied unless authorized in advance by Seller in writing. Upon Seller's request, Buyer shall promptly return all documents and other materials received from Seller. Seller shall be entitled to injunctive relief for any violation of this Section 18. This Section 18 does not apply to information that is: (a) in the public domain through no fault of Buyer; (b) known to Buyer at the time of disclosure without restriction as evidenced by its records; or (c) rightfully obtained by Buyer on a non-confidential basis from a third party.

19. Force Majeure. Seller shall not be liable or responsible to Buyer, nor be deemed to have defaulted or breached this Agreement, for any failure or delay in fulfilling or performing any term of this Agreement when and to the extent such failure or delay is caused by or results from acts or circumstances beyond the reasonable control of Seller including, without limitation, acts of God, flood, fire, earthquake, explosion, governmental actions, war, invasion or hostilities (whether war is declared or not), terrorist threats or acts, riot, or other civil unrest, national emergency, revolution, insurrection, epidemic, lock-outs, strikes or other labor disputes (whether or not relating to either party's workforce), or restraints or delays affecting carriers or inability or delay in obtaining supplies of adequate or suitable materials, materials or telecommunication breakdown or power outage (each a "**Force Majeure Event**"), provided that, if the event in question continues for a continuous period in excess of thirty (30) days, Buyer shall be entitled to give notice in writing to Seller to terminate this Agreement.

20. Assignment. Buyer shall not assign any of its rights or delegate any of its obligations under this Agreement without the prior written consent of Seller. Any purported assignment or delegation in violation of this Section 20 is null and void. No assignment or delegation relieves Buyer of any of its obligations under this Agreement.

21. Relationship of the Parties. The relationship between the parties is that of independent contractors. Nothing contained in this Agreement shall be construed as creating any agency, partnership, joint venture or other form of joint enterprise, employment or fiduciary relationship between the parties, and neither party shall have authority to contract for or bind the other party in any manner whatsoever.

22. No Third-Party Beneficiaries. This Agreement is for the sole benefit of the parties hereto and their respective successors and permitted assigns and nothing herein, express or implied, is intended to or shall confer upon any other person or entity any legal or equitable right, benefit or remedy of any nature whatsoever under or by reason of these Terms.

23. Governing Law. All matters arising out of or relating to this Agreement is governed by and construed in accordance with the internal laws of the State of California without giving effect to any choice or conflict of law provision or rule (whether of the State of California or any other jurisdiction) that would cause the application of the laws of any jurisdiction other than those of the State of California.

24. Dispute Resolution.

(a) If Buyer is an entity formed under the laws of the United States of America, or any of its states, districts or territories ("**U.S. Law**"), then any dispute, legal suit, action or proceeding arising out of or relating to this Agreement shall be adjudicated and decided in the federal courts of the United States of America or the courts of the State of California in each case located in the City of Los Angeles and County of Los Angeles, California and each party irrevocably submits to the exclusive and personal jurisdiction of such courts in any such dispute, suit, action or proceeding.

(b) If Buyer is an entity formed under the laws of any country, state, district or territory other than U.S. Law, then the parties irrevocably agree that any dispute, legal suit, action or proceeding arising out of or relating to this Agreement shall be submitted to the International Court of Arbitration of the International Chamber of Commerce ("**ICC**") and shall be finally settled under the Rules of Arbitration of the ICC. The place and location of the arbitration shall be in Los Angeles, California, pursuant to the ICC's Rules of Arbitration and shall be finally settled in accordance with said rules. The arbitration shall be conducted before a panel of three arbitrators. Each party shall select one arbitrator and the two arbitrators so selected shall select the third arbitrator, who shall act as presiding arbitrator. Notwithstanding the foregoing, if the matter under dispute is $500,000 or less, there shall only be one arbitrator who shall be mutually selected by both parties. If the party-selected arbitrators are unable to agree upon the third arbitrator, if either party fails to select an arbitrator, or in the case that only one arbitrator is required and the parties are unable to agree, then the International Court of Arbitration shall choose the arbitrator. The language to be used in the arbitral proceeding shall be English. The arbitrator(s) shall have no authority to issue an award that is contrary to the express terms of this Agreement or the laws of the State of California or applicable US Federal Law, and the award may be vacated or corrected on appeal to a court of competent jurisdiction for any such error. The arbitrator(s) shall be specifically empowered to allocate between the parties the costs of arbitration, as well as reasonable attorneys' fees and costs, in such equitable manner as the arbitrator(s) may determine. The arbitrator(s) shall have the authority to determine issues of arbitrability and to award compensatory damages, but they shall not have authority to award punitive or exemplary damages. Judgment upon the award so rendered may be entered in any court having jurisdiction or application may be made to such court for judicial acceptance of any award and an order of enforcement, as the case may be. In no event shall a demand for arbitration be made after the date when institution of a legal or equitable proceeding based upon such claim, dispute or other matter in question would be barred by the applicable statute of limitations. Notwithstanding the foregoing, either party shall have the right, without waiving any right or remedy available to such party under this Agreement or otherwise, to seek and obtain from any court of competent jurisdiction any interim or provisional relief that is necessary or desirable to protect the rights or property of such party, pending the selection of the arbitrator(s) hereunder or pending the arbitrator(s)' determination of any dispute, controversy or claim hereunder.

25. Notices. All notices, request, consents, claims, demands, waivers and other communications hereunder (each, a "**Notice**") shall be in writing and addressed to the parties at the addresses set forth on the face of the Acknowledgement or to such other address that may be designated by the receiving party in writing. All Notices shall be delivered by personal delivery, nationally recognized overnight courier (with all fees pre-paid), facsimile (with confirmation of transmission) or certified or registered mail (in each case, return receipt requested, postage prepaid). Except as otherwise provided in this Agreement, a Notice is effective only (a) upon receipt of the receiving party, upon confirmation of delivery by nationally recognized overnight courier or upon forty-eight (48) hours after being sent by certified or registered mail (as applicable), and (b) if the party giving the Notice has complied with the requirements of this Section 25.

26. Severability. If any term or provision of this Agreement is invalid, illegal or unenforceable in any jurisdiction, such invalidity, illegality or unenforceability shall not affect any other term or provision of this Agreement or invalidate or render unenforceable such term or provision in any other jurisdiction.

27. Survival. Provisions of these Terms which by their nature should apply beyond their terms will remain in force after any termination or expiration of this Order including, but not limited to, the following provisions: Compliance with Laws, Confidentiality, Governing Law, Dispute Resolution, Survival, and the restrictions on Software in Sections 10(b), (c) and (d).

Exhibit A
Warranty For "Specialty Products"
LIMITED WARRANTY

EXCEPT FOR THE WARRANTY SET FORTH BELOW IN THIS EXHIBIT A, SELLER MAKES NO WARRANTY WHATSOEVER WITH RESPECT TO THE GOODS (INCLUDING ANY SOFTWARE) OR SERVICES, INCLUDING ANY (a) WARRANTY OF MERCHANTABILITY; (b) WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE; (c) WARRANTY OF TITLE; OR (d) WARRANTY AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF A THIRD PARTY; WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE.

Warranty Period: The Warranty Period for Specialty Products is for one (1) year, and the Warranty Period for laser welders and laser markers is two (2) years (unlimited hours), and the Warranty Period for the laser pump diodes or modules is two (2) years or 10,000 clock hours, whichever occurs first (as applicable, the "**Warranty Period**"). The Warranty Period begins as follows: (i) on orders for Goods purchased directly by Buyer, upon installation at Buyer's site or thirty (30) days after the date of shipment, whichever occurs first; or (ii) on equipment purchased by a Buyer that is an OEM or systems integrators, upon installation at the end user's site or six (6) months after the date of shipment, whichever occurs first.

Acceptance Tests: Acceptance Tests (when required) shall be conducted at Sellers, Monrovia, CA, USA (the "**Testing Site**") unless otherwise mutually agreed in writing prior to issuance or acceptance of the Acknowledgement. Acceptance Tests shall consist of a final visual inspection and a functional test of all laser, workstation, enclosure, motion and accessory hardware. Acceptance Tests shall include electrical, mechanical, optical, beam delivery, and software items deliverable under the terms of the Acknowledgement. Terms and conditions for Additional Acceptance Tests either at Seller's or Buyer's facility shall be mutually agreed in writing prior to issuance or acceptance of the Acknowledgement.

Performance Warranty: The system is warranted to pass the identical performance criteria at Buyer's site as demonstrated during final Acceptance Testing at the Testing Site during the Warranty Period, as provided in the Acknowledgement. Seller explicitly disclaims any responsibility for the process results of the laser processing (welding, marking, drilling, cutting, etc.) operations.

Exclusions: Seller makes no warranty, express or implied, with respect to the design or operation of any system in which any Seller's product sold hereunder is a component.

Limitations: The limited warranty set forth on this Exhibit A does not cover loss, damage, or defects resulting from transportation to Buyer's facility, improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the equipment, or improper site preparation and maintenance. This warranty also does not cover damage from misuse, accident, fire or other casualties of failures caused by modifications to any part of the equipment or unauthorized entry to those portions of the laser which are stated. Furthermore, Seller shall not be liable for a breach of the warranty set forth in this Exhibit A if: (i) Buyer makes any further use of such Goods after giving such notice; (ii) the defect arises because Buyer failed to follow Seller's oral or written instructions as to the storage, installation, commissioning, use or maintenance of the Goods; (iii) Buyer alters or repairs such Goods without the prior written consent of Seller; or (iv) repairs or modifications are made by persons other than Seller's own service personnel, or an authorized representative's personnel, unless such repairs are made with the written consent of Seller in accordance with procedures outlined by Seller.

Seller further warrants that all Services performed by Seller's employees will be performed in a good and workmanlike manner. Seller's sole liability under the foregoing warranty is limited to the obligation to re-perform, at Seller's cost, any such Services not so performed, within a reasonable amount of time following receipt of written notice from Buyer of such breach, provided that Buyer must inform Seller of any such breach within ten (10) days of the date of performance of such Services.

Seller shall not be liable for a breach of the warranty set forth in this Exhibit A unless: (i) Buyer gives written notice of the defect or non-compliance covered by the warranty, reasonably described, to Seller within five (5) days of the time when Buyer discovers or ought to have discovered the defect or non-compliance and such notice is received by Seller during the Warranty Period; (ii) Seller is given a reasonable opportunity after receiving the notice to examine such Goods and (a) Buyer returns such Goods to Seller's place of business at Buyer's cost (prepaid and insured); or (b) in the case of custom systems, Seller dispatches a field service provider to Buyer's location at Buyer's expense, for the examination to take place there; and (iii) Seller reasonably verifies Buyer's claim that the Goods are defective or non-compliant and the defect or non-compliance developed under normal and proper use.

All consumable, optical fibers, and expendables such as electrodes are warranted only for defect in material and workmanship which are apparent upon receipt by Buyer. The foregoing warranty is negated after the initial use.

No warranty made hereunder shall extend to any product whose serial number is altered, defaced, or removed.

Remedies. With respect to any such Goods during the Warranty Period, Seller shall, in its sole discretion, either: repair such Goods (or the defective part). **THE REMEDIES SET FORTH IN THE FOREGOING SENTENCE SHALL BE BUYER'S SOLE AND EXCLUSIVE REMEDY AND SELLER'S ENTIRE LIABILITY FOR ANY BREACH OF THE LIMITED WARRANTY SET FORTH IN THIS EXHIBIT A.** Representations and warranties made by any person, including representatives of Seller, which are inconsistent or in conflict with the terms of this warranty, as set forth above, shall not be binding upon Seller. Products manufactured by a third party and third party software ("**Third Party Product**") may constitute, contain, be contained in, incorporated into, attached to or packaged together with, the Goods. Third Party Products are not covered by the warranty in this Exhibit A. For the avoidance of doubt, **SELLER MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO ANY THIRD PARTY PRODUCT, INCLUDING ANY (a) WARRANTY OF MERCHANTABILITY; (b) WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE; (c) WARRANTY OF TITLE; OR (d) WARRANTY AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF A THIRD PARTY; WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE.** Notwithstanding the foregoing, in the event of the failure of any Third Party Product, Seller will assist (within reason) Buyer (at Buyer's sole expense) in obtaining, from the respective third party, any (if any) adjustment that is available under such third party's warranty.

CHAPTER 1
SYSTEM DESCRIPTION

Section I: Features

For the rest of this manual the **LF Series Fiber Laser** will simply be referred to as "***the Laser,***" except in specific instances where unique descriptions are required such as specifications, connections, etc. Drawing on Amada Weld Tech's extensive experience in laser micro welding, this laser provides a platform for small welding applications. Small component welding demands small spot sizes and precise control of energy and pulse duration to ensure a highly reliable process.

Figure 1-1. LF Series Fiber Laser Welder

- **Designed for Fine Micro Welding.** Focused spot sizes down to 50 microns, and precise control of pulse width and peak power to enable fine micro welding.
- **Excellent power stability**. Fine micro welding applications require high stability of the laser source for reliable welding. The Laser offers excellent power and pulse-to-pulse stability with an internal air-to-water cooling mechanism which maintains stability irrespective of the ambient air temperature.
- **Easy Program Interface**. The laser may be operated in either pulsed or CW mode, with all the features necessary for control of the weld, including pulse shaping. The control interface can be integrated into the laser or provided separately for workstation integration.
- **Flexible Integration**. Can be integrated to any motion platform including both stage and gantry systems, as well as scan heads.
- **Remote Operation**. Laser schedule select and schedule changes can be made via an RS-232 connection.
- **HMI panel**. The laser can be programmed quickly, easily, and intuitively using a high definition 8" touchscreen.

Section II: System Components

Overview

While there are different configurations of the Laser, each model has 3 primary components

Figure 1-2. Primary Components

1 **FIBER LASER CONTROLLER:** The control unit has a HMI panel display that allows the input of laser parameters, an Emergency Stop switch, a Emission (Laser Start) switch, a key switch for laser operation, Alarm indicator, Laser Enable indicator and laser Emitting (status) indicator.

2 **FIBER LASER SUPPLY:** The engine for the laser. The front of this unit contains an operation keyswitch and status indicators. The rear of this unit has communication ports, main power input, and the fiber output from the system.

3 **CHILLER UNIT:** A closed loop cooling system to maintain consistent laser output. The front of this chiller unit has a temperature controller and chiller status indicator lights. The process supply connections and power input are located on the back of this unit.

Fiber Laser Controller

Figure 1-3. Fiber Laser Controller

1 **POWER INDICATOR:** Illuminates when touchscreen HMI is on.

2 **CONTROL KEYSWITCH:** When the main power is ON, turning this switch ON will make the laser operable. When shutting down the laser, turn this switch OFF and remove the key. A designated safety supervisor should keep the key.

3 **EMISSION BUTTON** with **START/STOP INDICATOR:** Pressing this button when the laser is ready will produce laser emission. If the Laser is programmed for continuous mode operation, pressing this button once will start a continuous output of programmed laser pulses. Pressing it again will stop laser emission (will not occur if the Laser is set for EXT. I/O control).

4 **ALARM INDICATOR:** Illuminates only when the Laser Supply System is in a fault condition. Reference the HMI panel for alarm condition.

5 **EMITTING INDICATOR:** Illuminates when the laser is emitting through the fiber.

6 **LASER ENABLED INDICATOR:** Illuminates when the main power is ON, the keyswitch is in the ON position, and there are no alarm conditions. The laser is prepared for emission when the Emission buttons are pressed.

7 **HMI PANEL DISPLAY:** Allows for input of laser parameters via a touchscreen.

8 **EMERGENCY STOP SWITCH:** This switch stops the laser immediately. Use this function only in an emergency.

9 **POWER SYSTEM SWITCH:** This switch turns system power on/off. ***NOTE:*** Main breaker must be ON position.

Fiber Laser Supply System (Type 1)

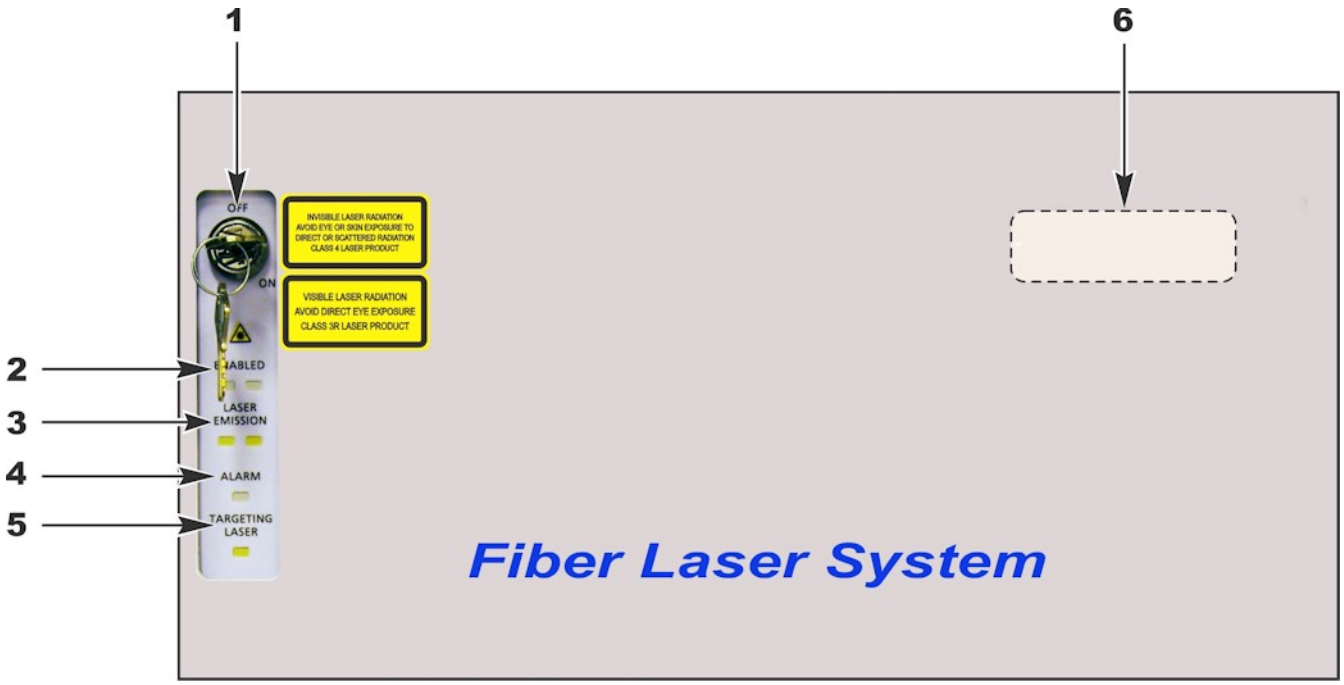


Figure 1-4. Fiber Laser Supply System Front Panel

1 **ON/OFF KEYSWITCH:** This keyswitch enables and disables the firing of the laser.

NOTE: Leave in the "ON" position if the system power is ON.

2 **ENABLED:** Indicates that the laser driver circuit is enabled and the laser emission is under external control. Two laser enabled status LEDs are provided for component redundancy.

3 **LASER EMISSION INDICATOR:** Indicates a voltage signal for emission is present. Two laser emission status LEDs are provided for component redundancy.

4 **ALARM INDICATOR:** This indicator illuminates when the laser is in a fault condition. Reference the pendant or software for information.

5 **TARGETING LASER INDICATOR:** This indicator illuminates when the targeting laser is turned on. This indicator is amber when the targeting laser is ON, and not indicating when the targeting laser is OFF.

6 **MODEL NUMBER LABEL:** "LF-xxxA" The "xxx" value is the maximum output of the Fiber Laser, in watts.

Fiber Laser Supply System (Type 2)

Figure 1-5. Fiber Laser Supply System Front Panel

1 **TOUCH SCREEN:** This screen can show the current status and settings of the laser module. The laser module will be controlled through the front panel display so this screen should only be used as reference.

2 **EMERGENCY STOP:** The laser shuts down and is not able to start when the e-stop button is pressed. Rotate the E-stop button to clear.

3 **CONTROL KEYSWITCH:** This keyswitch turns on the power to the laser module when it is set to ON or REM.

NOTE: **Leave in the "REM" position if the system power is ON.**

4 **LASER EMISSION INDICATOR:** This indicator bar illuminates when the laser is ready to emit.

Chiller (Type 1)

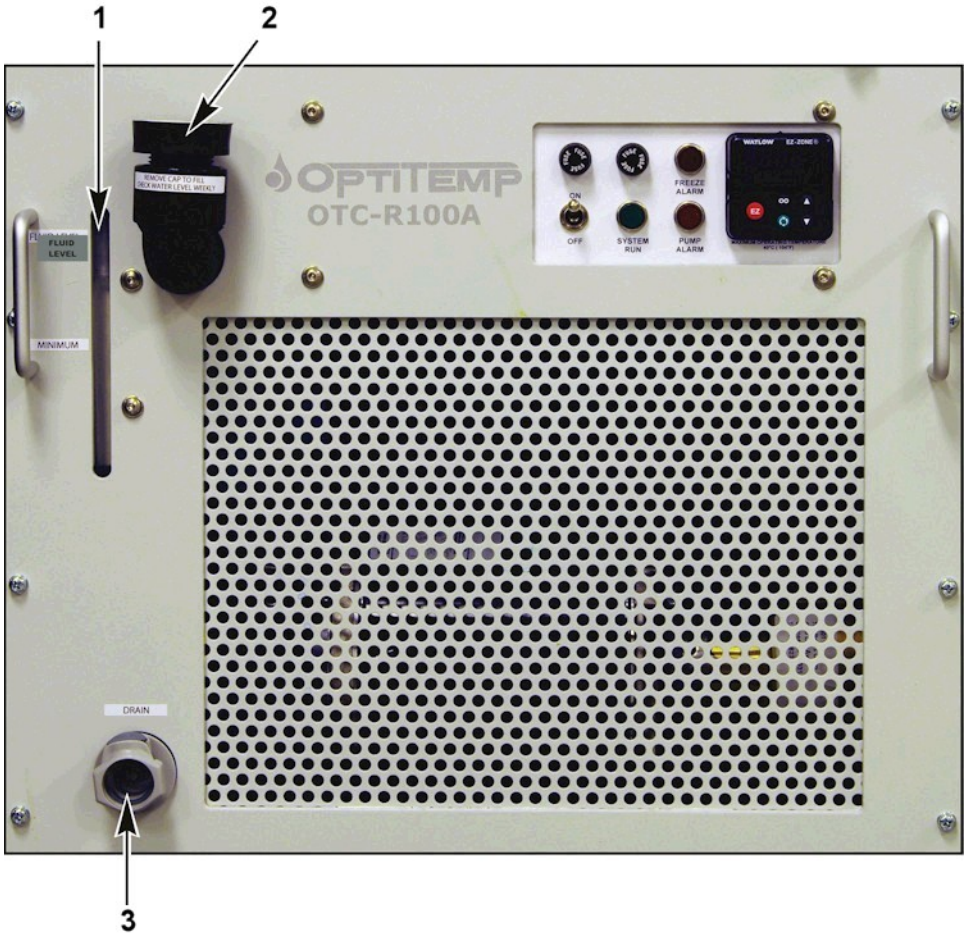


Figure 1-6. Type 1 Chiller Front Panel

1 **FLUID LEVEL SIGHT TUBE:** Shows the current fluid level in the chiller. This must be above the indicated line.

2 **FILLER CAP:** Port to add coolant to the chiller.

3 **DRAIN:** Port to drain coolant from the chiller for storage or replacement.

TEMPERATURE CONTROLLER: Configured at the factory, change setpoint if required to avoid condensation due to local dewpoint. Default setpoint 27°C.

ON/OFF SWITCH: Turns chiller on/off. Leave in **ON** position.

INDICATORS AND FUSES: Reports chiller problems. Check fuses if chiller operation problems occur.

Chiller (Type 2)

Magnetic Air Filter Not Shown

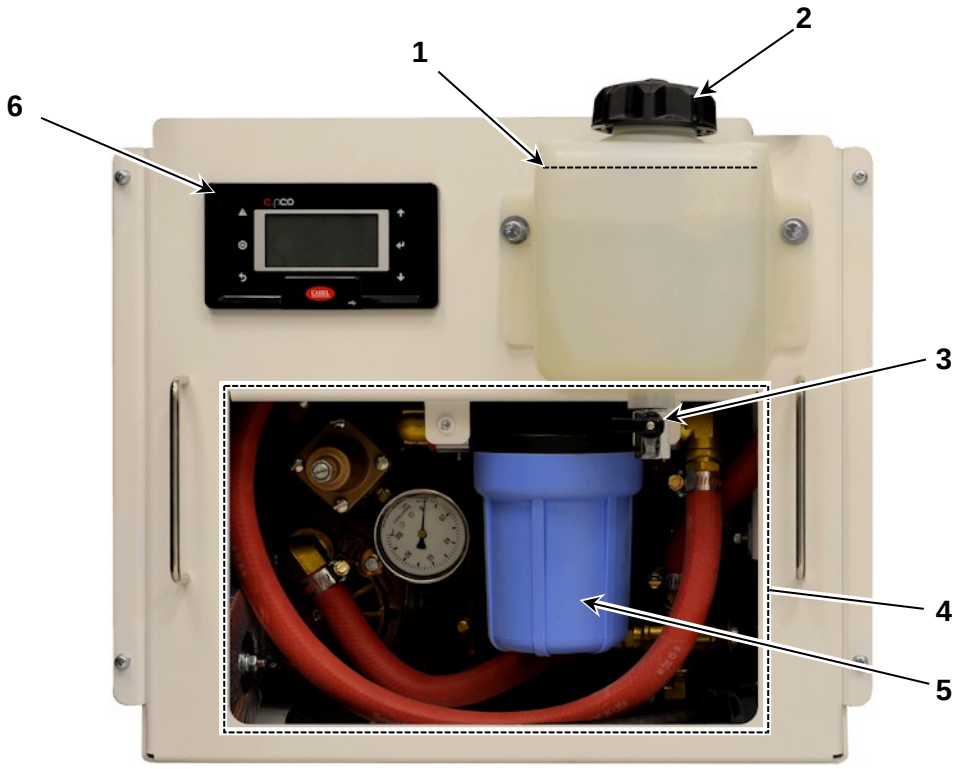


Figure 1-7. Type 2 Chiller Front Panel

1 **FLUID TANK FILL LINE:** Shows the current fluid level in the chiller. This must be above the indicated line.

2 **FILL CAP:** Port to add coolant to the chiller.

3 **RESEVOIR DRAIN:** Port to drain coolant from the tank. Another drain hose can be found behind air filter to drain lines.

4 **AIR FILTER:** Magnetic Air Filter (Not Shown) Keeps dust and debris from entering chiller.

5 **FILTER HOUSING:** Contains the water filter. Remove and drain after draining coolant for storage.

6 **TEMPERATURE CONTROLLER:** Configured at the factory, change setpoint if required to avoid condensation due to local dewpoint. Default setpoint 27°C.

ON/OFF SWITCH: Turns chiller on/off. Found in menu of Temperature controller.

CHAPTER 2
INSTALLATION AND SETUP

Section I: Planning

When planning for the installation of the Laser, assure that the following conditions are met:

Physical Requirements

- The Laser should be placed in a dedicated laser operation area. The person responsible for the area (the Laser Safety Officer) must isolate the laser operation area from other work areas and display signs warning that the laser operation area is off limits to unauthorized personnel.
- See *Appendix A, Technical Specifications* for specific weight and dimension requirements.
- The Laser should be placed on a firm, level floor that is free from vibration.
- Do not operate the unit where there is considerable dirt, dust, oil mist, chemicals fumes, moisture, or near a high-frequency noise source.
- Allow at least 39.4" (1.0 meter) clearance on all sides of the Laser to allow for cooling, maintenance, and servicing.
- The ambient temperature should be between 41°F - 105°F (5°C - 40°C). The ability of the internal cooling system to keep the unit working is inversely proportional to the duty cycle. *Appendix A, Technical Specifications* for details.
- The humidity should be 85% or less (non-condensing). The area should have no sudden temperature fluctuations.

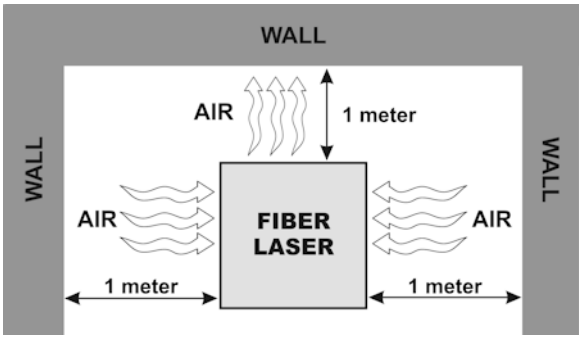


Figure 2-1. Ventilation

Power Requirements

Use a power supply of single -phase, 200 - 240 VAC +/-10% (50/60 Hz) having a sufficient breaker capacity as detailed in *Appendix A: Technical Specifications.*

Section II: Installation

Installation Procedures

1. Position the Fiber Laser in a suitable location near the Workstation.
2. Route the Laser Fiber to the Workstation, being careful not to kink or bend the Fiber.
3. Route and connect the following cables from the Fiber Laser to the Workstation:
   - **WORKSTATION I/O**
   - **WORKSTATION E-STOP / INTERLOCK**
   - **PROCESS OPTIC COOLING LINES (if required)**

   NOTE: All internal laser and chiller connections have been installed and tested at the factory. Process optic cooling line flow approx. 8L/min.
4. Place the Fiber Laser ON/OFF breaker (located on the upper back panel) in the OFF position.
5. Connect the Power Input Cord to a suitable power source.
6. Place the ON/OFF breaker in the ON position, open the front door, and verify the chiller and laser have powered up.
7. Place the ON/OFF breaker in the OFF position.
8. Check / Fill the Chiller coolant level as described in *Chapter 4, Maintenance.*
9. Make sure the keyswitch behind the front door on the laser module is in the ON position or REM position whenever the system power is ON. See Chapter 1 for details on which position to select.
10. Power up, program, and use the Fiber Laser as needed.

Section III: Connections Reference

CAUTION

- To ensure safety and optimal operation, the laser must be properly grounded.
- A Neutral connection is not strictly required by this laser as it can be used with single phase power or two legs of a three-phase power circuit. However a PE (protective earth) Ground is provided and ***must*** be used.
- It is important to note that the Neutral and PE Ground are ***not*** the same. ***Do not connect the Neutral line to the PE terminal.***

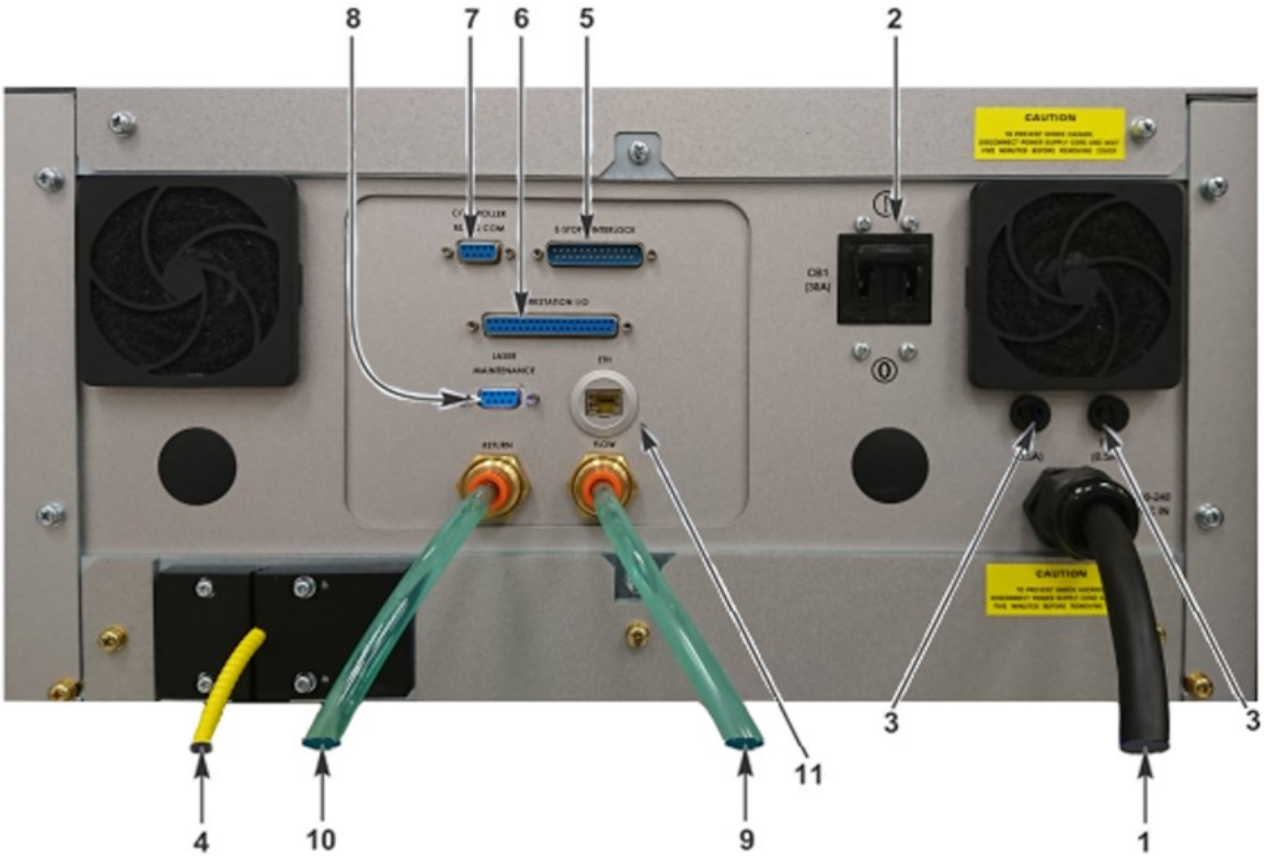


Figure 2-2. Rear Panel

1. **POWER INPUT CORD**
2. **MAIN SYSTEM CIRCUIT BREAKER / ON-OFF SWITCH**
3. **FAN POWER SUPPLY FUSES:** Supplies current to rear panel fans and internal hardware.
4. **FIBER OPTIC FEED THRU PORT:** Laser Fiber and other optional cables feed out to Workstation.
5. **E-STOP / INTERLOCK:** Connection to Workstation Emergency Stop and Interlock.
6. **WORKSTATION I/O:** Connection to Workstation I/O.
7. **CONTROLLER RS-232 COM:** Connection to fiber laser Controller.
8. **LASER MAINTENANCE:** For Factory Use (*Equipped only on some models).
9. **COOLING WATER OUT:** Connection to optical system 3/8 inch water cooling lines.
10. **COOLING WATER RETURN:** Connection to optical system 3/8 inch water cooling lines.

    Note: Opaque cooling lines preferred to prevent algae growth in cooling water.
11. **ETHERNET PORT:** Connection to fiber laser controller Ethernet.
    (*only on 8-932 models with updated controller)

Handling Fiber Optic Connection

Minimum Bend Radius

Optical fibers may be damaged and become unusable when they are bent beyond their minimum bend radius, subjected to twisting or exposed to the shock of a strong impact.

Core Diameter (um)	Minimum Bend Radius	
	(Inches)	(mm)
Single Mode	8	200
Multi Mode	6	150

Dirt or dust on the end surfaces on the optical fiber can damage the fiber. The damaged surfaces of the fibers can also cause contamination to adjacent lenses. To prevent contamination, do ***not*** remove the protective rubber fiber end caps from either end of the optical fiber until it is necessary.

Chiller (Type 1)

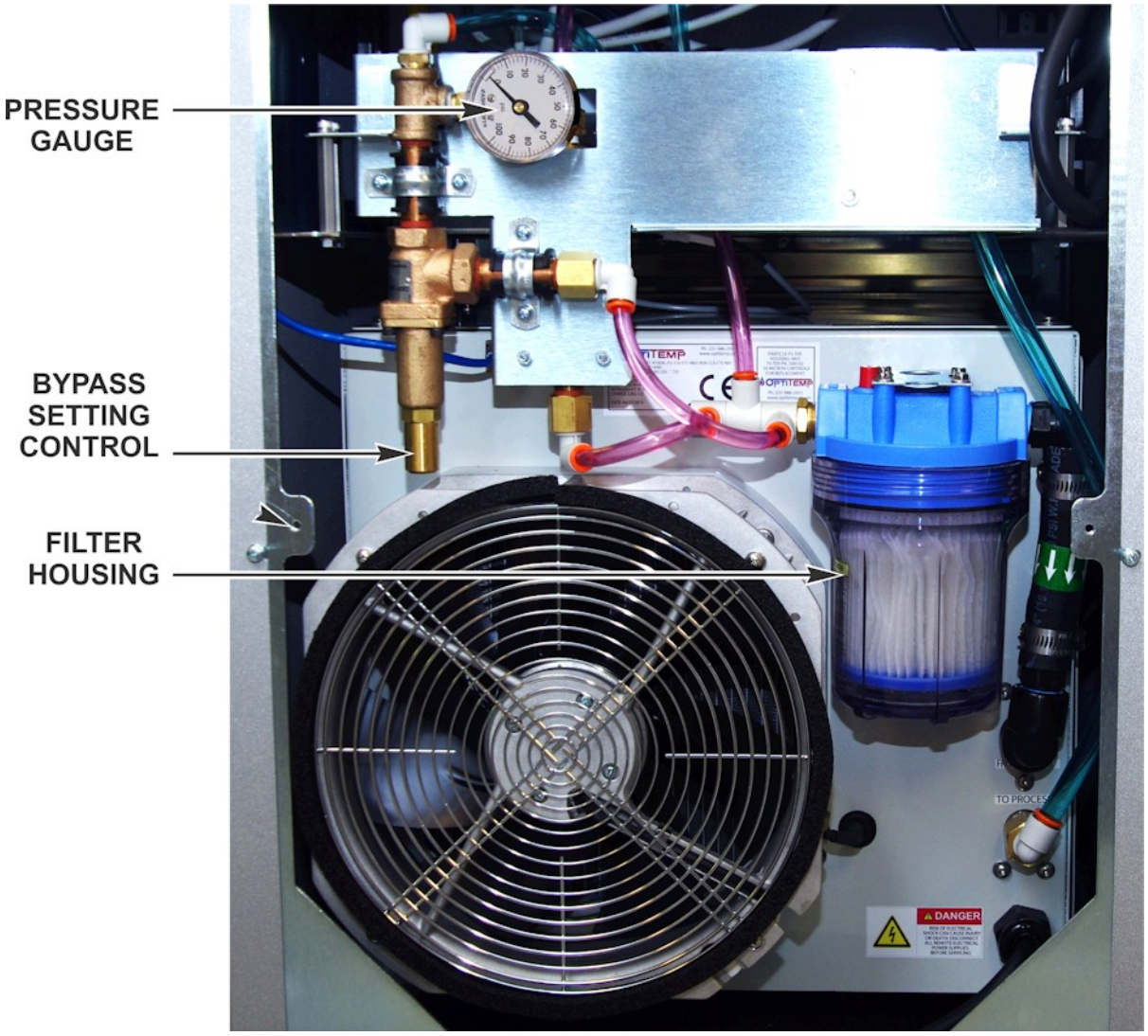


Figure 2-6. Refrigerant Chiller Rear Panel

COOLANT FILTER: This replaceable particulate filter removes dirt and other contaminants from closed circuit coolant system.

PRESSURE GAUGE: Used by the factory for configuring head optic bypass flow

BYPASS SETTING CONTROL: Used by the factory for configuring head optic bypass flow

Chiller (Type 2)

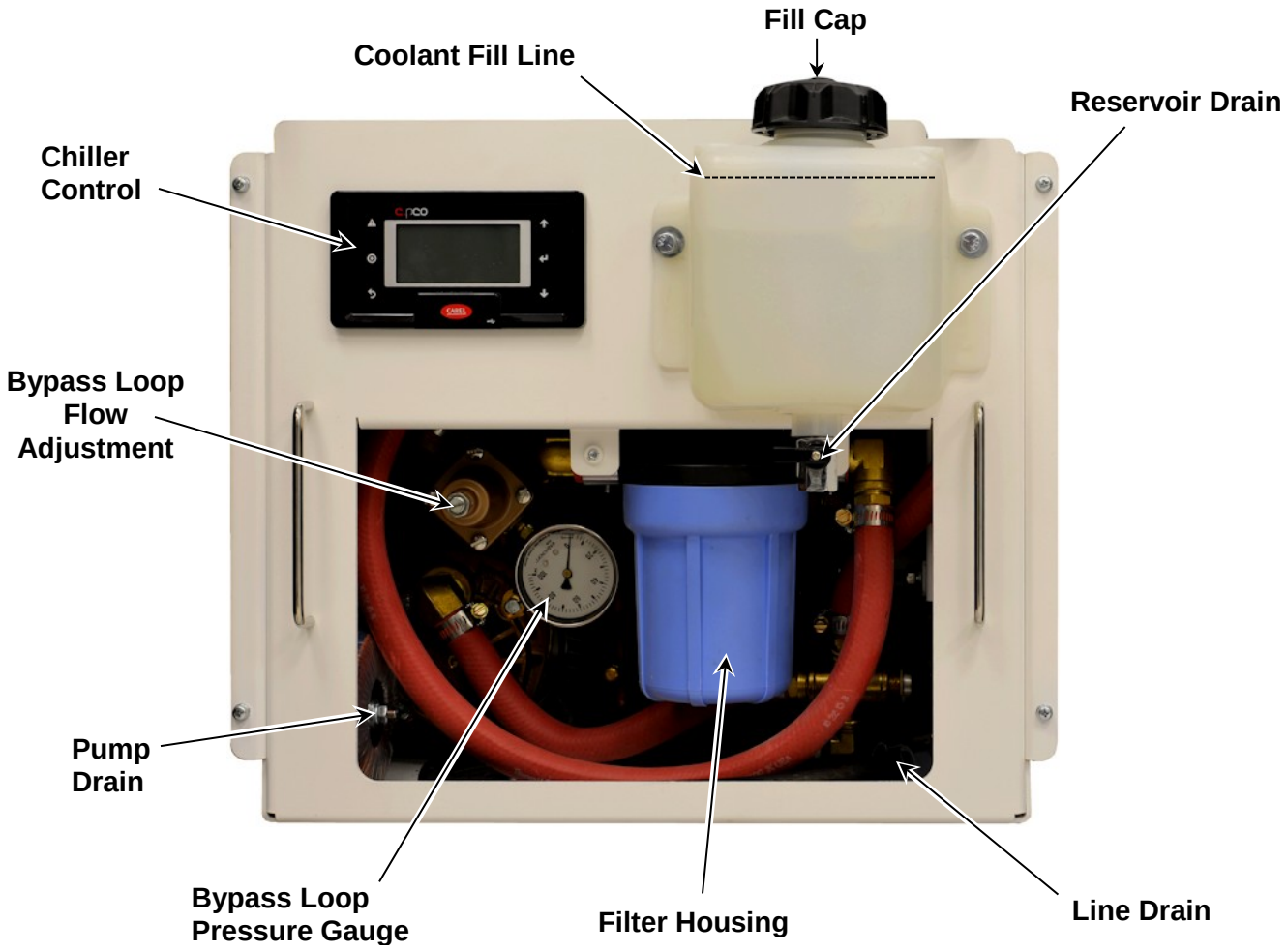


Figure 2-7. Type 2 Chiller Front Panel

COOLANT TANK: Fill to molded line below neck of tank.

COOLANT FILTER: This replaceable particulate filter removes dirt and other contaminants from closed circuit coolant system.

PRESSURE GAUGE: Used by the factory for configuring head optic bypass flow.

BYPASS SETTING CONTROL: Used by the factory for configuring head optic bypass flow.

SYSTEM DRAIN: Used to drain coolant from the system, except pump head.

PUMP DRAIN: Used to drain remaining coolant from pump head.

Section IV: Integration with External Equipment and Compliance with CE Safety Regulations

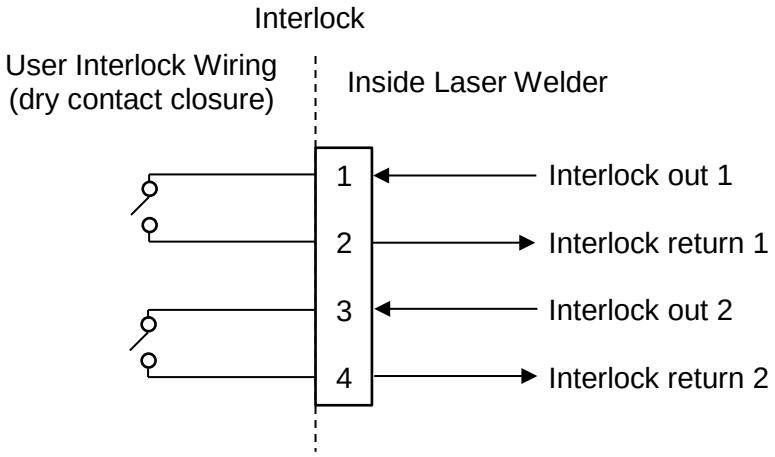
Proper integration of the fiber laser and external equipment is required for compliance with applicable safety regulations. The wiring diagrams in this section show typical implementations. Failure to select and implement a correct method of wiring can render the fiber laser unsafe. When properly integrated according to the guidelines in this manual the user can achieve a performance level for the laser of P_Ld.

Interlocks

The laser interlock mechanism is used to render the fiber laser safe for material handling without shutting down the laser controller itself. One example would be a door in a laser safety enclosure that must open for part loading and unloading. When the interlock channels are opened laser emission will cease and the diodes will be de-energized. If a laser mark operation is in process the fiber laser will be put into a fault condition that must be cleared before processing can start again. Some delay may occur between closing the interlock inputs and when the laser is again ready to fire. This interlock is designed to be connected to a laser enclosure safety door or any other device designed to protect personnel from laser radiation. A properly designed enclosure meeting the specifications of IEC60825-1 is a requirement, and the laser welder will comply with IEC60825-1 when correctly installed and wired in a compliant enclosure.

The laser interlock consists of two dry contact inputs. These must be opened and closed simultaneously or a fault will occur. There is no external reset required meaning that the interlock control circuit will allow laser operation as soon as the interlocks are closed. Rated life on the interlock circuit is 10 million cycles, after which the electromechanical components in the fiber laser welder must be replaced or renewed.

Since some delay occurs after the interlock is cleared it may be necessary to use an additional external safety shutter for processes that require quick regeneration and laser output after an interlock event. Contact Amada Weld Tech for more details

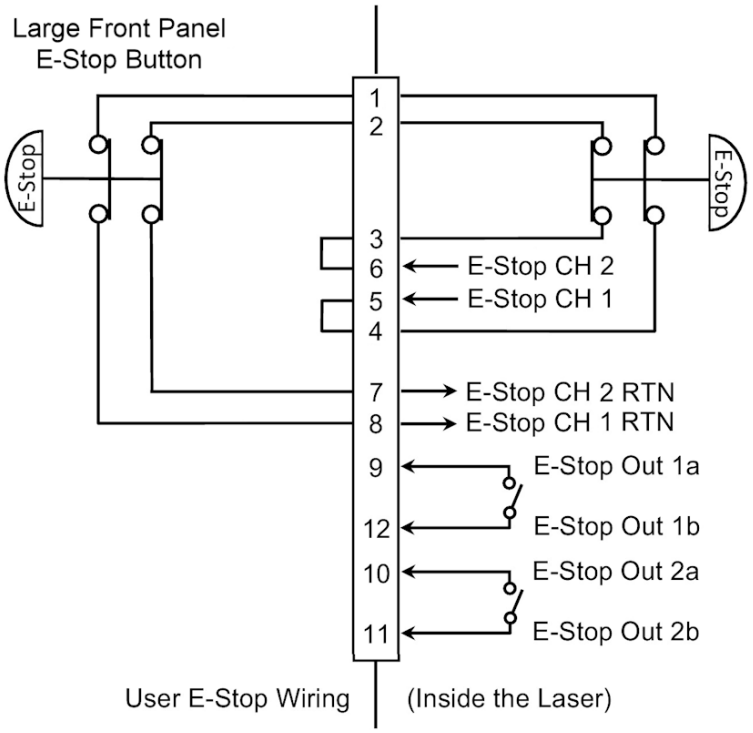


Emergency Stop for Simple Systems

Interfacing with External Emergency Stop Circuitry
E-STOP button(s) ONLY

The fiber laser can be interfaced to a simple system including an enclosure and one or more external emergency stop buttons. In this situation the fiber laser would not be connected to any larger automation system or control any other equipment. The dual channel output relays can be monitored to verify the status of the emergency stop circuit but no external equipment other than that outlined above should be included. Reset can be performed via the key switch or via the rear panel I/O reset input.

Dual channel relay outputs that close when the safety module circuit is satisfied are available.



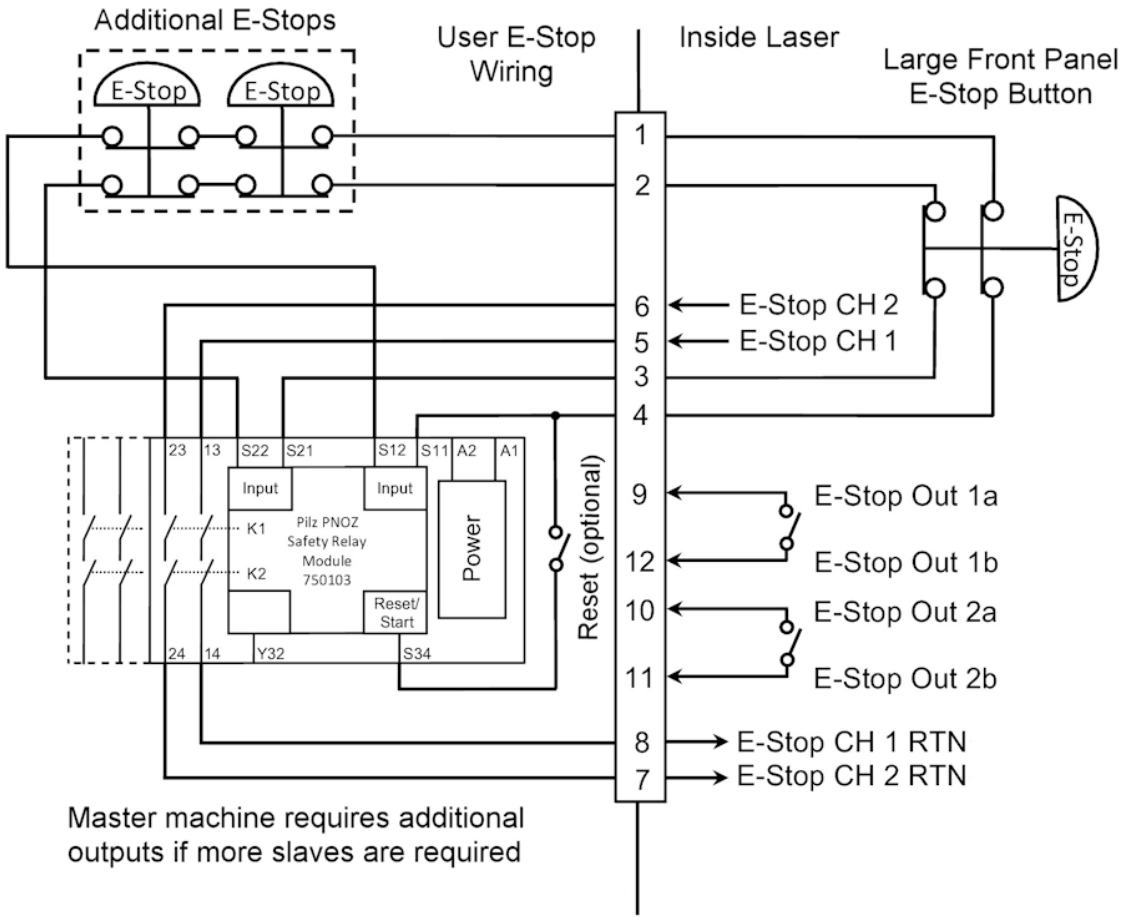
Emergency Stop for Complicated Systems

Interfacing with External Emergency Stop Circuitry
User Supplied Safety Relay Module(s) Required

Complicated Systems are those in which more than one emergency stop sub-circuit must be linked together. An example of this would be a machine that has a fiber laser welder, parts handler with pneumatic controls, PLC, and conveyor belt all of which have ESTOP buttons where one ESTOP button stops all devices. Any situation in which more than one device must be connected together and respond identically to an emergency stop event is considered a complicated system.

Complicated systems are integrated using certified safety controllers or safety relays. In this situation one device is the “master” and the rest of the devices are the “slaves”. The fiber laser is considered a slave device in this configuration and its emergency stop must be controlled by the larger machine’s safety controller. The output of the external safety relay module closes the input to the fiber laser welder safety box and allows the system to clear the emergency stop state.

In this wiring example a Pilz PNOZ family safety relay module controls the fiber laser and interfaces two external emergency stop buttons. In this example the Pilz device would also control additional emergency stop functions outside of the fiber laser welder using expansion contacts. The more devices which must be implemented the more expansion contacts must be added to the Safety Relay Module. Any suitable IEC13849-1 compliant safety relay controller is acceptable as long as it is implemented in this manner. The end user is responsible for verifying compliance of the machine as a whole.



Factory Test Jumper Emergency Stop Wiring

Make sure that the **Emergency Stop** is wired in accordance with *Appendix B, Electrical and Data connections* and the safety requirements listed above. The factory-installed jumper must be removed and rewired according to all applicable safety standards for the system to meet specified levels of machine safety. Do not operate the machine without correctly integrating it into a workstation with the appropriate level of safety.

The DB25 jumper for bypassing Emergency Stop for testing only is configured as follows:

Jumper #1	Pin 1 connected to Pin 8
Jumper #2	Pin 2 connected to Pin 7
Jumper #3	Pin 4 connected to Pin 5
Jumper #4	Pin 3 connected to Pin 6

Factory Test Jumper Remote Interlock Wiring

Make sure the Remote Interlock is wired in accordance with *Appendix B, Electrical and Data connections*. The factory test jumper must be removed and wired according to all applicable safety standards for the system to meet specified levels of machine safety. Observe all laser precautions when testing with the factory test jumper installed. The factory-installed jumper for testing is configured as follows:

Jumper #1	Pin 14 connected to Pin 15
Jumper #2	Pin 16 connected to Pin 17

CHAPTER 3
OPERATING INSTRUCTIONS

Section I. Welding Preparation

Preparation

Before operating the Laser, you ***must*** be familiar with the following:

- The principles of laser welding and the use of programmed weld schedules.
- The **location** and **function** of Controls and Indicators (see *Chapter 1, Description*).
- How to **select** and **use** the Control functions for your specific welding applications.

General Operator Safety

WARNING

Be sure to wear protective glasses for Nd:YAG with an optical density of ***at least 7+*** at a 1,070 nanometer wavelength.

- To prevent blindness or eye injury, ***wear safety goggles at all times during welding***.
- Do ***not*** touch the welded parts immediately after the weld process, because the welded parts can get very hot.
- Be careful of moving parts. You can be injured by moving parts during the welding process.
- Do ***not*** wear loose clothing or jewelry around moving parts. They may get caught and cause injury.

Starting the Laser

1. Turn the Laser **MAIN POWER** switch ON.
2. When prompted, turn the keyswitch to the ON position. Once any of the operating screens appear, the Laser is ready for welding.

Section II. Operation Control Panel

Prepare Processing Point and Set the Weld Schedule

1. Turn the Enable setting OFF so the laser cannot emit.
2. Adjust the position of the laser beam output unit (focus head). Set the proper working distance for the beam output unit (focus head).
3. Select the field to be modified by lightly touching this field. When the keypad appears, enter the desired value. Pressing enter will exit this field.

Schedule Screen

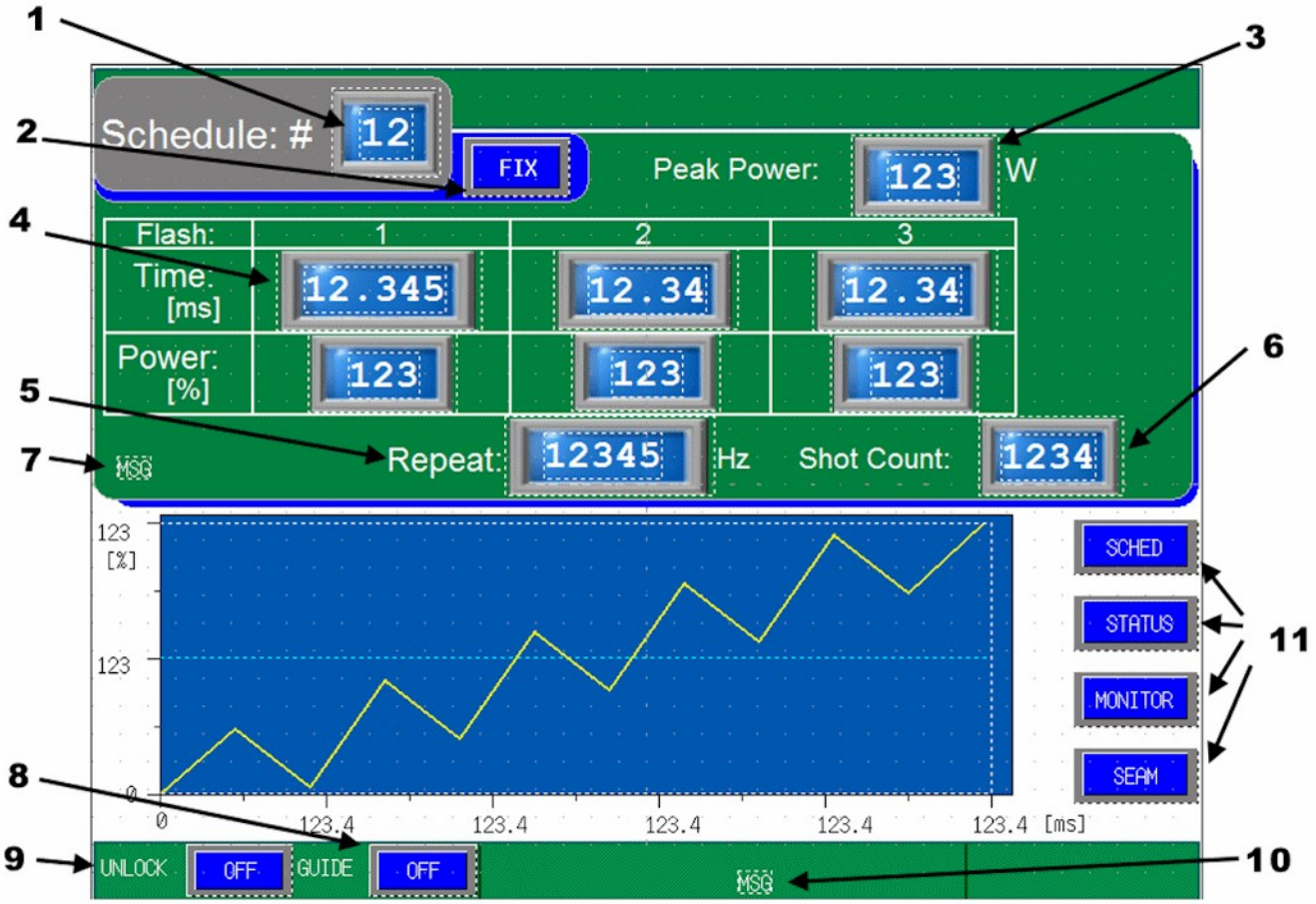


Figure 3-1. Schedule Screen (FIX)

1 Schedule Number Displays the schedule number that is currently active. A schedule is a stored set of laser output parameters. Since different welds require different welding parameters, each may be stored separately using different schedule numbers. The controller is capable of storing up to 32 schedules (0-31).

2 Form Mode Choose the form of the laser schedule. The schedule could be set for FIX (3 section pulse in ms), FLEX (10 point pulse in ms), or CW (10 point wave in seconds). 20 point schedules can be set on the updated controller on 8-932 models. See Figure 3-2 and 3-3.

3 Peak Power The peak power parameter sets the reference value of the maximum output power of the laser. The actual programmed laser output is set as a percentage of this peak power value. The setting can be changed between 0 and the max rating of the unit.

NOTE: The laser is unstable when the output power is less than 10% of the maximum power. In this case, any programmed power less than 10W will be unstable and may fault the laser.).

4 Flash These parameters define the pulse shape of the laser output. Flash segment parameters are defined as a time, in ms, and percentage of peak power. The range is 00.00ms to 99.99ms and 000 to 100% inclusive. Cool segment parameters are defined as a time in ms with a range from 0.00ms to 99.9ms inclusive. The power output for a cool segment is always fixed to 000%.

NOTE: The flash 1 time has a minimum value of 00.005ms and a maximum value of 50.000ms).

5 Repeat The repeat parameter sets the number of laser pulses per second. The setting can be changed between 0 and 50000 inclusive.

6 Shot Count Sets the number of times you want the laser to output a pulse profile as defined by the flash and cool parameters. The frequency in which the laser outputs the shots is defined by the repeat parameter. If the shot count is set to zero, the laser will output the pulse profiles indefinitely until it receives a stop signal when in external control mode, or the start/stop button is pressed when in panel control mode.

7 Schedule Warning Displays any warnings of the schedule that is currently active. For example, if seam mode is selected, the schedule will indicate it is in seam mode. Or if the pulse width of the schedule is longer than the repetition interval, then the schedule will run in CW mode and will be indicated as such.

8 Guide Beam Turns the guide beam ON and OFF.

9 Laser Fire Unlock Unlocks or enables the hardware Emission switch (Laser Fire) located on left bottom corner of the control panel.

10 Control Mode Displays the active laser control mode. Control modes include:

Panel Control
(The laser is being controlled by the front panel interface)

Ext Control
(The laser is being controlled via the I/O interface)

RS-232 Control
(The laser is being controlled via the RS-232 command interface)

Ext + RS232 Control
(The laser is being controlled via the I/O and RS-232 command interfaces)

No Communication!

11 Screen Menu This allows you to toggle between the different screens.

Schedule Screen (Continued)

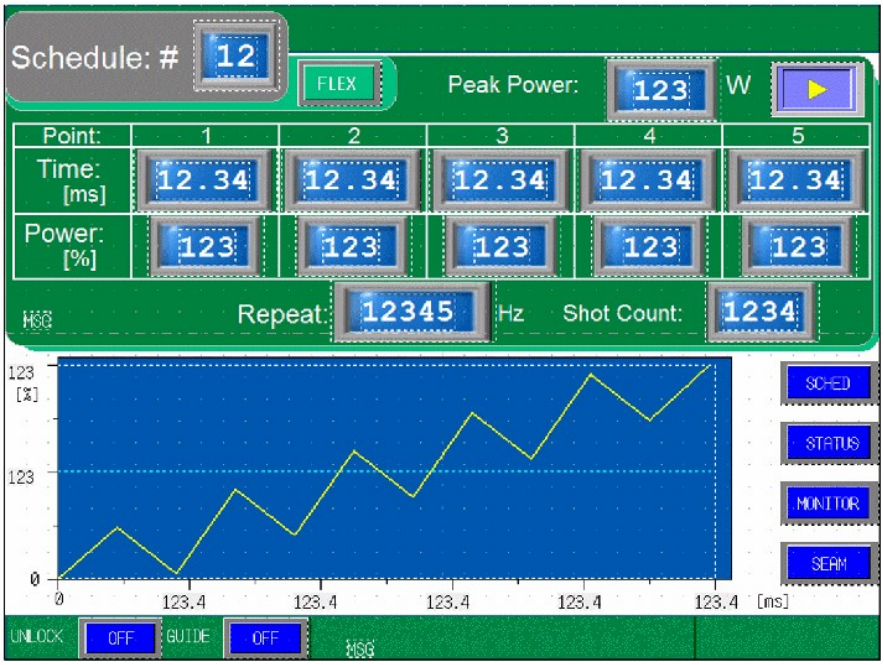


Figure 3-2. Schedule Screen (FLEX)

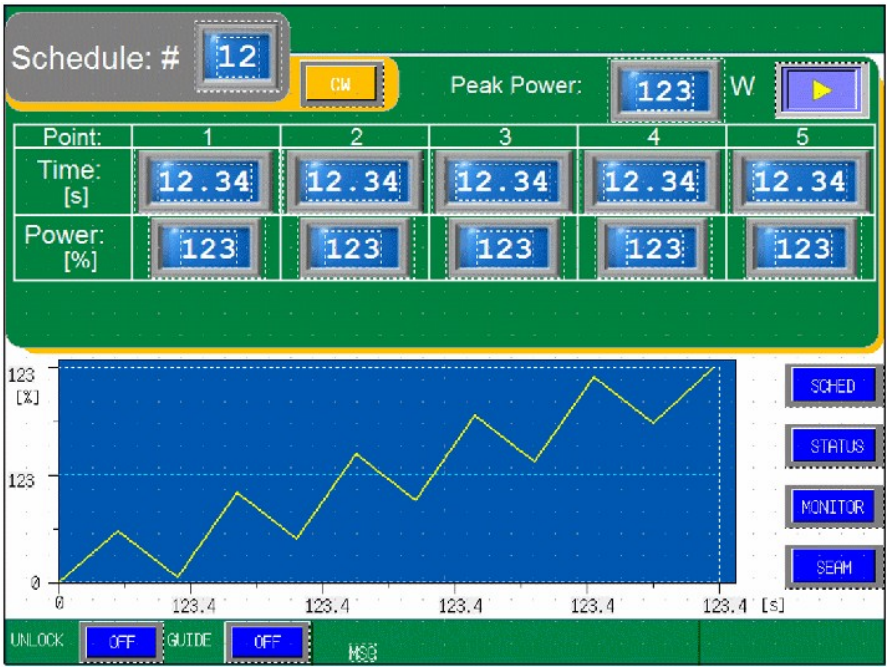


Figure 3-3. Schedule Screen (CW)

SEAM WELD Screen

The Seam Weld function allows the laser to vary in strength at any point within a continuous stream of laser pulses for both **FIX** and **FLEX** waveforms. The most common method of this feature is to gradually increase the laser output power at the beginning of a seam weld and gradually decrease the laser power at the end of a seam weld to allow for a smooth overlap at the beginning and ending of a continuous weld.

Below is an example of how the Seam Weld function operates. In the top example waveform, the laser is generating a series of 10 programmed output weld pulses without the Seam Weld function.

In the bottom waveform, the laser is generating the same series of 10 programmed output weld pulses with the Seam Weld function "active". In this example waveform, the Seam Weld function is active during the first and last 3 output pulses (**Shot 1**, **Shot 2, Shot 3, Shot 8, Shot 9** and **Shot 10**).

The **SEAM WELD MODE** can be set in the SEAM WELD screen shown below. To enable the Seam function for each schedule (**FIX** or **FLEX**), the Seam Mode option must be ON and the **REPEAT** and **SHOT** ≥ 1.

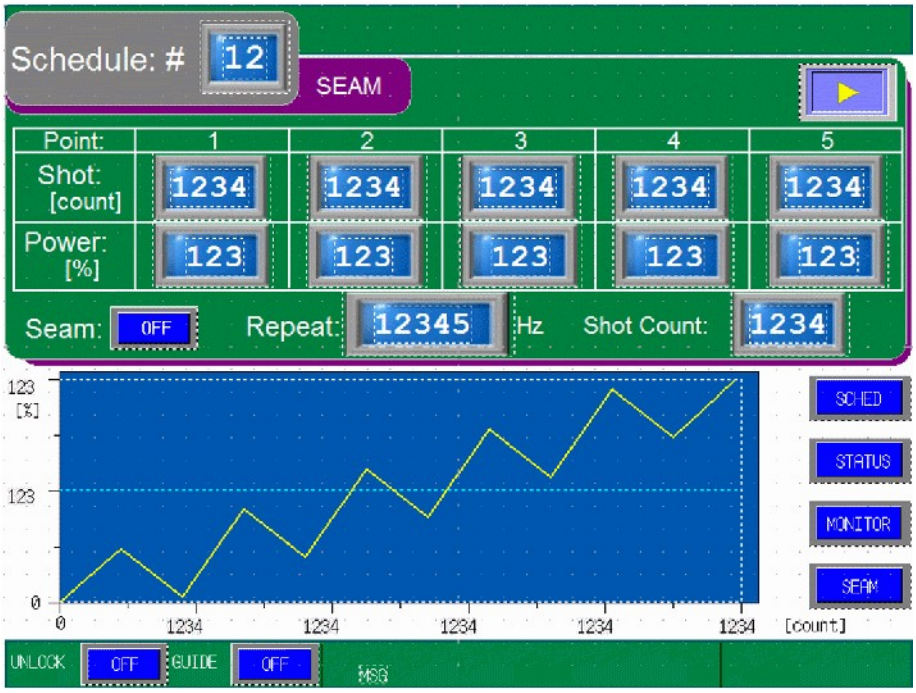


Figure 3-4. SEAM Weld Screen

Status Screen

8-932 Model with updated controller board:

Figure 3-5. Status Screen

1 Version Display This displays the version of the firmware in the Laser Controller and Touchscreen Display.

2 Laser Status This indicates status of the **Laser** in detail. It lets you know:

- Communication to the Laser is working OK.
- Laser Internal Temperature

3 Chiller Status This indicates status of the **Chiller** in detail. It lets you know:

- Communication to the Chiller is working OK.
- Chiller Temperature
- Chiller Set Temperature

4 Error Record The Error Record (History) Page will be displayed when this button is pressed.

8-931 / 8-930 Model:

Figure 3-5. Status Screen

1 Version Display This displays the version of the firmware in the Laser Controller and Touchscreen Display.

2 Laser Status This indicates status of the **Laser** in detail. It lets you know:

- Communication to the Laser is working OK.
- Any Laser Alarms
- Laser firing (Emitting)
- Laser Enable

3 Chiller Status This indicates status of the **Chiller** in detail. It lets you know:

- Communication to the Chiller is working OK.
- Any Chiller Alarms
- Chiller Mode
- Pump ON/OFF

Error Record Screen

Only on 8-932 models with updated controller board:

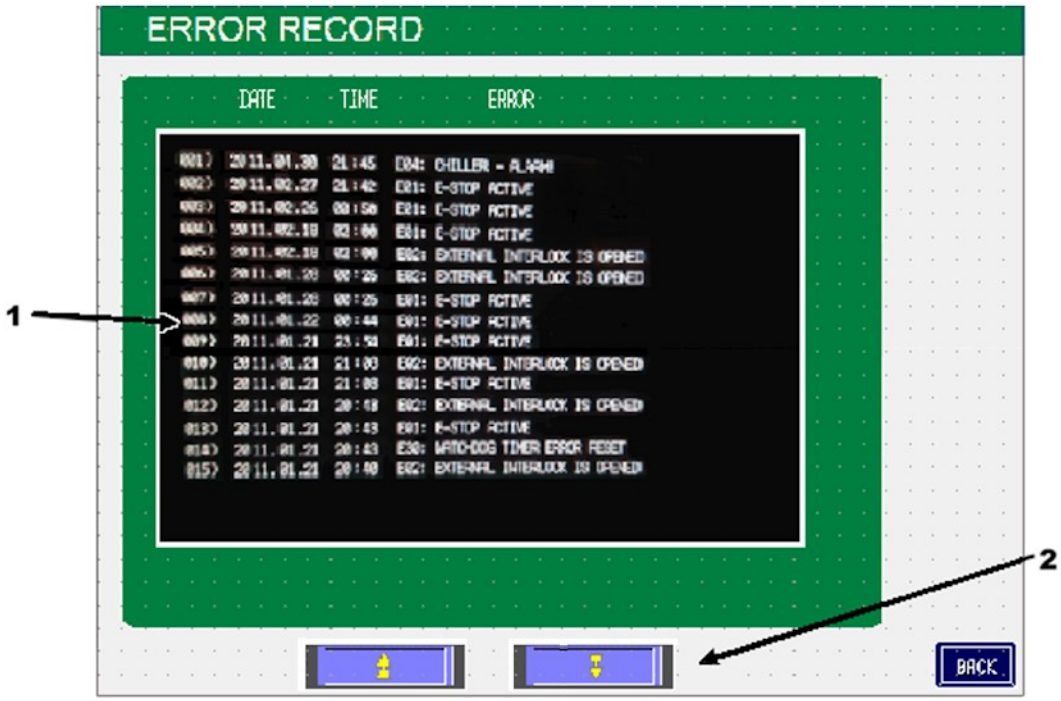


Figure 3-6. Error Record Screen

1	**Error Record**	Displays a list that shows the most recent 100 errors that occurred in the past. The list shows the type of error and the date/time of when the error occurred.
2	**Scroll Up / Down Buttons**	The Error Record window cannot show all 100 errors at once, so the Up/Down buttons can be used to show older error records that are not shown in the initial display.

Monitor Screen

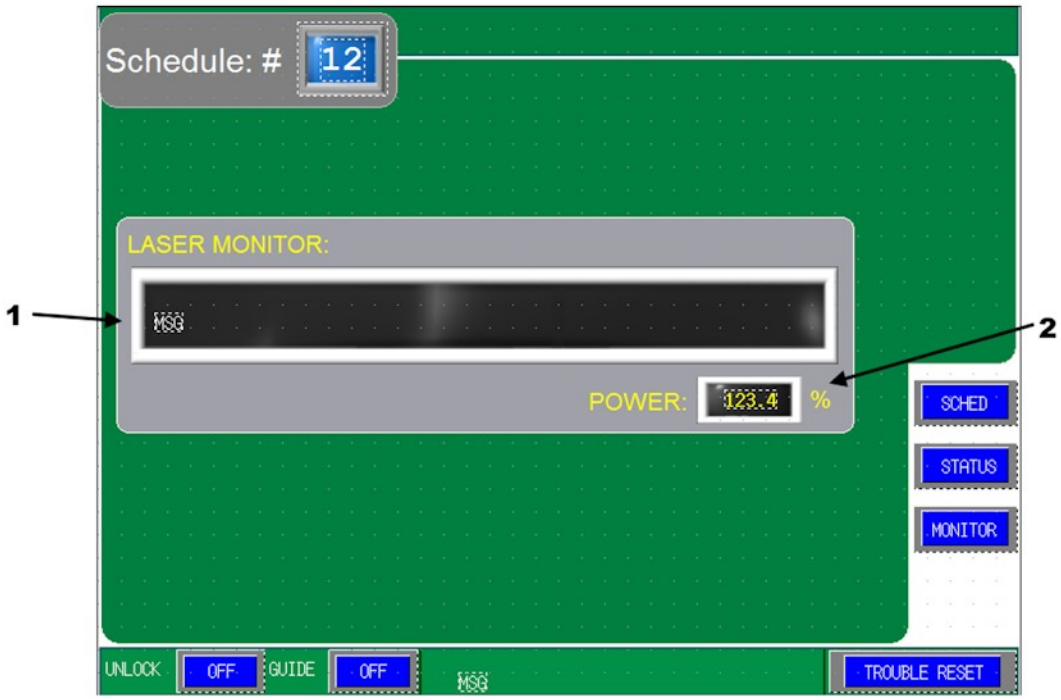


Figure 3-6. Monitor Screen

1 Laser Status Displays the current laser status. Status strings include:

EMITTING!

IDLE, WAITING FOR START SIGNAL ... (SAFETY DELAY)

CONTROL KEY OFF, TURN ON KEY SWITCH CYCLE REQUIRED BDO ALARM! (OVER TEMP)

BDO ALARM! (DAMAGE)

THERMISTOR OVER TEMP ALARM! SNAP SWITCH OVER TEMP ALARM! MEMORY SETTINGS

PSU FAILURE!

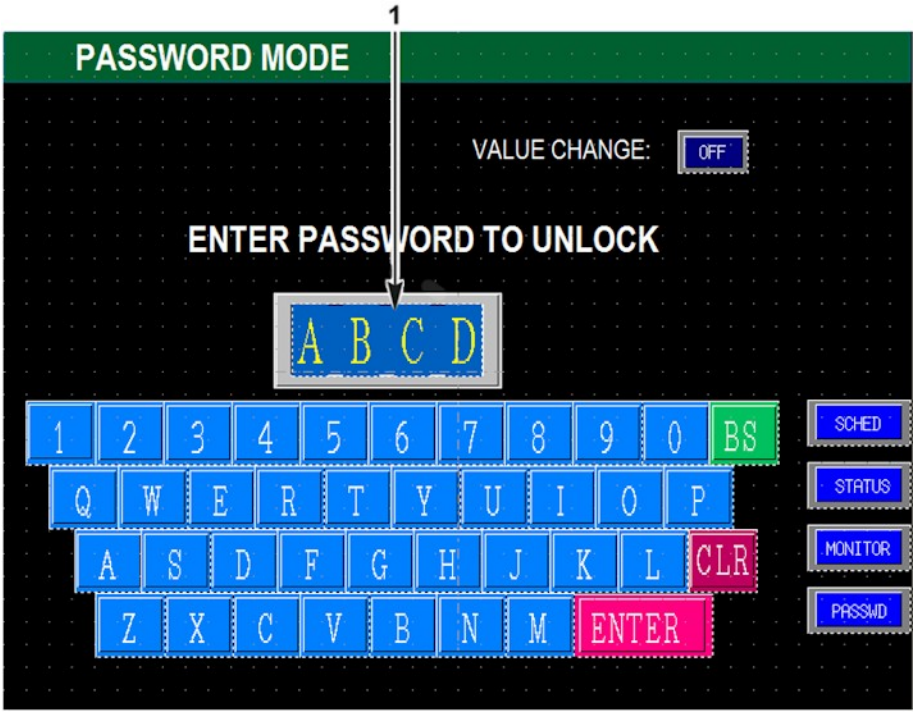
GROUND FAULT ALARM!

OUTPUT POWER ALARM!

2 Power Monitor This displays the value of the power monitor that is internal to the laser module. This value is different from the actual output power from the fiber and should only be used as reference.

Password Screen

Only on 8-932 models with updated controller board:



1 ENTER PASSWORD TO UNLOCK

When Password protection is implemented, a password will be required in order to change a schedule setting. Input the 4-digit password (numbers and/or letters) using keyboard in the lower part of the screen. This column is normally blank. The factory setting is **0000**.

DESCRIPTION OF KEYBOARD	
CLR (Clear All)	Press this key to clear all characters.
BS (Backspace)	Press this key to clear last character entered.
ENTER	Press this key to enter password.

When an incorrect password is entered, the message window shown on the right will appear. Press the **OK** button to return to the Password screen.

When a correct password is entered, the screen shown on the right will appear.

2 VALUE CHANGE

In order to implement a new Password, the Value Change button must be **ON**. The Value Change button is only effective when the password has been entered correctly. When you press this button, the window for selecting **ON/OFF** appears.

ON	Allows changing the setting.
OFF	Prohibits changing the setting.

The setting (**ON** or **OFF**) is displayed on the button.

3 ENTER A NEW PASSWORD

When the original Password is correctly entered and the Value Change is **ON**, a new 4 character alphanumeric Password can be entered. When finished, press the **ENTER** button.

Once the Password is entered, a confirmation screen will appear. Type in the new Password again followed by pressing the **ENTER** button.

If the confirmation Password differs from the new Password, the screen on the right will appear, press **OK** to clear the error message screen and re-enter the Password.

Trouble Screen

Figure 3-7. Trouble Screen

Error Display will show if any error messages would occur. If there are multiple errors messages and the list grows beyond the size of display, the UP and DOWN buttons could be used to view.

Change DISP Order	Changes the list order from the one specified internally, to one that is timed based.
TROUBLE RESET	Pressing this button will clear the errors displayed if the issues causing the errors have been corrected.

Section III. External I/O

Welding Using the External I/O

Program the welding parameters using one of the methods described above using the control panel.

1. Close the **CONTROL CHANGEOVER** signal on the **EXT-I/O (1)** Connector and verify that **EXTERNAL CONTROL** is displayed on the **STATUS** Screen.
2. Turn the Laser Enable **ON**. Close the **ENABLE-ON/OFF** signal on **EXT. I/O (1)**.
3. Check the Processing Site.
   - Close the **GUIDE BEAM** signal on **EXT-I/O (1)**.
   - The guide beam will show the processing site with a red dot. This is the position for the laser processing.
   - If the processing site is dislocated, adjust by moving the output unit or workpiece. Verify the working distance before proceeding.
4. Select a Schedule number. Input the Schedule Number on **EXT. I/O (1)** by combining input signals; **SCHEDULE 1, 2, 4, 8**, and **16**.
5. Perform Laser Processing.
   - Close the **LASER START** signal on **EXT. I/O (1)**.
   - Verify an output response on the **POWER MONITOR** screen.

   NOTE: Refer to ***Appendix B, Electrical and Data Connections*** for connection details.

Shutdown through External I/O

1. Open all I/O connections by turning the Enable OFF.
2. Turn the Control key switch to the OFF position.
3. Turn the main power switch on the back panel of the laser OFF.

CHAPTER 4
MAINTENANCE

Section I: Precautions

WARNING: ***Before*** starting any maintenance, carefully read ***all*** instructions, **WARNINGS**, and **CAUTIONS.**

DANGER

Service personnel, or anyone who may be exposed to laser beams, ***must*** wear safety goggles having a minimum optical density of 7+ at a 1,070 nanometer wavelength.

- Turn the power to the laser OFF and disconnect it from the A.C. source ***before*** performing any maintenance work.
- When turning power **ON** to check operation during any maintenance procedure, make sure that everyone who may be exposed to the laser beam during maintenance is wearing laser protective glasses.
- Do ***not*** modify the laser.
- Keep the exterior of the laser clean. Use a dry or slightly dampened cloth to clean. If heavily soiled, use a cloth moistened with a mild detergent or alcohol. Do ***not*** use paint thinner, benzene or acetone.

Section II. Trouble Messages

#	Message	Meaning	Corrective Action	Reset Method
01	**E-STOP ACTIVE**	E-stop circuit is open	Close E-stop circuit.	Press trouble reset button on panel after error condition has been corrected.
02	**EXTERNAL INTERLOCK IS OPENED**	Safety interlock is interrupted	Ensure all interlocks are properly set.	Press trouble reset button on panel after error condition has been corrected.
03	**LASER – ALARM!**	General laser module error	Check for other laser alarm messages to troubleshoot cause of error.	Press trouble reset button on panel. If alarm does not clear, requires service visit; please contact factory.
04	**CHILLER – ALARM!**	Chiller operation has stopped	Check for water level, water temperature, kinked water lines or any other chiller related component.	Press trouble reset button on panel after error condition has been corrected.
05	**KEY SWITCH CYCLE REQUIRED**	Key switch must be turned OFF then ON again to restore normal operation	Turn the key switch OFF, then ON	No action required
06	**BDO INTERLOCK / OVER TEMP**	Beam delivery module is disconnected or temperature is too high	Check beam delivery connection. Adjust ambient air temperature. Apply cooling air to beam delivery module if error persists during normal operation.	Press trouble reset button on panel after error condition has been corrected.
07	**BDO ALARM! (DAMAGE)**	Beam delivery module is damaged	Internal laser fault; no corrective action possible	Requires service visit. Please contact factory.
08	**THERMISTOR OVER TEMP ALARM!**	Internal temperature is too high	Check chiller (if equipped). Lower ambient air temperature if above 35°C. Turn off laser. Allow laser to cool	Turn on laser. Press trouble reset button on pendant after error condition has been corrected.
09	**SNAP SWITCH OVER TEMP ALARM!**	Internal temperature is too high	Check chiller (if equipped). Lower ambient air temperature if above 35°C. Turn off laser. Allow laser to cool	Turn on laser. Press trouble reset button on panel after error condition has been corrected.
10	**PSU FAILURE!**	Power supply unit in laser is damaged	Internal laser fault; no corrective action possible	Requires service visit. Please contact factory.

#	Message	Meaning	Corrective Action	Reset Method
11	**GROUND FAULT ALARM!**	An unsafe condition exists in the laser module	Internal laser fault; no corrective action possible	Requires service visit. Please contact factory.
12	**MEMORY ALARM!**	Internal buss communication error	Internal laser fault; no corrective action possible	Requires service visit. Please contact factory.
13	**SEED POWER ALARM!**	Seed laser power output is too low	Internal laser fault; no corrective action possible	Press trouble reset button on panel. If alarm does not clear, requires service visit; please contact factory.
14	**OUTPUT POWER ALARM!**	Laser output power is too low	Internal laser fault; no corrective action possible	Press trouble reset button on panel. If alarm does not clear, requires service visit; please contact factory.
15	**AMBIENT TEMPERATURE TOO HIGH/LOW**	Ambient air temperature is too high or too low.	Adjust ambient air temperature	Press trouble reset button on panel after error condition has been corrected.
16	Reserved for later use	--	--	--
17	**CHILLER – TEMPERATURE TOO HIGH**	Chiller temperature is too high	Prepare environment to cool the water temperature in the chiller.	Press trouble reset button on panel after error condition has been corrected.
18	**CHILLER – TEMPERATURE TOO LOW**	Chiller temperature is too low	Prepare environment to warm the water temperature in the chiller.	Press trouble reset button on panel after error condition has been corrected.
19	**CHILLER – LOW PROCESS FLOW**	Chiller flow output is too low	Check if there is any blockage in the water lines and also check for other chiller errors	Press trouble reset button on panel after error condition has been corrected.
20	**CHILLER – LOW COOLANT LEVEL**	Chiller coolant level in reservoir tank is too low	Fill more coolant/water in the reservoir tank.	Press trouble reset button on panel after error condition has been corrected.
21	**CHILLER – FAN FAILURE**	Chiller fan has failed	Fan will need to be replaced	Requires service visit. Please contact factory.
22	**CHILLER – UNIT FAILURE**	Chiller unit has encountered a systemic failure	Power cycle the chiller unit	Requires service visit. Please contact factory.
23	**CONTROLLER – ETHERNET RXBUF OVERRUN**	Control board has encountered an problem with the Ethernet	Check Ethernet connection	Press trouble reset button on panel. If alarm does not clear, requires service visit; please contact factory.

#	Message	Meaning	Corrective Action	Reset Method
24	**CONTROLLER – ETHERNET RXBUF OVERRUN**	Control board has encountered an problem with the Ethernet	Check Ethernet connection	Press trouble reset button on panel. If alarm does not clear, requires service visit; please contact factory.
25	**LASER – COMMUNICATION ERROR**	Equipment control board lost internal communication with Laser engine	Check Ethernet connection between control board and laser; Make sure laser engine has power on	Press trouble reset button on panel. If alarm does not clear, requires service visit; please contact factory.
26	**CHILLER – COMMUNICATION ERROR**	Equipment control board lost internal communication with Chiller	Check Ethernet connection between control board and chiller; Maker sure chiller has power on	Press trouble reset button on panel. If alarm does not clear, requires service visit; please contact factory.
27	**CONTROLLER – COMMUNICATION ERROR**	Equipment control board Ethernet communication has failed	Check Ethernet connection on control board.	Press trouble reset button on panel. If alarm does not clear, requires service visit; please contact factory.
28	Reserved for later use	--	--	--
29	Reserved for later use	--	--	--
30	**WATCHDOG TIMER ERROR RESET**	An error in the equipment control board caused it to reset itself	Self resets	If error keeps occurring, requires service visit; please contact factory.

*** For 8-932 Model Only. The RS-232 serial command to extract error codes "RT" will only show codes 01 ~ 04 for 8-931/8-930 model.**

Section III. Routine Maintenance Schedule

To ensure reliable and safe operation of the Laser, you should regularly perform routine inspection, cleaning, and maintenance as indicated in the table below.

ACTION	FREQUENCY
ENCLOSURE	
Replace fuses.	As required when necessary.
CONTROL UNIT	
Replace fuses.	As required when necessary.
Repair/Replace damaged cables.	As required when necessary.
CHILLER	
Inspect cooling water level	As required when inspected.
Add cooling water	As required when inspected.
Clean air filter (If applicable)	As needed or monthly.
Completely drain cooling water	Long periods of non-use, possibility of freezing.
Replace cooling water filter cartridge (If applicable)	When necessary, or every 3 months.
LASER UNIT	
No user maintenance required.	

Rear Panel Access

Laser's rear panel is easily removable.

Some maintenance procedures require access to the rear panels of the internal components. When maintenance is required:

- Make sure laser is completely off. Wait 5 minutes before removing panel.
- Remove screws and remove cover.

When you have finished maintenance:

- Make sure that the interior of the enclosure is clean and dry.
- Place panel back flush to the rear of the Laser. Reinstall screws.

Figure 4-1. Remove Rear Cover

Section IV: Maintenance Procedures

Chiller (Type 1)

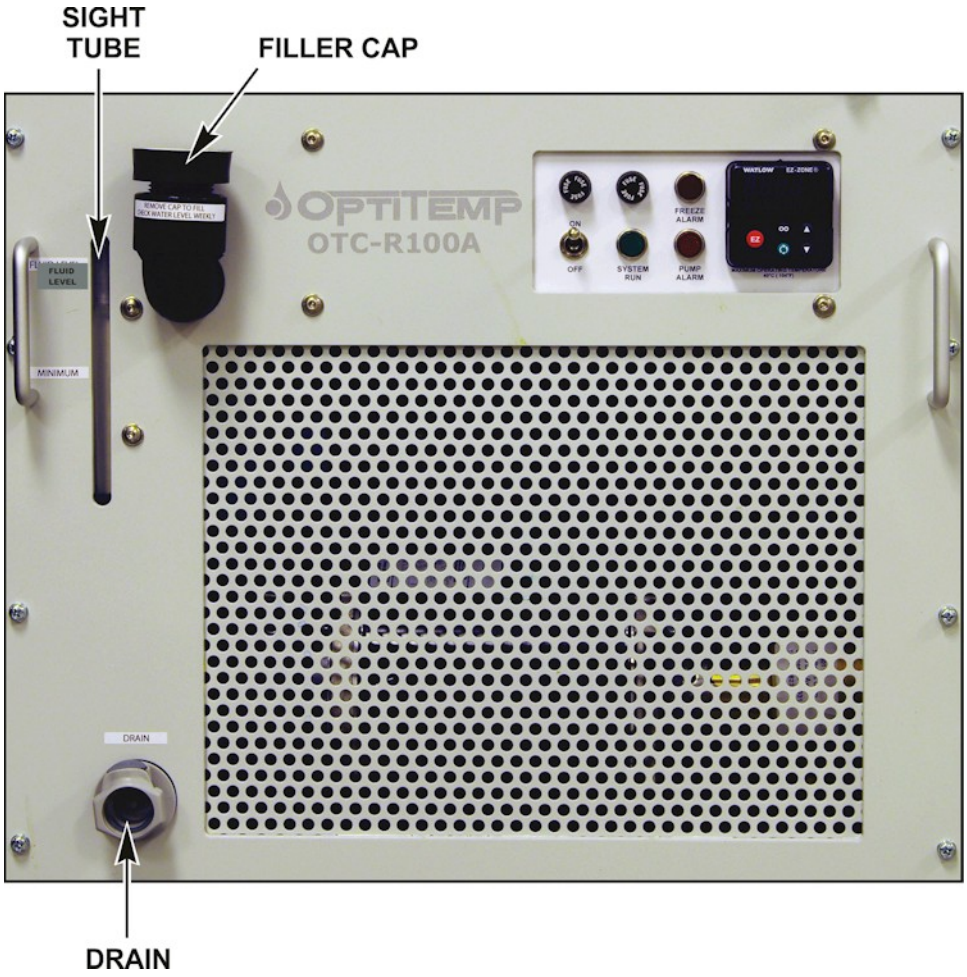


Figure 4-3. Refrigerant Chiller Type 1 Front Panel

Approved Coolants

1. The recommended coolant is distilled water instead of tap water. Corrosion inhibitors are recommended where conductivities are above 240 microsiemens/cm.
2. The only approved fluids are distilled water or "DYNALENE 30% PG" Propylene Glycol coolant by Dynalene corporation (or equivalent). The coolant and particle filter should be changed every 90 days.

Checking Coolant Level and Starting the Chiller (Type 1)

1. Verify that the coolant level in the sight tube on the front of the unit is between the **HIGH** and **LOW** lines on the indicator.
2. Remove the filler cap and add distilled water until the **HIGH** line is reached. Replace the filler cap.
3. Turn the power switch on the unit to ON. Following the system checkout the system will start. If the **PUMP ALARM** indicator illuminates it could mean the fluid level is now low.
4. Turn the power switch to the OFF position. Repeat steps 1 and 2 above.
5. The system is now ready for operation.

Draining the System Coolant (Type 1)

1. Remove power from the unit.
2. Attach the short drain hose to the **DRAIN** connection on the front of the chiller. Place the open end in a waste container.
3. Open the drain valve and allow the coolant to flow into the container.
4. Drain any additional coolant from the process connections. If possible, use compressed air < 40psi applied to the rear panel optics connections to blow out the remaining lines. Use a container to catch any expelled coolant.
5. Open the back panel of the laser and unscrew the clear filtration housing. Empty any water from this container and remove the filter. Replace the empty clear filter housing.
6. Close the system drain, the system is now ready for storage or transportation in warm climates.

Additional Procedures for Exposure to Cold Climate Conditions (Type 1)

1. Drain the unit.
2. Apply power back to the unit.
3. Add enough propylene glycol into the fluid reservoir to ensure the fluid tank level float is met. This requires greater than 25% of the fluid reservoir to be filled.
4. Connect a short piece of hose to the chiller **TO PROCESS** and **FROM PROCESS** ports.
5. Turn the unit on for 30 seconds to allow the propylene glycol to contact all the wetted components.
6. Turn the chiller OFF and disconnect power.
7. Attach the short drain hose to the front of the unit. Drain as much fluid as possible.
8. Close the system **DRAIN** and reconnect the hoses to the laser. The system is now ready for transport in cold climates.

Replacing the Water Filter (Chiller Type 1)

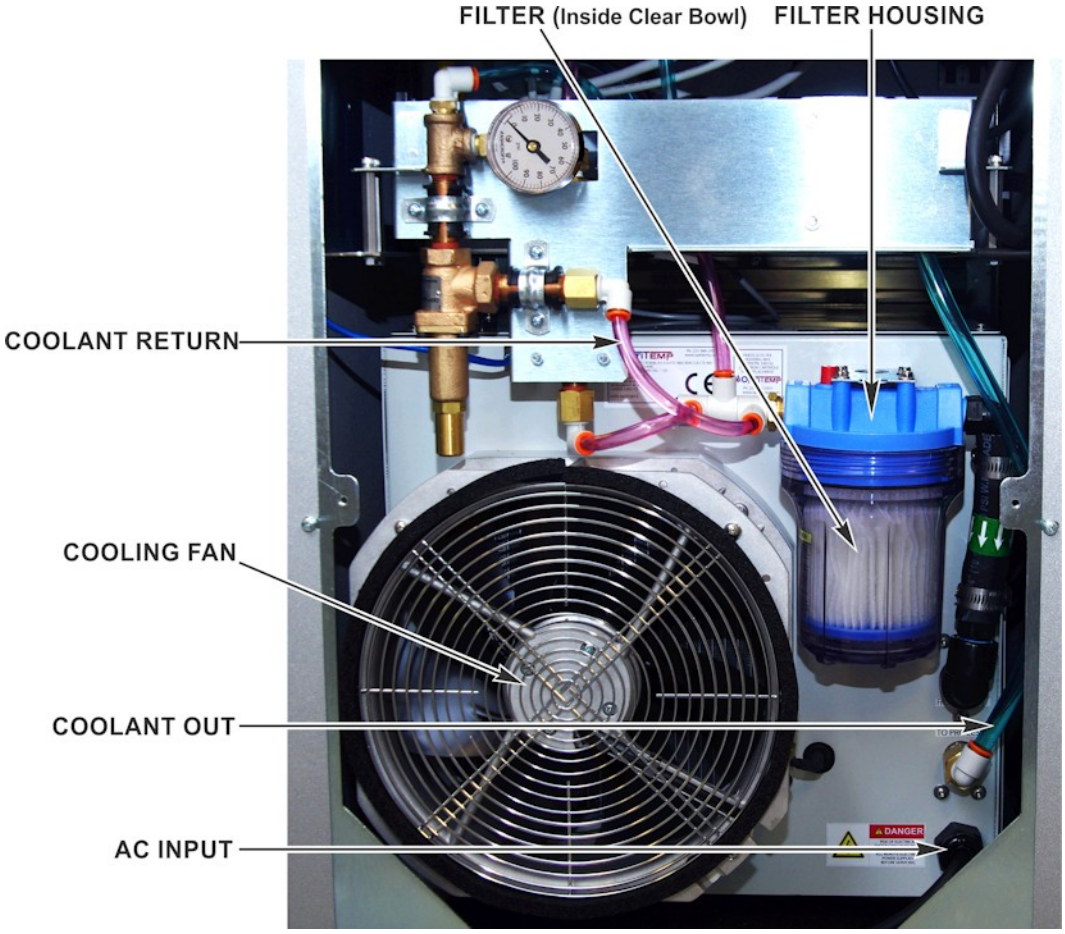


Figure 4-4. Refrigerant Chiller Rear Panel

1. Turn power to the unit OFF.
2. Open the rear panel of the laser enclosure.
3. Carefully remove the clear bowl portion of the water filter housing. Use care to not get water on adjacent components.
4. Remove the filter and drain the water from the clear bowl.
5. Place a new filter in the clear bowl and screw back onto the blue filter housing.
6. Turn the power to the chiller and the laser ON.
7. Verify that the coolant level is between the **LOW** and **HIGH** marks.

Chiller (Type 2)

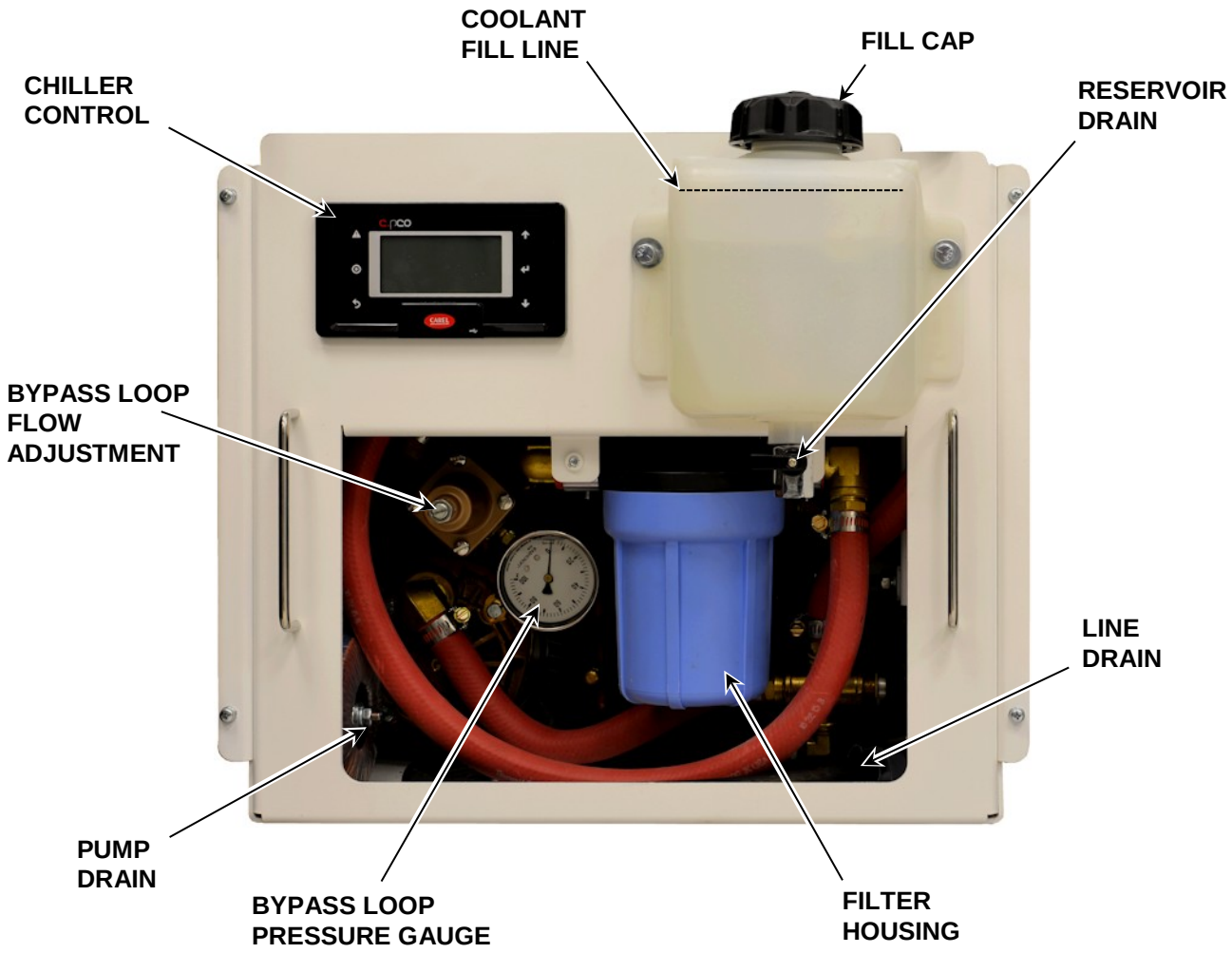


Figure 4-5. Refrigerant Chiller Type 2 Front Panel

Approved Coolants

1. The recommended coolant is distilled water instead of tap water. Corrosion inhibitors are recommended where conductivities are above 240 microsiemens/cm.
2. The only approved fluids are distilled water or “DYNALENE 30% PG” Propylene Glycol coolant by Dynalene corporation (or equivalent). The coolant and particle filter should be changed every 90 days.

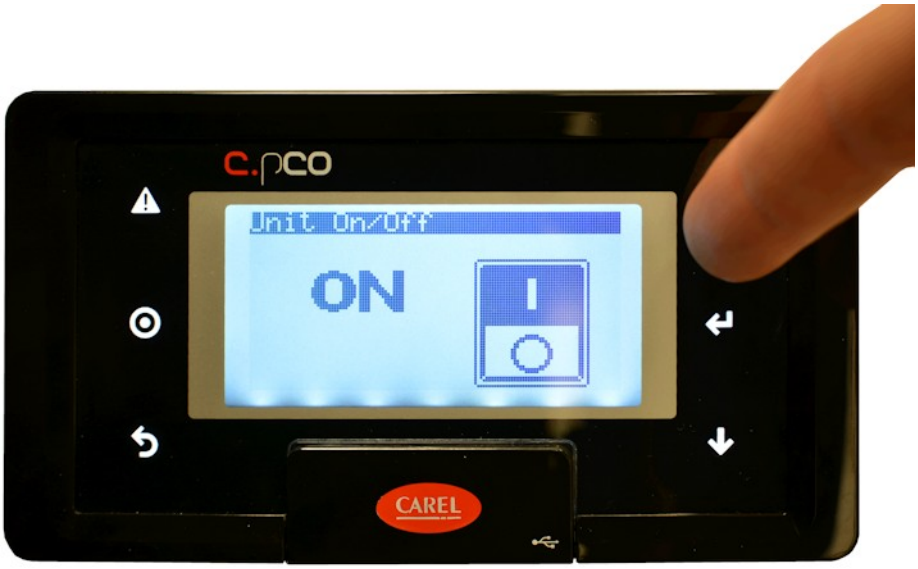
Checking Coolant Level and Starting the Chiller (Type 2)

1. Verify that the coolant level in the reservoir on the front of the unit is at the coolant fill line. See Figure 4-5.
2. If required remove the filler cap and fill to the coolant fill line embossed on the reservoir. Do not ever fill while the power is on as the reservoir level drops when the pump is on.
3. Turn the power switch on the unit to ON. Following the system checkout the system will start. The chiller can take up to 30 seconds to start. If the chiller pump does not start look at the chiller control LCD and determine the cause. The Status line should read "ON" once the pump starts.
4. If the system has been recently transported liquid refrigerant may have pooled in the compressor. Clearing this out is a simple procedure. On first startup allow the chiller to run for 5 seconds and then turn "OFF". Turn it back "ON", then back off after 5 seconds. Repeat 2 times to purge any liquid refrigerant out of the compressor, then leave it "ON" to purge air from the pump lines. This procedure is not required if the system has not been recently moved.
5. It is possible that the chiller pump circuit will be air-locked or bubbles will be present in the cooling lines on initial startup. Do not be alarmed – as long as water was filled to the fill line the chiller will not be damaged and the chiller will purge itself of entrained air while running. If there is no flow and the pressure gauge flutters and does not rise up to at least 40PSI after a few minutes it may be necessary to shut off the chiller, wait for a short time, and restart. Trapped air is most likely to occur with long external cooling loops. Pre-filling these loops with coolant is another usually unnecessary but effective way to deal with entrapped air. Replacing the long process loop with a short jumper hose until the chiller is bled is another approach.
6. If the system pressure gauge does not rise within a couple of minutes of startup there is an air-lock in the pump. To clear this place a rag or paper towel under the pump housing and crack open the pump drain plug. It is not necessary or desirable to remove this plug. When cracked open the pump will flood with coolant. Once coolant drips from the plug it can be tightened and the system can be restarted.

Potential Status Indications

a. **Off by Keypad** – the system has been turned off manually.

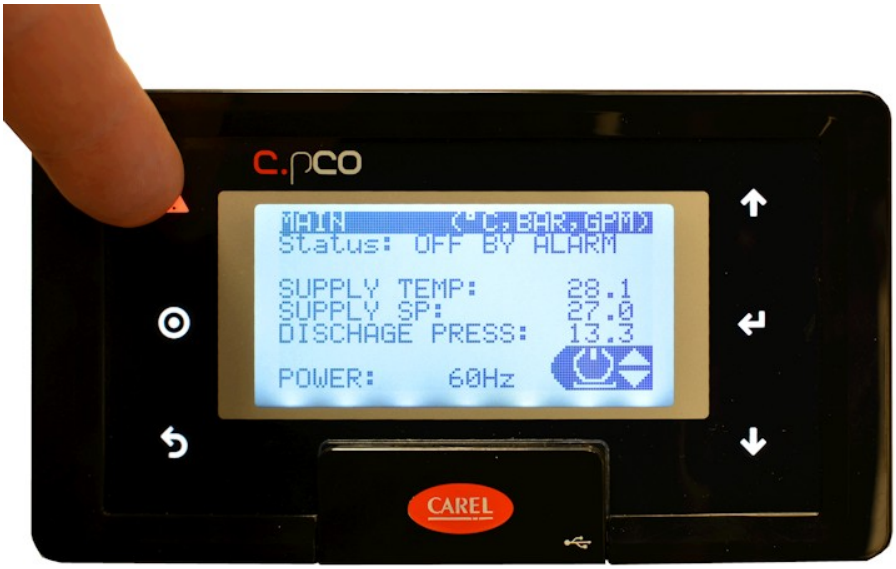
Use the Up/Down/Enter arrows on the right side to turn the system ON.



Then press the Back (lower left) arrow to return to the main screen.

b. Alarm – An error exists

Status: **OFF BY ALARM** combined with the red error triangle and beep noise indicates the presence of an error that must be cleared. To see the error, push the red triangle button.



In the case of this Liquid Level Alarm the coolant is low. Fill coolant, then clear the alarm using the keypad cycling procedure above in **OFF BY KEYPAD**.

7. When Status becomes **ON** the system is now ready for operation. It may be necessary to clear a Chiller Fault from the touch screen panel on the front of the LF unit.

Draining the System Coolant for Maintenance/Flush (Type 2)

1. Remove power from the unit.
2. Drain the reservoir using the drain cock at the bottom of the reservoir on the front of the unit and catching spillage.
3. Pull the line drain hose out of the unit and drain the fluid from the Line Drain valve. Close the valve and return to the clip when complete.

4. Unscrew and remove the water filter housing, remove the filter, and empty. Reinstall the filter housing.
5. If freezing temperatures or storage > 1 month are expected drain the pump sump drain. Place an absorbent pad beneath the pump head and back the pump drain plug out until coolant exits. Only a small volume of coolant will come out. Tighten the drain plug.
6. Drain any additional coolant from the process connections. If possible, use compressed air < 40 psi applied to the rear panel optics connections to blow out the remaining lines. Use a container to catch any expelled coolant. Some coolant may be pushed back into the filter housing.
7. The system is now ready for storage or transportation in warm climates.

Additional Procedures for Exposure to Cold Climate Conditions (Type 2)

1. Drain the unit.
2. Add enough propylene glycol into the fluid reservoir to ensure the fluid tank level float is met. This requires greater than 25% of the fluid reservoir to be filled.
3. Apply power back to the unit.
4. Connect a short piece of hose to the LF laser **FLOW** and **RETURN** ports.
5. Turn the unit on for 30 seconds to allow the propylene glycol to contact all the wetted components.
6. Turn the chiller OFF and disconnect power.
7. Drain as much fluid as possible.
8. The system is now ready for transport in cold climates.

Replacing the Water Filter (Chiller Type 2)

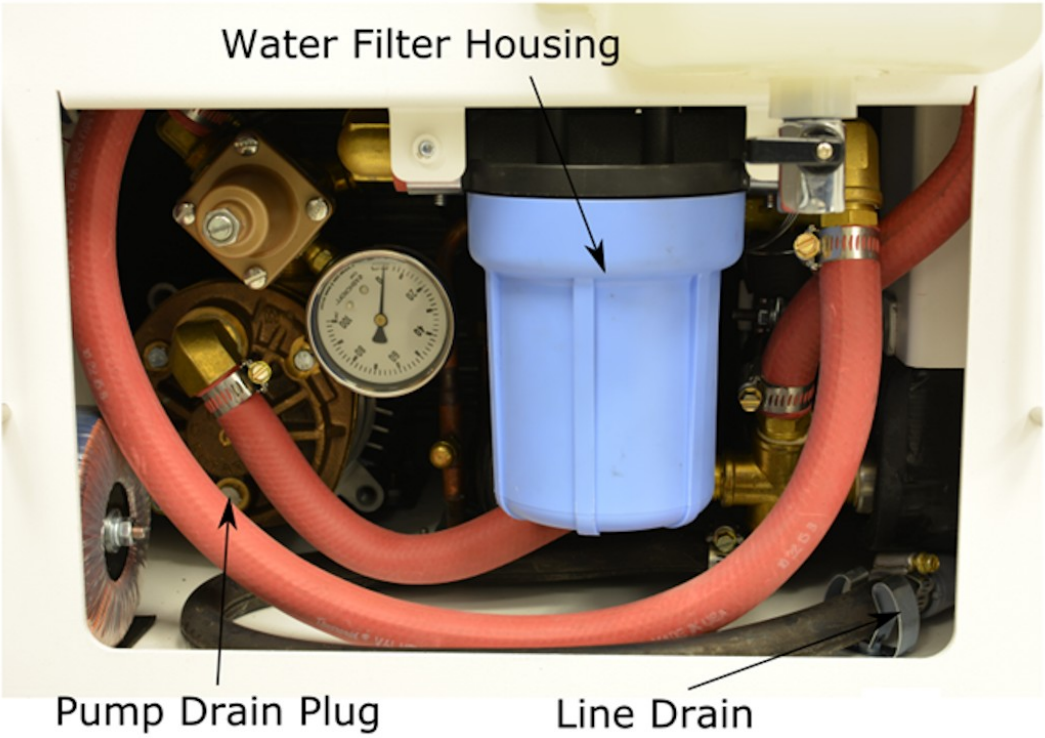


Figure 4-6. Refrigerant Chiller Detail

1. Turn power to the unit OFF.
2. Open the front door panel of the laser enclosure.
3. Carefully remove the blue bowl portion of the water filter housing. Use care to not get water on adjacent components.
4. Remove the filter and drain the water from the clear bowl.
5. Place a new filter in the clear bowl and screw back onto the blue filter housing.
6. Turn the power to the chiller and the laser ON.
7. Verify that the coolant level is at the correct level.

Section V: Parts Lists

Consumable Parts (With Type 1 Chiller)

Name	Part Number
Cooling water (Distilled water)	900-241
Fan fuse, 0.75A 250V	330-013
Controller fuse, 10A 250V	330-210
Water Filter Cartridge (for Refigerant type Chiller)	318-021
DYNALENE 30% Propylene Glycol Solution	900-393

Consumable Parts (With Type 2 Chiller)

Name	Part Number
Cooling water (Distilled water)	900-241
Water Filter Cartridge (for Refigerant type Chiller)	318-021
DYNALENE 30% Propylene Glycol Solution	900-393

Section VI: Repair Service

Repair Service

If you have problems with your Welder that you cannot resolve, please contact our laser service department at the address, phone number, or e-mail address indicated in the **FOREWORD** section of this manual.

Appendix A
Technical Specifications
Section I. Laser Physical Specifications

PHYSICAL SPECIFICATIONS – LF-250A; LF-500A			
Parameter		**LF-250A-xx-xx**	**LF-500A-xx-xx**
		All Modes All Fibers	**All Modes All Fibers**
Physical Properties	Dimensions (W x H x D)	20.1 in. (511 mm) x 41.3 in. (1050 mm) x 36.3 in. (922 mm)	
	Weight	325 lbs. (147.4 kg)	
Laser	Maximum Average Power	250W Nominal. See Laser Output Characteristic Table	500W Nominal. See Laser Output Characteristic Table
	Pulse Width	0.01 – 99.99ms (Pulsed CW output), CW	
	Pulse Width Resolution	0.01ms	
	Central Emission Wavelength	1070±10 nm	
	Single Fault Maximum Output Power (1050 - 1250nm)	Up to 1.5x rated power in CW mode, 5x rated power at beginning of pulse in pulse mode	
	Repetition Rate	1 – 50,000 Hz, CW	
	Positioning Guide Beam	Built-in visible laser (red) 630 - 680 nm	
	Guide Beam Max Power	5.0 mW	
Power Supply	Voltage	200 - 240 V ± 10% VAC 50 - 60 Hz single phase	
	Maximum Running Current	24A RMS	
	Breaker Rated Current	30A	
Cooler	Heat Exchange Method	Air-Water	
	Ambient Operating Temperature	41 - 105°F (5 - 40°C)	
	Operating Humidity	Less than 85% (non-condensing)	
Controller	Schedule Setting	Up to 32 schedules	
	Monitor	Status Monitor Average Power (W)	
	Alarms	Messages are displayed on screens	
	External Communication (RS-232)	Baud Rate: variable 9600 (default) Start Bits: 1 Data Bits: 8 Parity: Even Stop Bits: 2 Flow control: None	
Safety	CDRH Compliance	Complies with 21CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice N. 50, dated June 24, 2007.	
	CE Compliance	Incomplete machine for Incorporation. See Certificate of Incorporation in this manual for details.	
	IEC 13849-1 Performance Level	P_Ld when properly integrated	

APPENDIX A: TECHNICAL SPECIFICATIONS

PHYSICAL SPECIFICATIONS – LF-300A; LF-500A			
Parameter		**LF-300A**	**LF-500A**
		All Modes All Fibers	**All Modes All Fibers**
Physical Properties	Dimensions (W x H x D)	20.1 in. (511 mm) x 41.3 in. (1050 mm) x 36.3 in. (922 mm)	
	Weight	325 lbs. (147.4 kg)	
Laser	Maximum Average Power	300W Nominal. See Laser Output Characteristic Table	500W Nominal. See Laser Output Characteristic Table
	Pulse Width	0.01 – 99.99ms (Pulsed CW output), CW	
	Pulse Width Resolution	0.01ms	
	Central Emission Wavelength	1070±10 nm	
	Single Fault Maximum Output Power (950 - 1200nm)	2kW	
	Repetition Rate	1 – 50,000 Hz, CW	
	Positioning Guide Beam	Built-in visible laser (red) 630 - 680nm	
	Guide Beam Max Power	1.0 mW	
Power Supply	Voltage	200 - 240 V ± 10% VAC 50 - 60 Hz single phase	
	Maximum Running Current	24A RMS	
	Breaker Rated Current	30A	
Cooler	Heat Exchange Method	Air-Water	
	Ambient Operating Temperature	41 - 105°F (5 - 40°C)	
	Operating Humidity	Less than 85% (non-condensing)	
Controller	Schedule Setting	Up to 32 schedules	
	Monitor	Status Monitor Average Power (W)	
	Alarms	Messages are displayed on screens	
	External Communication (RS-232)	Baud Rate: variable 9600 (default) Start Bits: 1 Data Bits: 8 Parity: Even Stop Bits: 2 Flow control: None	
Safety	CDRH Compliance	Complies with 21CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice N. 50, dated June 24, 2007.	
	CE Compliance	Incomplete machine for Incorporation. See Certificate of Incorporation in this manual for details.	
	IEC 13849-1 Performance Level	P_Ld when properly integrated	

PHYSICAL SPECIFICATIONS – LF-700A; LF-1000A			
Parameter		**LF-700A-xx-xx**	**LF-1000A-xx-xx**
		All Modes All Fibers	**All Modes All Fibers**
Physical Properties	Dimensions (W x H x D)	20.1 in. (511 mm) x 41.3 in. (1050 mm) x 36.3 in. (922 mm)	
	Weight	495 lb. (224 kg)	
Laser	Maximum Average Power	700W Nominal. See Laser Output Characteristic Table	1000W Nominal. See Laser Output Characteristic Table
	Pulse Width	0.01 – 99.99ms (Pulsed CW output), CW	
	Pulse Width Resolution	0.01ms	
	Central Emission Wavelength	1070 ± 10nm	
	Single Fault Maximum Output Power (950 - 1200nm)	2kW	
	Repetition Rate	1 – 50,000 Hz, CW	
	Positioning Guide Beam	Built-in visible laser (red) 630 - 680 nm	
	Guide Beam Max Power	1.0 mW	
Power Supply	Voltage	200 - 240 V ± 10% VAC 50 - 60 Hz single phase	
	Maximum Running Current	35A RMS	
	Breaker Rated Current	40A	
Cooler	Heat Exchange Method	Air-Water	
	Ambient Operating Temperature	41 - 94°F (5 - 35°C)	
	Operating Humidity	Less than 85% (non-condensing)	
Controller	Schedule Setting	Up to 32 schedules	
	Monitor	Status Monitor Average Power (W)	
	Alarms	Messages are displayed on screens	
	External Communication (RS-232)	Baud Rate: variable 9600 (default) Start Bits: 1 Data Bits: 8 Parity: Even Stop Bits: 2 Flow control: None	
Safety	CDRH Compliance	Complies with 21CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice N. 50, dated June 24, 2007.	
	CE Compliance	Incomplete machine for Incorporation. See Certificate of Incorporation in this manual for details.	
	IEC 13849-1 Performance Level	P_Ld when properly integrated	

Section II. Laser Output Specifications

Output Optic and Fiber Configuration Options by Model

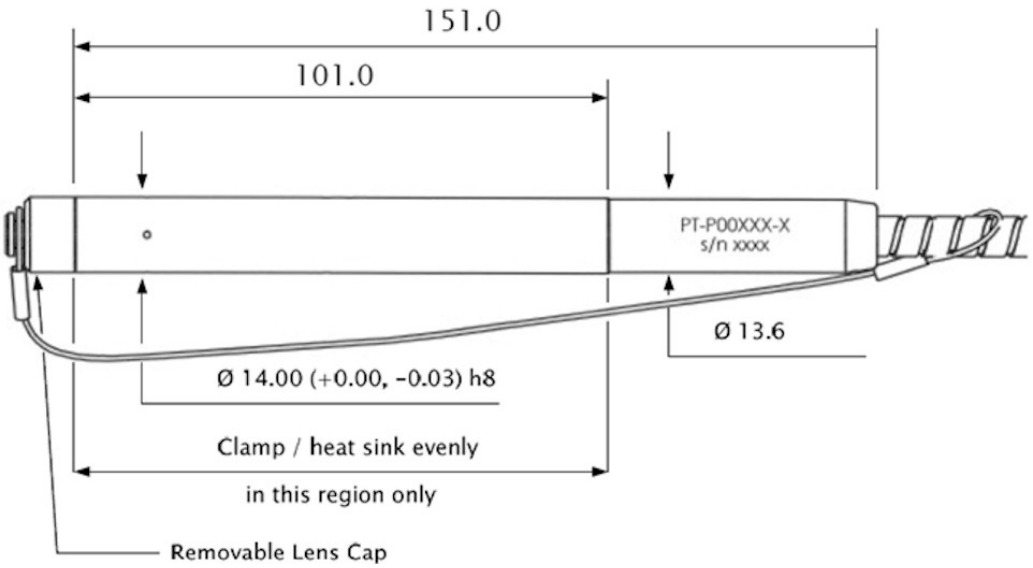
LF Laser Model	Fiber Core Diameter (if applicable)	Fiber Length	LLK-Q Connector (Water Cooled)	QBH-Style Connector (Water Cooled)	QBH-Style Connector (Non-Water Cooled)	Collimated Style Output Optic
LF-250A-AR-SM		6m				X
LF-250A-AQ-M35	35µm	6m				X
LF-300A-AK-SM		5m			X	
LF-300A-AL-M50	50µm	5m			X	
LF-500A-AB-SM		6m	X			
LF-500A-AM-SM		10m	X			
LF-500A-AC-M100	100µm	6m	X			
LF-500A-AN-M100	100µm	10m	X			
LF-500A-AS-M50	50µm	10m	X			
LF-500A-AH-SM		5m			X	
LF-500A-AJ-M50	50µm	5m			X	
LF-700A-AU-SM		5m		X		
LF-700A-AV-M50	50µm	5m		X		
LF-1000A-AT-SM		5m		X		
LF-1000A-AP-M50	50µm	5m		X		

Laser Output Characteristics

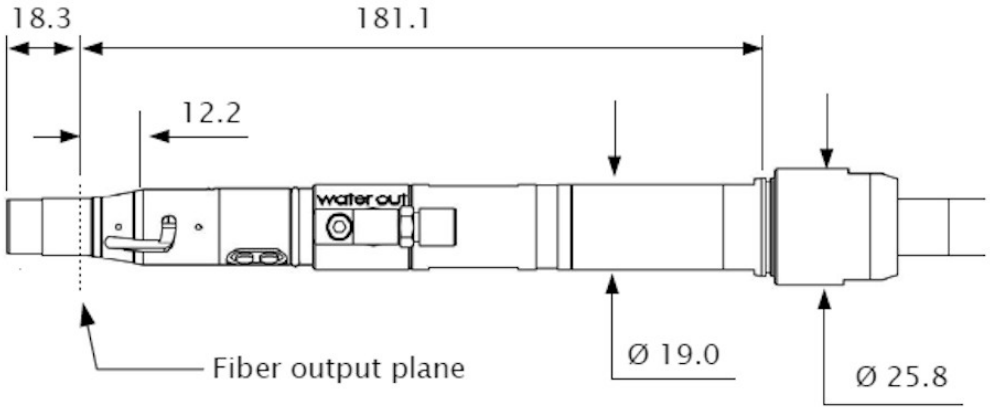
LF Laser Model	Nominal Max Power Setting (W)	Min Measured Power Output From Fiber (W)	Max Measured Power Output From Fiber (W)	Max M^2 or Beam Parameter Product	Short Term RMS Power Instability at Full Rated Output Power	Long Term RMS Power Instability at Full Rated Output (4hrs)
LF-250A-AR-SM	250	245.0	275.0	$M^2 < 1.1$	< 3.0%	< 3.0%
LF-250A-AQ-M35	250	245.0	275.0	$M^2 = 3.5 \pm 0.5$	< 3.0%	< 3.0%
LF-300A-AK-SM	300	285.0	*Not specified*	$M^2 < 1.1$ (1.05 typical)	< 2.0%	< 3.0%
LF-300A-AL-M50	300	285.0	*Not specified*	BPP < 2.0 mm x mrad	< 2.0%	< 3.0%
LF-500A-AB-SM LF-500A-AM-SM	500	480.0	550.0	$M^2 < 1.1$	< 3.0%	< 3.0%
LF-500A-AC-M100 LF-500A-AN-M100	500	480.0	550.0	$M^2 = 15 \pm 2.0$	< 3.0%	< 3.0%
LF-500A-AS-M50	500	480.0	550.0	$M^2 = 6.5 \pm 1.0$	< 3.0%	< 3.0%
LF-500A-AH-SM	500	480.0	*Not specified*	$M^2 < 1.1$ (1.05 typical)	< 2.0%	< 3.0%
LF-500A-AJ-M5	500	480.0	*Not specified*	BPP < 2.0 mm x mrad	< 3.0%	< 3.0%
LF-700A-AU-SM	700	685.0	*Not specified*	$M^2 < 1.1$ (1.05 typical)	< 2.0%	< 3.0%
LF-700A-AV-M50	700	685.0	*Not specified*	BPP < 2.0 mm x mrad	< 2.0%	< 3.0%
LF-1000A-AT-SM	1000	980.0	*Not specified*	$M^2 < 1.1$ (1.05 typical)	< 2.0%	< 3.0%
LF-1000A-AP-M50	1000	980.0	*Not specified*	BPP < 2.0 mm x mrad	< 2.0%	< 3.0%

Section III. Dimensions

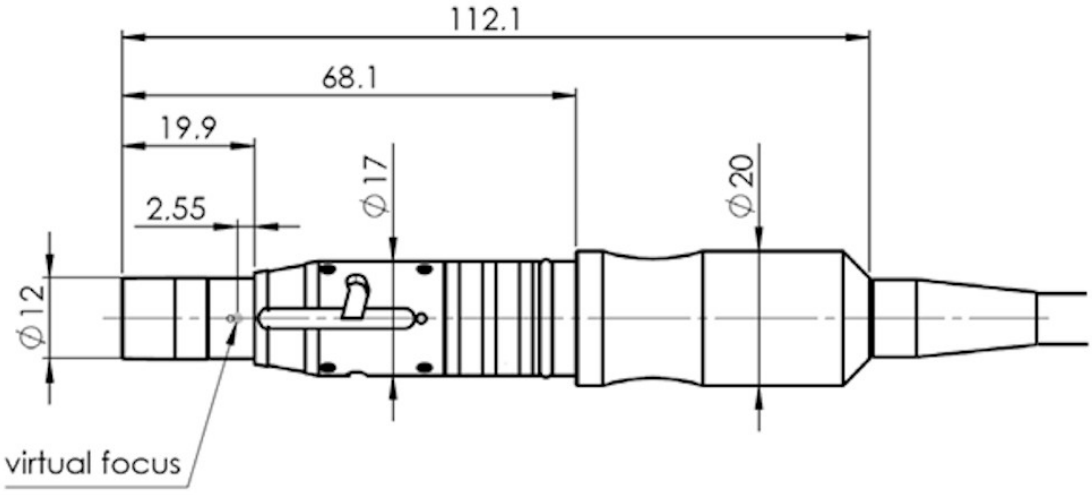
Optical Output Interface – Collimated Style (air cooled)



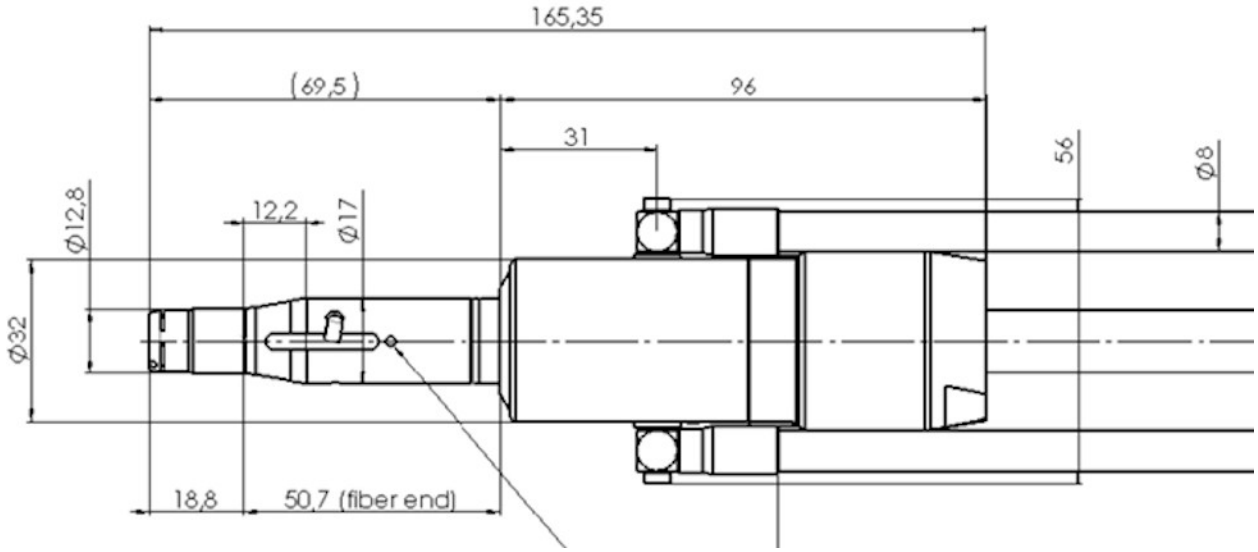
Optical Output Interface – QBH-style connector (water cooled)



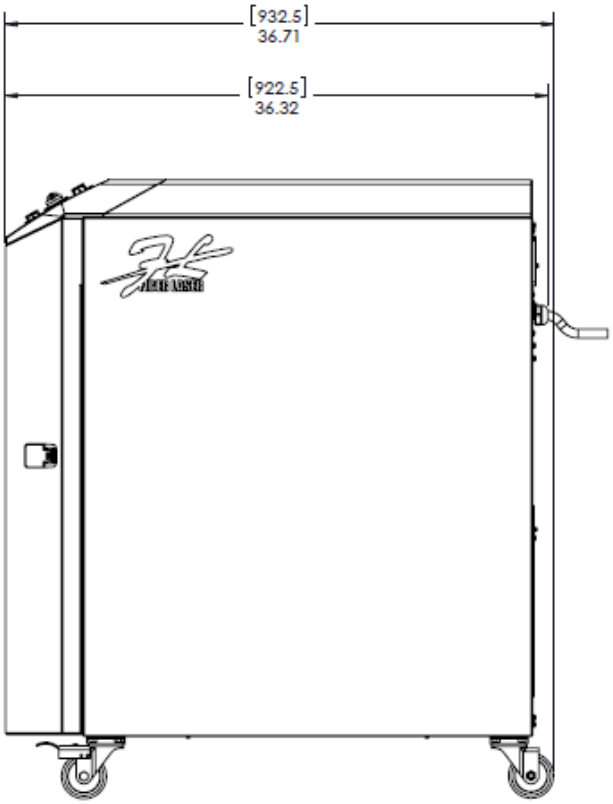
Optical Output Interface – QBH-style connector (non-water cooled)

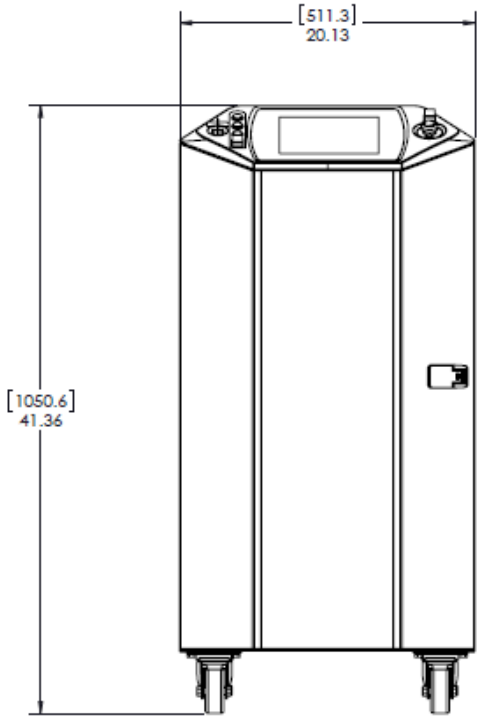


Optical Output Interface – LLK-Q (water cooled)



Chassis Dimensions





APPENDIX B
ELECTRICAL AND DATA CONNECTIONS

External Input / Output (EXT. I/O) Connectors

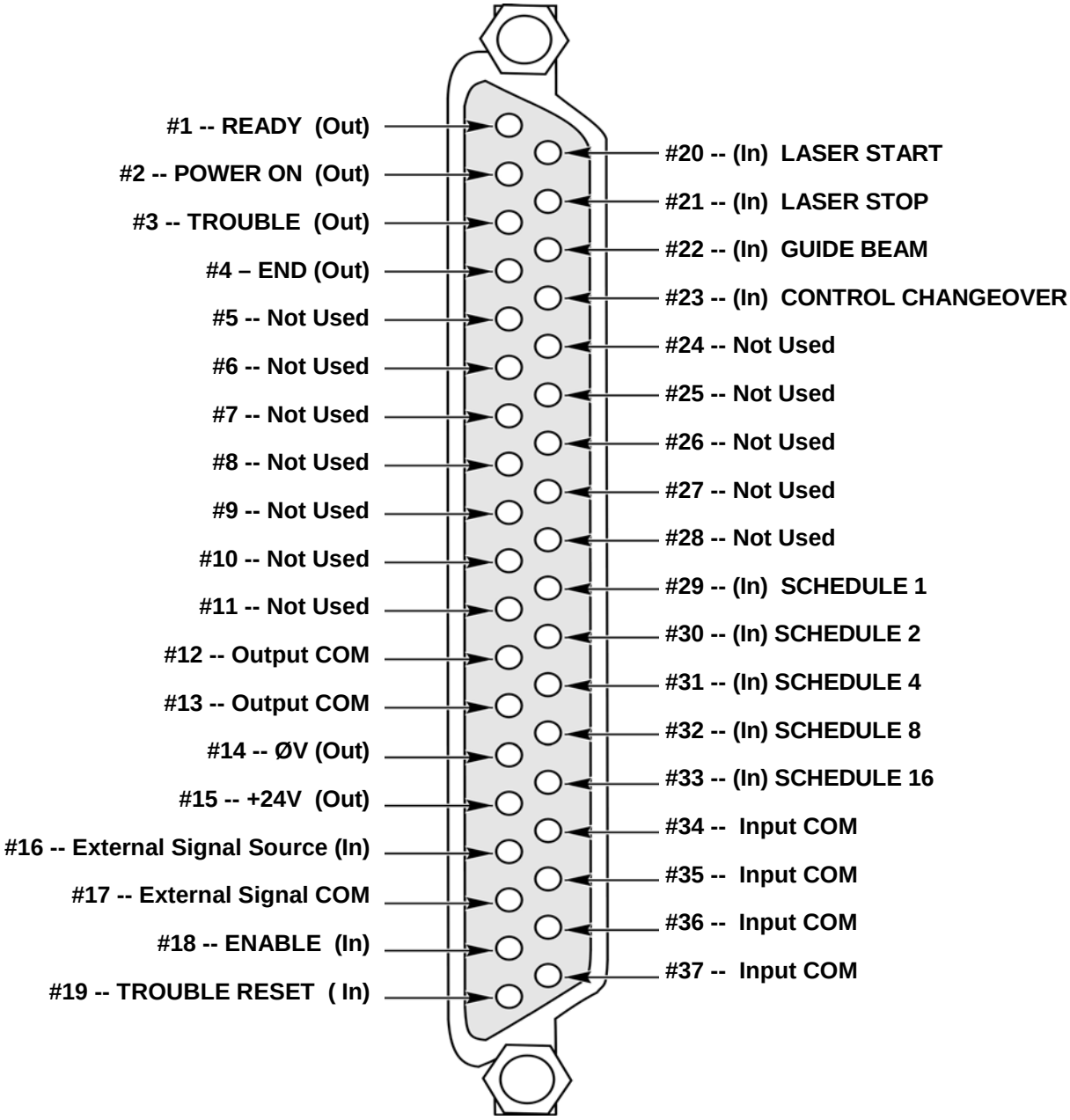


Figure B-1. EXT. I/O (1) D-SUB 37-Pin Configuration

External Input Signal Connections

Description of EXT I/O (1) Connector Input Pins

Pin No.	Description	
14	**0 V OUT.** Power supply for external input signals. This pin is exclusively used for the Laser. Do not use it for powering external equipment.	
15	**+24 V OUT.** Power supply for external input signals. This pin is exclusively used for the laser. Do not use it for powering external equipment.	
16	**EXTERNAL SIGNAL SOURCE.** Input terminal for the external signal power supply. Connect it to Pin 14 or Pin 15, depending on the input signal circuitry.	
17	**EXTERNAL SIGNAL COM.** Common input terminal for external signals. Connect it to Pin 15 or Pin 14, depending on the input signal circuitry.	
18	**ENABLED.** When the circuit between this pin and COM is closed, the laser module is enabled. When the circuit is opened, the laser module is disabled.	
19	**TROUBLE RESET.** If trouble arises, an alarm is activated. When the cause of trouble has been eliminated and this pin is turned ON, the alarm will be canceled.	
20	**LASER START.** When the circuit between this pin and COM is closed, the laser WILL FIRE. The input signal should be closed for at least 40ms. When the signal is input repeatedly, make sure that the circuit is left open for at least 40ms between each input.	
21	**LASER STOP.** When the circuit between this pin and COM is opened during repeated laser oscillation (when [pps] is set), the laser oscillation stops. This input must be normally closed for the Laser to operate.	
22	**GUIDE BEAM.** When the circuit between this pin and COM is closed, the guide beam will turn ON.	
23	**CONTROL CHANGEOVER (External).** When the circuit between this pin and COM is closed, the laser will be controlled through the external I/O connectors.	
29	SCHEDULE 1	Each **SCHEDULE** number is selected by a combination of the schedule signals 1, 2, 4, 8 and 16. For the **SCHEDULE** number and the combinations of signals, see the table below.
30	SCHEDULE 2	
31	SCHEDULE 4	
32	SCHEDULE 8	
33	SCHEDULE 16	

Selection of Schedule Numbers

Input SCH. #	SCH 1 (pin 29)	SCH 2 (pin 30)	SCH 4 (pin 31)	SCH 8 (pin 32)	SCH 16 (pin 33)
00					
01	♦				
02		♦			
03	♦	♦			
04			♦		
05	♦		♦		
06		♦	♦		
07	♦	♦	♦		
08				♦	
09	♦			♦	
10		♦		♦	
11	♦	♦		♦	
12			♦	♦	
13	♦		♦	♦	
14		♦	♦	♦	
15	♦	♦	♦	♦	
16					♦
17	♦				♦
18		♦			♦
19	♦	♦			♦
20			♦		♦
21	♦		♦		♦
22		♦	♦		♦
23	♦	♦	♦		♦
24				♦	♦
25	♦			♦	♦
26		♦		♦	♦
27	♦	♦		♦	♦
28			♦	♦	♦
29	♦		♦	♦	♦
30		♦	♦	♦	♦
31	♦	♦	♦	♦	♦

♦ **=** Input pin COM circuit closed.

Blank = Input pin COM circuit open.

External Input Signal Connections

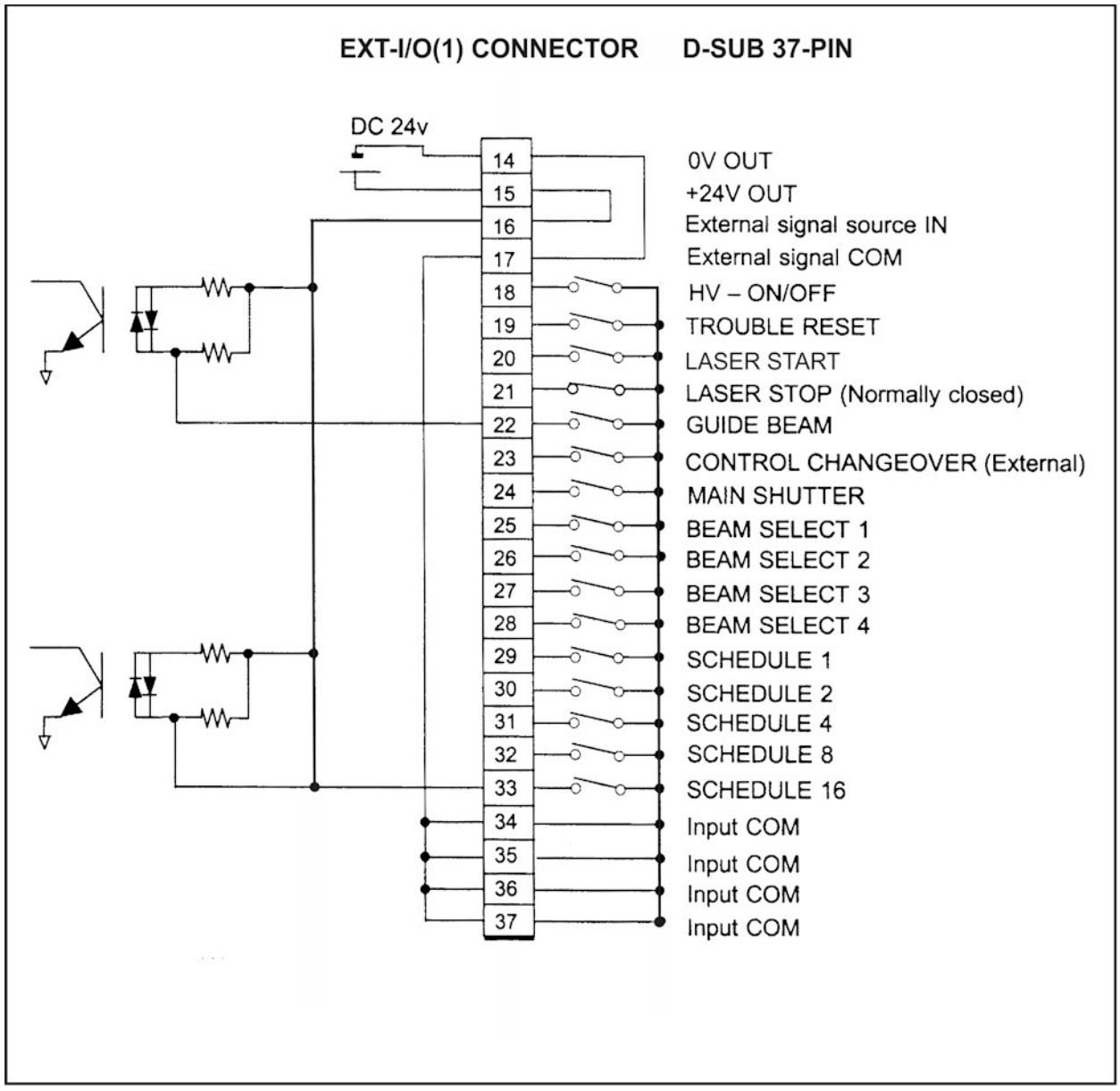


Figure B-2. When External Inputs are Contacts

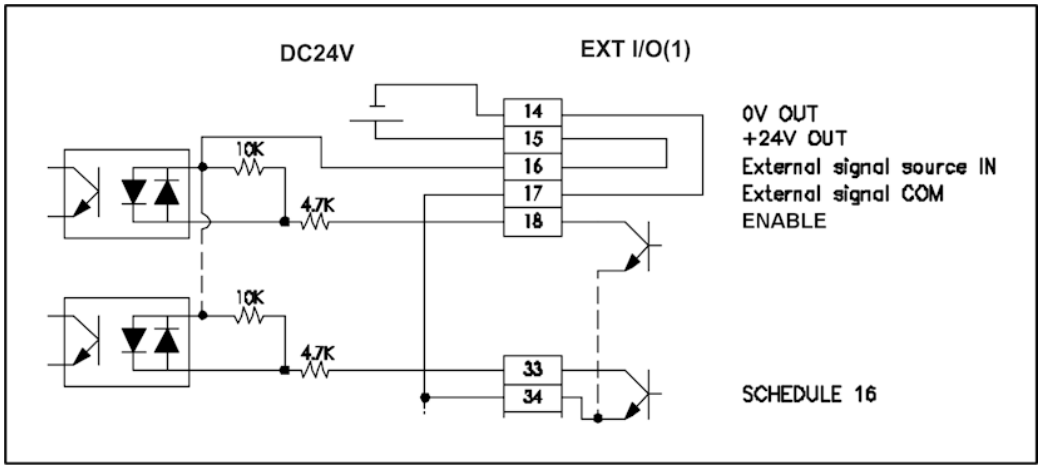


Figure B-3. When External Inputs are NPN Transistors

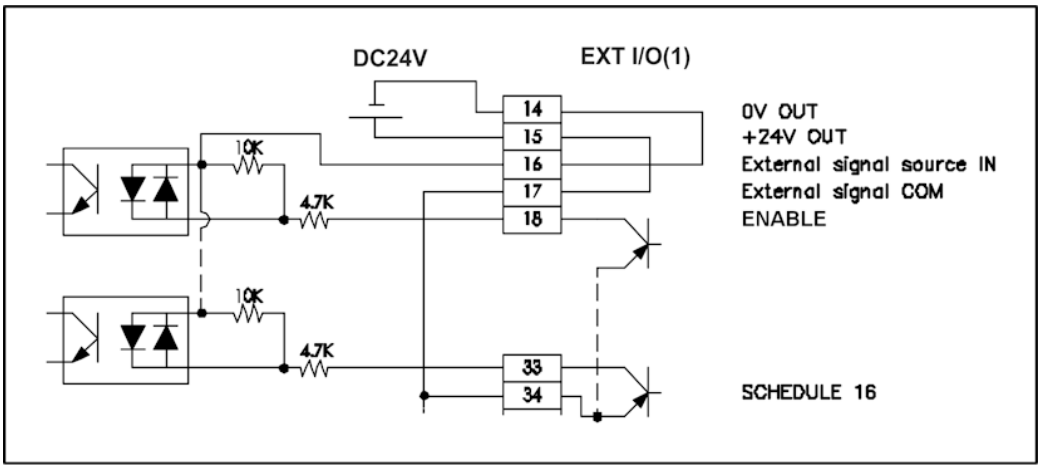


Figure B-4. When External Inputs are PNP Transistors

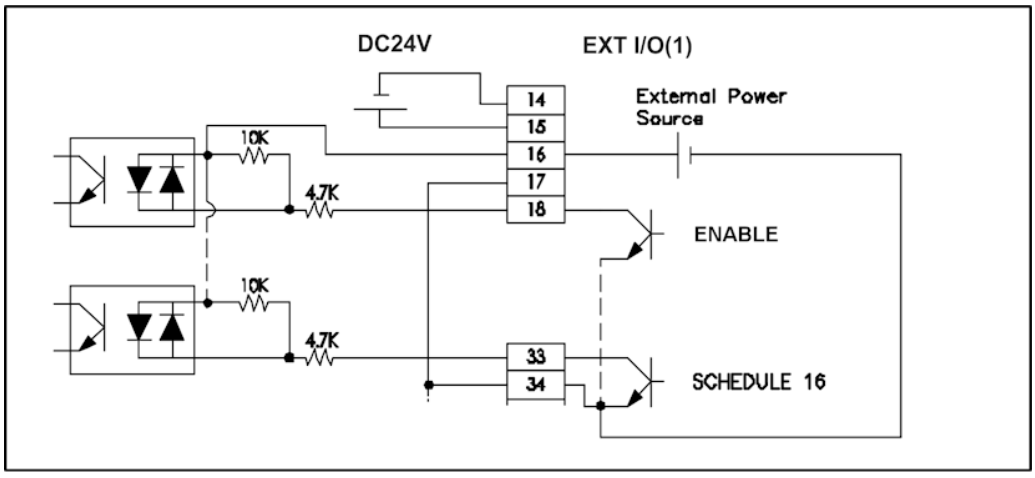


Figure B-5. When External Power Source is Supplied

External Output Signal Connections

Description of EXT I/O (1) Connector Input Pins

Pin No.	Description
1	**Ready.** When the laser module is enabled and it is ready to fire, the circuit is closed and the Ready signal is active.
2	**Power ON**. When the control key is turned on and the laser module has power, the circuit is closed and the signal stays active until the control key is turned off.
3	**Trouble.** If trouble arises, the circuit is opened until it is reset.
4	**End.** After the laser has fired, the circuit is closed for 40ms.

Connection of External Output Signals

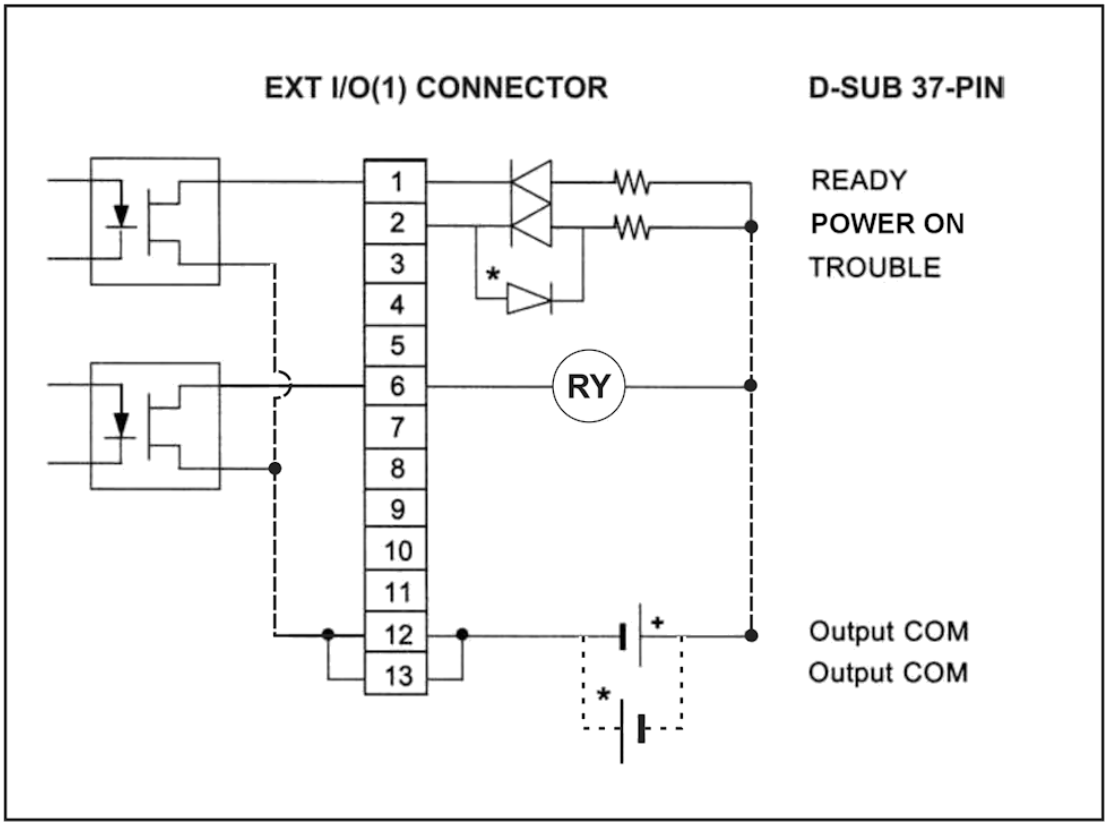


Figure B-6. EXT I/O(1) Connector

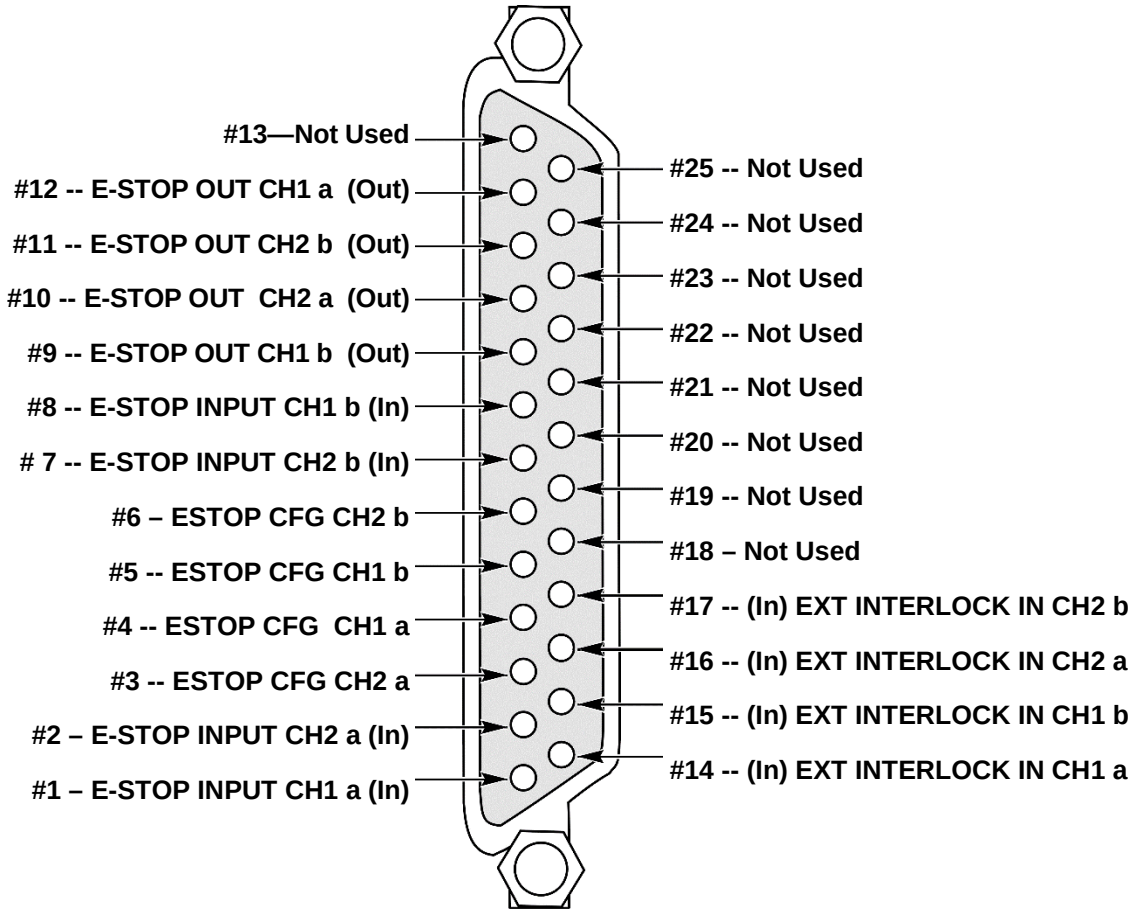


Figure B-7. EXT. I/O (2) D-SUB 25-Pin Configuration

Description of EXT I/O (2) Connector Input Pins

See Chapter 2 for wiring and connection information for E-Stop and Interlock Input wiring

Pin No.	Description
1	**E-STOP IN CH1 a.** When the circuit between pin 1 and 8 is opened, an E-stop will be activated. This will turn off the diode power to the laser. For normal operation, both E-stop Input connections (channels 1 & 2) must be closed. If either E-Stop is activated, the Laser will go into E-Stop mode and must manually be reset by Laser Operator. Refer to *Chapter 2, Installation* for details.
2	**E-STOP IN CH2 a.** When the circuit between pin 2 and 7 is opened, the E-stop will be activated. This will turn off the diode power to the laser. For normal operation, both E-stop Input connections (channels 1 & 2) must be closed. If either E-Stop is activated, the Laser will go into E-Stop mode and must manually be reset by Laser Operator. Refer to *Chapter 2, Installation* for details.
3	**E-STOP CFG CH2 a**. Used for configuration and connection with external emergency stop hardware. Refer to *Chapter 2, Installation* for details.
4	**E-STOP CFG CH1 a.** Used for configuration and connection with external emergency stop hardware. Refer to *Chapter 2, Installation* for details.
5	**E-STOP CFG CH1 b.** Used for configuration and connection with external emergency stop hardware. Refer to *Chapter 2, Installation* for details.
6	**E-STOP CFG CH2 b.** Used for configuration and connection with external emergency stop hardware. Refer to *Chapter 2, Installation* for details.
7	**E-STOP IN CH2 b.** When the circuit between pin 2 and 7 is opened, the E-stop will be activated. This will turn off the diode power to the laser. For normal operation, both E-stop Input connections (channels 1 and 2) must be closed. If either E-Stop is activated, the Laser will go into E-Stop mode and must manually be reset by Laser Operator.
8	**E-STOP IN CH1 b.** When the circuit between pin 1 and 8 is opened, an E-stop will be activated. This will turn off the diode power to the laser. For normal operation, both E-stop Input connections (channels 1 & 2) must be closed. If either E-Stop is activated, the Laser will go into E-Stop mode and must manually be reset by Laser Operator.
14	**INTERLOCK IN CH1 a.** When connection between pin 14 and 15 is opened, the Interlock will be activated. This will disable the laser. Interlock will reset once both Interlock inputs 1 and 2 are closed simultaneously.
15	**INTERLOCK IN CH1 b.** When connection between pin 14 and 15 is opened, the Interlock will be activated. This will disable the laser. Interlock will reset once both Interlock inputs 1 and 2 are closed simultaneously.
16	**INTERLOCK IN CH2 a.** When connection between pin 16 and 17 is opened, the Interlock will be activated. This will disable the laser. Interlock will reset once both Interlock inputs 1 and 2 are closed simultaneously.
17	**INTERLOCK IN CH2 b.** When connection between pin 16 and 17 is opened, the Interlock will be activated. This will disable the laser. Interlock will reset once both Interlock inputs 1 and 2 are closed simultaneously.

Description of EXT I/O (2) Connector OUTPUT Pins

Pin No.	Description
9	**E-STOP OUT 1.** When the laser is put into an E-stop condition, the contacts between pin 9 and 12 will open.
10	**E-STOP OUT 2.** When the laser is put into an E-stop condition, the contacts between pin 10 and 11 will open.
11	**E-STOP OUT 2.** When the laser is put into an E-stop condition, the contacts between pin 10 and 11 will open.
12	**E-STOP OUT 1.** When the laser is put into an E-stop condition, the contacts between pin 9 and 12 will open.

CAUTION

Proper integration of the Laser with external equipment is required for compliance with applicable safety regulations. The following wiring diagrams represent typical implementations. Failure to select and implement a correct method of wiring can render the Laser unsafe.

Dual E-Stop / Interlock Wiring

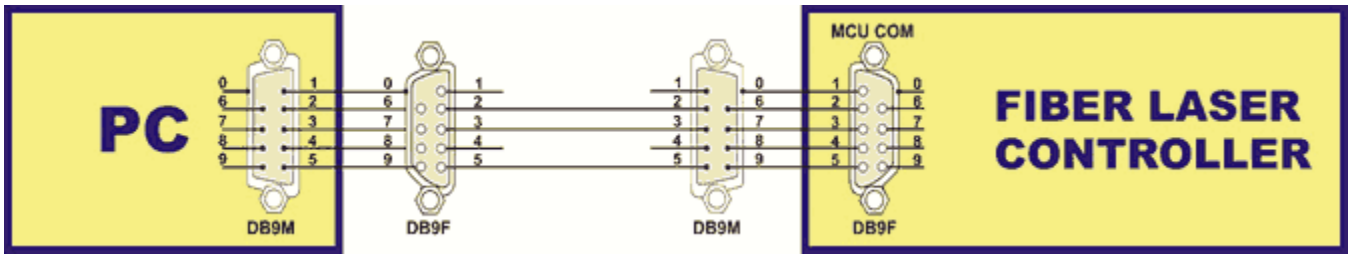
Please refer to Chapter 2: Installation for details on safely integrating the Emergency Stop and Remote Interlock functions.

APPENDIX C
EXTERNAL RS-232 COMMUNICATION

The fiber laser controller is considered a DCE (data circuit-terminating equipment) device. If interfacing with a computer, which is a DTE (data terminal equipment) device, a standard DB9 serial cable should be used.

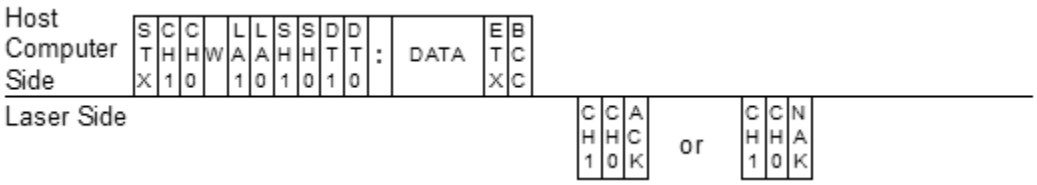
Transmission Mode: Baud Rate	RS-232 compliant, asynchronous, full-duplex 9600	**Factory Default Settings:**
Data Format	Baud Rate: 9,600 bps, 19,200 bps, 38,400 bps, or 57,600 bps	9600 bps
	Data bit: 8, 7	8 data bits
	Stop bit: 2, 1	2 stop bits
	Parity bit: Even, Odd, None	Even Parity
Character Code:	ASCII	

* **Variable data format only available on updated control on 8-932 models; 8-931/8-930 only supports default setting**s



Commands

1.	Data Setting	Code: W



1. CH1 and CH0 represent the unit number (CH1 = tens, CH0 = ones).
2. LA1 and LA0 represent the classification number of the setting. (LA1 = tens, LA0 = ones).

Fiber Laser Version	
84	Schedule settings for both FIX and FLEX
85	Schedule settings for FIX
86	Schedule settings for FLEX - TIME 01 to 10
87	Schedule settings for FLEX - TIME 11 to 20 *(8-932 Model Only)*
88	Schedule settings for FLEX - WATT 01 to 10
89	Schedule settings for FLEX - WATT 11 to 20 *(8-932 Model Only)*
66	Schedule settings for CW - TIME 01 to 10
67	Schedule settings for CW - TIME 11 to 20 *(8-932 Model Only)*
68	Schedule settings for CW - WATT 01 to 10
69	Schedule settings for CW - WATT 11 to 20 *(8-932 Model Only)*
75	SEAM Setting – WAVE ON/OFF
76	SEAM Setting – No. of shots: 01 ~ 10
77	SEAM Setting – No. of shots: 01 ~ 10 *(8-932 Model Only)*
78	SEAM Setting – Laser Energy: 01 ~ 10
79	SEAM Setting – Laser Energy: 11 ~ 20 *(8-932 Model Only)*

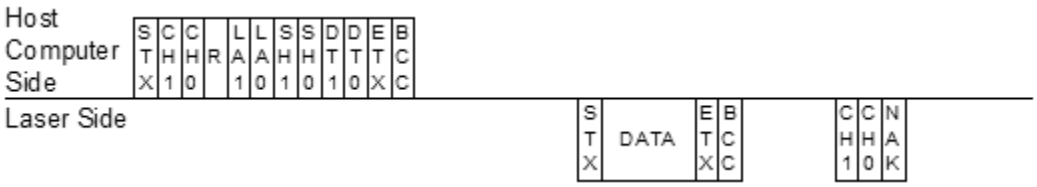
3. SH1 and SH0 represent the Schedule number (SH1 = tens, SH0 = ones)
   Enter the No. of the schedule you want to change within the data range of 00 to 31. Use 2 spaces (☐☐) to keep the current Schedule No.
4. DT1 and DT0 represent the Data (#) number (DT1 = tens, DT0 = ones)
   - See the Setting and Monitor section below for detailed information.
   - Enter 99 to enter data in a batch.

- Data: (Data No.1), (Data No.2), (Data No.3), … (the last Data No.)
- Insert a comma and space [,] between data values.
- The monitor data (Water Temperature, Total Count, Good Count and Energy Monitor Value) will not be written.

5. If the transmitted data is valid an [ACK] will be returned. If not, a [NAK] will be returned.

6. The Laser accepts data from the host PC only when in communication line control mode. The Laser returns a NAK in any other mode.

2.	Data Read	Code: R



1. CH1 and CH0 represent the unit number (CH1 = tens, CH0 = ones).
2. LA1 and LA0 represent the classification number of the setting (LA1 = tens, LA0 = ones).

Fiber Laser Version	
84	Schedule settings for both FIX and FLEX
85	Schedule settings for FIX
86	Schedule settings for FLEX - TIME 01 to 10
87	Schedule settings for FLEX - TIME 11 to 20 *(8-932 Model Only)*
88	Schedule settings for FLEX - WATT 01 to 10
89	Schedule settings for FLEX - WATT 11 to 20 *(8-93 2Model Only)*
66	Schedule settings for CW - TIME 01 to 10
67	Schedule settings for CW - TIME 11 to 20 *(8-932 Model Only)*
68	Schedule settings for CW - WATT 01 to 10
69	Schedule settings for CW - WATT 11 to 20 *(8-932 Model Only)*
75	SEAM Setting – WAVE ON/OFF
76	SEAM Setting – No. of shots: 01 ~ 10
77	SEAM Setting – No. of shots: 01 ~ 10 *(8-932 Model Only)*
78	SEAM Setting – Laser Energy: 01 ~ 10
79	SEAM Setting – Laser Energy: 11 ~ 20 *(8-932 Model Only)*

3. SH1 and SH0 represent the schedule number (SH1 = tens, SH0 = ones)
   Available data range is 00 to 31. Enter the number of the Schedule you want to read.
   Use 2 spaces ( ) to keep the current Schedule number.
4. DT1 and DT0 represent the Data (#) number (DT1 = tens, DT0 = ones)
   - See the Setting and Monitor section below for detailed information.
   - Enter 99 to enter data in a batch.
     – Data: (Data No.1), (Data No.2), (Data No.3), ... (the last Data No.)
     – Insert a comma and space [,] between data values.
     – The monitor data (Water Temperature, Total Count, Good Count and Energy Monitor Value) will not be written.
     – Fiber Laser: Data Fields that are not used/supported should be set to 0 (see data tables 84 and 85)
5. If the transmitted data is valid an [ACK] will be returned. If not, a [NAK] will be returned.
6. There is usually a delay in returning the BCC (checksum) from the laser. When performing this command, wait for the BCC (checksum) before issuing another command.

Classifications – for Read and Write Commands

- 84 Schedule Settings for both **FIX** and **FLEX**

DATA #	ITEM	DATA RANGE Fiber Laser
01	**FORM** on the (Program Box) **SCHEDULE** screen Selection of waveform setting 0:FIX 1: FLEX 2:CW	0 – 2
02	Set waveform display on the (Program Box) **SCHEDULE** screen 0: OFF 1: ON	Not Used; Fixed to 0
03	Output **PEAK** value on the (Program Box) **SCHEDULE** screen:	000 – 500 (W) 000-1000 (W)
04	**REPEAT** on the (Program Box) **SCHEDULE** screen Repeat PPS (pulse repetition speed)	000 – 50000 (Hz)
05	**SHOT** on the (Program Box) **SCHEDULE** screen Repeat shot count (number of consecutive shots)	0000 – 9999
06	**HIGH** on the (Program Box) **POWER MONITOR** screen Energy monitor upper limit setting	Not Used; Fixed to 0000
07	**LOW** on the (Program Box) **POWER MONITOR** screen Energy monitor lower limit setting	Not Used; Fixed to 0000
08	Power monitor waveform display on the (Program Box) **POWER MONITOR** screen 0: OFF 1: ON	Not Used; Fixed to 0
09	**REFERENCE SET** on the (Program Box) **POWER MONITOR** screen	Not Used; Fixed to 000

- 85 Schedule Settings for **FIX** only

DATA #	ITEM	DATA RANGE Fiber Laser
01	**UP SLOPE** Time on the (Program Box) **SCHEDULE** screen	Fixed to 000
02	**FLASH 1** Time on the (Program Box) **SCHEDULE** screen	000 – 49999 (x 0.001ms)
03	**FLASH 2** Time on the (Program Box) **SCHEDULE** screen	000 – 9999 (x 0.01ms)
04	**FLASH 3** Time on the (Program Box) **SCHEDULE** screen	000 – 9999 (x 0.01ms)
05	**DOWN SLOPE** Time on the (Program Box) **SCHEDULE** screen	Fixed to 000
06	Not used.	Fixed to 0000
07	**FLASH 1** Watt on the (Program Box) **SCHEDULE** screen	000 – 100 (%)
08	**FLASH 2** Watt on the (Program Box) **SCHEDULE** screen	000 – 100 (%)
09	**FLASH 3** Watt on the (Program Box) **SCHEDULE** screen	000 – 100 (%)
10	Not used.	Fixed to 0000
11	**[~]** on the (Program Box) **POWER MONITOR** screen. Reads the approximate laser output energy of the set waveform.	Fixed to 0000
12	**COOL 1 TIME** on the **SCHEDULE** screen.	Fixed to 000
13	**COOL 2 TIME** on the **SCHEDULE** screen.	Fixed to 000

- 86 Schedule Settings for FLEX - TIME 01 to 10

Controller:

DATA #	ITEM	DATA RANGE (x 0.01ms)
01	**Point 1** Time on the (Program Box) SCHEDULE screen	0000 – 9999
02	**Point 2** Time on the (Program Box) SCHEDULE screen	0000 – 9999
03	**Point 3** Time on the (Program Box) SCHEDULE screen	0000 – 9999
04	**Point 4** Time on the (Program Box) SCHEDULE screen	0000 – 9999
05	**Point 5** Time on the (Program Box) SCHEDULE screen	0000 – 9999
06	**Point 6** Time on the (Program Box) SCHEDULE screen	0000 – 9999
07	**Point 7** Time on the (Program Box) SCHEDULE screen	0000 – 9999
08	**Point 8** Time on the (Program Box) SCHEDULE screen	0000 – 9999
09	**Point 9** Time on the (Program Box) SCHEDULE screen	0000 – 9999
10	**Point 10** Time on the (Program Box) SCHEDULE screen	0000 – 9999
11	[~] on the (Program Box) POWER MONITOR screen. Reads the approximate laser output energy of the set waveform.	Not Used

- 87 Schedule Settings for FLEX - TIME 11 to 20 ***(8-832 Model Only)***

Controller:

DATA #	ITEM	DATA RANGE (x 0.01ms)
01	**Point 11** Time on the (Program Box) SCHEDULE screen	0000 – 9999
02	**Point 12** Time on the (Program Box) SCHEDULE screen	0000 – 9999
03	**Point 13** Time on the (Program Box) SCHEDULE screen	0000 – 9999
04	**Point 14** Time on the (Program Box) SCHEDULE screen	0000 – 9999
05	**Point 15** Time on the (Program Box) SCHEDULE screen	0000 – 9999
06	**Point 16** Time on the (Program Box) SCHEDULE screen	0000 – 9999
07	**Point 17** Time on the (Program Box) SCHEDULE screen	0000 – 9999
08	**Point 18** Time on the (Program Box) SCHEDULE screen	0000 – 9999
09	**Point 19** Time on the (Program Box) SCHEDULE screen	0000 – 9999
10	**Point 20** Time on the (Program Box) SCHEDULE screen	0000 – 9999
11	[~] on the (Program Box) **POWER MONITOR** screen. Reads the approximate laser output energy of the set waveform.	Not Used

- 88 Schedule Settings for FLEX - POWER 01 to 10

Controller:

DATA #	ITEM	DATA RANGE (x 1%)
01	**Point 1** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
02	**Point 2** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
03	**Point 3** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
04	**Point 4** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
05	**Point 5** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
06	**Point 6** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
07	**Point 7** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
08	**Point 8** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
09	**Point 9** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
10	**Point 10** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
11	[~] on the (Program Box) **POWER MONITOR** screen. Reads the approximate laser output energy of the set waveform.	Not used

- 89 Schedule Settings for FLEX - POWER 11 to 20 ***(8-832 Model Only)***

Controller:

DATA #	ITEM	DATA RANGE (x 1%)
01	**Point 11** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
02	**Point 12** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
03	**Point 13** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
04	**Point 14** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
05	**Point 15** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
06	**Point 16** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
07	**Point 17** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
08	**Point 18** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
09	**Point 19** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
10	**Point 20** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
11	[~] on the (Program Box) **POWER MONITOR** screen. Reads the approximate laser output energy of the set waveform.	Not used

- 66 Schedule Settings for CW - TIME 01 to 10

Controller:

DATA #	ITEM	DATA RANGE (x 0.01s)
01	**Point 1** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
02	**Point 2** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
03	**Point 3** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
04	**Point 4** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
05	**Point 5** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
06	**Point 6** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
07	**Point 7** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
08	**Point 8** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
09	**Point 9** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
10	**Point 10** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999

- 67 Schedule Settings for CW - TIME 11 to 20 ***(8-832 Model Only)***

Controller:

DATA #	ITEM	DATA RANGE (x 0.01s)
01	**Point 11** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
02	**Point 12** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
03	**Point 13** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
04	**Point 14** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
05	**Point 15** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
06	**Point 16** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
07	**Point 17** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
08	**Point 18** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
09	**Point 19** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999
10	**Point 20** Time on the (Program Box) **SCHEDULE** screen	0000 – 9999

- 68 Schedule Settings for CW - POWER 01 to 10

Controller:

DATA #	ITEM	DATA RANGE (x 1%)
01	**Point 1** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
02	**Point 2** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
03	**Point 3** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
04	**Point 4** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
05	**Point 5** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
06	**Point 6** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
07	**Point 7** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
08	**Point 8** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
09	**Point 9** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
10	**Point 10** Watt on the (Program Box) **SCHEDULE** screen	000 – 100

- 69 Schedule Settings for CW - POWER 11 to 20 ***(8-832 Model Only)***

Controller:

DATA #	ITEM	DATA RANGE (x 1%)
01	**Point 11** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
02	**Point 12** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
03	**Point 13** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
04	**Point 14** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
05	**Point 15** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
06	**Point 16** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
07	**Point 17** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
08	**Point 18** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
09	**Point 19** Watt on the (Program Box) **SCHEDULE** screen	000 – 100
10	**Point 20** Watt on the (Program Box) **SCHEDULE** screen	000 – 100

- 75 SEAM Weld Setting – ON / OFF

Controller:

DATA #	ITEM	DATA RANGE (x 1%)
01	Turn ON / OFF the [SEAM] Weld Function	0: OFF 1: ON

- 76 SEAM Weld Settings - Shot 01 to 10

Controller:

DATA #	ITEM	DATA RANGE
01	**Point 1** Shot on the **SEAM** screen	0000 – 9999
02	**Point 2** Shot on the **SEAM** screen	0000 – 9999
03	**Point 3** Shot on the **SEAM** screen	0000 – 9999
04	**Point 4** Shot on the **SEAM** screen	0000 – 9999
05	**Point 5** Shot on the **SEAM** screen	0000 – 9999
06	**Point 6** Shot on the **SEAM** screen	0000 – 9999
07	**Point 7** Shot on the **SEAM** screen	0000 – 9999
08	**Point 8** Shot on the **SEAM** screen	0000 – 9999
09	**Point 9** Shot on the **SEAM** screen	0000 – 9999
10	**Point 10** Shot on the **SEAM** screen	0000 – 9999

- 77 SEAM Weld Settings - Shot 11 to 12 ***(8-832 Model Only)***

Controller:

DATA #	ITEM	DATA RANGE
01	**Point 11** Shot on the **SEAM** screen	0000 – 9999
02	**Point 12** Shot on the **SEAM** screen	0000 – 9999
03	**Point 13** Shot on the **SEAM** screen	0000 – 9999
04	**Point 14** Shot on the **SEAM** screen	0000 – 9999
05	**Point 15** Shot on the **SEAM** screen	0000 – 9999
06	**Point 16** Shot on the **SEAM** screen	0000 – 9999
07	**Point 17** Shot on the **SEAM** screen	0000 – 9999
08	**Point 18** Shot on the **SEAM** screen	0000 – 9999
09	**Point 19** Shot on the **SEAM** screen	0000 – 9999
10	**Point 20** Shot on the **SEAM** screen	0000 – 9999

- 78 SEAM Weld Settings - POWER 01 to 10

Controller:

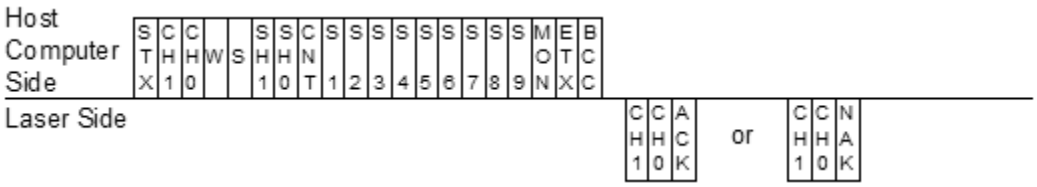
DATA #	ITEM	DATA RANGE (x 1%)
01	**Point 1** Power on the **SEAM** screen	000 – 100
02	**Point 2** Power on the **SEAM** screen	000 – 100
03	**Point 3** Power on the **SEAM** screen	000 – 100
04	**Point 4** Power on the **SEAM** screen	000 – 100
05	**Point 5** Power on the **SEAM** screen	000 – 100
06	**Point 6** Power on the **SEAM** screen	000 – 100
07	**Point 7** Power on the **SEAM** screen	000 – 100
08	**Point 8** Power on the **SEAM** screen	000 – 100
09	**Point 9** Power on the **SEAM** screen	000 – 100
10	**Point 10** Power on the **SEAM** screen	000 – 100

- 79 SEAM Weld Settings - POWER 11 to 20 ***(8-832 Model Only)***

Controller:

DATA #	ITEM	DATA RANGE (x 1%)
01	**Point 11** Power on the **SEAM** screen	000 – 100
02	**Point 12** Power on the **SEAM** screen	000 – 100
03	**Point 13** Power on the **SEAM** screen	000 – 100
04	**Point 14** Power on the **SEAM** screen	000 – 100
05	**Point 15** Power on the **SEAM** screen	000 – 100
06	**Point 16** Power on the **SEAM** screen	000 – 100
07	**Point 17** Power on the **SEAM** screen	000 – 100
08	**Point 18** Power on the **SEAM** screen	000 – 100
09	**Point 19** Power on the **SEAM** screen	000 – 100
10	**Point 20** Power on the **SEAM** screen	000 – 100

3.	Status, Control Mode and Schedule No. Settings	Code: W S



1. CH1 and CH0 represent the unit number (CH1 = tens, CH0 = ones)
2. SH1 and SH0 represent the schedule number (SH1 = tens, SH0 = ones)
   Available data range is 00 to 31. Enter the number of the Schedule you want to read.
   Use 2 spaces (☐☐) to keep the current Schedule number.
3. CNT = Control mode

   Laser cannot be set to external control mode or maintenance mode form the host PC.
   - ☐ : Keep current setting (space bar)
   - 0 : Panel control (laser controller)
   - 1 : External control (Schedules are set on the laser controller.)
   - 2 : External Communication Control
   - 3 : Maintenance
   - 4 : (Not used)
   - 5 : External control (Schedules are set through the communication line.)

Controller			
LASER CONTROLLER	**EXT-I/O**	**CONTROL MODE SET THROUGH THE COMMUNICATION LINE**	**CONTROL MODE ACTUALLY SET**
MAINTENANCE MODE	**CONTROL CHANGE-OVER**		
OFF	OFF	0: Panel control	0: Panel control
OFF	OFF	1: External control (Panel)	Not available (no change)
OFF	OFF	2: Communication line control	2: Communication line control
OFF	OFF	3: Maintenance	Not available (no change).
OFF	OFF	5: External control (RS-485)	Not available (no change).
OFF	ON	0: Panel control	1: External control (Schedules are set on the laser controller.)
OFF	ON	2: Communication line control	5: External control (Schedules are set through the communication line.)
OFF	ON	Other than 0 or 2	Settings other than 0 or 2 are ignored (no change)
ON	Ignored	Ignored	Not available (no change)

NOTE: Leave all other fields blank when changing the "CNT" control mode.

(Enter □ for all other items).

- When the Laser is in 1: External control (laser controller) mode:
  - The Laser receives 2: Communication line control --- The Laser will go into 5: External control (communication line) mode.
  - When the EXT-I/O control changeover is turned OFF --- The Laser goes into 0: Panel control mode.
- When the Laser is in 5: External control (communication line) mode:
  - The Laser receives 0: Panel control --- The Laser will go into 1: External control (laser controller) mode.
  - The EXT-I/O control changeover is turned OFF --- The Laser goes into 2: Communication line control mode.
- The key switch is turned OFF --- The Laser goes into 0: Panel control mode.

4. Status

Fiber Laser Version	
S1= Enable	0: OFF 1: ON
S2= Guide LD	0: OFF 1: ON
S3= Main shutter	(0: OFF 1: ON : No change is made.)**
S4= Branch shutter 1	Not supported. Must be set to _: No change is made
S5= Branch shutter 2	Not supported. Must be set to _: No change is made
S6= Branch shutter 3	Not supported. Must be set to _: No change is made
S7= Branch shutter 4	Not supported. Must be set to _: No change is made
S8= Branch shutter 5	Not supported. Must be set to _: No change is made
S9= Branch shutter 6	Not supported. Must be set to _: No change is made

** Setting the main shutter status bits can be done, but currently has no effect on the system.

5. **MON** = Automatic transmission of monitor data

Fiber Laser Version
Not supported. Must be set to 0: No change is made

6. The Laser accepts data from the host PC only when in communication line control mode. The Laser returns a NAK in any other mode.

Fiber Laser Version
Not supported. Returns NAK

4.	Status Read	Code: R S

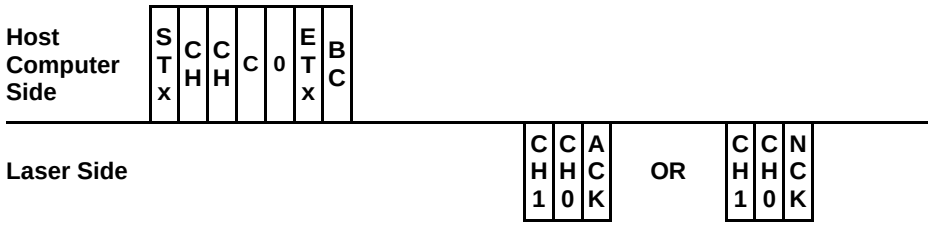
1. CH1 and CH0 represent the unit number (CH1 = tens, CH0 = ones)
2. SH1 and SH0 represent the schedule number (SH1 = tens, SH0 = ones)
   Available data range is 00 to 31. Enter the number of the Schedule you want to read. Use 2 spaces ( ) to keep the current Schedule number.
3. CNT = Control mode
   You cannot set the Laser to external control mode or maintenance mode on the host PC.
   0: Panel control (laser controller)
   1: External control (Schedules are set on the laser controller.)
   2: External Communication Control
   3: Maintenance
   4: (Not used)
   5: External control (Schedules are set through the RS-485communication line.)
   6: External control (Schedules are set through the RS-485communication line.)
4. Status

Fiber Laser Version	
S1= Enable	Return Enable
S2= LD	Return Guide LD
S3= Main shutter	Return Main Shutter**
S4= Branch shutter 1	Not used, fixed to 0
S5= Branch shutter 2	Not used, fixed to 0
S6= Branch shutter 3	Not used, fixed to 0
S7= Branch shutter 4	Not used, fixed to 0
S8= Branch shutter 5	Not used, fixed to 0
S9= Branch shutter 6	Not used, fixed to 0

** States of main shutter, and branch shutter 1 are returned. Currently, these status bits do not reflect the state of the laser.

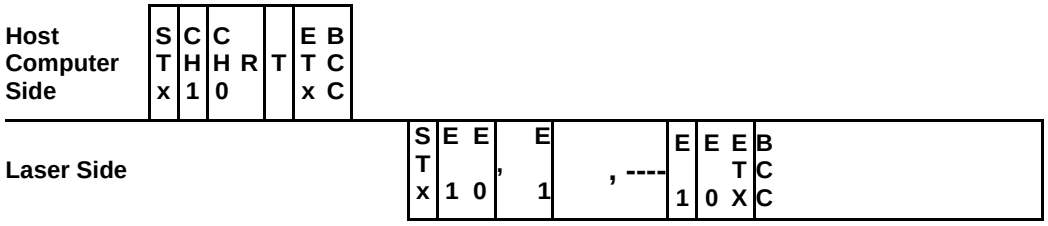
5. MON = Automatically sends laser power monitor data (0: OFF 1: ON.) (Fiber Laser – Not used, fixed to 0.
6. RDY = Ready status (0: Laser not ready 1: Laser is ready for use) (Fiber Laser – Currently not supported, fixed to 0).
7. There is usually a delay in returning the BCC (checksum) from the laser. When performing this command, wait for the BCC (checksum) before issuing another command.

5.	Trouble Reset Command	Code: C 0



1. CH1 and CH0 represent the unit number (CH1 = tens, CH0 = ones).
2. After receiving the command, the laser resets the Trouble Status (alarm).
3. The Laser accepts data from the host PC only when in communication line control mode. The Laser returns a NAK in any other mode.

6.	Trouble Read (Error Status)	Code: R T



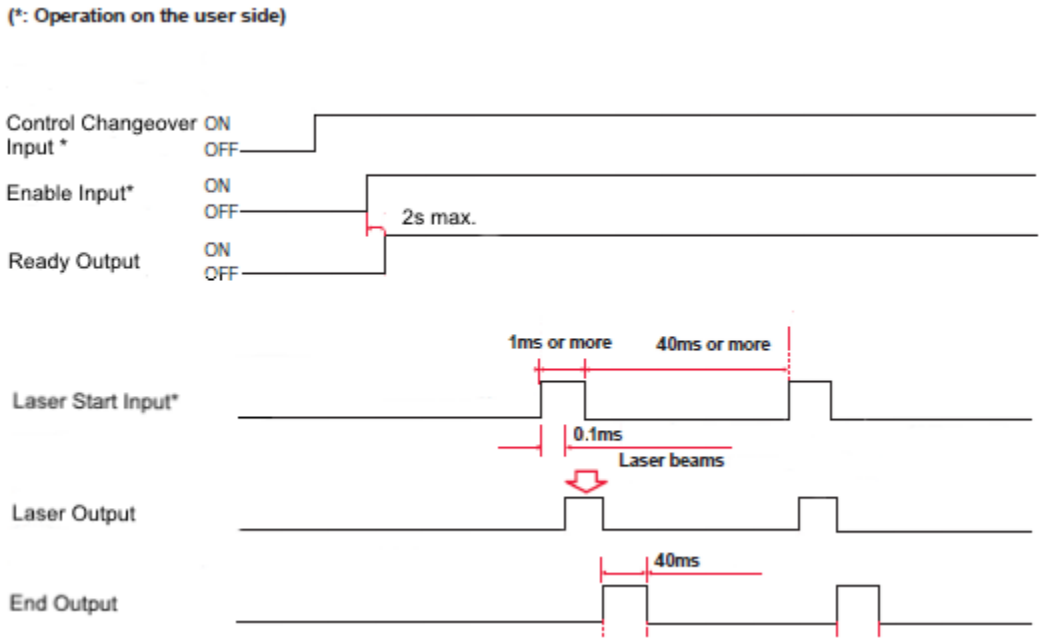
1. CH1 and CH0 represent the unit number (CH1 = tens, CH0 = ones).
2. E1 and E0 represent the 2-digit error code. (E1 = tens, E0 = ones). All error numbers are transmitted. If no error has occurred, the read error will be 00.
3. There is usually a delay in returning the BCC (checksum) from the laser. When performing this command, wait for the BCC (checksum) before issuing another command.

APPENDIX D
SYSTEM TIMING

Below are the most commonly used system timing diagrams for the laser.

Operation with Laser Controller (PANEL CONTROL)

The following diagram shows the lapse of time in the case where the laser is enabled from the panel control and laser is fired using the start button on the front panel.

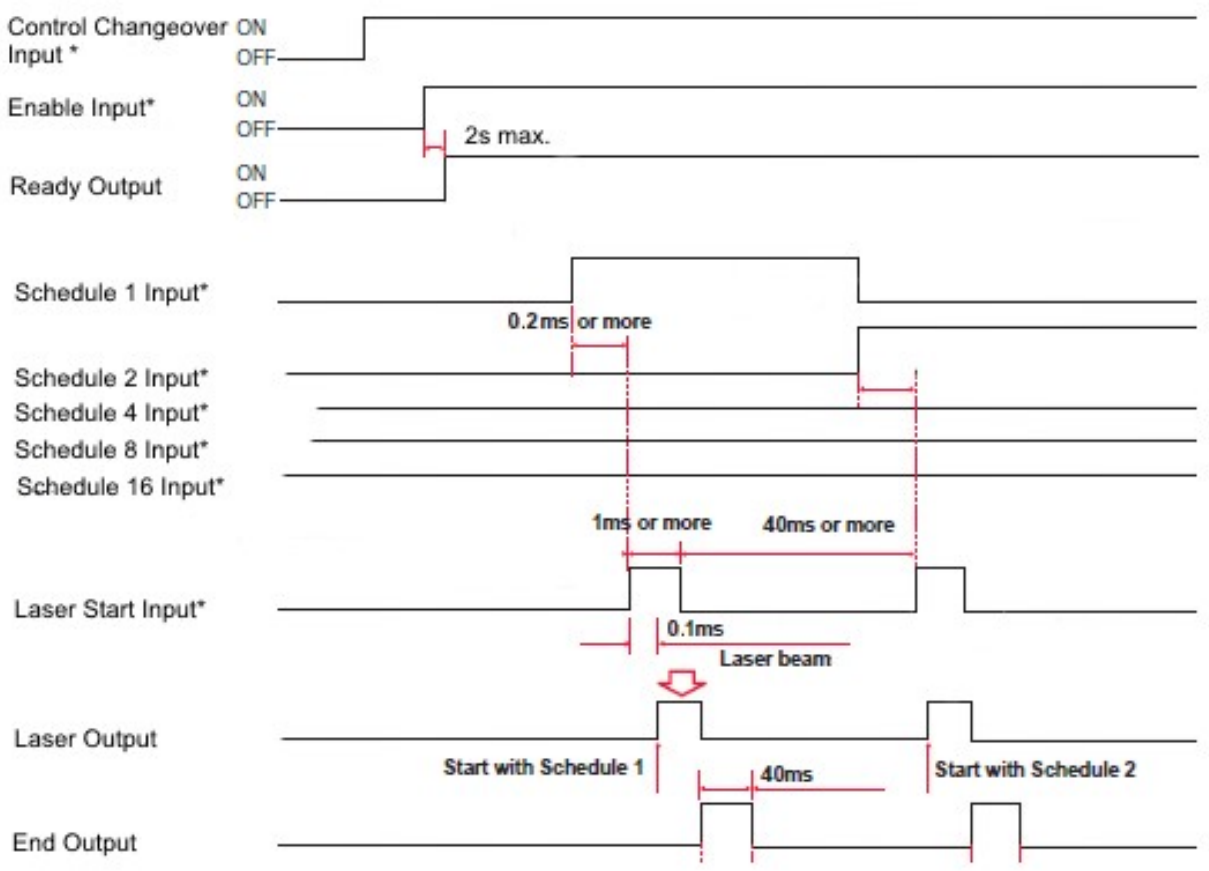


Operation by external input signals (EXTERNAL CONTROL)

The following diagram shows the lapse of time in the case where external I/O signals are used to start the laser using one schedule and then following it with another laser start signal using a different schedule number.

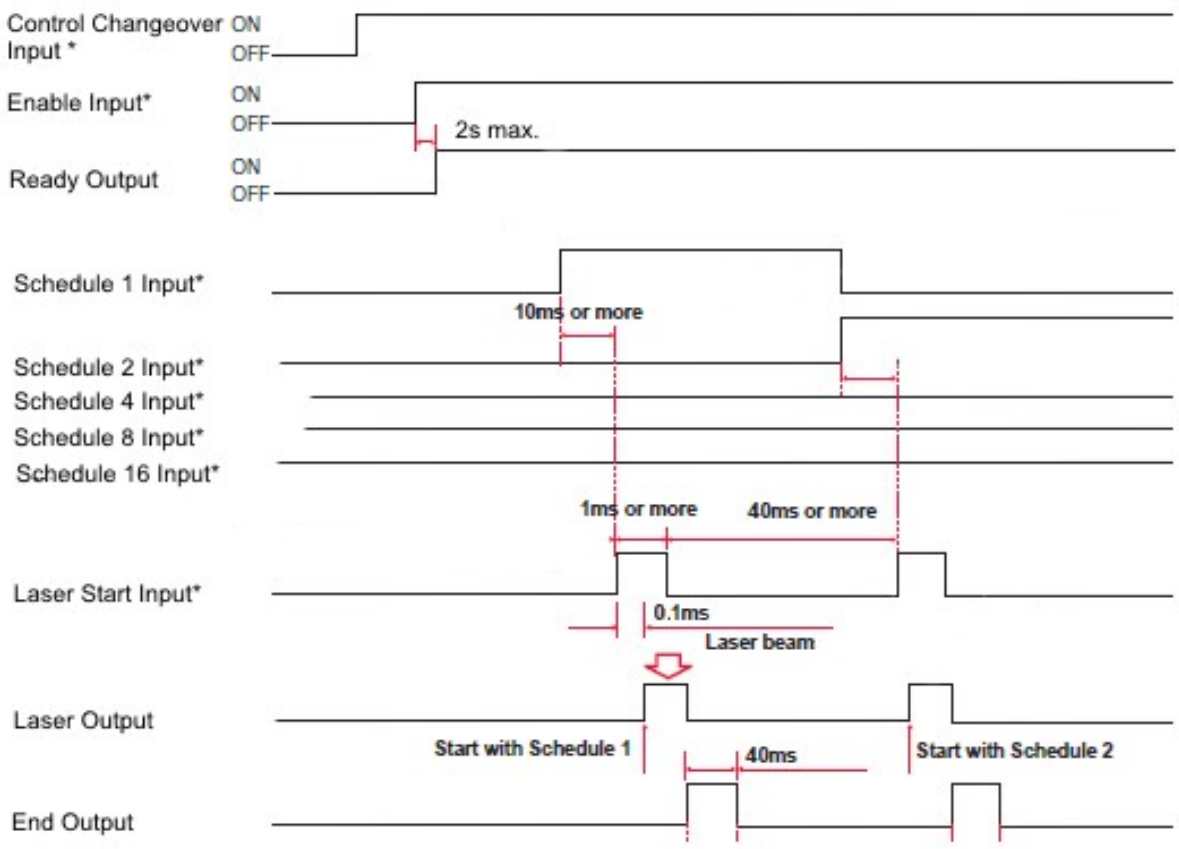
(8-932 models w/ updated controller)

(*: Operation on the user side)



(Other models)

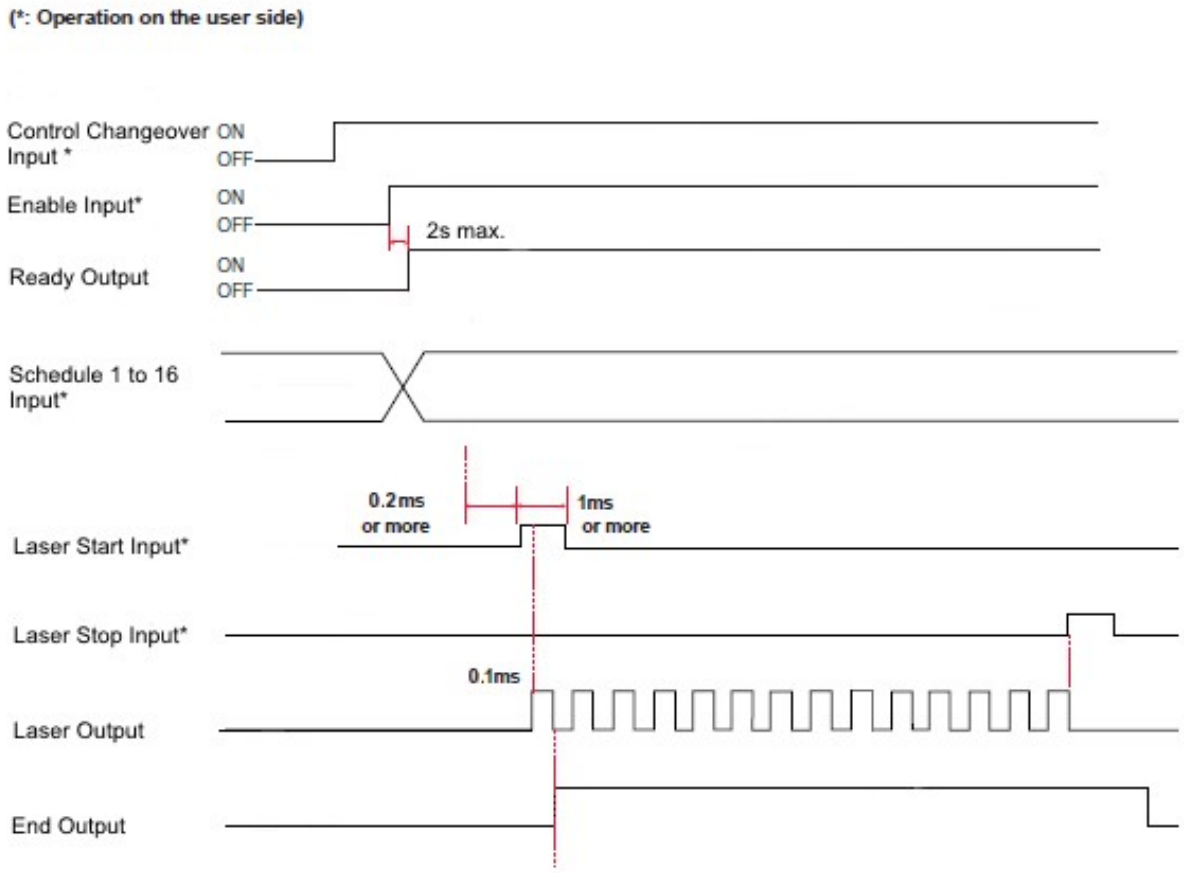
(*: Operation on the user side)



Repeated Operation (25 pps or more) (EXTERNAL CONTROL)

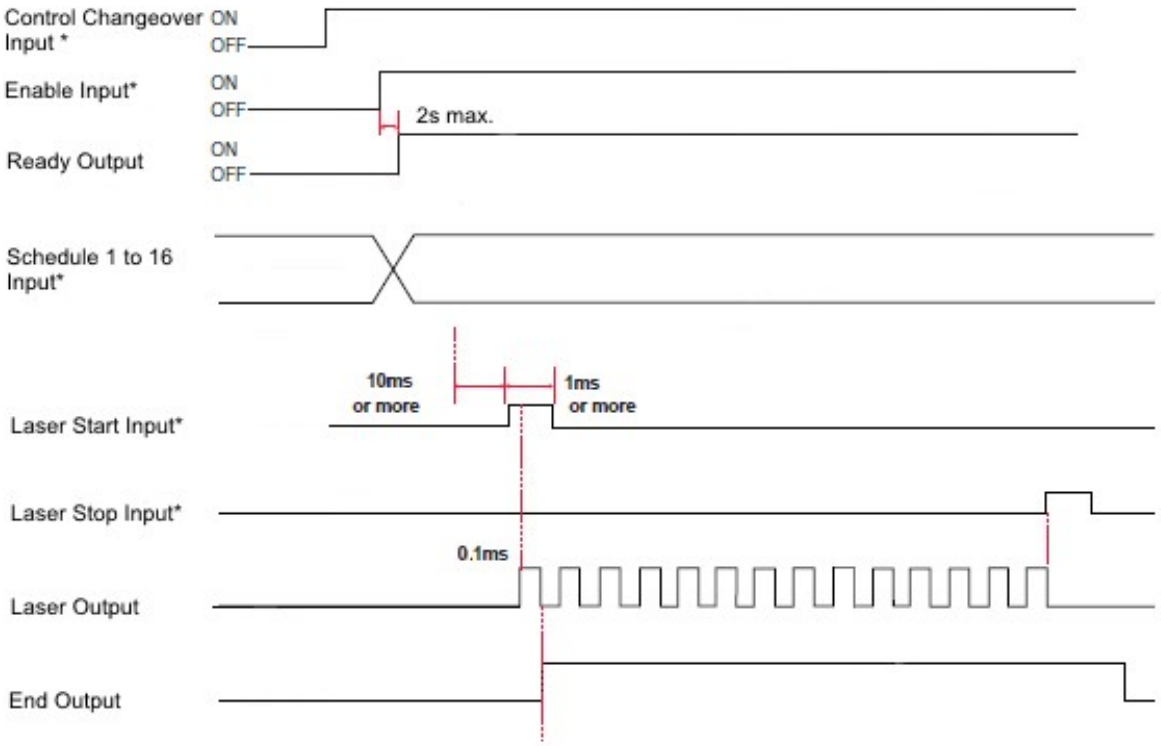
The following diagram shows the lapse of time in the case where laser is output according to the number of repeated outputs of 25 pps or more.

(8-932 models w/ updated controller)



(Other models)

(*: Operation on the user side)



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