Nd:YAG LASER WELDER

ML-2551A(-CE) / ML-2550A(-CE)

and

LW300A(E) / LW400A(E)

USER MANUAL

990-538 REV L

Printed in the United States of America

Revision Record

Revision	EO	Date	Basis of Revision
A	19390	8/02	Production release
B	19670	3/03	Updated features and specifications.
C	40857	1/11	Corrections + MLE-118A use.
D	42307	2/13	Corrections and updates.
E	42509	5/13	Corrections and updates.
F	42506	11/13	Corrections and update to Miyachi America name and logo.
G	43483	12/14	Update to Amada Miyachi America name and logo.
H	43879	11/15	Updated to Amada Miyachi America format.
J	44679	09/17	See ECO for description
K	46110	05/21	Updated to Amada Weld Tech name + updates. See ECO
L	47212	01/24	Update Manual Title

This Manual Covers the Following Models

The LW and ML Laser models are identical and only differ in labeling. The ML model numbers will be used exclusively starting in the year 2021. All Laser models listed below are commonly referred to as the "ML-2550A Series" Laser Welders. Depending on the date of manufacture the Laser colors may appear different than shown in this manual.

220VAC, 3Ø, 50/60Hz – Water-Cooled Models

8-8xx-01-xx		8-8xx-02-xx			8-8xx-03-xx
Amada Miyachi America	Amada Miyachi Corporation	Amada Miyachi America	Amada Miyachi Corporation		Amada Weld Tech Inc.
LW300A	ML-2551A	LW300A	ML-2551A	→	ML-2551A
LW400A	ML-2550A	LW400A	ML-2550A	→	ML-2550A

400VAC, 3Ø, 50/60Hz – Water-Cooled Models

8-xxx-01-xx		8-xxx-02-xx		8-xxx-03-xx			8-xxx-04-xx
Amada Miyachi America	Amada Miyachi Corporation	Amada Miyachi America	Amada Miyachi Corporation	Amada Miyachi America	Amada Miyachi Corporation		Amada Weld Tech Inc.
Non CE Compliant		Non CE Compliant		CE Compliant			CE Compliant
LW300AE	ML-2551A-CE	LW300AE	ML-2551A-CE	LW300AE	ML-2551A-CE	→	ML-2551A-CE
LW400AE	ML-2550A-CE	LW400AE	ML-2550A-CE	LW400AE	ML-2550A-CA	→	ML-2550A-CE

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Chapter 4. MLE-115A Programming Functions

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CONTACT US

Thank you for purchasing an AMADA WELD TECH Pulsed Nd:YAG Laser. Upon receipt of the laser, please inspect it thoroughly for shipping damage ***before*** you install it. If there is any damage, contact the shipping company immediately to file a claim, and notify us at:

AMADA WELD TECH INC.
1820 South Myrtle Avenue
Monrovia, California 91016

Phone: **(626) 303-5676**

FAX: **(626) 358-8048**

E-Mail: **info@amadaweldtech.com**

The contents of this manual are subject to change without notice. If you have any questions, or find any errors or omissions in this manual, please contact us.

AMADA WELD TECH is not responsible for any losses or injury due to the improper use of this product.

It is our intent to strive for quality in workmanship and materials with every Laser Welder we manufacture. It is important that you read and understand this manual before attempting installation or operation.

CDRH COMPLIANCE STATEMENT

The AMADA WELD TECH, ML-2551A(-CE) / ML-2550A(-CE) and LW300A(E) / LW400A(E) Nd:YAG Lasers are 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.

Reference CDRH Accession number is available upon request.

SAFETY PRECAUTIONS

Before using this equipment, read the **SAFETY PRECAUTIONS** carefully to understand the correct usage of the equipment.

- These precautions are given for 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:

WARNING

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

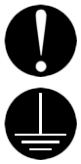
DANGER

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

CAUTION

Denotes operations and practices that may result in personal injury or damage to the equipment 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 INSIDE OF THE LASER UNNECESSARILY.

High voltages are present inside the equipment cabinet. Do ***not*** touch the inside of the Laser unnecessarily with the power turned ON.

NEVER DISASSEMBLE, REPAIR, OR MODIFY THE LASER.

These actions can cause electric shock and fire. Do ***not*** do anything other than the maintenance described in the Operator Manual.

DO NOT LOOK AT OR TOUCH THE LASER BEAM.

Both direct laser beams and reflected laser beams are ***highly dangerous***. If the beam enters the eye directly, it can cause 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.

CAUTION

Keep water and water containers away from the Laser

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

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.

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.

Disposal

Properly handle and dispose of used materials.
For the disposal of electronic waste please contact AMADA WELD TECH.

General Precautions

This Operator's Manual describes the Operation and Maintenance of the ML-2551A(-CE) / ML-2550A(-CE) and LW300A(E) / LW400A(E) Nd:YAG Laser Welders, and provides instructions relating to its SAFE use. Procedures described in this manual ***must*** be performed as detailed by ***qualified*** and ***trained*** personnel.

- ***Before*** attempting to use the laser, please read this instruction manual ***and*** the Laser Safety Manual (AMADA WELD TECH AMERICA Part Number 990-502) thoroughly for safety reasons and to effectively take advantage of the full capabilities of the Laser Welder.
- ***After*** reading this manual, retain it for future reference when any questions arise regarding the proper and SAFE operation of the Nd:YAG Laser Welder.

Installation Precautions

- Install the Laser securely on a firm and level surface.
- **ML-2551A / ML-2550A Models** and **LW300A / LW400A:**
  Connect to an A.C. Service of three-phase 200 / 220 / 240 VAC +10%/-15%, 50 A, 50/60 Hz.
- **ML-2551A-CE / ML-2550A-CE** and **LW300AE / LW400AE:**
  Connect to an A.C. Service of three-phase 380 / 400 VAC ± 10%, 30 A, 50/60 Hz.
- Be sure to apply good grounding to the laser.
- This manual does not cover adjustments made prior to start-up, as such adjustments are performed by our engineers after the Laser is installed. For space requirements and power supplies, see *Appendix A, Technical Specifications.*
- Use the Laser in a place where the ambient temperature is between 41 - 95 °F (5 - 35 °C) and humidity is 85% (non-condensing) or less and where there are no sudden temperature fluctuations.
- Do ***not*** use the Laser in the following places:
  - Where there is considerable dirt, dust, mist, chemicals, fumes, moisture, or near a high-frequency noise source.
  - Where the Laser may be subjected to vibration or impact.
  - Where moisture may be condensed on the surface of the Laser.
  - Where there is a high concentration of CO_2, NOx (nitrogen oxides) or SOx (sulfur oxides).
    (Air containing more than 0.1% CO_2 may shorten the life of the ion-exchange resin).
- If the outside of the Laser is stained, wipe it with a dry or slightly moistened cloth. If it is badly stained, use a neutral detergent or alcohol to clean it. Do ***not*** use paint thinner, acetone, benzene, etc. which can discolor or deform the parts.
- Do ***not*** put screws, coins, etc. in the Laser, since they can cause a malfunction.

Installation Precautions (continued)

- Operate the switches and buttons carefully by hand. If they are operated roughly or with the tip of a screwdriver, a pen, etc. they can cause a malfunction.
- Operate the switches and buttons one at a time. If two or more of them are operated simultaneously, the Laser may develop trouble.
- The outer panels and the covers are electrically connected to the main unit by connecting ground cables. When the panels, covers and connecting cables are removed and installed again, make sure that all these ground cables are put back into place correctly. Also, make sure that the cables do not block the optical path of the oscillator or get caught between the outer panel and the frame.

Operation Precautions

When operating or servicing the Laser Welder unit, always wear Protective Goggles having an optical density of at least 7^{+} at a wavelength of 1064 nanometers for the operation of the ML-2551A(-CE) / ML-2550A(-CE) and LW300A(E) / LW400A(E) Nd:YAG Laser Welders.

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

Establish and control a dedicated Laser Operation Area. The LSO 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 Precautions

- Do ***not*** modify the Laser Welder without prior written approval from AMADA WELD TECH.
- ***Before*** performing any maintenance on the Laser, read *Chapter 6, 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.

Cold Weather Precautions

- Rapid temperature changes may cause dew condensation on the end faces of the Nd:YAG rod and on other optical surfaces. This will attract dust and can cause damage to the optical surfaces. If this occurs, see *Chapter 6, Maintenance* for corrective action.
- If the temperature drops below 32 °F (0 °C), the water inside the Laser's cooling system can freeze, thus damaging the unit. Take special care to keep the ambient temperature above 32 °F (0 °C). If the temperature is likely to drop below 32 °F (0 °C), drain the water in accordance to the procedure described in *Chapter 6, Maintenance.*

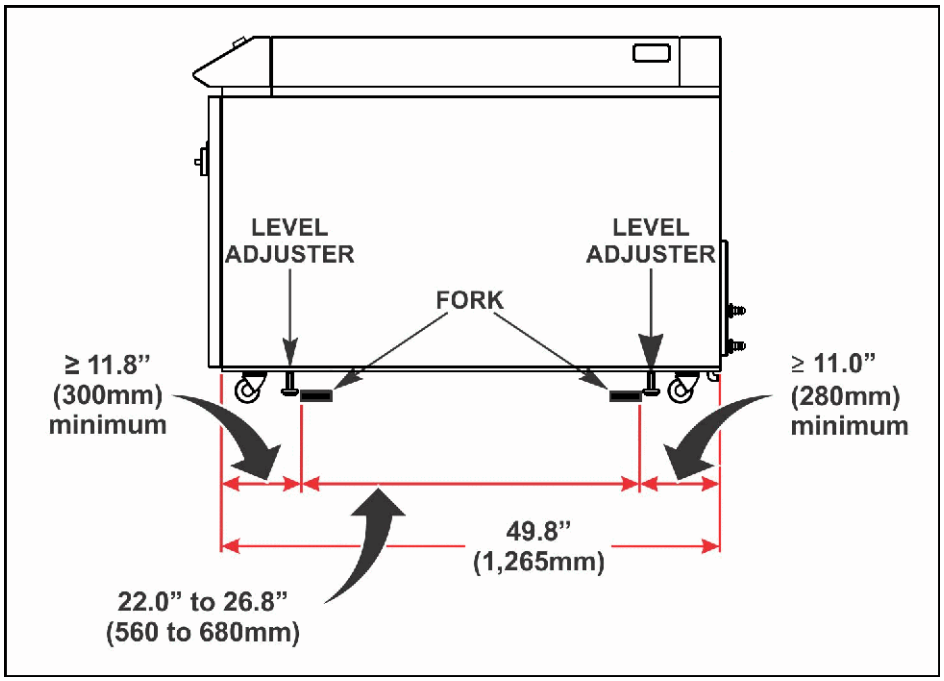
Transporting Precautions

When transporting the Laser, observe the following precautions to prevent an accident to the worker and damage to the Laser.

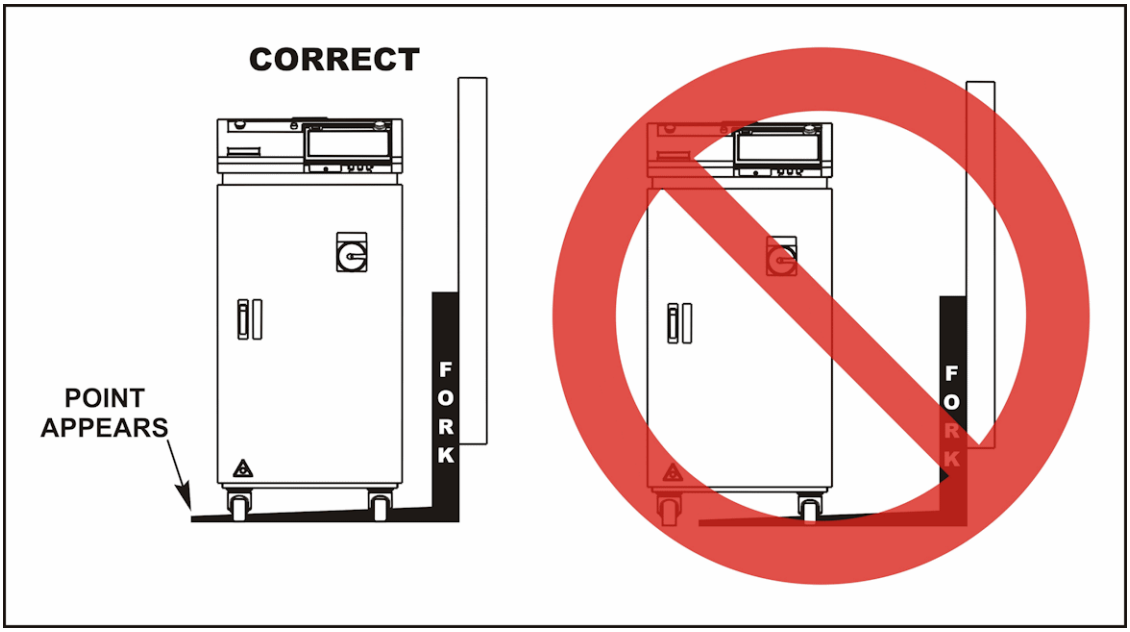
- Package the Laser securely.
- The worker must wear a helmet, safety shoes and gloves for safety. (Leather gloves are recommended)
- When transporting the Laser, use a lift truck, crane, belt, etc., with a capacity of at least 1100 pounds (500 kg) of allowable load.
- Retract the level adjuster fully when transporting the Laser.

Lift Truck/Forklift Precautions

- As shown below, adjust the distance between the lift truck forks to at least 22.0” (560 mm). Verify that the fork does ***not*** hit the level adjuster.
- When transporting, belt the Laser to the lift truck and keep it horizontal.

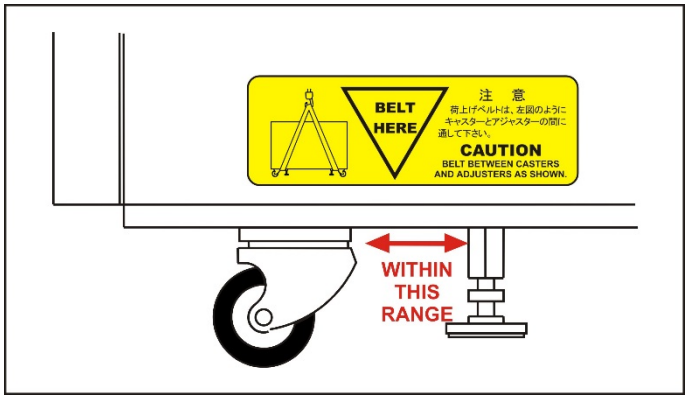


When using a fork lift, insert the forks fully until the points appear from under the Laser.

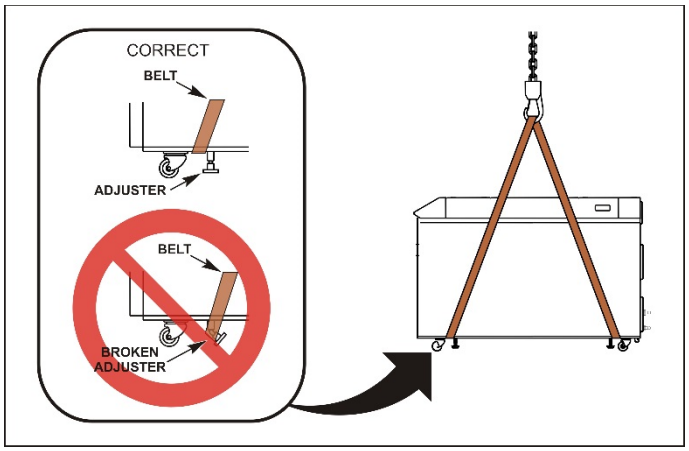


Crane Precautions

- When lifting the Laser, belt it between the caster and level adjuster as shown in the **BELT HERE** label.
- Use two belts.
- During transportation, keep the Laser horizontal.

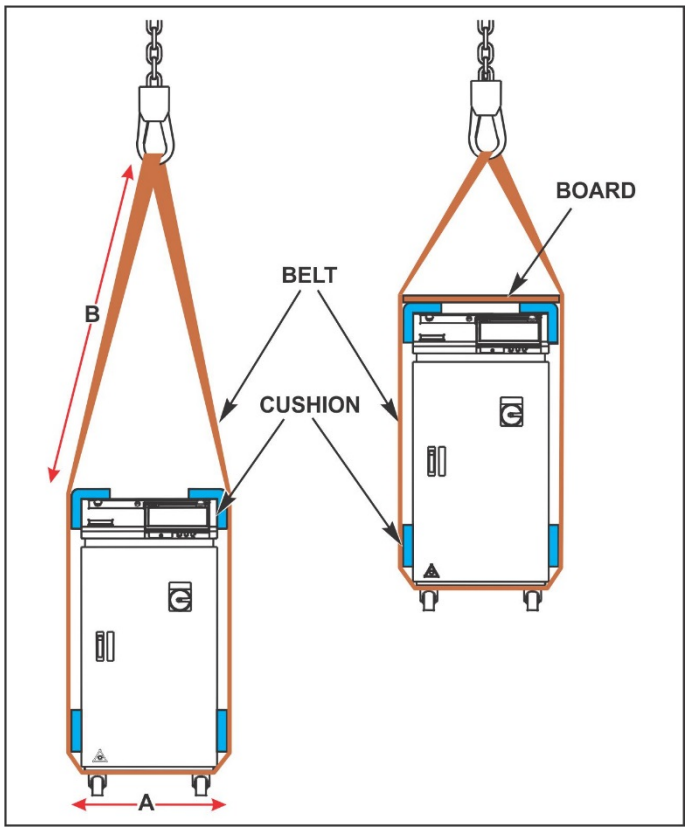


- To prevent damaging the level adjusters, make sure that the lifting belt is ***not*** interfering with the level adjuster.



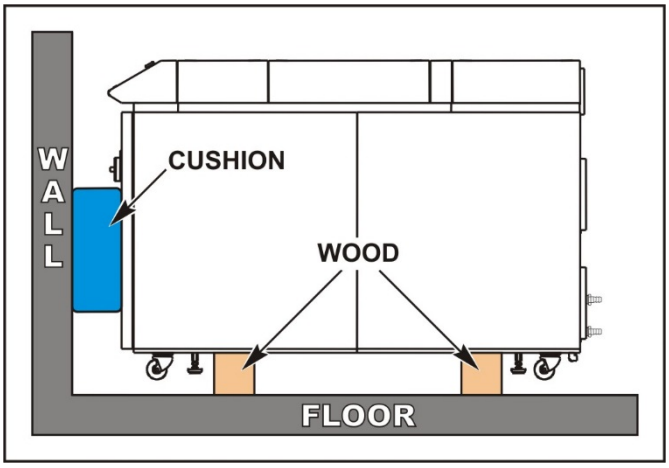
Using Cushions

- When lifting with a belt, properly cushion the Laser.
- When craning the Laser, use cushions (blanket, sponge, or rubber) between the Laser and belts to prevent damaging the Laser. Keep the Laser stable.
- Verify that the distance (**B**) between the top corner of the Laser and the crane hook is at least 1.5 times the Laser width (**A**) [including the protective cushions].
- When the belt is not long enough as shown, insert a board (plywood, laminated board, or angle board) on the Laser to prevent damage to the top surface of the Laser.
- Do ***not*** belt the front door, as it may become deformed and will not open/close properly.

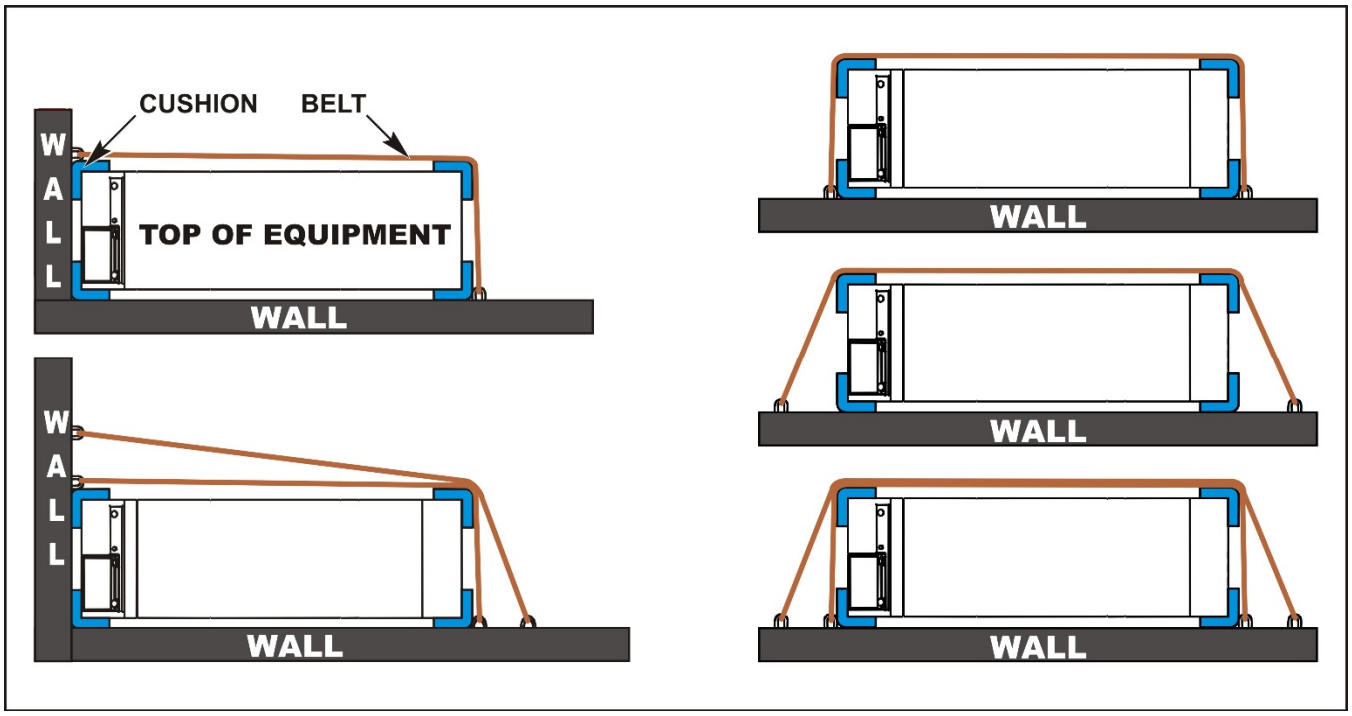


Shipping Precautions

- Fix the Laser firmly using belts, cushions, etc., to prevent an accidental fall or damage due to vibration.
- Retract the level adjuster fully when freighting the Laser.
- Insert a board and thick cushion between the front door and wall to provide enough clearance between the wall and the upper front panel of the Laser.



- Insert wood between the bottom of the Laser and floor to balance the Laser.
- Belt and fix the laser using at least two planes of floor and wall. Be sure to use cushions between the Laser and the belt(s) to prevent damaging the laser.



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 ML-2551A(-CE) / ML-2550A(-CE) and LW300A(E) / LW400A(E) Laser will be referred to simply as the ***Laser***. The Laser is a compact, pulsed, Nd:YAG laser designed as a precision spot and seam welder. It incorporates the following features in its design:

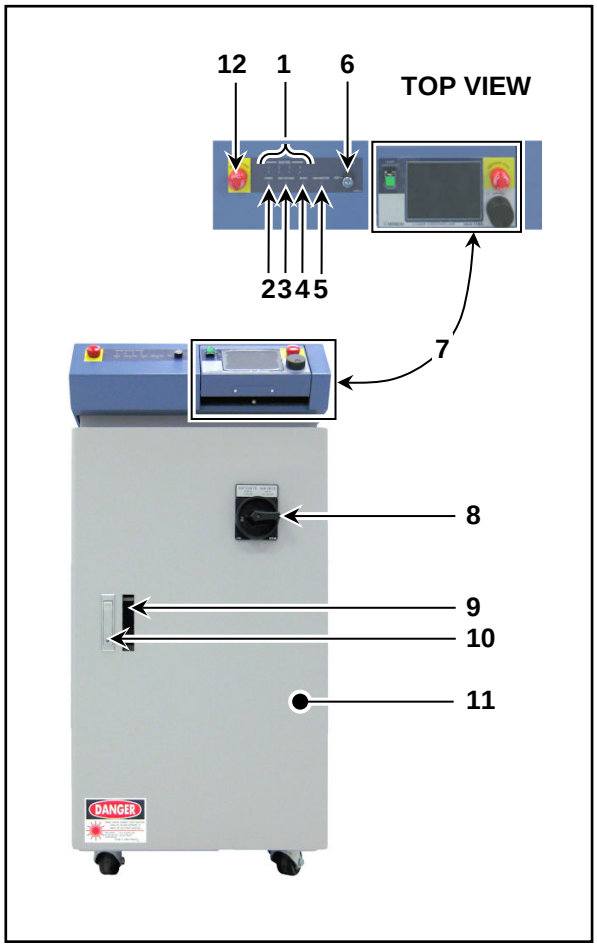
- The Compact Nd:YAG Laser is equipped with laser power feedback control to operate with the same performance shot after shot.
- The Laser can handle a wide variety of workpieces. Up to 32 different weld schedule settings can be programmed into the laser, each with its own unique weld characteristics.
- High output repetition (500 pps max.) supports seam welding and high-speed processing.
- The Laser controller is detachable from the main body of the Laser which allows remote control.
- A variety of input and output signals allow the Laser to be connected to automated equipment.
- The power monitor measures both the oscillation output energy (J) and its mean power (W). In addition, an oscillation output energy comparator (upper-lower limit judgment) is provided for quality control purposes.
- For seam welding, the output can be set to fade-in at the start of a weld and fade-out at the end of a weld, to smooth overlaps at both ends of the weld.
- Use of high-precision optical fiber eliminates the optical axis adjustment usually needed every time the fiber is removed and reinstalled.

Options

- Optical fiber breakage/detatchment detection is available.
- Multi-Workstation Interlock function is available.
- The Laser can be operated by two different Laser Controller's; the MLE-118A (Color LCD display) and the MLE-115A (Black & Gray LCD display).
- The external communications function allows central control of all data, such as parameter settings and monitored values for the Laser**.**

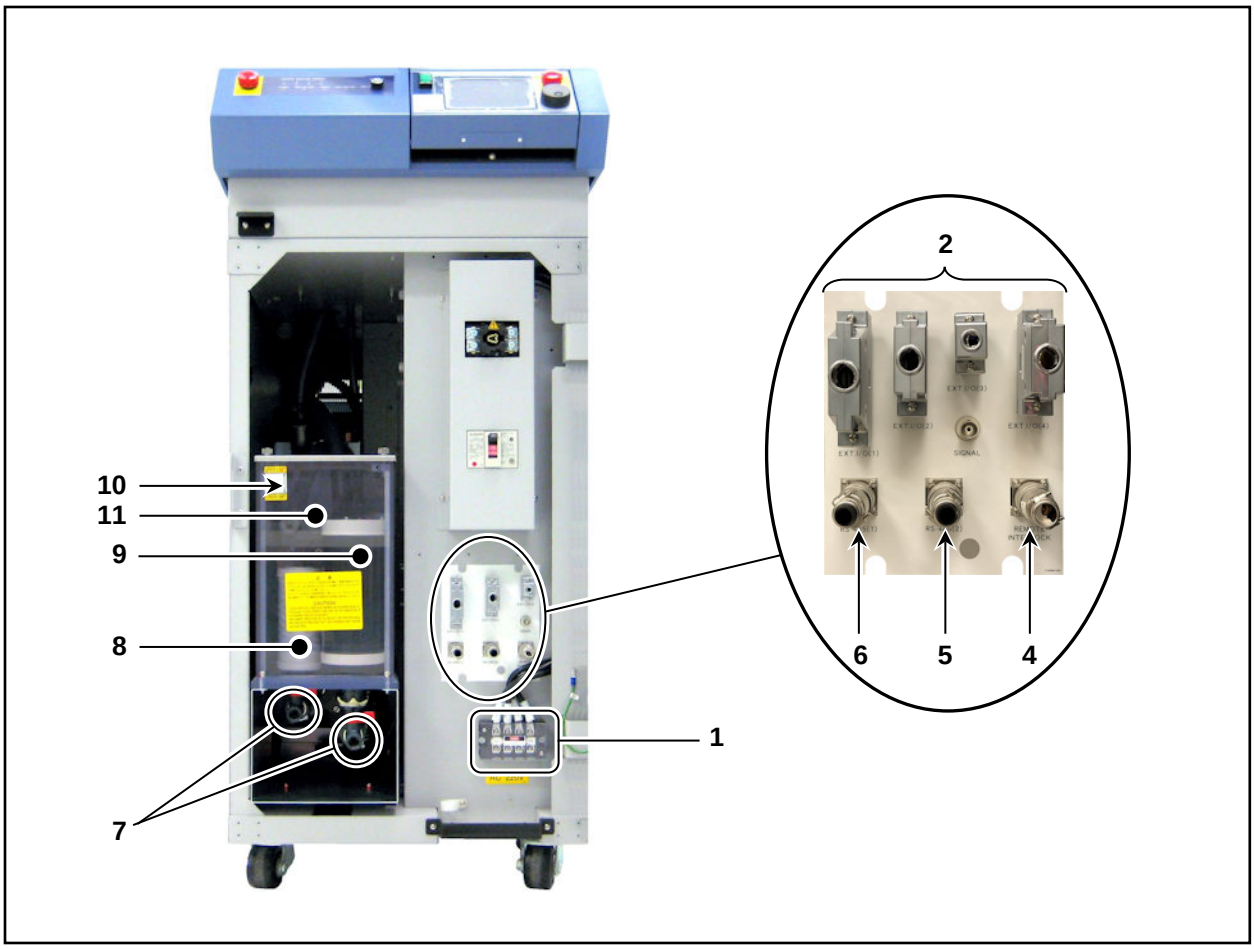
Section II: System Components

Front Panel



1. **SHUTTER (1 to 4).** Lights to indicate which branch shutters (1-4) are open.
2. **POWER Lamp.** Lights up when the **MAIN POWER** switch is turned on, indicating that power is ON.
3. **HIGH VOLTAGE Lamp.** Indicates that high voltage is present in the laser oscillator.
4. **READY Lamp.** Lights up when the capacitor bank is charged and the laser is ready to fire.
5. **MAIN SHUTTER Lamp.** Stays on while the main (resonator) shutters are open.
6. **CONTROL Key Switch.** When **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 Laser Safety Officer (LSO) should keep the key.
7. **Laser Controller.** Sets the weld schedules and operates the Laser. Displays various data on its Liquid Crystal Display (LCD). There are two different Laser Controllers available for this Laser model; the MLE-118A and MLE-115A. The MLE-115A is shown in the illustrations throughout this manual.
8. **MAIN POWER Switch.** Switches power to the Laser **ON** and **OFF**.
9. **Water Level Viewing Window.** Allows the user to view the cooling water level in the cooling water tank.
10. **Front Door Handle.** Press the button under the handle and the handle will pop out. Pull the handle up to open the front door. After closing the door, put back the handle back into place and the door will latch.
11. **Front Door.** Opens for access to the cooling water tank, power supply terminals, I/O connections and the main circuit breaker.
12. **EMERGENCY STOP Switch.** Pressing this switch will stop the Laser immediately. This switch has the same effect as turning the **CONTROL** switch to OFF. On 400 VAC CE models, activating the **EMERGENCY STOP Switch** has the same effect as turning the **MAIN POWER** switch OFF, ***however*** the Power Supply will remain ON. To **RESET** this switch, rotate it clockwise.

Middle Panel



1. **EXT. I/O (1), EXT. I/O (2), EXT. I/O (3), EXT. I/O (4) Connectors**
   (Refer to *Appendix B: Electrical & Data Connections* for detailed information).

   - **EXT I/O (1)** and **EXT I/O (2):** Used for output signals (e.g. alarm signals, monitor judgment signals) and input signals (e.g. start signal, schedule signals, etc.).
   - **EXT I/O (3):** Used to input and output Emergency Stop signals (for simple systems).
   - **EXT I/O (4):** Used to input and output redundant Emergency Stop and Remote Interlock signals. This function works independently from EXT I/O (3) and the Remote Interlock connectors.

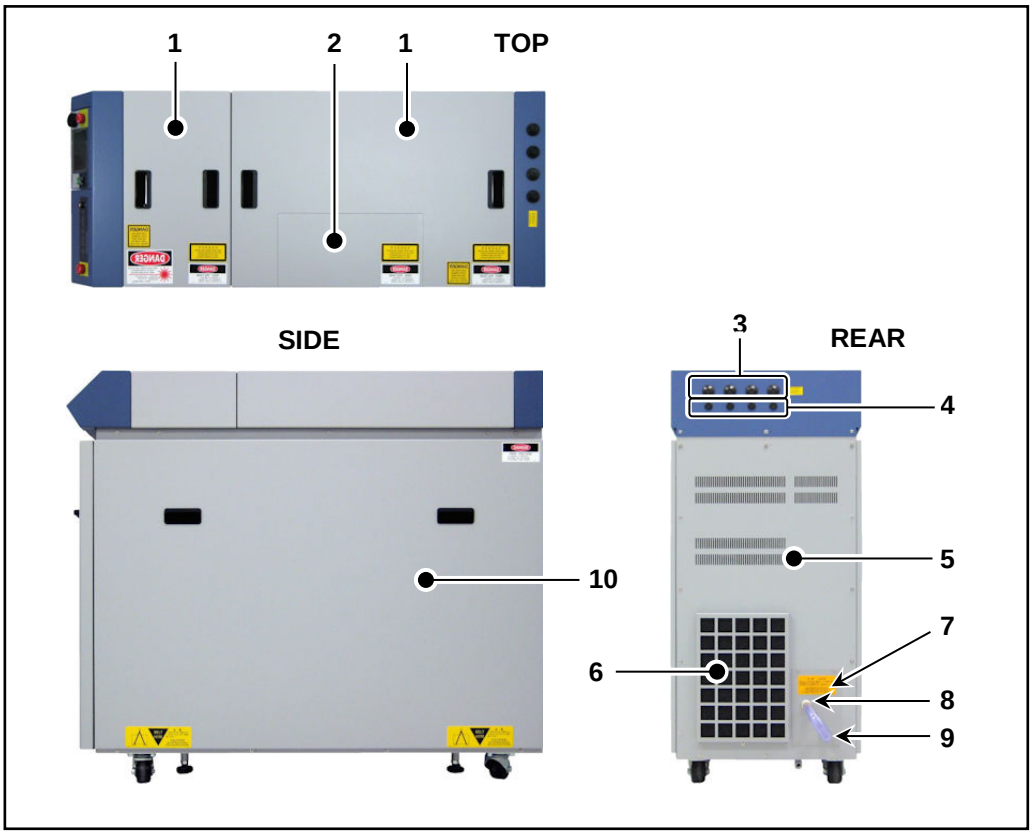
     NOTE: Depending on the configuration and date of manufacture, the Dual E-Stop/Interlock option may not be available.

2. **SIGNAL Connector.** This BNC connector can be used to connect the Laser to an oscilloscope so you can view the output waveform of each Laser output pulse.

   NOTE: $V_{OUT} \approx 1$ V/kW.

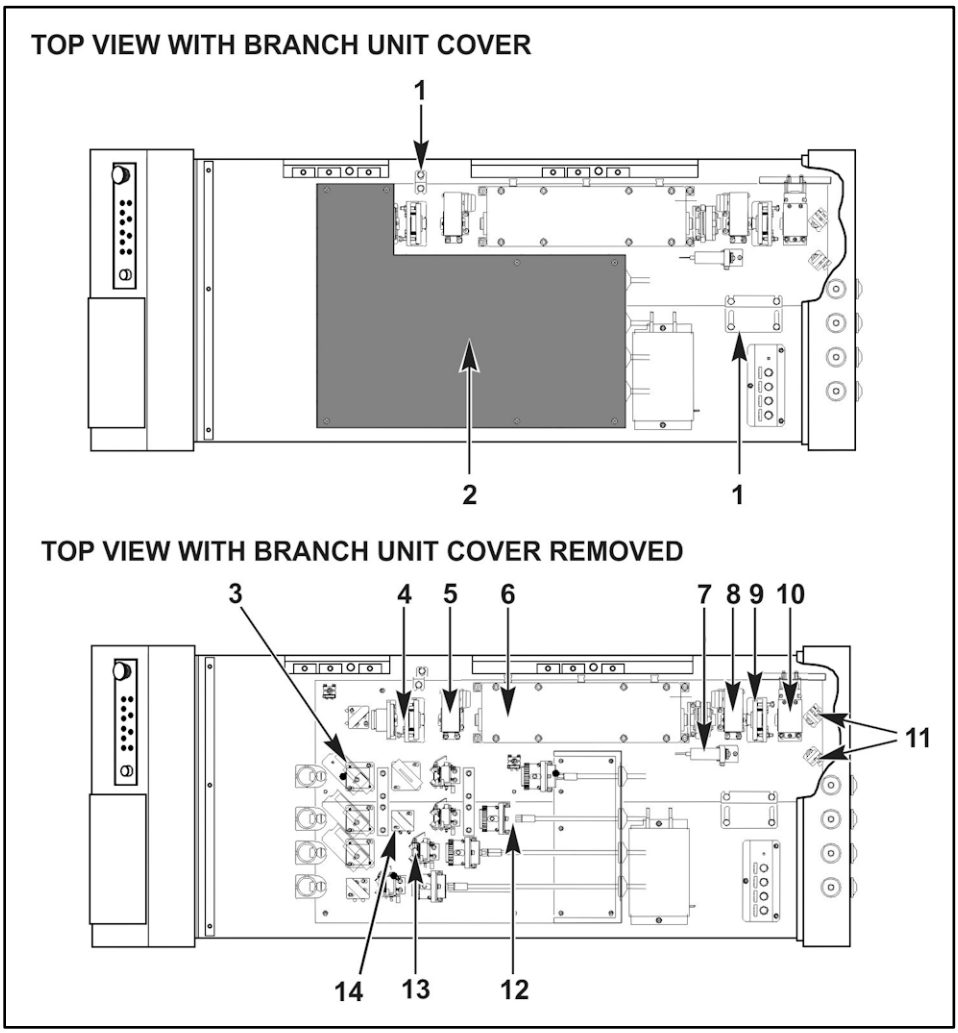
3. **REMOTE INTERLOCK Connector.** Used to connect the Laser to the Remote Interlock circuit for safety. When disconnected (opened), the main (resonator) shutters close to prevent laser emission.
4. **RS-485 (2) Connector.** For external communications (optional).
5. **RS-485 (1) Connector.** For external communications (optional).
6. **Power Supply Terminals.** If you open the front door, you will see the power input terminals. Connect the terminals to a 3-phase power supply of 200 / 220 / 240 VAC or 380 / 400 VAC. To ensure safety and optimal operation, the laser must be properly grounded. A Neutral connection is not required or used on this laser. 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.
7. **Drains.** For draining water from the cooling water tank.
8. **Water Filter.** Removes dirt and other contaminants from the secondary cooling water. The physical location of the Water Filter & Ion-Exchange Resin Cartridge may be reversed depending on the date of manufacture.
9. **Ion-exchange Resin (Deionizer).** Used to deionize the secondary cooling water. The physical location of the Water Filter & Ion-Exchange Resin Cartridge may be reversed depending on the date of manufacture.
10. **Water Level Label.** Shows the proper level of the secondary cooling water.
11. **Cooling Water Tank.** Holds secondary cooling water used for cooling the Nd:YAG rod, flashlamp and the electronics.

Top, Side, and Rear Panels



1. **Head Covers A & B.** Covers the laser oscillator.
2. **Flashlamp Access Cover.** Open this cover when replacing the flashlamp.
3. **Optical Fiber Inlets.** These inlets are on the top and rear of the Laser. Pass the optical fibers through the grommets and connect them to the "Laser Beam Input Units" (see below).
4. **Cable Inlet.** Pass the Fiber Breakage/detachment or Multi-Workstation Interlock wires through these grommets (optional). Depending on the configuration, there may be connectors installed in these locations.
5. **Rear Cover.** Covers the Power Supply and Cooler on the rear of the Laser.
6. **Air Filter.** Covers the air intake to prevent dust and dirt from getting into the Laser. The main cooling fan for the electronic assemblies is behind this filter. The filter orientation may appear different depending on the date of manufacture.
7. **Solenoid Valve Cover.** Covers the solenoid valve used to control the flow-rate of the primary cooling water.
8. **Cooling Water Outlet.** For the primary cooling water. Connect to an external cooling unit (chiller).
9. **Cooling Water Inlet.** For the primary cooling water. Connect to an external cooling unit (chiller).
10. **Side Covers.** Located on both sides of the Laser, they cover the Laser Power supplies and Cooler.

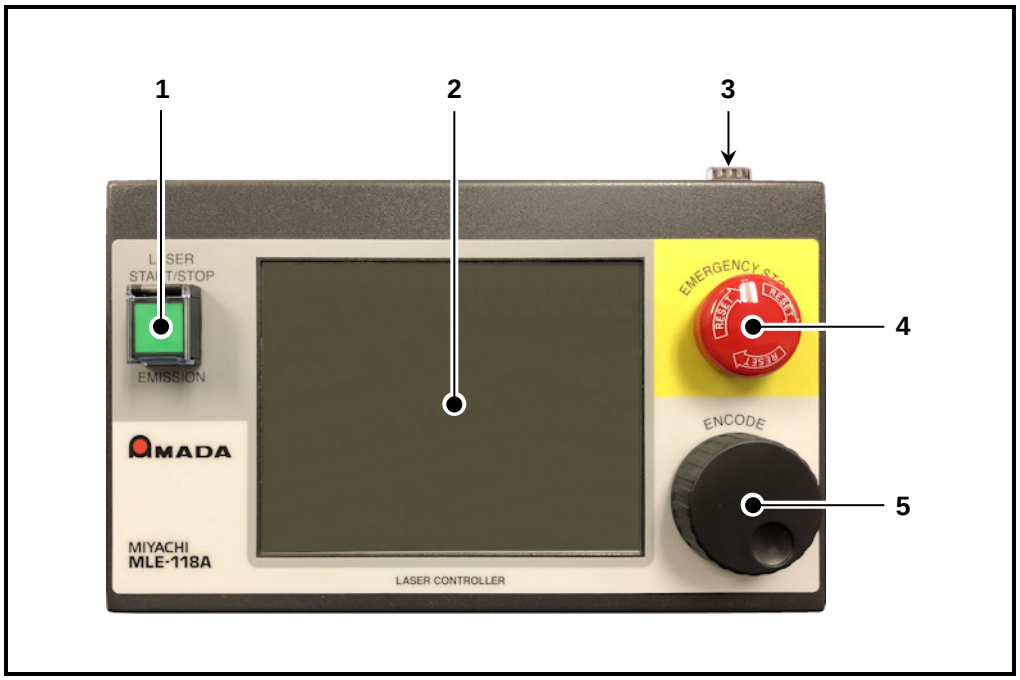
Laser Oscillator



1. **Hold-down Brackets.** The yellow hold-down brackets are used to lock the laser oscillator in place to prevent any damage or dislocation during transportation. Be sure to remove both hold-down brackets before starting operations.
2. **Branch Unit Cover.** Do ***not*** remove this dust-proof cover except when installing and removing the optical fibers.
3. **Timeshare Unit (Only for Time Shared configurations).** When closed, laser light output is reflected internally. Depending on the configuration, 0 – 3 timeshare shutters will be installed.
4. **Resonator Mirror Holder (PR).** Holds the Partially Reflective resonator mirror. Light excited in the Laser Chamber is amplified between the two resonator mirrors and output through this mirror as a laser beam.
5. **Main (Resonator) Shutter # 1.** When this shutter is closed, the laser beam will not be produced even if the flashlamp is turned ON. This shutter opens and closes in unison with **Main Sutter # 2**.

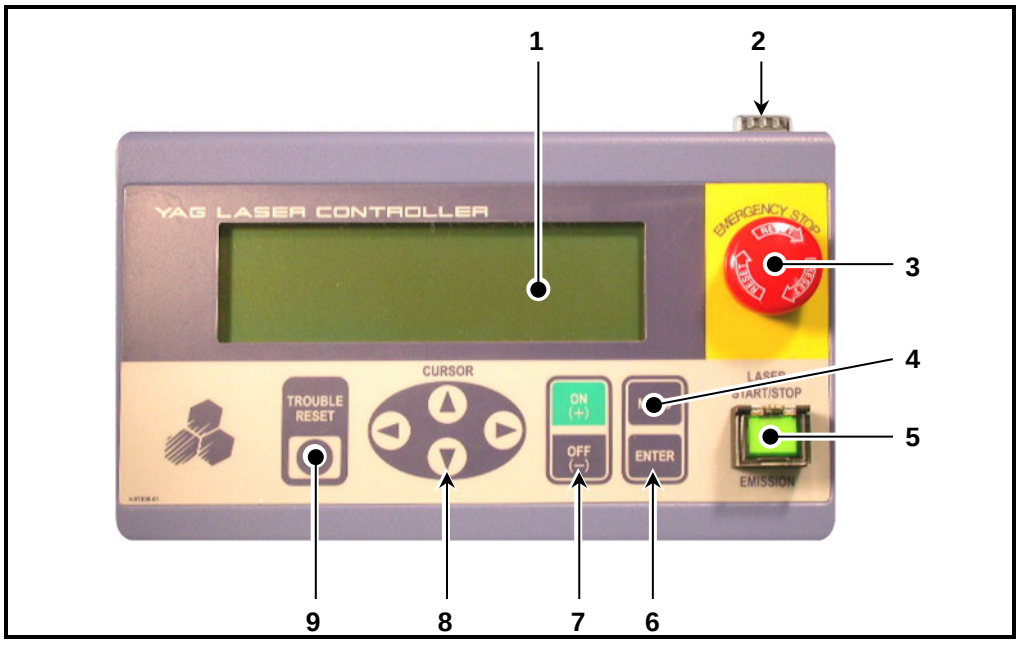
6. **Laser Resonator / Oscillator Chamber.** Contains the flashlamp and the Nd:YAG rod. The flashlamp lights up to excite the Nd:YAG rod and emit the laser beam.
7. **Guide Beam**. Outputs a red, visible laser beam. This visible laser beam is used as a guide beam for oscillation adjustment and incident beam adjustment. Additionally the guide beam can also be used for positioning parts to be welded (since the Nd:YAG beam is invisible).
8. **Main (Resonator) Shutter # 2**. When this shutter is closed, the laser beam will not be produced even if the flashlamp is turned ON. This shutter opens and closes in unison with **Main Sutter # 1**.
9. **Resonator Mirror Holder (HR).** Holds the Highly Reflective resonator mirror. Light excited in the Laser Chamber is amplified between the two resonator mirrors and output as a laser beam.
10. **Power Monitor Unit.** Measures the resonator power and energy output of the Nd:YAG laser beam.
11. **Guide Beam Steering Mirrors.** Adjusts the guide beam (visible laser beam) so that this beam passes down the center of the Nd:YAG laser beam optical path.
12. **Laser Beam Input Unit (up to 4).** Connect the optical fiber to this unit. The Laser Beam Input Unit focuses the laser beam emitted from the laser oscillator chamber into the optical fiber. Depending on the configuration, 1 – 4 laser beam input units will be installed.
13. **Branch Shutter (up to 4).** When closed, the laser light output is blocked for that output. Depending on the configuration, 1 – 4 branch shutters will be installed.
14. **Beamsplitter (up to 4).** Splits a laser beam into the number of deliveries and reflects them onto each laser beam input unit. Depending on the configuration, 1 to 4 beamsplitters will be installed.

MLE-118A - Laser Controller (Control Panel)



1. **LASER START/STOP Button with EMISSION INDICATOR.** Pressing this button when the **READY** lamp is on and the resonator shutters are open; will produce laser emission internal to the Laser. If the optical fibers are connected and the branch shutters are open, laser emission will be produced at the optical fiber output. 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). Emission indicator illuminates when the unit is able and ready to fire the laser.
2. **Liquid Crystal Display.** Displays data such as schedule settings and monitored data.
3. **Line Cable Connector.** Connect the supplied line cable to the Laser for operation.
4. **EMERGENCY STOP Switch.** Press the **EMERGENCY STOP** switch in an emergency and the laser will stop immediately. This switch has the same function as the other **EMERGENCY STOP** switch on the Laser. Use this function ***only*** in an emergency.
5. **ENCODE Function Switch.** Used to control all functions of the Laser. Turn the **ENCODE** button clockwise and counter-clockwise to scroll through the various menu screen functions. Once you land on a field you want to change (highlighted in yellow), select the **ENCODE** button by pressing it downward. Rotate the **ENCODE** button to change parameters, then select the **ENCODE** button by pressing it downward to set the changed value. All menu navigation and function selections are achieved using this button.

MLE-115A - Laser Controller (Control Panel)



1. **Liquid Crystal Display.** Displays data such as schedule settings and monitored data.
2. **Line Cable Connector.** Connect the supplied line cable to the Laser for operation.
3. **EMERGENCY STOP Switch.** Press the **EMERGENCY STOP** switch in an emergency and the laser will stop immediately. This switch has the same function as the other **EMERGENCY STOP** switch on the Laser. Only use this function in an emergency.
4. **MENU Key.** Each time the **MENU** key is pressed, a different menu function will be displayed.
5. **LASER START/STOP Button** with **EMISSION INDICATOR.** Pressing this button when the **READY** lamp is on and the resonator shutters are open; will produce laser emission internal to the Laser. If the optical fibers are connected and the branch shutters are open, laser emission will be produced at the optical fiber output. 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). Emission indicator illuminates when the unit is able and ready to fire the laser.
6. **ENTER Key.** Stores numerical and changed settings in the Laser Controller. The Laser Controller will not recognize set or changed data, unless the **ENTER** key is pressed. Once you change any setting, be sure to press the **ENTER** key.
7. **ON(+)/OFF(-) Key.** Use this key when you want to change the numerical value or switch an **ON/OFF** setting of the selected item. Press **ON (+)** to increase the number; **OFF (-)** to decrease.
8. **CURSOR Key.** Moves the cursor (▲▼◀▶) up, down, left and right on the LCD screen.
9. **TROUBLE RESET Key.** If trouble arises, an alarm will be activated. Eliminate the cause of the trouble, then press this key to reset the alarm.

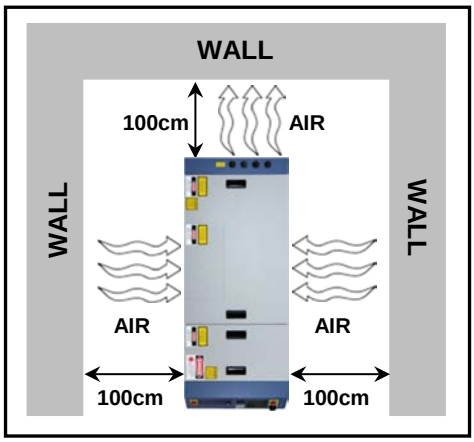
CHAPTER 2
INSTALLATION AND SETUP

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 dimensional 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 or areas where there is a high concentration of CO_2, NOx (nitrogen oxides), or SOx (sulfur oxides).
- The ambient temperature should be between 41 °F – 95 °F (5 °C – 35 °C). The ability of the internal cooling system to maintain the correct operating temperature is inversely proportional to the duty cycle. Refer to *Appendix A, Technical Specifications* for details. The humidity should be 85% or less (non-condensing). The area should have no sudden temperature fluctuations.
- Allow adequate clearance on all sides of the Laser to allow for cooling, maintenance, and servicing. (see figure to the right)



Power Requirements

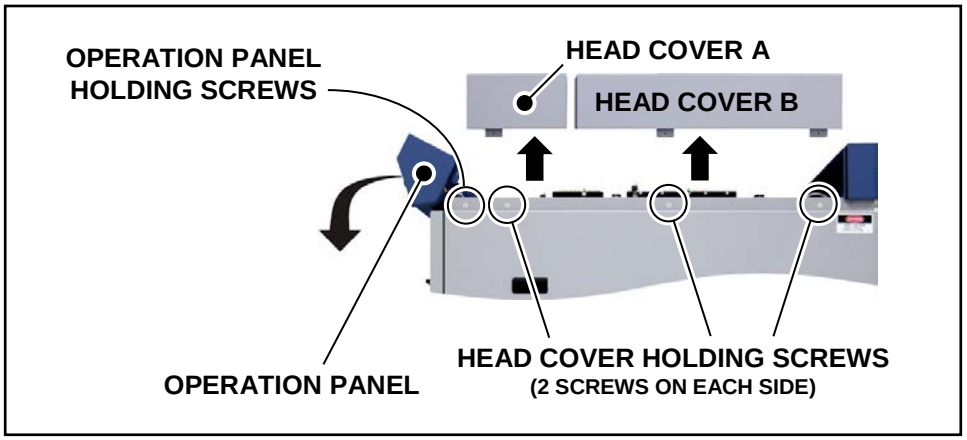
- **ML-2551A / ML-2550A** and **LW300A / LW400A Models:** Connect to a power source of three-phase, 200 / 220 / 240 VAC +10%/-15% (50 / 60 Hz) having a capacity of at least 50 A. The Laser is shipped standard for 220 VAC. Consult with AMADA WELD TECH if operating on 200 VAC or 240 VAC.
- **ML-2551A-CE / ML-2550A-CE** and **LW300AE / LW400AE Models:** Connect to a power source of three-phase, 380 / 400 VAC ± 10% (50 / 60 Hz) having a capacity of at least 30 A. The Laser is shipped standard for 400 VAC. Consult with AMADA WELD TECH if operating on 380 VAC.
- To ensure safety and optimal operation, the laser must be properly grounded. A Neutral connection is not required or used on this laser. However a PE (protective earth) Ground is provided and ***MUST*** be used. ***DO NOT*** connect the Neutral line to the PE terminal. Service should be from a ground fault circuit breaker that is inverter high frequency surge-resistant.

Section II: Installation

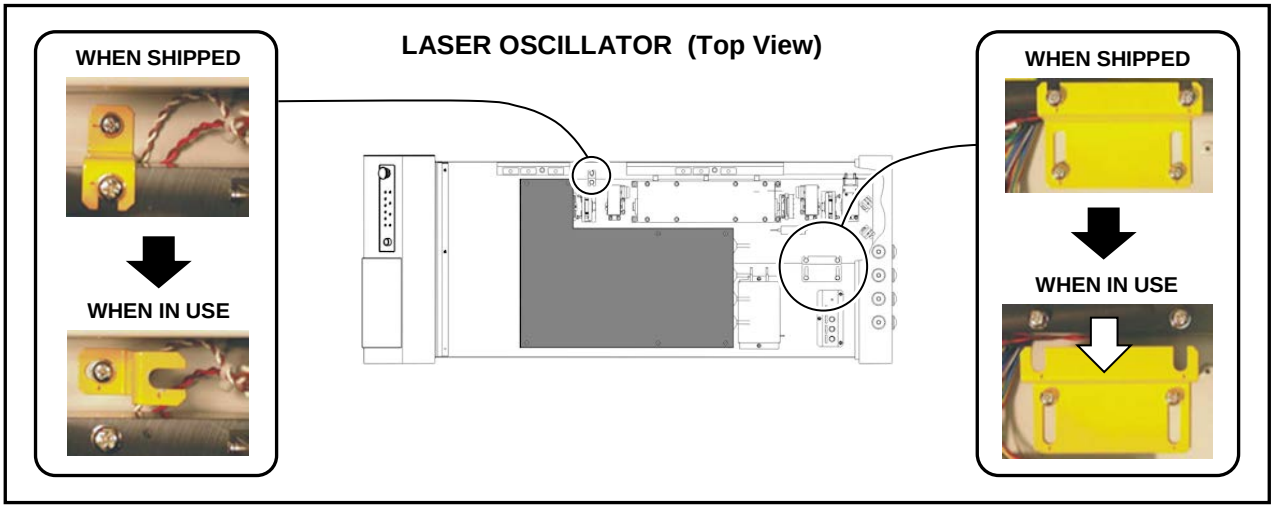
Removing the Oscillator Hold-down Brackets

Oscillator hold-down brackets are provided on the laser to protect the oscillator against vibration and shock during transportation. These brackets should be removed ***before*** operation.

1. Remove the Operation Panel holding screws on both sides of the Laser and tilt the operation panel forward as shown.



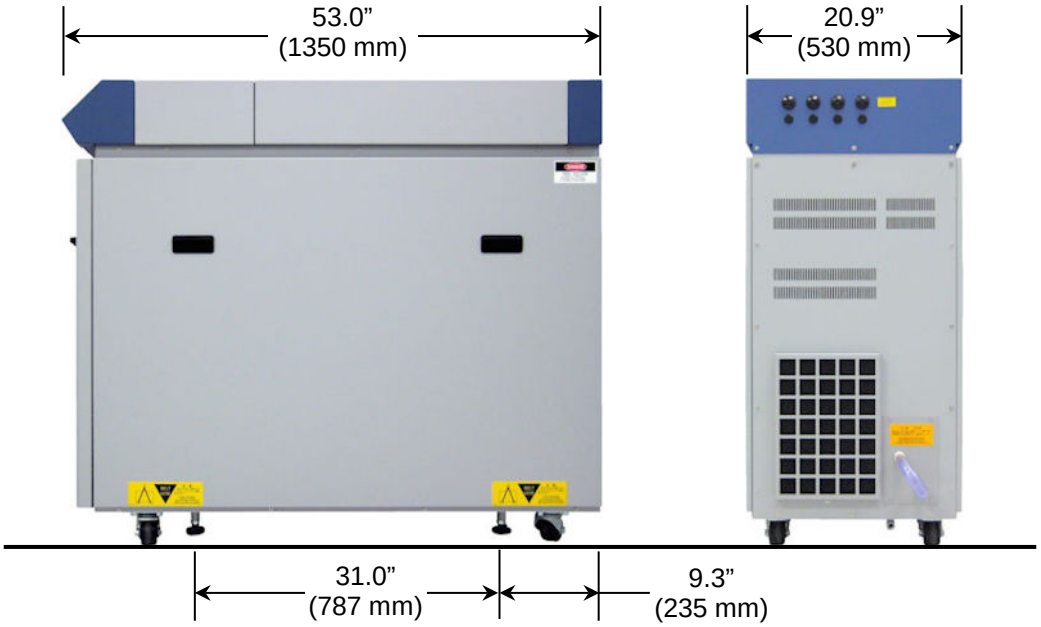
2. Remove all Head Cover holding screws, then pull both Head Covers up as shown to remove.
3. Loosen the screws to disengage the hold-down brackets from the oscillator base. The oscillator is supported with rubber legs to absorb slight vibrations. Do ***not*** subject the Laser to shock or strong vibrations.

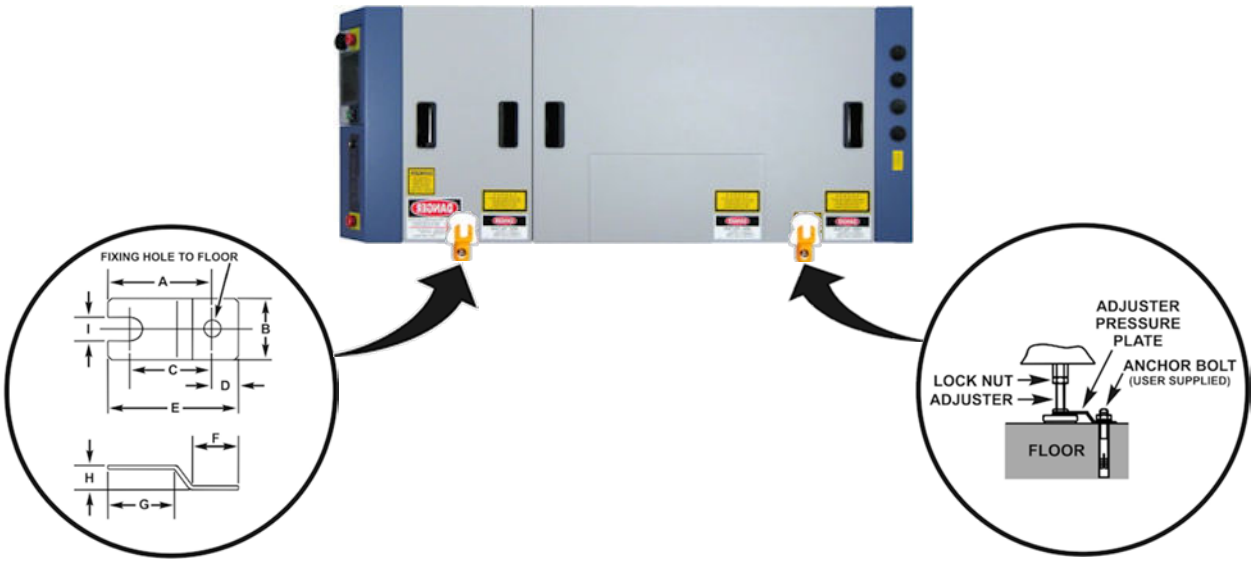


NOTE: When transporting the Laser after it has been installed, secure the oscillator with the hold-down brackets as it was when shipped.

Securing the Laser (optional)

Secure the Laser to the floor (optional) using the supplied **AWTA # KC-1275C-3** adjuster pressure plates.





ADJUSTER PRESSURE PLATE DIMENSIONS

A = 2.9 INCH (74.5 mm)	**F = 1.3 INCH (33 mm)**
B = 2.0 INCH (50 mm)	**G = 1.9 INCH (48 mm)**
C = 2.3 INCH (59 mm)	**H = 0.8 INCH (20 mm)**
D = 0.77 INCH (19.5 mm)	**I = 0.75 INCH (19 mm)**
E = 3.7 INCH (94 mm)	

Supplying Power

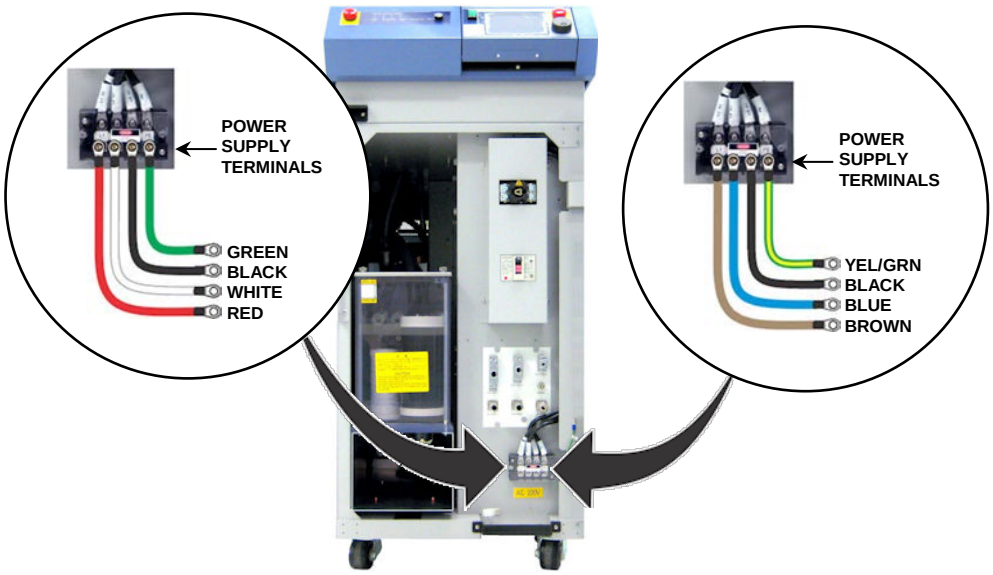
To ensure safety and optimal operation, the laser must be properly grounded. A Neutral connection is not required or used on this laser. However a PE (protective earth) Ground is provided and **MUST** be used. ***DO NOT*** connect the Neutral line to the PE terminal. Service should be from a ground fault circuit breaker that is inverter high frequency surge-resistant.

Open the front door and remove the terminal block cover to access the power supply input terminals. Route the power cable through the bottom of the Laser and connect it to the power supply input terminals, checking the color of the wires. The phases must be connected to the laser in a specific order. If you get an **E05: Phase Trouble** error when first turning on the laser, simply reverse two of the phases.

220VAC Models: The Laser is factory jumpered for 220 VAC operation. Consult AMADA WELD TECH if you plan on operating the Laser at 200 VAC or 240 VAC.

Depending on the date of manufacture, the 240 VAC option may not be available.

400VAC Models: The Laser is factory jumpered for 400 VAC operation. Consult AMADA WELD TECH if you plan on operating the Laser at 380 VAC.



Power Cable Requirements

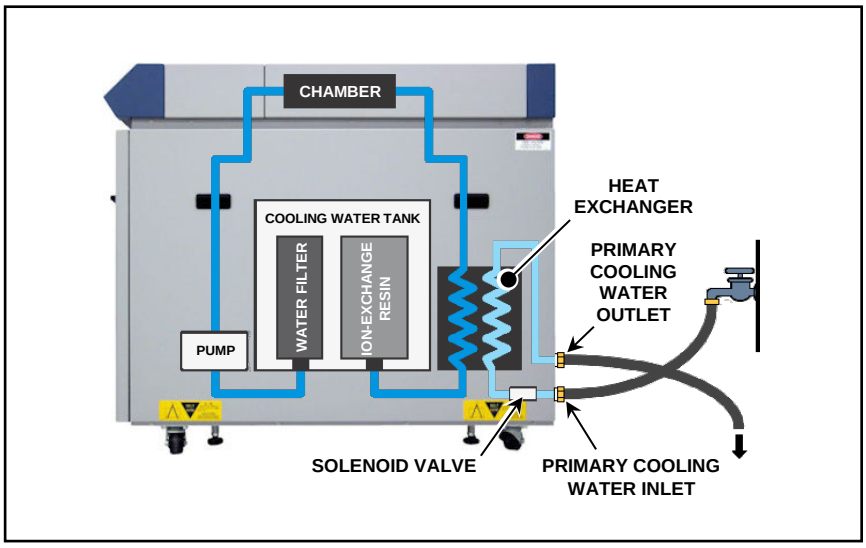
3-Phase Power Supply	200 / 220 / 240 VAC	380 / 400 VAC
Rated Voltage	300 VAC	600 VAC
Number of Cores	3	3
Cross Section	8 AWG (8 mm^2)	9 AWG (6 mm^2)

Cooling Water System

The Laser uses ***two*** isolated cooling water systems:

Primary Cooling Water	External: for cooling the Secondary cooling water.
Secondary Cooling Water	Internal: for cooling the flashlamp, Nd:YAG rod and electronics.

Cooling Water Block Diagram



Temperature is maintained by allowing the primary cooling water to cycle through the laser. Once the secondary cooling water reaches a predefined high temperature set-point, the Solenoid Valve is energized which allows the primary cooling water to flow through the Heat Exchanger. Once the secondary cooling water reaches the low temperature set-point, the Solenoid Valve is turned off. Connect the primary cooling water supply to the hose barbs on the rear panel of the laser.

Parameter	ML-2551A(-CE) / ML-2550A(-CE) LW300A(E) / LW400A(E)
Minimum Cooling Capacity	3.36 ton
	10,150 kcal/hr
	40,332 BTU/hr
	11.82 kW (maximum)
Water Temperature Range	5 °C ~ 35 °C (41 °F ~ 95 °F)
Recommended Flow Rate (at maximum output)	16 L/min (@ 30 °C / 86 °F) 25 L/min (@ 35 °C / 95 °F)
Differential Pressure	14.2 psi ~ 42.6 psi (98 ~ 294 kPa)
Maximum Pressure	42.6 psi (294 kPa)
Water Inlet Diameter	15 mm

Connecting the Hose for Primary Cooling Water

Connect the supplied 15 mm braided hoses to the cooling water inlet and the outlet on the rear of the Laser. Tighten the hoses using the supplied hose bands.

NOTE
Use city water or water for industrial use for the primary cooling water, with a maximum pressure of 42.6 psi (294 kPa) and a differential pressure of 14.2 to 42.6 psi (98 to 294 kPa). The required flow rate will vary depending on cooling water temperature. Refer to *Appendix A* for flow rate requirements.

Supplying the Secondary Cooling Water

 **CAUTION**
Use ion-exchanged water or steam-distilled water for the secondary cooling water. Tap water, water for industrial use, ground water, super pure water (16 MΩ/cm resistivity) and water with ethyl glycol may cause corrosion or clogging, resulting in a failure.

1. Remove the water tank cover and floating panel from the cooling water tank. Keep clean.
2. Fill the tank with secondary cooling water up to the line reading [HIGH] on the water level gauge label, using the supplied PH-10 hand pump.
3. After filling the tank, put the floating panel on top of the water. The floating panel helps maintain a more stable water level, when the water pump is in operation.
4. Re-install the water tank cover back onto the cooling water tank. Once you have supplied the cooling water and started the Laser, the water level may drop slightly. If so, add more cooling water. Make sure that the floating panel is removed when adding the cooling water.

   NOTES

   - Only use the supplied PH-10 hand pump for the secondary cooling water. To avoid contamination, do ***not*** use it for any other purpose.
   - You can use the floating panel repeatedly until it starts cracking or breaking apart. If the panel becomes stained, clean it using tap water and a soft sponge, then rinse it with ion-exchanged water or steam-distilled water.

Handling Fiber Optic Cables

Minimum Bend Radius for Specified Core Diameter

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 (µm)	Minimum Bend Radius	
	(Inches)	(mm)
200 µm	7	175
300 µm	7	175
400 µm	7	175
600 µm	10	255
800 µm	12	305
1000 µm	14	355

Dirt or dust on the end surfaces of an 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.

Optical Fiber Connection

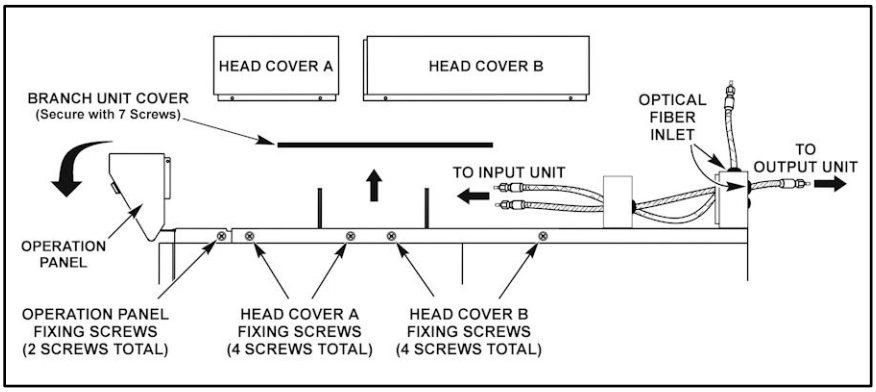
The Laser uses high-precision optical fiber. Once the laser beam is adjusted, no further adjustment is necessary, even if the optical fiber is removed and re-installed again.

NOTES

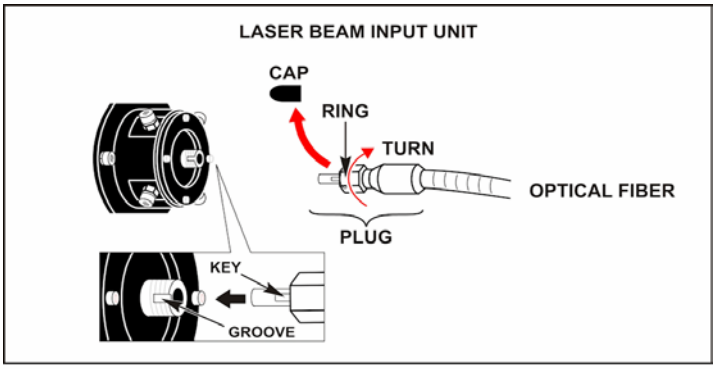
- Make sure that the end face of the optical fiber is free of stains and/or dust. If any dust or stains are found, blow the end face clear using a camera lens air blower or wipe it off using lens-cleaning paper. (See *Chapter 6, Section IV: Maintenance Procedures, Cleaning the Optical Fiber*.) Use a fiber inspection tool (AWTA # 4-60091-01) as necessary to verify the cleanliness.
- Do ***not*** over-tighten the ring on the fiber plug, ***hand-tighten only***. The laser beam may become misaligned if the plug is too tight.

Connecting to the Laser Beam Input Unit (Inside the Laser)

1. Remove the Operation Panel holding screws on both sides of the Laser, then tilt the Operation Panel forward.
2. Remove all Head Cover holding screws , then pull both Head Covers up to remove.
3. Remove the Branch Unit Cover.
4. Pass the optical fiber with its protective rubber cap into the Laser through one of the optical fiber inlets located on the top or rear of the Laser



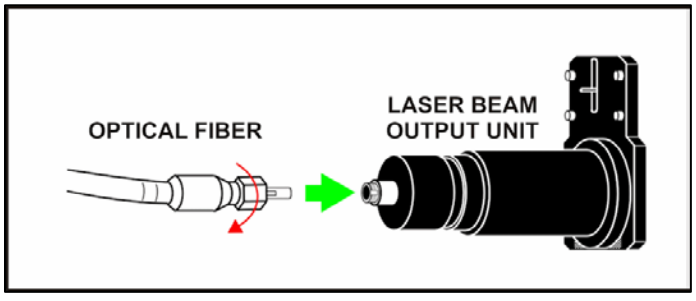
5. Remove the protective cap from the end of the passed fiber and blow off any dust using an air blower, then connect the fiber(s) to the laser beam input unit(s). Align the key of the fiber plug with the groove of the Input Unit. Do ***not*** over-tighten the fiber plug, ***hand-tighten only***.



6. Re-attach the Branch Unit Cover and Head Covers, then return the Operation Panel to its original position and tighten the holding screws.

Connecting to Laser Beam Output Unit (Focus Head)

Remove the protective cap from the end of the fiber and blow off any dust using an air blower, then connect the fiber to the output unit (focus head). Align the key of the fiber plug with the groove of the output unit (focus head). Do ***not*** over-tighten the fiber plug, ***hand-tighten only.***



CAUTION: Be careful ***not*** to apply any shock to the optical fiber or bend it beyond its minimum bending radius.

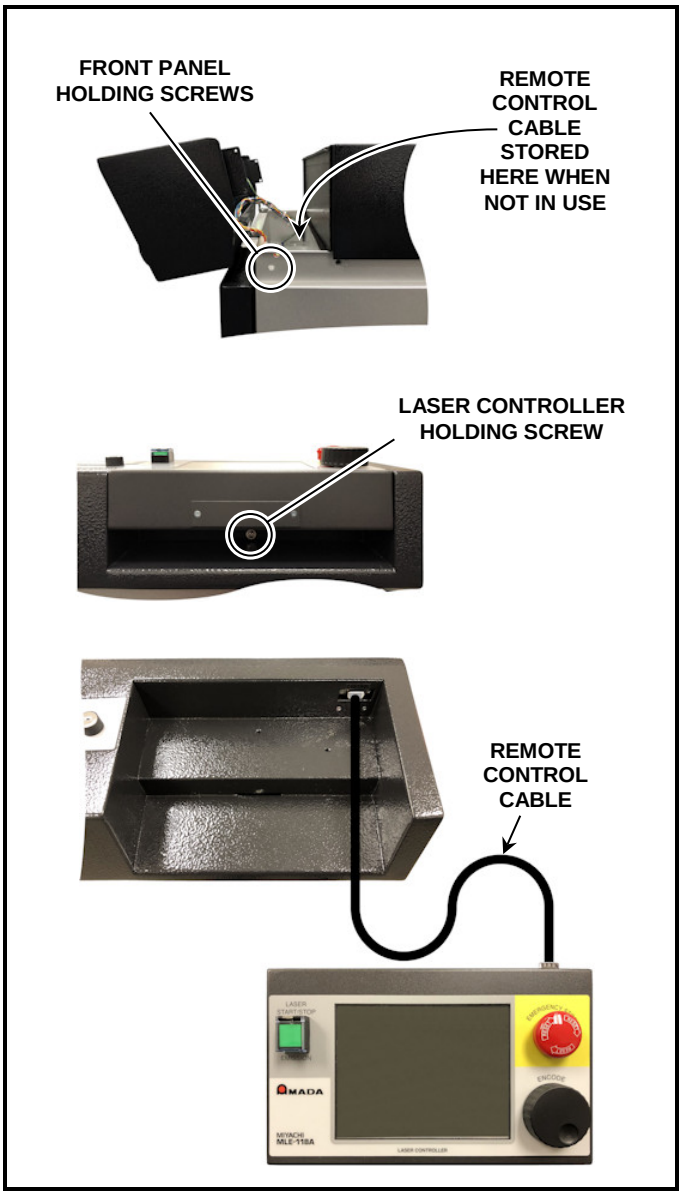
Connecting the Laser Controller Remotely (Optional)

CAUTION
To prevent electrical shock, be sure to turn the Laser power **OFF** before disconnecting / connecting any cables.

If the Laser Controller is to be located away from the Laser, an extension controller cable ***must*** be used in order to connect the Laser Controller to the Laser.

1. Remove the Operation Panel holding screws on both sides of the Laser, then tilt the Operation Panel forward.
2. Remove the Controller cable, cable clamp, and clamp screw (located in a plastic bag behind the Operation Panel).
3. Return the Operation Panel to its original position and tighten the holding screws.
4. Remove the laser controller holding screw.
5. Pull the Laser Controller toward you to take it out.
6. Connect the Controller cable between the Laser Controller and the Laser.
7. Clamp the cable to the laser with the cable clamp and clamp screw.

   NOTE: In the example shown, the MLE-118A is shown for illustrative purposes. The same procedure applies for the MLE-115A Laser Controller.



CHAPTER 3
MLE-118A PROGRAMMING FUNCTIONS

Section I. LCD Control Screens

General Navigation

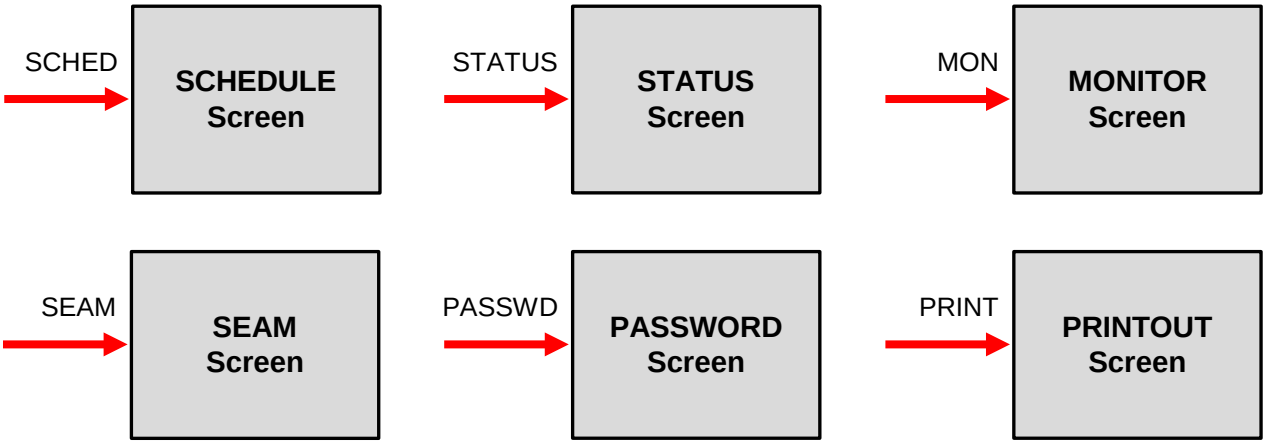
All control functions of the Laser are controlled by the **ENCODE** button. Turn the **ENCODE** button clockwise and counter-clockwise to scroll through the various menu screen functions. Once you land on a field you want to change (highlighted in yellow), select the **ENCODE** button by pressing it downward. Once selected, the field will (1) either turn green indicating that it can be changed, or (2) a pop-up window will appear showing the options for this particular field. If a pop-up window appears, rotate the **ENCODE** button until the option you want to change is highlighted in yellow, then press the **ENCODE** button to select. If a pop-up window appears that you do not want to change, select the **CANCEL** option to return to the previous screen.

About the LCD Screens

There are six main LCD menu screens used to control the Laser, listed vertically on the right side.

- **Schedule Screen** – used to set the parameters of your weld.
- **Status Screen** – used to control the output process.
- **Monitor Screen** – used to display output weld information.
- **Seam Screen** – used to set the parameters of your seam weld.
- **Password Screen** – used to password protect the saved settings in the Laser.
- **Printout Screen** – used to print-out schedule and monitor information.

When each of the Menu buttons is pressed, the selected Menu will display:



Screen Content

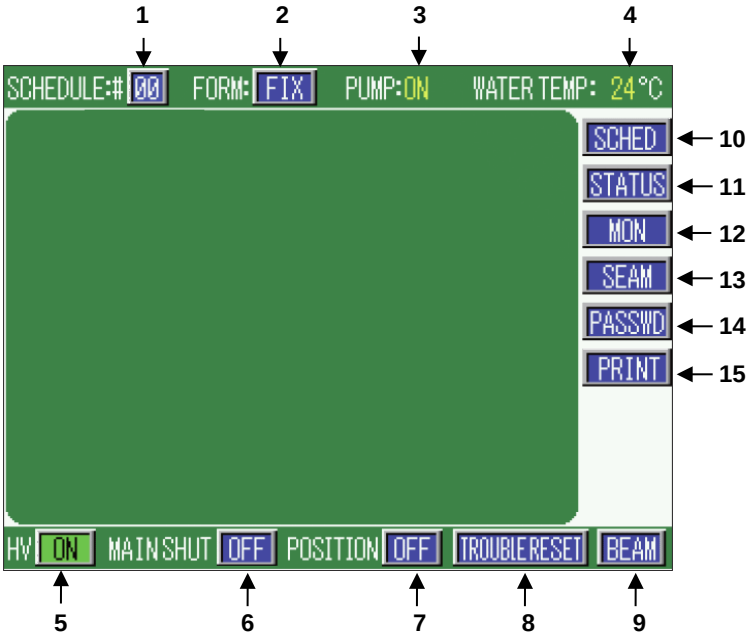
The content of each LCD screen differs based on the menu screen; however some parameters/settings are common to ***all*** screens. The content of each screen is outlined below.

SCREEN	CONTENTS	
	Individual Screen	**Common to Each Screen**
SCHEDULE	Laser Output Peak Setting (kW) Repeat Setting (PPS) Up-Slope Time Settings (ms) Number of Shots Setting [FLASH/Point] Laser Output Time Setting (ms) [FLASH/Point] Laser Output Value Setting (%) Down-Slope Time Setting (ms) [COOL 1/2] No Laser Output Time (ms) Seam Weld Mode (ON/OFF)	Schedule # Form: Fix or FLEX Pump (ON/OFF) Water Temperature (°C) (HV) High Voltage (ON/OFF) Main Shut – Main Shutter (ON/OFF) Position - Guide Beam (ON/OFF) Trouble Reset Beam - Branch Shutters (ON/OFF)
STATUS	Reset Shot Count Preset/Reset Reset Good Count Preset/Reset Guide Beam Blinking Control (ON/OFF) Optical Fiber Settings (SI/GI/mm)	
POWER MONITOR	Laser Output Energy (J) Laser Output Average Power (W) Total Shot Count Good Shot Count Laser Energy Upper/Lower Limit Setting (J) Lamp Input Power Display (%) Lamp Input Power Upper Limit Setting (%)	

Section II. How to Use the LCD Screens

Common to All Screens

There are common functions that are displayed on each LCD screen, as described below:



1. **SCHEDULE #** – Displays the schedule number selected on the **SCHEDULE** screen. 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 Laser is capable of storing up to 32 schedules (SCH # 00 - 31).
2. **FORM** – There are two options in the **FORM** field: **FIX** and **FLEX**. When the **FORM** field is selected, a pop-up window will display, which will allow you to choose the **FORM** option. Options: **FIX** / **FLEX** / **CANCEL**.
3. **PUMP** – Displays the status of the internal water pump. When **ON** is displayed, it indicates that the internal cooling water pump is operating.
4. **WATER TEMP** – Displays the temperature of the secondary (internal) cooling water.
5. **HV** – Field used to turn the HV (High Voltage) on/off. When **ON** the laser is capable of producing an output. When selected a pop-up window will display, which will allow you to turn the High Voltage **ON** and **OFF**.

   Options: **ON** / **OFF** / **CANCEL**.
6. **MAIN SHUT** – Field used to open (on) / close (off) the Main Shutters. When selected a pop-up window will display, which will allow you to open/close the Main Shutters.

   Options: **ON** / **OFF** / **CANCEL**.

7. **POSITION** – Field used to turn the visible Guide Beam on/off. When selected a pop-up window will display, which will allow you to turn the Guide Beam on/off.

   Options: **ON** / **OFF** / **CANCEL**.

8. **TROUBLE RESET** – When an error occurs in the Laser, a Trouble Error Code will display on the LCD screen. Correct the cause of the error and then select **TROUBLE RESET** to clear the error and resume normal operation. If the source of the error is not cleared, the Trouble Error Code will not reset. The Laser will not operate until all Errors have been cleared.

9. **BEAM** – Field used to display the installed branch shutters. When selected a pop-up window will display, which will allow you to open/close each installed branch shutter. When **ON** is selected for any branch shutter, the branch shutter will open. A field must be turned **ON** in order to get a laser output on that particular output branch. When **OFF** is selected, the branch shutters will close.

   For example, if the laser is configured with a **3E** output (3 energy-shared outputs); **SHUTTER-1** through **SHUTTER-3** must be turned **ON** in order to get an output on branch fibers 1, 2, and 3.

   Options: **SHUTTER 1: ON/OFF**
   SHUTTER 2: ON/OFF
   SHUTTER 3: ON/OFF
   SHUTTER 4: ON/OFF
   CANCEL

10. **SCHED** – Field used to select the **Schedule Screen.**

11. **STATUS –** Field used to select the **Status Screen.**

12. **MON –** Field used to select the **Power Monitor Screen.**

13. **SEAM –** Field used to select the **Seam Weld Screen.**

14. **PASSWD –** Field used to select the **Password Screen.**

    NOTE: The **Password Screen** is not visible from the **Maintenance Mode Screen.**

15. **PRINT –** Field used to select the **Print-out Screen.**

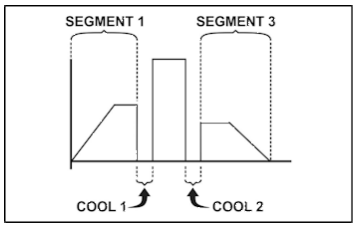
    NOTE: The **Print-out Screen** is not visible from the Maintenance Mode Screen.

SCHEDULE Screen

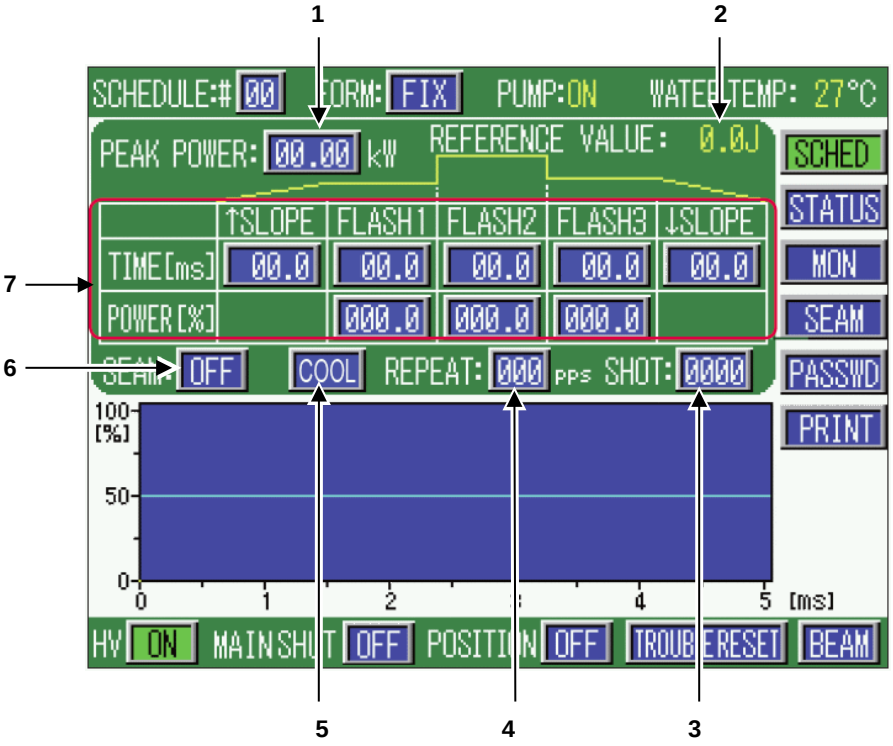
The Laser is capable of processing two types of **[FORM]** outputs:

- **[FIX]** Output – Defines a laser output process over three time segments.
- **[FLEX]** Output – Defines a laser output process over twenty discrete points.

[FORM: FIX] Function



The majority of all laser processing can be completed using the **[FORM: FIX]** output mode. The Laser output can be defined over three time segments, including a power ramp **UP/DOWN** feature in segments 1 and 3 as shown on the right.



1. **PEAK POWER** – Sets the reference value of the peak laser output. The actual programmed laser output is set as a percentage of this Peak Power value. The maximum Peak Power output setting varies depending on the Laser Model. Example: **PEAK** 4.00 kW x 50% = 2.0 kW

   Note: If Initialization Switch **MSW1-6** is **ON**, the Maximum Peak Power ≤ 0.10 kW. (*see pg 3-23*).

Model	Maximum Peak Setting
ML-2551A(-CE) / LW300A(E)	5.0 kW (≤ 10 ms)
ML-2550A(-CE) / LW400A(E)	8.0 kW (≤ 10 ms)

2. **REFERENCE VALUE** – Displays the estimated laser output energy in Joules (**J**) of the programmed waveform. Though the Laser computes the output energy based on the programmed settings, due to optical and electrical characteristics, its estimated value will differ slightly from the monitored (measured) value. Use the estimated laser output energy as an approximation**.**

3. **SHOT** – Sets the number of times (shots) you want to output the laser beam consecutively. The setting can be changed between 0 and 9999. When **REPEAT > 0** and **SHOT = 0**, the Laser will continue to output a laser beam until it receives a laser-stop signal.

4. **REPEAT** – Sets the number of laser pulses per second (PPS). The setting can be changed between 0 and 500. When it is set to **0**, the laser pulse is ***not*** repeated.

5. **COOL** – Sets a value of time between **FLASH1-FLASH2** and **FLASH2-FLASH3** when there will be no laser output. When selected a pop-up window will display, which will allow you to set the **COOL1** time (time between **FLASH1-FLASH2**) and **COOL2** time (time between **FLASH2-FLASH3**).

6. **SEAM** – Field used to activate the **SEAM** weld function that is used to suppress the output waveform over a predetermined amount of time. Options:

   OFF: Turns the seam weld function **OFF** (disables **SEAM** weld function).
   ON: Activates the seam weld function (enables **SEAM** weld function).
   CANCEL: No change made.

7. **FORM (FIX Settings)** – These settings are used to define the pulse shape of the Laser output over three segments. The pulse shape is defined using the **↑SLOPE**, **FLASH 1** / **2** / **3** and **↓SLOPE** parameters. **FLASH 1 / 2 / 3** are used to define how long (ms) and how much power (%) should be delivered to the output during that particular time segment.

   ↑SLOPE Sets the upslope (the laser beam is gradually intensified) within the time set for **FLASH1**. Set **FLASH1** first and then set **↑SLOPE**. (Note: **↑SLOPE** ≤ **FLASH1**). **↑SLOPE** can also eliminate "overshoot" on the rising edge of the output pulse.

   FLASH1 Sets the first segment laser output time and the first laser output value (%).

   FLASH2 Sets the second segment laser output time and the second laser output value (%).

   FLASH3 Sets the third segment laser output time and the third laser output value (%).

   ↓SLOPE Sets the downslope (the laser beam gradually weakens) within the time set for **FLASH 3**. Make sure that **↓SLOPE** is ≤ **FLASH3.**

   The range of the **FLASH 1 / 2 / 3** parameters depends on the laser model.

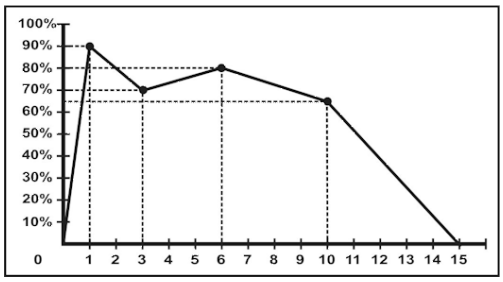
Model	↑SLOPE + FLASH1 + COOL1 + FLASH2 + COOL2 + FLASH3 + ↓SLOPE
ML-2551A(-CE) / LW300A(E)	$0.1 \leq t \leq 99.9$ ms and 0 – 200% value
ML-2550A(-CE) / LW400A(E)	$0.1 \leq t \leq 99.9$ ms and 0 – 200% value

   The maximum peak power output available for each laser model depends on the output pulse width. See the graphs in *Appendix A, Section III, Maximum Peak Power* for more information.

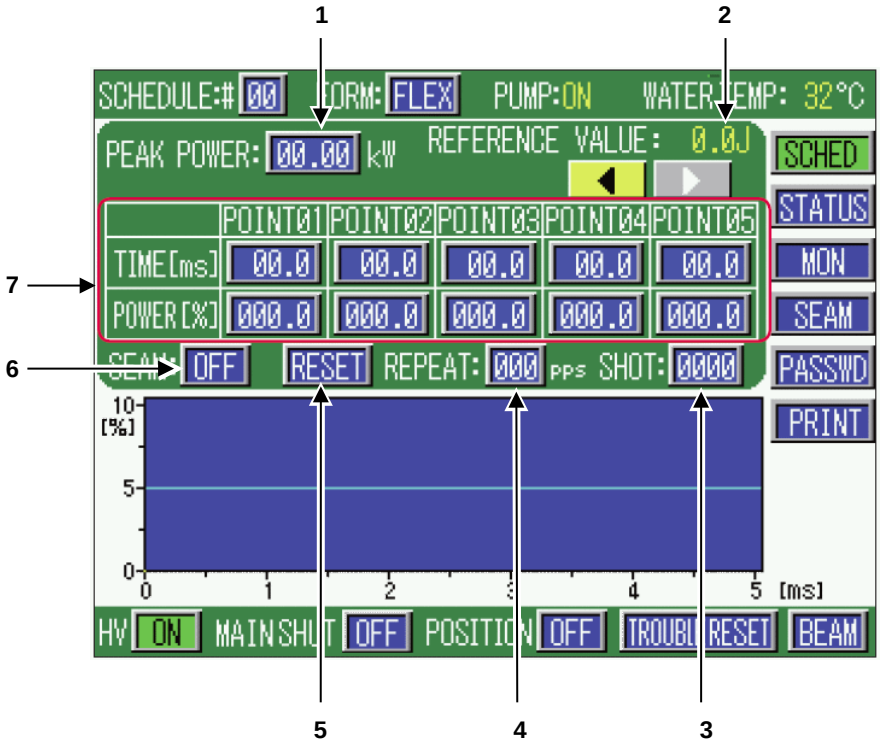
[FORM: FLEX] Function

Occasionally, the need for a non-conventional waveform is needed. Any user-specified output may be defined using the **[FORM: FLEX]** output mode. With **FLEX** mode, the Laser output can be defined over twenty discrete points in time.

An example of a programmed **FLEX** waveform is shown on the right. In this example the entire waveform is 15 mS long specified with 5 points.



Point 1	1.0mS	90.0%
Point 2	2.0mS	70.0%
Point 3	3.0mS	80.0%
Point 4	4.0mS	65.0%
Point 5	5.0mS	00.0%



1. **PEAK POWER** – Sets the reference value of the peak laser output. The actual programmed laser output is set as a percentage of this Peak Power value. The maximum Peak Power output setting varies depending on the Laser Model. Example: **PEAK** 4.00 kW x 50% = 2.0 kW

   NOTE: If Initialization Switch **MSW1-6** is **ON**, the Maximum Peak Power ≤ 0.1 kW (*see page 3-23*).

Laser Model	Maximum Peak Setting
ML-2551A(-CE) / LW300A(E)	5.0 kW (≤ 10 ms)
ML-2550A(-CE) / LW400A(E)	8.0 kW (≤ 10 ms)

2. **REFERENCE VALUE** – Displays the estimated laser output energy in Joules (**J**) of the programmed waveform. Though the Laser computes the output energy based on the programmed settings, due to optical and electrical characteristics, its estimated value will differ slightly from the monitored (measured) value. Use the estimated laser output energy as an approximation.

3. **SHOT** – Sets the number of times (shots) you want to output the laser beam consecutively. The setting can be changed between 0 and 9999. When **REPEAT > 0** and **SHOT = 0**, the Laser will continue to output a laser beam until it receives a laser-stop signal.

4. **REPEAT** – Sets the number of laser pulses per second (PPS). The setting can be changed between 0 and 500. When it is set to **0**, the laser pulse is ***not*** repeated.

5. **RESET** – When **ON** is selected, all the settings from **SHOT01** to **SHOT20** will be cleared.

6. **SEAM** – Field used to activate the **SEAM** weld function that is used to suppress the output waveform over a predetermined amount of time. Options:

   OFF: Turns the seam weld function **OFF** (disables **SEAM** weld function).
   ON: Activates the seam weld function (enables **SEAM** weld function).
   CANCEL: No change made.

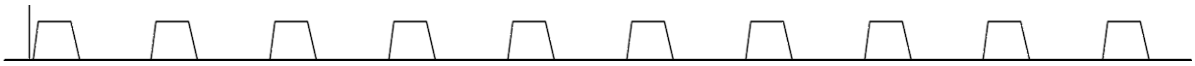
7. **Point 1 through Point 20** – Sets the laser output time and laser output value (%) for each point to form a free (user-defined) waveform. You can set up to 20 discrete points. The maximum setting for each point depends on the laser. To scroll the Point display, use the ◀ and ▶ function buttons to scroll through each point setting (01 through 20).

Laser Model	Point 1 to Point 20	Point Settings
ML-2551A(-CE) / LW300A(E)	0.3 – 99.9 ms	0.1 ms ≤ t ≤ 99.9 ms and 0 – 200%
ML-2550A(-CE) / LW400A(E)	0.3 – 99.9 ms	0.1 ms ≤ t ≤ 99.9 ms and 0 – 200%

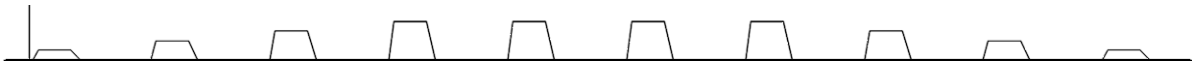
Seam Function

The Seam 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.

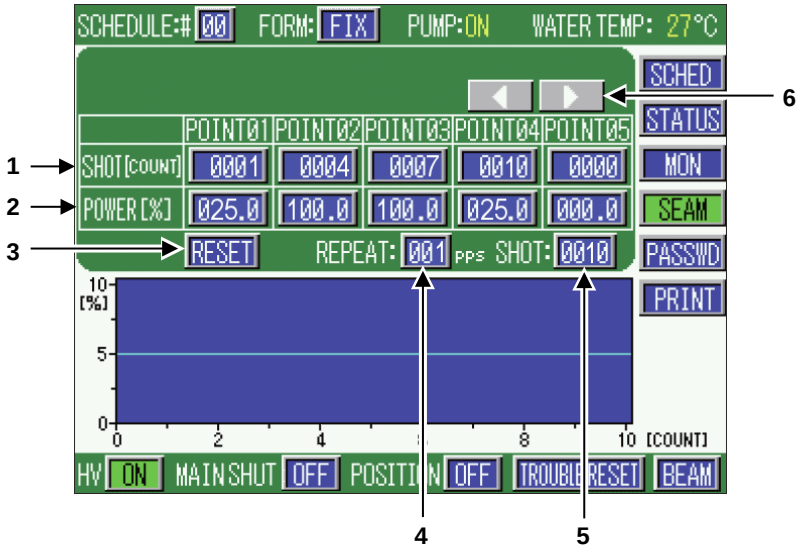
Below is an example of how the Seam Weld function operates. In the top example waveform, the laser is generating a series of 10 programmed output weld pulses without the Seam Weld function.



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** settings for this example are shown in the screen shot below. To enable the **SEAM** function for any given Schedule # (**FIX** or **FLEX**), the **SEAM** option (on either Schedule Screen) must be set to **ON** and the **REPEAT** and **SHOT** ≥ **1**.



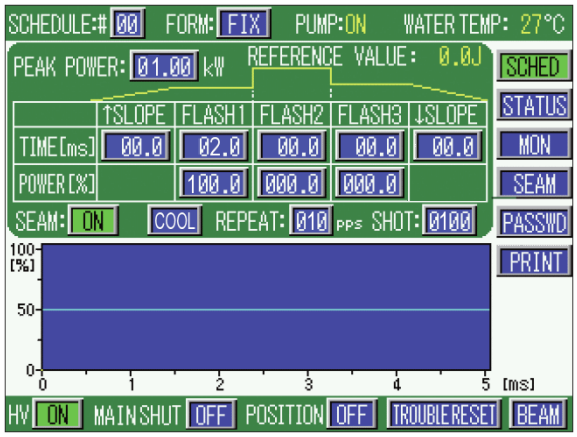
1. **SHOT [COUNT]** – Sets the number of output pulses for **Point01**, **Point02**, etc.
2. **POWER [%]** – Sets the Laser output value of each **Point** (0 – 150%) as the ratio of the **Peak Power** set on the **SCHEDULE** Screen. The % Energy values on the **SEAM WELD MODE** screen, override the % Energy values on the **SCHEDULE** screen.

3. **RESET** – When **ON** is selected, all the settings from **Point01** to **Point20** will be cleared.
4. **REPEAT** – Sets the number of laser output pulses per second. This is the same function as **REPEAT** on the **SCHEDULE** screen. When **REPEAT > 0** and **SHOT = 0**, the laser will fire continuously until the Laser Stop signal is activated. This is the same function as **SHOT** on the **SCHEDULE** screen.
5. **SHOT** – Sets the number of Laser outputs (0000 to 9999). When the laser output count reaches the set value, the Laser stops. For example, when **SHOT** is set to 1, a single shot output is performed.
6. ◀ and ▶ – Used to scroll through all points (**Point01** through **Point20**).

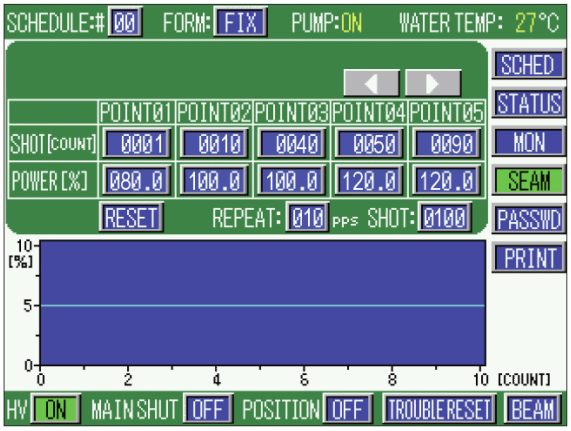
EXAMPLE: SEAM WELD MODE

In the example below, a simple rectangular output pulse (1 kW x 2 mS) is programmed in the **FORM: FIX SCHEDULE** screen at a 10pps repetition rate with a total of 100 shots. The **SEAM WELD MODE** screen is turned **ON** in order to vary the laser output power over the weld process.

SCHEDULE [FORM:FIX] screen

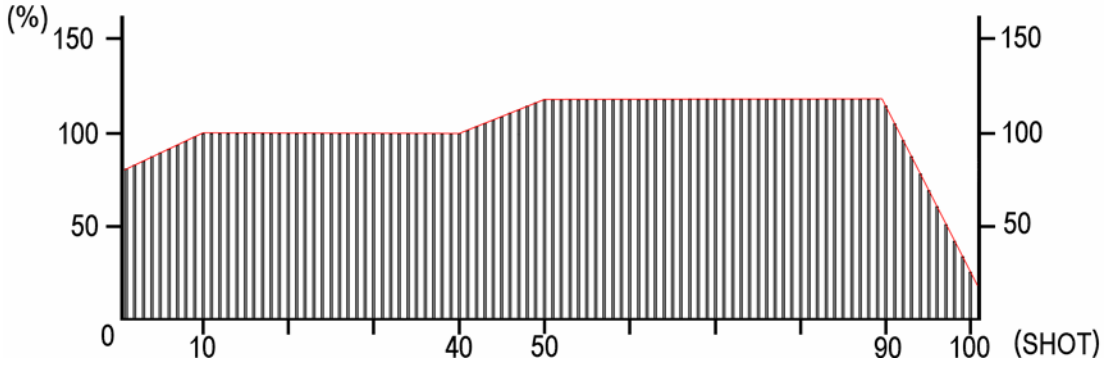


SEAM WELD MODE screen

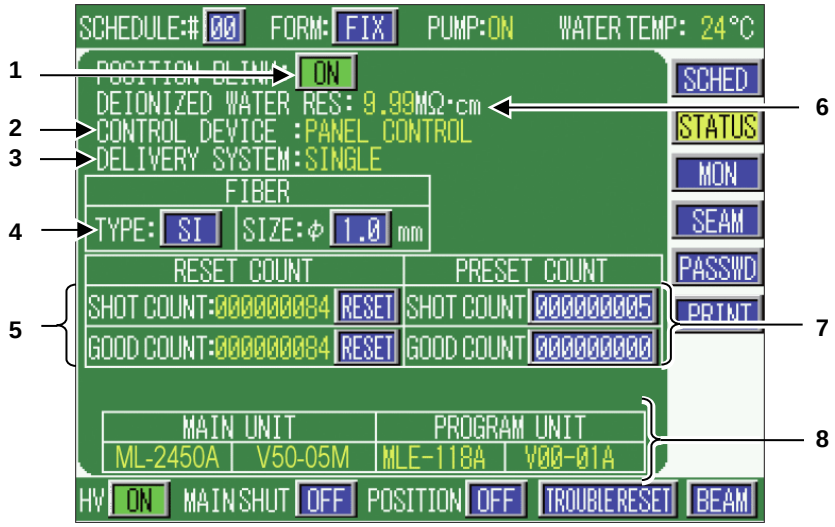


Note: The **POINT06** values (not shown in screen above) are: **SHOT = 0100** and **POWER [%] = 20%.**

When the above parameters are entered into the Laser, the Laser Output will have the following response (where 100% output = 1.00 kW):



Status Screen



1. POSITION BLINK

When selected **ON**, the guide beam laser will blink continuously. This feature can be helpful when trying to align dark colored parts to be welded. When **OFF** is selected, the guide beam laser will not blink.

2. CONTROL DEVICE Mode

Displays the currently selected control method;
EXTERNAL CONTROL, **PANEL CONTROL** or **RS-485 CONTROL**.

EXTERNAL CONTROL	The Laser is controlled by a programmable controller or other similar device connected to the **EXT. I/O** connectors.
PANEL CONTROL	The Laser is controlled by the Control Panel (Program Box).
RS-485 CONTROL	The Laser is controlled by a personal computer connected to the RS-485 (1) or the RS-485 (2) connector (optional).

3. DELIVERY SYSTEM

This field is used to display the lasers optical configuration. The output configuration is set by a dipswitch on the Main PCB. See *Appendix B, Section II, Energy-sharing and Time-sharing* for more information.

DISPLAY	OPTICAL CONFIGURATION
SINGLE	Single (One) output
2 ENERGY SHARE	Two Energy-Shared Outputs
3 ENERGY SHARE	Three Energy-Shared Outputs
4 ENERGY SHARE	Four Energy-Shared Outputs
2 WAY TIME SHARE	Two Time-Shared Outputs
3 WAY TIME SHARE	Three Time-Shared Outputs
4 WAY TIME SHARE	Four Time-Shared Outputs
2 ENERGY 2 WAY TIME	Two Time-Shared Outputs with Two Energy-Shares each
INDEPENDENT CONTROL	Independent Branch Control

4. FIBER

This function prevents excessive power from being applied to the optical fiber. Input the fiber type (SI/GI) and core diameter of the optical fiber being used. The maximum output power for any given optical fiber is automatically computed and limited to prevent fiber damage. Setting range of core diameter: ϕ 0.2 to 1.0 mm for all Laser models.

- The factory default setting is **SI Φ 1.0 mm**.
- If the schedule settings for **PEAK, FLASH** (pulse width and power setting) and **REPEAT** do not match the fiber type and core diameter, an **E51: SET ERROR FIBER** or **E48: OVER RATE FIBER** warning will appear. In these cases change the input settings.
- If the end face surface of the optical fiber is stained, broken, damaged, or covered with dust, a warning message will not necessarily appear on the screen. Be sure to put the cap on the optical fiber when it is not in use.
- If the end face of the optical fiber is broken, check the lenses on both the input and output units for damage. If the lenses are stained, clean them with the method described in *Chapter 6, Maintenance*.
- Do not remove the Laser Beam Input Unit unless absolutely necessary. Doing so will require that the input unit be re-aligned to the laser beam.

5. RESET COUNT

Resets the **TOTAL Shot Count** and the **GOOD Shot Count**. Move the cursor to the counter you want to reset, then select the **ENCODE** key. The count will be set back to **000000000**.

6. DEIONIZE WATER RES

This field displays the resistivity of the secondary cooling water supply.

7. PRESET COUNT

Sets the desired number of laser outputs for the total shot count and the good shot count. When the count has reached this set number, the following messages will appear:

When the SHOT count has reached the set number.

When the GOOD count has reached the set number.

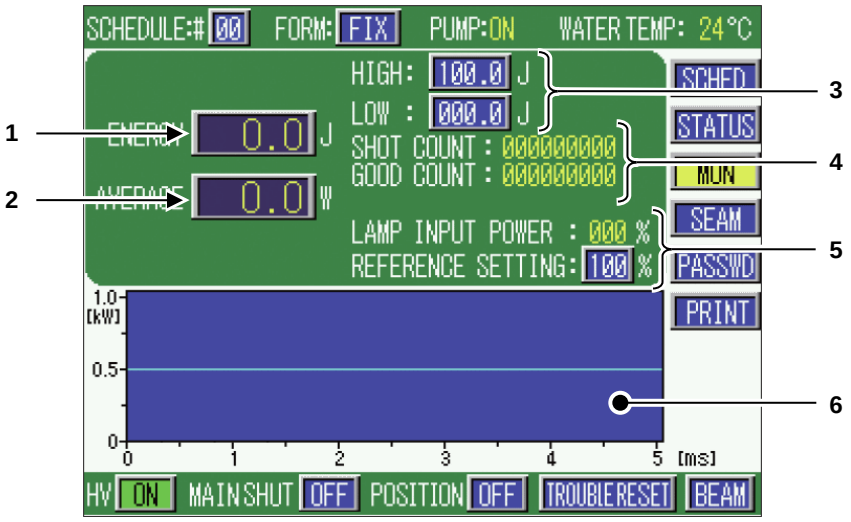
Select **TROUBLE RESET** to return to the previous screen.

8. ROM VERSION

This field displays the firmware revisions inside the Laser (Main CPU & Program Box). The actual location and layout of this data may differ depending on the firmware revision of the Program Box.

Power Monitor Screen

Whenever the Laser is fired, the **POWER MONITOR** screen automatically displays the measured output.



1. ENERGY

Displays the measured laser energy in Joules (J) of the laser oscillator. Each time the laser is fired, its output is measured and displayed. In the case of high-repetition outputs, the energy is displayed at periodic intervals. This is because the repetitions are faster than the LCD refresh rate. The displayed energy will differ from the actual delivered energy at the workpiece. This difference varies based on the optical configuration of the system.

2. AVERAGE

Displays the total mean power in Watts (**W**) of the laser oscillator (averaged over one second). Each time the laser is fired, its output is measured and displayed. In the case of high-repetition outputs, the energy is displayed at periodic intervals. This is because the repetitions are faster than the LCD refresh rate. The displayed average power will differ from the actual delivered power at the workpiece. This difference varies based on the optical configuration of the system.

3. HIGH / LOW alarm limits

To aid in critical welding processes, a **HIGH / LOW** energy output monitor is provided. Set the allowable energy range for the selected schedule. If the measured output energy falls ***outside*** of this range, an Error Code will display on the LCD screen and the Laser will stop firing.

HIGH	000.0J
LOW	000.0J

4. SHOT COUNT GOOD COUNT

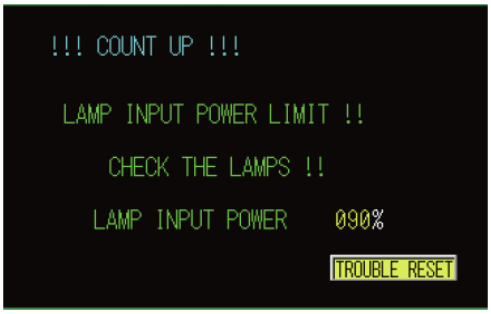
SHOT COUNT	123456789
GOOD COUNT	123456789

SHOT COUNT displays the total number of times the laser was fired. The shot count can be reset to 000000000 on the **STATUS** screen.

GOOD COUNT displays the number of ***Good*** shots that were fired. A ***Good*** shot count means that the measured output energy was within the acceptable range set by the **HIGH / LOW** alarm limits. The good count can be reset to 000000000 on the **STATUS** screen.

5. REFERENCE SETTING and LAMP INPUT POWER

REFERENCE SETTING is used to set the maximum input power to the flashlamp. If the input power exceeds this limit, the following screen will appear, indicating that the flashlamp needs replacement.



NOTE: If this display continues for more than 3 seconds, an **OVERRATE** alarm will also occur.

LAMP INPUT POWER displays the ratio of the flashlamp input power to the output capacity of the Discharge Unit. A value of 100% means that the Discharge Unit is producing the maximum amount of designed output power. As a flashlamp ages, it requires more power to flash. In normal operation, Power Feedback automatically draws the power required from the Discharge Unit to maintain a constant output, thereby compensating for an aging flashlamp.

The best way to use this feature is to set the **REFERENCE SETTING** to 95% ~ 98%. Then as the flashlamp starts to age, it will require more power to maintain a constant output. Eventually the **LAMP INPUT POWER** will reach the **REFERENCE SETTING** value and *Lamp Input Power Limit* screen will appear. Once this alarm condition exists the operator can set the **REFERENCE SETTING** value to 100% and schedule a flashlamp replacement to minimize production down-time.

6. GRAPH

This section of the Power Monitor screen will display the graphical representation of the measured output pulse. The scale limits of the graph will automatically resize based on the measured output pulse. Due to the resolution of this graph, it should only be used for reference and not as an absolute measurement.

PASSWORD MODE Screen

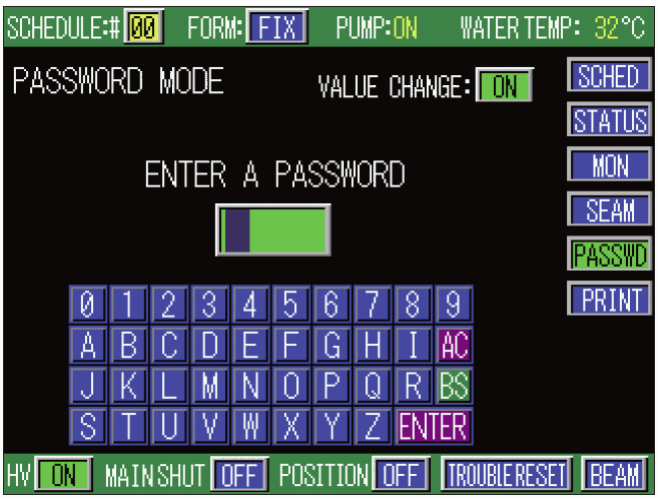
The Password Mode screen is used to prevent unauthorized users from changing laser parameters. The **PASSWORD** consists of a user-defined combination of four letters and/or numbers.

On the Program Box, rotate the **ENCODE** button to the **PASSWD** field, then select the **ENCODE** button. To exit the **PASSWORD MODE** screen, select any other menu function.

NOTES:

- The initial (factory-set) password is **REDS**. You will need to enter this in order to gain access to the password edit screen.

1. To enter or change a password rotate the **ENCODE** button to highlight the **VALUE CHANGE** field, then select. When **ON**, the password may be changed.
2. Rotate the **ENCODE** button until the first password field position is highlighted. Using the **ENCODE** button, select the **PASSWORD** characters from the tile set. Press the **ENCODE** button to select.
3. Repeat for password characters 2 through 4.



AC = Clear All Characters
BS = Backspace

4. Select **ENTER** to check the validity of the entered Password.

   CAUTION: If you change the password, write it down for future reference. The Laser is ***not*** capable of displaying the set password. If a password is set and forgotten, the only way to gain access to the laser is to remove the back-up battery from the Main PCB (with the Laser power in the **OFF** position). Allow the on-board memory capacitor to fully discharge (up to 3 hours), then initialize the laser as described later in this Chapter. All Schedule information will be lost and the password will reset back to the factory default: **REDS**.

5. If entering a new Password, you will be prompted to re-enter the Password again. If the Passwords do not match, the new Password will not be saved.

Incorrect Password

If the password is incorrect;

WRONG PASSWORD, ENTER CORRECT ONE

will display. You can exit out of the Password screen by selecting a different Menu option.

Password-Protected Settings & Functions

SCHEDULE number	**UP SLOPE TIME**
FORM: FIX/FLEX mode in Wave Shape Control	**FLASH 1 TIME**
PEAK POWER (output peak value)	**COOL 1 TIME**
REPEAT function	**FLASH 2 TIME**
SHOT (total # of laser outputs)	**COOL 2 TIME**
POINT 1 to 20 (time in mS and output %)	**FLASH 3 TIME**
FIBER TYPE: SI/GI	**DOWN SLOPE TIME**
FIBER CORE DIAMETER	**POSITION BLINK: ON/OFF** of Guide Beam (LD)
Upper Limit **(HIGH)** of **ENERGY** monitor	**TOTAL SHOT COUNT RESET**
Lower Limit **(LOW)** of **ENERGY** monitor	**TOTAL GOOD COUNT RESET**
REFERENCE SET	**RESET SHOT COUNT**
CONTROL (in Maintenance Mode)	**PRESET SHOT COUNT**
SHOT COUNT	**CURRENT** (in Maintenance Mode)
GOOD COUNT	**PULSE WIDTH** (in Maintenance Mode)

PRINTOUT MODE Screen

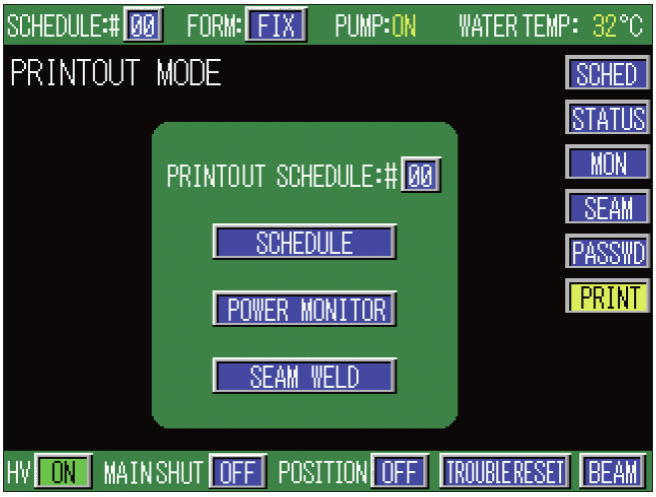
You can print out and view the welding conditions of each schedule using the **PRINTOUT MODE** screen. When activated, the conditions are sent to both RS-485 connectors for printout. The output print protocol is designed for use with a serial printer. Best results are achieved using a *Sanei Electric Inc., BL2-58SNWJC* printer. Due to differences in printer protocols, the generated output may differ from the examples shown on the following pages. The welding conditions are also displayed on the screen in the event a printer is unavailable.

1 On the Program Box, rotate the **ENCODE** button to the **PRINT** field, then select the **ENCODE** button.

2 Select the **SCHEDULE #** for the print-out that you want and then select what you want to print (**SCHEDULE**, **POWER MONITOR**, **SEAM WELD**).

3 To exit the Print-out Mode screen, rotate the **ENCODE** button and select any other menu function.

NOTE: The **CONTROL** key switch must be turned **ON**.



Printing the Welding Conditions of Each Schedule

1. Verify the proper **SCHEDULE #** is selected.
2. Rotate the **ENCODE** button to the **SCHEDULE** field and then select it.
3. The schedule conditions for the selected **SCHEDULE #** will be sent to the printer.

Printing Out the Power Monitor Measurements

1. Verify the proper **SCHEDULE #** is selected.
2. Rotate the **ENCODE** button to the **POWER MONITOR** field and then select it.
3. The set values and measured values from the Monitor Screen will be sent to the printer.

   NOTE: Each time the laser is fired, the monitored waveform data is updated.

Printing Out the Seam Weld Conditions

1. Verify the proper **SCHEDULE #** is selected.
2. Rotate the **ENCODE** button to the **SEAM WELD** field and then select it.
3. The set values on the **SEAM** screen will be sent to the printer.

Welding Condition Print-Out Examples – Schedule Screen

Example **FORM:FIX**

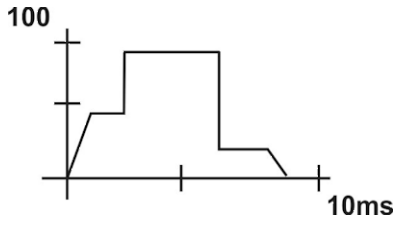
SCHEDULE
-SCH. #00 FORM:FIX

PEAK POWER = 01.00kW

U-SLOPE = 00.5ms
FLASH 1 = 01.5ms 040.0%
FLASH 2 = 03.0ms 080.0%
FLASH 3 = 01.0ms 020.0%
D-SLOPE = 00.3ms

REPEAT = 010PPS
SHOT = 0430

ESTIMATED VALUE = 3.1J



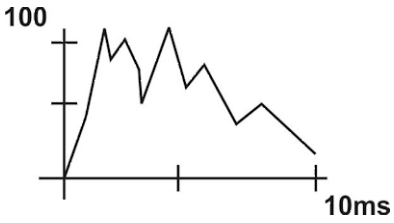
Example **FORM:FLEX**

SCHEDULE
-SCH. #00 FORM:FLEX

PEAK POWER = 02.00kW

Point1 = 00.4ms 032.2%
Point2 = 00.8ms 107.0%
Point3 = 01.1ms 084.1%
Point4 = 01.4ms 094.2%
Point5 = 01.8ms 072.3%
Point6 = 02.1ms 060.4%
Point7 = 02.5ms 036.0%
Point8 = 02.9ms 100.5%
Point9 = 03.4ms 060.0%
Point10 = 03.7ms 102.0%
Point11 = 04.0ms 042.1%
Point12 = 04.5ms 070.3%
Point13 = 04.8ms 062.0%
Point14 = 05.1ms 050.4%
Point15 = 06.1ms 013.0%
Point16 = 06.7ms 011.2%
Point17 = 06.8ms 008.7%
Point18 = 07.2ms 040.0%
Point19 = 08.8ms 012.1%
Point20 = 10.0ms 000.0%

REPEAT = 002PPS
SHOT = 1120



ESTIMATED VALUE = 8.8J

Power Monitor Examples – Power Monitor Screen

Example **FORM:FIX**

POWERMONITOR
-SCH. #00

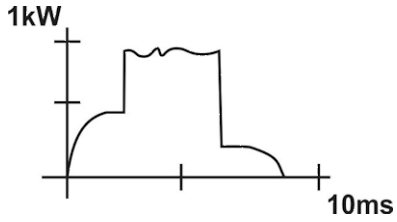
ENERGY
3.1 J

AVERAGE
30.3 J

HIGH = 04.00J
LOW = 00.00J

LAMP INPUT PWR 000%
REFERENCE SET 120%

SHOT COUNT = 000000708
GOOD COUNT = 000000241



Example **FORM:FLEX**

POWERMONITOR
-SCH. #01

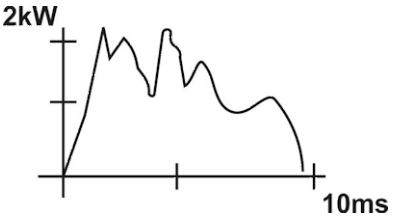
ENERGY
8.8 J

AVERAGE
25.9 W

HIGH = 04.00J
LOW = 00.00J

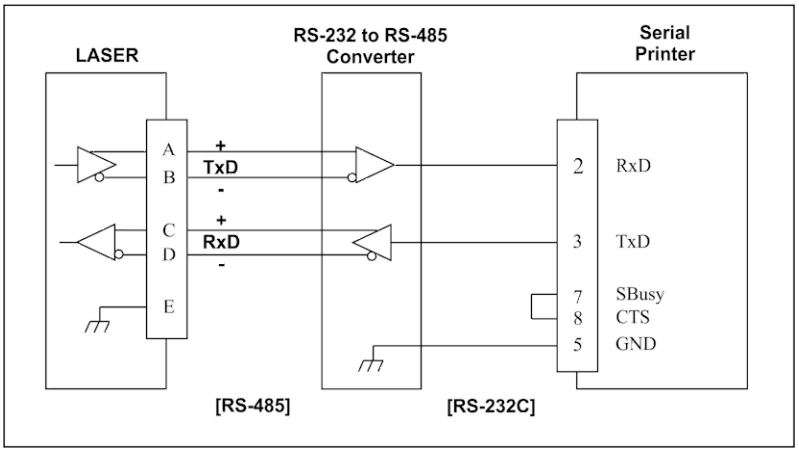
LAMP INPUT PWR 000%
REFERENCE SET 120%

SHOT COUNT = 000000713
GOOD COUNT = 000000246



Connecting the Serial Printer

The serial printer (Sanei Electric Inc., BL2-58SNWJC or equivalent) can be connected to either RS-485 (1) or RS-485 (2).



Section III. Hidden Menu Screens

Overview

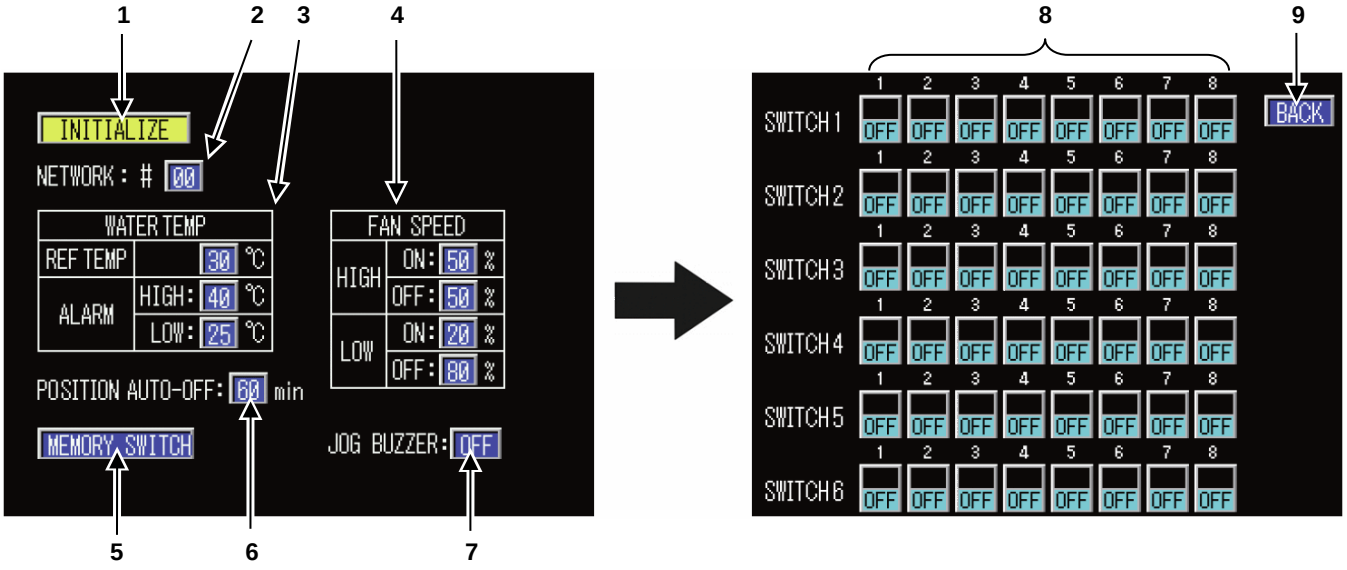
There are two hidden screens in the Laser used to **INITIALIZE**, **SETUP** and **CONFIGURE** the Laser.

CAUTION: These screens should ***only*** be used by trained personnel. If the parameters on these screens are set incorrectly, the Laser may become inoperable.

Initialization Screen

The **INITIALIZATION** screen is primarily used for the RS-485 communication settings and maintenance functions.

1. Turn ***both*** the **MAIN POWER** switch and Keyswitch to the **OFF** position.
2. Press ***and hold*** the **ENCODE** button while turning the **MAIN POWER** switch **ON**.
3. When the picture of the Laser is displayed, turn the **ENCODE** button CCW (counter-clockwise) while continuously holding down the **ENCODE** button.
4. Once the **INITIALIZATION** screen appears, release the **ENCODE** button.
5. ***After*** making changes, turn the Laser power OFF then ON again in order to initialize the Laser with the new settings.



1. INITIALIZE

Select **ON** to restore the laser factory default settings. When this option is selected ***ALL*** schedule data will be erased. Record or save the Schedule Data before Initializing the Laser to avoid having to re-create all Schedule data

Example: Use when the Main PCB is re-programmed or replaced, or after the back-up battery on the Main PCB is replaced.

2. NETWORK # 00-31

This field is used to select the device (Laser) number for the optional RS-485 communications function. When connecting multiple Lasers together, each Laser needs a unique **NETWORK ID** number. The factory default setting for all lasers is **00.**

3. WATER TEMPERATURE ALARM SETTINGS - L 25°C H 40°C

These fields are used to set the water temperature threshold upper and lower limits. If the temperature exceeds either of these set limits, the Laser will not operate ***until*** the water temperature returns to normal. The **REF TEMP** setting is the optimal temperature point. In order to prevent poor performance, do ***not*** change these setting values.

4. FAN SPEED SETTINGS

CAUTION: These are factory set, do ***not*** change these values.

5. MEMORY SWITCH

When **MEMORY SWITCH** is selected, the ***Memory Switch Settings*** screen will display.

6. POSITION AUTO-OFF 60MIN

These fields are used to control the position guide beam. These settings are used to automatically turn the position guide beam **OFF** to extend the life of the diode in the event the guide beam is accidentally left **ON**. This field is adjustable from 01 to 98 minutes. If the time is set for **00MIN**, the position guide beam will not light. If the time is set for **99MIN**, the position guide beam will not turn **OFF**.

NOTE: The factory default setting is **60MIN**.

7. JOG BUZZER

This function controls whether a sound is made when the **ENCODE** button is rotated.

8. MEMORY SWITCH SETTINGS SCREEN (MSW)

The software switches are part of the Initialization Screen and they are used to set-up specific Laser functions. When shipped from the factory, all switches are set in the **OFF** position. If the Laser is re-initialized (by selecting **INITIALIZE: ON** from the previous screen), all of these switch settings will revert back to the factory settings (all **OFF**).

MSW1

Position	Function	ON	OFF (default)
MSW1-1	Automatic High Voltage startup	High Voltage will ***not*** turn ON during start-up	High Voltage will turn ON during start-up
MSW1-2	Enable Start Input on EXT-I/O(1)-20 when in Panel Control mode.	Start Input enabled	Start Input disabled
MSW1-3	*Not Used (leave OFF)*		
MSW1-4	Laser Start Signal Accept Time (Firmware ≥ V50-11N)	Laser will fire on any Input transition ≥ 20 µS.	Input pulse must meet Laser Accept Time setting.
MSW1-5	*Not Used (leave OFF)*		
MSW1-6	Energy Measurement Resolution	00.00 J (x 10) Peak Power ≤ 0.10 kW	000.0 J (x1)
MSW1-7	Time Setting Resolution	0.05 mS steps Maximum setting ≤ 5 mS	0.1 mS steps
MSW1-8	*Not Used (leave OFF)*		

MSW2

Position	RS-485 Function	ON	OFF (default)
MSW2-1	Data Bit Length	7 bits	8 bits
MSW2-2	Parity Bit	No parity	With parity
MSW2-3	Parity Mode	Odd parity	Even parity
MSW2-4	Stop Bit	1 stop bit	2 stop bits
MSW2-5	RS-485 Communication Baud Rate (*see table below*) Refer to *Appendix D* for communication information.		
MSW2-6			
MSW2-7	*Not Used (leave OFF)*		
MSW2-8	Enable Start Input on EXT-I/O(1)-20 when in RS-485 Communications	Start Input enabled	Start Input disabled

MSW3

Position	Function	ON	OFF
MSW3-1	*Not Used (leave OFF)*		
MSW3-2	Laser Start/Accept Times	*(see table below)*	
MSW3-3			
MSW3-4			
MSW3-5	END signal after Laser fires	Enabled	Disabled
MSW3-6	Trigger Signal Output, EXT-I/O(1)-7 (Firmware ≥ V00-02H)	Trigger Output active	No Trigger Output
MSW3-7	*Not Used (leave OFF)*		
MSW3-8	Dummy Shot visible on SCHED screen	Enabled	Disabled

MSW2 - RS-485 Comm. Baud Rate detail:

Communication Baud Rate	MSW2-5	MSW2-6
9,600 bps (*default*)	OFF	OFF
19,200 bps	OFF	ON
38,400 bps	ON	OFF
9,600 bps	ON	ON

MSW3 - Laser Start/Accept Times detail:

Laser Accept Times	MSW3-4	MSW3-3	MSW3-2
16 mS (*default*)	OFF	OFF	OFF
8 mS	OFF	OFF	ON
4 mS	OFF	ON	OFF
1 mS	OFF	ON	ON
0.1 mS	ON	x	x

x – don't care

MSW4 (see *Appendix B, Section III* for more information on *Independent Control*)

Position	Function
MSW4-1	Branch Shutter 1 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-2	Branch Shutter 2 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-3	Branch Shutter 3 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-4	Branch Shutter 4 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-5	*Not Used (leave OFF)*
MSW4-6	*Not Used (leave OFF)*
MSW4-7	*Not Used (leave OFF)*
MSW4-8	*Not Used (leave OFF)*

MSW5 (see *Appendix B, Section III* for more information on *Independent Control*)

Position	Function
MSW5-1	Time-Share 1 – When in Independent Control mode, turn **ON** if time-share shutter 1 is installed.
MSW5-2	Time-Share 2 – When in Independent Control mode, turn **ON** if time-share shutter 2 is installed.
MSW5-3	Time-Share 3 – When in Independent Control mode, turn **ON** if time-share shutter 3 is installed.
MSW5-4	*Not Used (leave OFF)*
MSW5-5	*Not Used (leave OFF)*
MSW5-6	*Not Used (leave OFF)*
MSW5-7	*Not Used (leave OFF)*
MSW5-8	*Not Used (leave OFF)*

MSW6 – *Not Used (leave OFF)*

9. BACK – This button returns to the Initialization Screen.

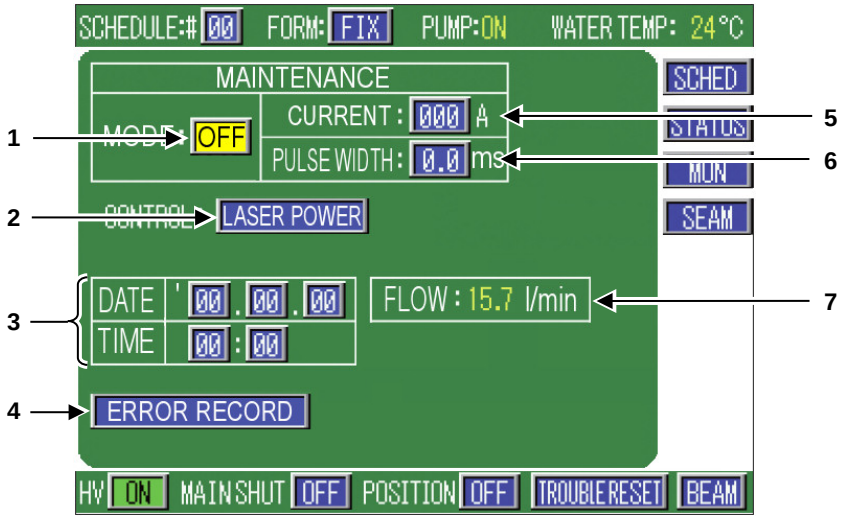
Maintenance Mode Screen

The Maintenance Mode Screen is used for maintenance functions such as, checking the status and alignment of the laser. This screen is not typically used by the laser operator. For information on the Maintenance Screen contents, please consult with AMADA WELD TECH.

CAUTION: An incorrect setting in this screen may make the Laser inoperable.

1. Rotate the **ENCODE** button to the **Passwd** field.
2. Press and hold the **ENCODE** button for 2 seconds (until you hear a faint beep).
3. Rotate the **ENCODE** button to the **Print** field.
4. Press and hold the **ENCODE** button for 2 more seconds, until the Maintenance Mode Screen appears, then release the **ENCODE** button.
5. To exit the Maintenance Mode screen, rotate the **ENCODE** button to any **MENU** key, then press the **ENCODE** button.

   NOTE: The **CONTROL** key switch must be turned **ON**.



1. MODE

To aid in laser alignment, turn Maintenance Mode **ON**. While in Maintenance Mode, the Program Box is the only way of controlling the laser. When Maintenance Mode is **ON**, all fields in the Maintenance Mode screen become active.

2. CONTROL

This field is used to display the status of the feedback control system.

DISPLAY	FEEDBACK STATUS
LASER POWER	POWER FEEDBACK ENABLED (CLOSED LOOP)
CURRENT	POWER FEEDBACK DISABLED (OPEN LOOP)

When set to **LASER POWER**, the power feedback circuit is active. The Laser should always be set to **LASER POWER** mode for normal operation.

CURRENT mode is used to supply a user-defined current through the flashlamp.
CURRENT mode should ***only*** be used during oscillator alignment by factory-trained personnel.

3. DATE / TIME

These fields are used for entering the current date and time (24-Hour clock). Date and time are not needed for normal operation. These fields become important when using the **PRINT** mode and **ERROR RECORDS**.

FORMAT: ' [YR] . [MO] . [DAY]

[HR] : [MIN]

EXAMPLE: **' 10.02.09** = **February 9, 2010**
14:05 **2:05 p.m.**

4. ERROR RECORD

This field is used to view the error log when enabled. The error log will display the last 50 errors with the most recent error listed at the top of the list.

5. CURRENT

This is the flashlamp current setting. Used ***only*** when **LASER CONTROL** is set to **CURRENT** mode. The flashlamp current adjustment must ***only*** be performed by factory-trained personnel.

Range: $70\ A \leq I \leq 300\ A$

6. PULSE WIDTH

This controls the output pulse width. Used ***only*** when **LASER CONTROL** is set to **CURRENT** mode. This pulse width adjustment must ***only*** be performed by factory-trained personnel.

Range: $0.3\ mS \leq t \leq 5.0\ mS$

7. FLOW

The **FLOW** field displays the measured flow rate of the internal water pump. As the water filter and de-ionized cartridge get clogged, the flow rate will drop.

CHAPTER 4
MLE-115A PROGRAMMING FUNCTIONS

Section I. LCD Control Screens

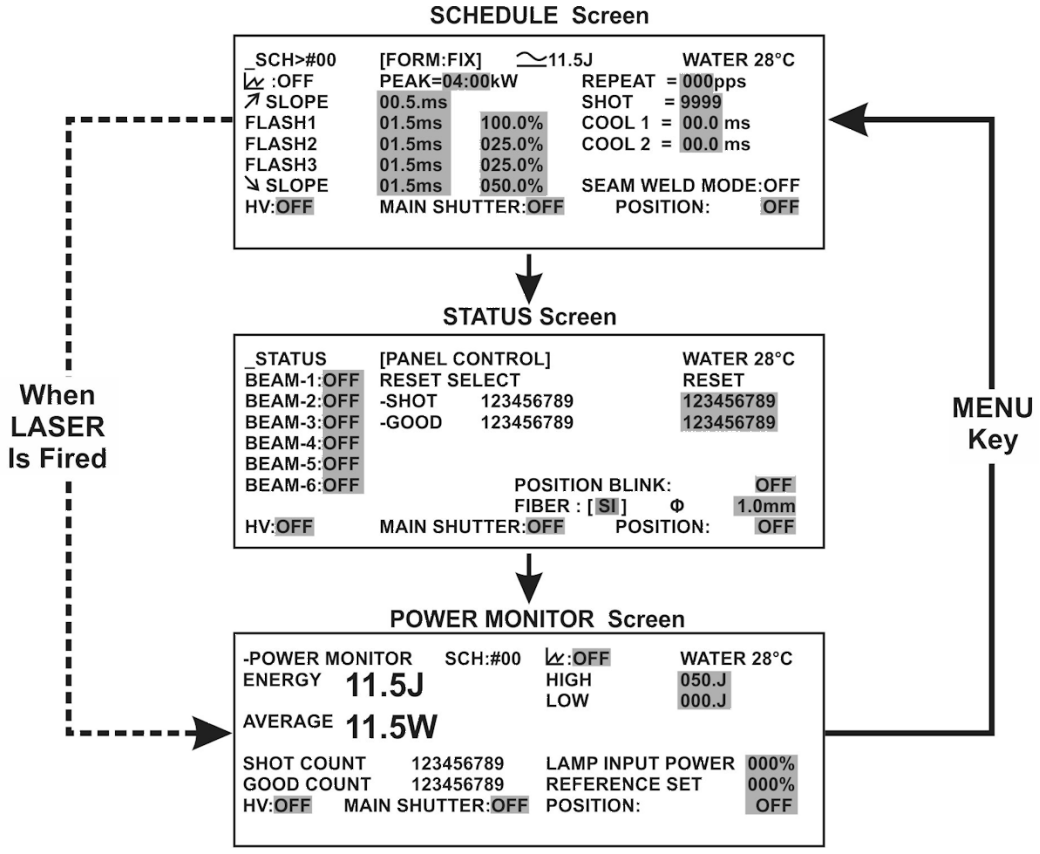
About the LCD Screens

There are three main LCD screens used to control the Laser.

- **Schedule Screen** – used to set the parameters of your weld.
- **Status Screen** – used to control the output process.
- **Power Monitor** – used to display output weld information.

Each time the **MENU** key is pressed, the **CONTROL** screen will change as shown below. If the Laser is fired while viewing the **SCHEDULE** screen, the **POWER MONITOR** screen will automatically appear after the Laser has fired.

NOTE: if the characters or numbers are **shaded**, the values may be changed by the operator.



Screen Content

The content of each LCD screen differs based on the screen, however some parameters are common to ***all*** screens. The content of each screen is outlined below.

SCREEN	CONTENTS	
	Individual Screen	**Common to Each Screen**
SCHEDULE	Schedule Number [FORM] Output Mode (FIX or FLEX) Graph Display (ON/OFF) Laser Energy (⁓) Display (J) Laser Output Peak Setting (kW) Repeat Setting (PPS) ↗ Slope Time Settings (ms) Number of Shots Setting [FLASH/Point] Laser Output Time Setting (ms) [FLASH/Point] Laser Output Value Setting (%) ↘ Slope Time Setting (ms) [COOL 1/2] No Laser Output Time (ms) Seam Weld Mode (ON/OFF)	(HV) High Voltage (ON/OFF) Main Shutter (ON/OFF)
STATUS	[STATUS] Laser Control Method [BEAM] Branch Shutter Control (ON/OFF) Shot Count Preset/Reset Good Count Preset/Reset Guide Beam Blinking Control (ON/OFF) Optical Fiber Settings (SI/GI/mm)	Position Guide Beam (ON/OFF)
POWER MONITOR	Schedule Number Graph Display (ON/OFF) Laser Output Energy (J) Laser Output Average Power (W) Total Shot Count Good Shot Count Laser Energy Upper/Lower Limit Setting (J) Lamp Input Power Display (%) Lamp Input Power Upper Limit Setting (%)	Water Temperature (°C)

Section II. How to Use the LCD Screens

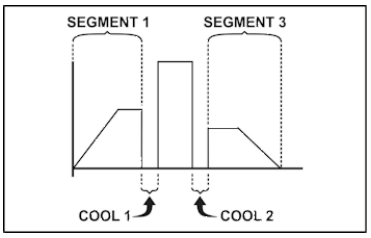
SCHEDULE Screen

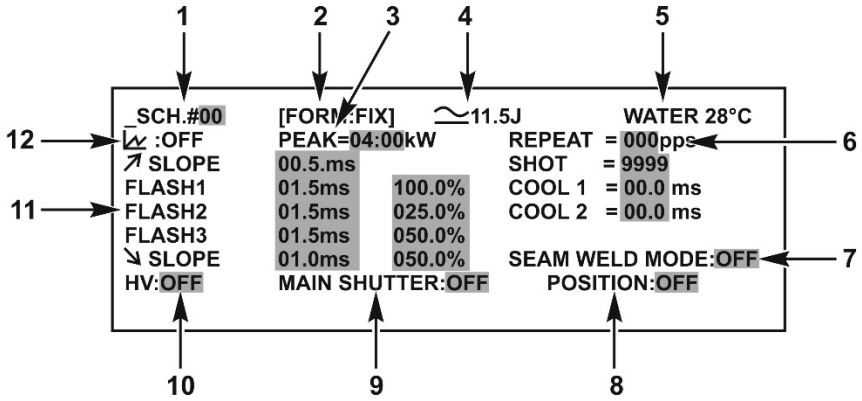
The Laser is capable of processing two types of **[FORM]** outputs:

- **[FIX]** Output – Defines a laser output process over three time segments.
- **[FLEX]** Output – Defines a laser output process over twenty discrete points.

[FORM: FIX] Function

The majority of all laser processing can be completed using the **[FORM: FIX]** output mode. The Laser output can be defined over three time segments, including a power ramp **UP/DOWN** feature in segments 1 and 3 as shown on the right.





1. **SCH #** – Displays the schedule number selected on the **SCHEDULE** screen. 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 Laser is capable of storing up to 32 schedules (SCH # 00 – 31).

2. **FORM** – There are two options in the **FORM** field: **FIX** and **FLEX**. When the **FORM** field is selected, you can choose the **FORM** option. This section describes the **FIX** output mode feature.

   NOTE: If the **[FORM]** output mode is switched, all waveform setting values will be set to "**0**".

3. **PEAK** – Sets the reference value of the Peak Power laser output. The actual programmed laser output is set as a percentage of this Peak Power value. The maximum Peak Power output setting of the laser output varies depending on the model number of the laser.

   Example: **PEAK** 4.00 kW x 50% = 2.0 kW

   Note: If Initialization Switch **MSW1-6** is **ON**, the Max Peak Power ≤ 0.10 kW (see pg 4-15).

Model	Maximum Peak Setting
ML-2551A(-CE) / LW300A(E)	5.0 kW (≤ 10 ms)
ML-2550A(-CE) / LW400A(E)	8.0 kW (≤ 10 ms)

4. ⁓ – Displays estimated laser output energy in Joules (**J**) of the programmed waveform. Though the Laser computes the output energy based on the programmed settings, due to optical and electrical characteristics, its estimated value will differ slightly from the monitored (measured) value. Use the estimated laser output energy as an approximation.

5. **WATER** – Displays the temperature of the internal cooling water.

6. **REPEAT SHOT**
REPEAT sets the number of laser pulses per second (PPS). The setting can be changed between 0 and 500. When it is set to **0**, the laser pulse is ***not*** repeated.

REPEAT = 000PPS
SHOT = 0000

SHOT sets the number of times (shots) you want to output the laser beam consecutively. The setting can be changed between 0 and 9999. When **REPEAT > 0** and **SHOT = 0**, the Laser will continue to output a laser beam until it receives a laser-stop signal.

7. **SEAM WELD MODE Screen**

Field used to activate the SEAM weld function that is used to suppress the output waveform over a predetermined amount of pulses. Options:

OFF: Turns the fade-in/out seam weld function OFF.

ON: Activates the fade-in/out function for seam welding.

SET: Displays the **SEAM** weld setting screen.

8. **POSITION** – When **ON**, a visible guide beam laser is displayed at each laser output to aid in process alignment. When **OFF** is selected, the guide beam laser is turned off.

9. **MAIN SHUTTER** – When **ON** is selected, the main shutters are opened and the Laser is ready for oscillation. When **OFF** is selected, no laser output is possible.

10. **HV** – **HV** stands for **HIGH VOLTAGE**. If **ON** is selected, the high voltage is turned on and the **HIGH VOLTAGE** lamp will light up. When **OFF** is selected, the high voltage is not supplied and laser output is not possible.

11. **FORM : FIX Settings** – The **FORM:FIX** settings are used to define the pulse shape of the Laser output over three segments. The pulse shape is defined using the ↗ **SLOPE**, **FLASH 1 / 2 / 3**, ↘ **SLOPE**, and **COOL 1 / 2** parameters. **FLASH 1 / 2 / 3** are used to define how long (ms) and how much power (%) should be delivered to the output during that particular time segment.

↗ SLOPE	00.5ms	
FLASH 1	01.5ms	100.0%
FLASH 2	01.5ms	025.0%
FLASH 3	03.0ms	050.0%
↘ SLOPE	01.0ms	

↗ SLOPE Sets the upslope (the laser beam is gradually intensified) within the time set for **FLASH1**. Set **FLASH1** first and then set **↗ SLOPE**. (Note: **↗ SLOPE ≤ FLASH1)**. **↗ SLOPE** can also eliminate "overshoot" on the rising edge of the output pulse.

FLASH1 Sets the first segment laser output time and the first laser output value (%).

FLASH2 Sets the second segment laser output time and the second laser output value (%).

FLASH3 Sets the third segment laser output time and the third laser output value (%).

↘ SLOPE Sets the downslope (the laser beam gradually weakens) within the time set for **FLASH 3**. Make sure that **↘ SLOPE** is ≤ **FLASH3.**

COOL 1 Sets value of time between **FLASH1** - **FLASH2** when there will be no laser output. When set to **0**, there will be no cooling period.

COOL 2 Sets value of time between **FLASH2** - **FLASH3** when there will be no laser output. When set to **0**, there will be no cooling period.

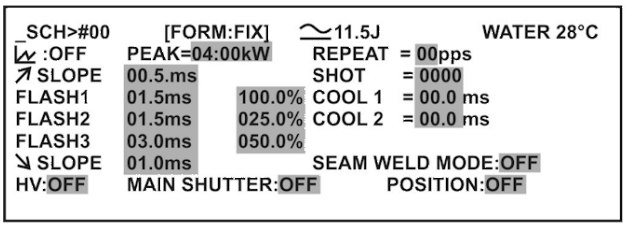
The range of the **FLASH 1 / 2 / 3** parameters depend on the laser model.

Model	↗ SLOPE + FLASH1 + COOL1 + FLASH2 + COOL2 + FLASH3 + ↘ SLOPE
ML-2551A(-CE) / LW300A(E)	0.1 ≤ t ≤ 99.9 ms and 0 – 200% value
ML-2550A(-CE) / LW400A(E)	0.1 ≤ t ≤ 99.9 ms and 0 – 200% value

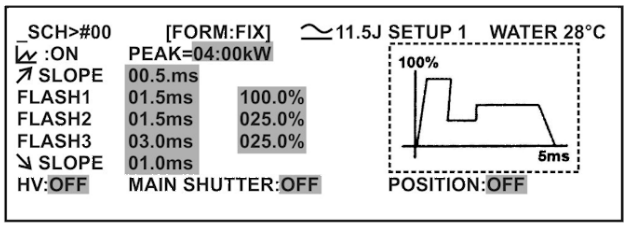
The maximum peak power output available for each laser model depends on the output pulse width. See the graphs in *Appendix A, Section III: Maximum Peak Power* for more information.

12. **(Graph)** – When **ON** is selected, a graphical representation of the programmed waveform is displayed. The X-axis is expressed in ms, the Y-axis as a percentage (of peak power).

When the graph is displayed, it hides the **REPEAT SHOT** field on the right side of the screen. To access the **REPEAT SHOT** field, turn the graph **OFF**.



GRAPH OFF



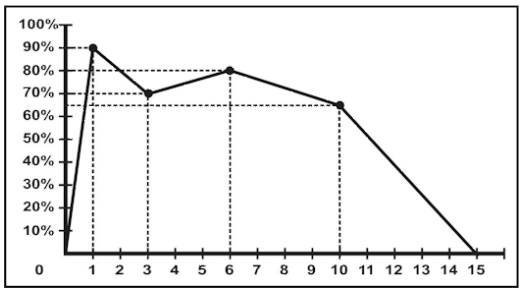
GRAPH ON

[FORM: FLEX] Settings

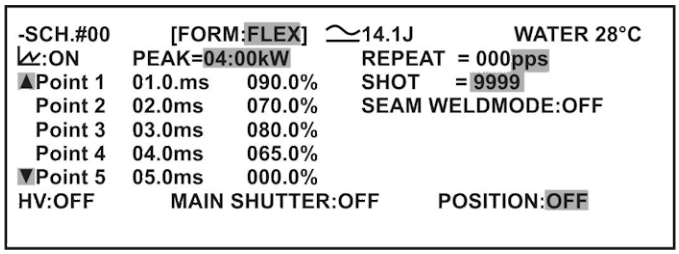
Occasionally, the need for a non-conventional waveform is needed. Any user-specified output may be defined using the **[FORM: FLEX]** output mode. With **FLEX** mode, the Laser output can be defined over twenty discrete points in time.

An example of a programmed **FLEX** waveform is shown on the right. In this example the entire waveform is 15 mS long specified with 5 points.

Point 1 1.0 mS 90.0%
Point 2 2.0 mS 70.0%
Point 3 3.0 mS 80.0%
Point 4 4.0 mS 65.0%
Point 5 5.0 mS 00.0%



All screen settings are the same as the **[FORM: FIX]** screen, with the exception of the waveform entry values which are explained below:



Point01 through Point20

Sets the laser output time and laser output value (% of Peak Power) for each point to form a free (user-defined) waveform. You can set up to 20 discrete points. The maximum setting for each point depends on the laser. To scroll the Point display, use the ▲ and ▼ function icons to scroll through each point setting (01 through 20).

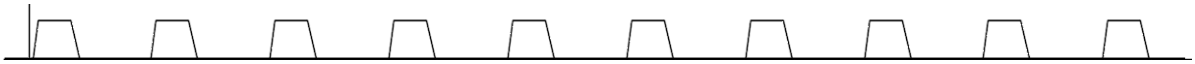
Laser Model	Point 1 to Point 20*	Point Settings
ML-2551A(-CE) / LW300A(E)	0.0 – 99.9 ms	0.1 ms ≤ t ≤ 99.9 ms and 0 – 200%
ML-2550A(-CE) / LW400A(E)	0.0 – 99.9 ms	0.1 ms ≤ t ≤ 99.9 ms and 0 – 200%

* where: 0.3 mS ≤ Last Point Value ≤ 99.9 mS

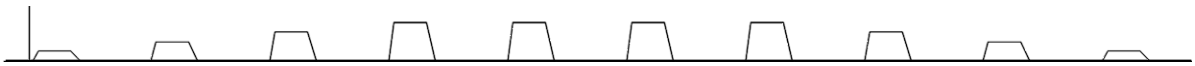
SEAM WELD Screen

The Seam 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.

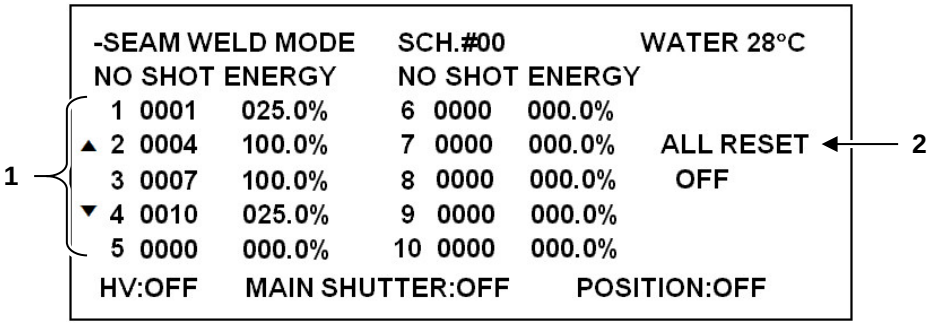
Below is an example of how the Seam Weld function operates. In the top example waveform, the laser is generating a series of 10 programmed output weld pulses without the Seam Weld function.



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** settings for this example are shown in the screen shot below. To enable the Seam function for any given Schedule # (**FIX** or **FLEX**), the **SEAM WELD MODE** option (on either Schedule Screen) must be **ON** and the **REPEAT** and **SHOT** ≥ 1.



1. NO SHOT ENERGY

SHOT defines what shot number to apply the change in *Energy %*.

ENERGY sets the Laser output value of each Point (0 – 150%) as the % ratio of the **Peak Power** specified on the **SCHEDULE** Screen. When the **SEAM WELD MODE** is set to **ON**, the *Energy %* values on the **SEAM WELD MODE** screen over-ride the **SCHEDULE** screen values.

When the laser is firing a series of seam weld pulses, it sets the **ENERGY** % at the shot count specified in **SHOT** field of the **SEAM WELD MODE** screen. The output **ENERGY** % varies gradually (either increases or decreases depending on the next **ENERGY** % specified) until it reaches the next specified shot count. This process repeats for each specified **SHOT** entry.

You can program up to 20 discrete **SHOT** and **ENERGY** values from Number 01 to Number 20. Use the ▲ and ▼ function keys, to scroll through all input fields (**SHOT01** through **SHOT20)**. Press the **MENU** key to return to the **SCHEDULE** screen.

- If there are more points specified on the **SEAM WELD** screen than the total number of **SHOT**s specified on the **SCHEDULE** screen, the Laser will use all of the **SEAM WELD** points specified up to the number of **SHOT**s specified on the **SCHEDULE** screen. The rest of the **SEAM WELD** values (above the **SHOT** number) will be ignored.
- If there are more **SHOT**s specified on the **SCHEDULE** screen than the total number of points specified on the **SEAM WELD** screen, the Laser will use all of the **SEAM WELD** point's specified then use the settings specified at the last point for the remainder of the shots.

2. **ALL RESET –** When **ON** is selected, all the settings from **SHOT01** to **SHOT20** will be cleared.

EXAMPLE: SEAM WELD MODE

In the example below, a simple rectangular output pulse (1 kW x 2 mS) is programmed in the **FORM: FIX SCHEDULE** screen at a 10 pps repetition rate and a total of 100 shots. The **SEAM WELD MODE** screen is made active in order to vary the laser output power over the entire seam weld process.

SCHEDULE [FORM:FIX] screen

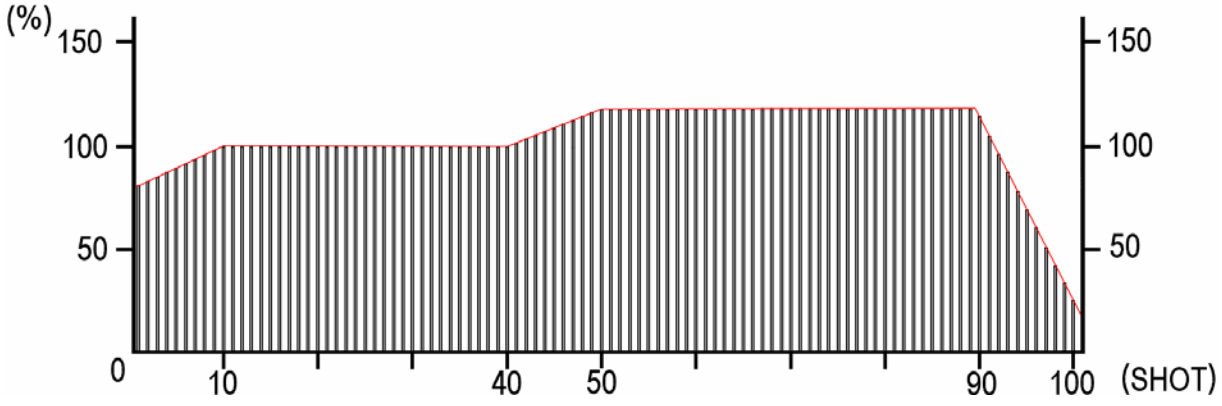
SCH #00	[FORM:FIX]	⌒11.5J	WATER 28°C
⌊ :OFF	PEAK=01.00kW		REPEAT = 010pps
↗ SLOPE	00.0ms		SHOT = 0100
FLASH1	02.00ms	100.0%	COOL 1 = 00.0 ms
FLASH2	00.00ms	000.0%	COOL 2 = 00.0 ms
FLASH3	00.00ms	000.0%	
↘ SLOPE	00.0ms	000.0%	SEAM WELD MODE: ON
HV:OFF	MAIN SHUTTER:OFF		POSITION:OFF

SEAM WELD MODE screen

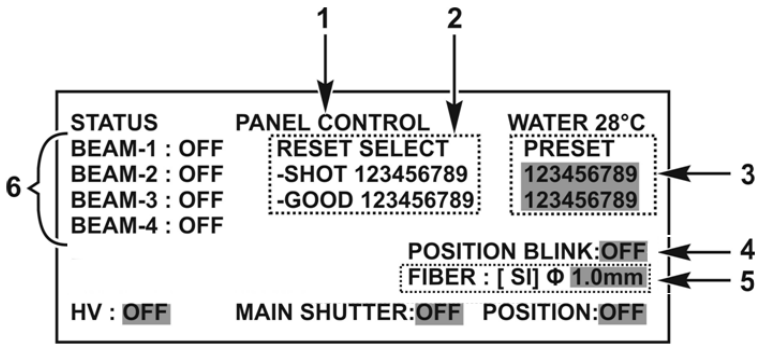
-SEAM WELD MODE		SCH.#00		WATER 28°C
NO SHOT	ENERGY	NO SHOT	ENERGY	
1	0001 080.0%	6	0100 020.0%	
▲ 2	0010 100.0%	7	0000 000.0%	ALL RESET
3	0040 100.0%	8	0000 000.0%	OFF
▼ 4	0050 120.0%	9	0000 000.0%	
5	0090 120.0%	10	0000 000.0%	
HV:OFF	MAIN SHUTTER:OFF		POSITION:OFF	

Note: The **POINT06** values (not shown in screen above) are: **SHOT = 0100** and **POWER [%] = 20%.**

When the above parameters are entered into the Laser, the Laser Output will have the following response (where 100% output = 1.00 kW):



Status Screen



1. CONTROL DEVICE Mode

Displays the currently selected control method;
EXTERNAL CONTROL, **PANEL CONTROL** or **RS-485 CONTROL**.

EXTERNAL CONTROL	The Laser is controlled by a programmable controller or other similar device connected to the **EXT. I/O** connectors.
PANEL CONTROL	The Laser is controlled by the Control Panel.
RS-485 CONTROL	The Laser is controlled by a personal computer connected to the RS-485 (1) or the RS-485 (2) connector. (optional)

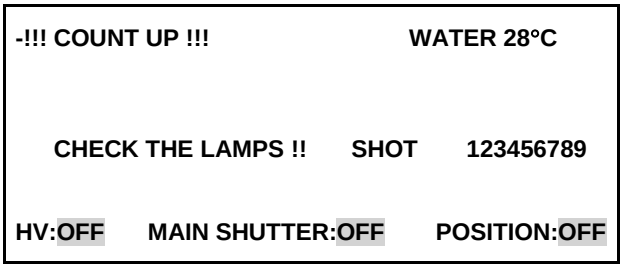
2. RESET SELECT

Resets the **TOTAL Shot Count** and the **GOOD Shot Count**. Move the cursor to the counter you want to reset, then press the **ENTER** key. The count will be set back to **000000000**.

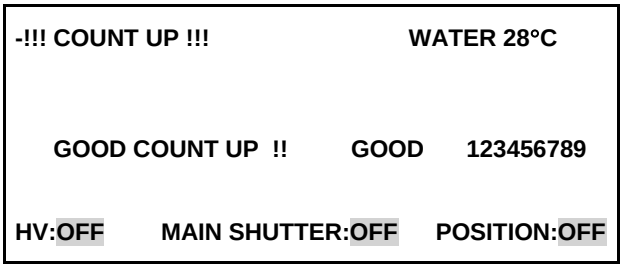
3. PRESET

Sets the desired number of laser outputs for the total shot count and the good shot count. When the count has reached the set number, the following messages will appear:

When the SHOT count has reached the set number.



When the GOOD count has reached the set number.



Press the **TROUBLE RESET** key to return to the previous screen.

4. POSITION BLINK

When selected **ON**, the guide beam laser will blink continuously. This feature can be helpful when trying to align dark colored parts to be welded. When **OFF** is selected, the guide beam laser will not blink.

5. FIBER

This function prevents excessive power from being applied to the optical fiber. Input the fiber type (SI/GI) and the core diameter of the optical fiber being used. The maximum output power for any given optical fiber is automatically computed and limited to prevent fiber damage. Setting range of core diameter: ϕ 0.2 to 1.0 mm for all Laser models.

- The factory default setting is **SI Φ 1.0 mm**. When a beam expander and/or internal aperture are used, set the fiber diameter to one setting larger.
- If the schedule settings for **PEAK, FLASH** (pulse width and power setting) and **REPEAT** do not match the fiber type and core diameter, an **E51: SET ERROR FIBER** or **E48: OVER RATE FIBER** warning will appear. In these cases change the input settings.
- If the end face surface of the optical fiber is stained, broken, damaged, or covered with dust, a warning message will not necessarily appear on the screen. Be sure to put the cap on the optical fiber when it is not in use or unprotected.
- If the end face of the optical fiber is broken, check the lenses on both the input and output units for damage. If the lenses are stained, clean them with the method described in *Chapter 6, Maintenance*.
- Do not remove the Laser Beam Input Unit unless absolutely necessary. Doing so will require that the input unit be re-aligned to the laser beam.

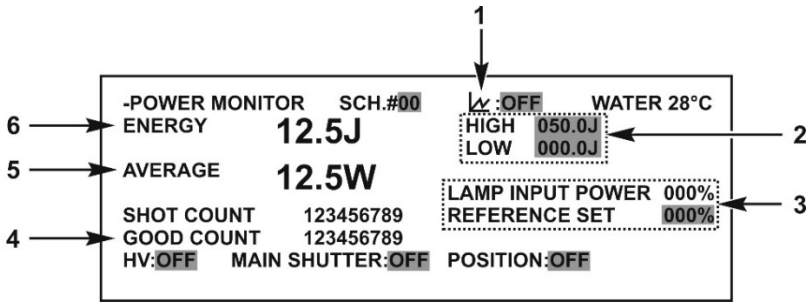
6. BEAM-1 to BEAM-4

Field used to display the installed branch shutters. Each BEAM field allows the operator to open/close each installed branch shutter. When **ON** is selected for any branch shutter, the branch shutter will open. A field must be turned **ON** in order to get a laser output on that particular output branch. When **OFF** is selected, the branch shutter will close.

For example, if the laser is configured with a **3E** output (3 energy-shared outputs), **BEAM-1** through **BEAM-3** must be turned **ON** in order to get an output on branch fibers 1, 2, and 3.

Power Monitor Screen

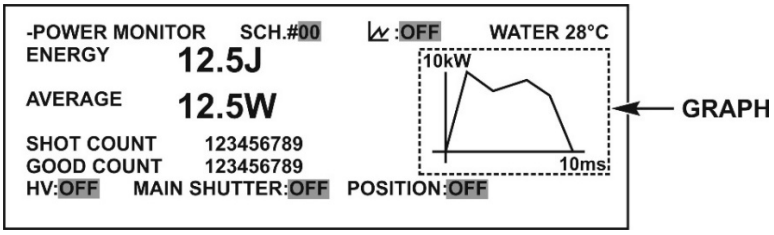
Whenever the Laser is fired, the **POWER MONITOR** screen automatically displays the measured output.



1. **Graph**

When **ON** is selected, a graphical representation of the measured output waveform is displayed. The X-axis is displayed in ms, and the Y-axis displays the peak power of the output pulse.

When the graph is displayed, it hides the **HIGH**, **LOW**, **LAMP INPUT PWR** and the **REFERENCE SET** fields. To access any of these fields, turn the graph **OFF.**



If the displayed waveform exhibits "overshoot", try adding/increasing the upslope (↗ **SLOPE**) time by 0.1 to 1.0 ms in the **SCHEDULE** screen until the overshoot is eliminated.

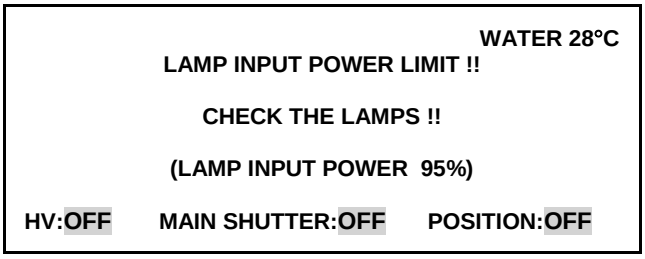
2. **HIGH / LOW** alarm limits

To aid in critical welding processes, a **HIGH / LOW** energy output monitor is provided. Set the allowable energy range for the selected schedule. If the measured output energy falls ***outside*** of this range, an Error Code will display on the LCD screen and the Laser will stop firing.

HIGH	000.0J
LOW	000.0J

3. **REFERENCE SET and LAMP INPUT POWER**

REFERENCE SET is used to set the maximum input power to the flashlamp. If the input power exceeds this limit, the following screen will appear, indicating that the flashlamp needs replacement.



NOTE: If this display continues for more than 3 seconds, an **OVERRATE** alarm will also occur.

LAMP INPUT POWER

LAMP INPUT POWER displays the ratio of the flashlamp input power to the output capacity of the Discharge Unit. A value of 100% means that the Discharge Unit is producing the maximum amount of designed output power. As a flashlamp ages, it requires more power to flash. In normal operation, Power Feedback automatically draws the power required from the Discharge Unit to maintain a constant output, thereby compensating for an aging flashlamp.

The best way to use this feature is to set the **REFERENCE SETTING** to 95% ~ 98%. Then as the flashlamp starts to age, it will require more power to maintain a constant output. Eventually the **LAMP INPUT POWER** will reach the **REFERENCE SETTING** value and *Lamp Input Power Limit* screen will appear. Once this alarm condition exists the operator can set the **REFERENCE SETTING** value to 100% and schedule a flashlamp replacement to minimize production down-time.

4. SHOT COUNT GOOD COUNT

SHOT COUNT displays the total number of times the laser was fired. The shot count can be reset to 000000000 on the **STATUS** screen.

SHOT COUNT	123456789
GOOD COUNT	123456789

GOOD COUNT displays the number of ***Good*** shots that were fired. A ***Good*** shot count means that the measured output energy was within the acceptable range set by the **HIGH / LOW** alarm limits. The good count can be reset to 000000000 on the **STATUS** screen.

5. AVERAGE

Displays the total mean power in Watts (**W**) of the laser oscillator (averaged over one second). Each time the laser is fired, its output is measured and displayed. In the case of high-repetition outputs, the energy is displayed at periodic intervals. This is because the repetitions are faster than the LCD refresh rate. The displayed average power will differ from the actual delivered power at the workpiece. This difference varies based on the optical configuration of the system.

6. ENERGY

Displays the measured laser energy in Joules (J) of the laser oscillator. Each time the laser is fired, its output is measured and displayed. In the case of high-repetition outputs, the energy is displayed at periodic intervals. This is because the repetitions are faster than the LCD refresh rate. The displayed energy will differ from the actual delivered energy at the workpiece. This difference varies based on the optical configuration of the system.

Section III. Hidden Menu Screens

Overview

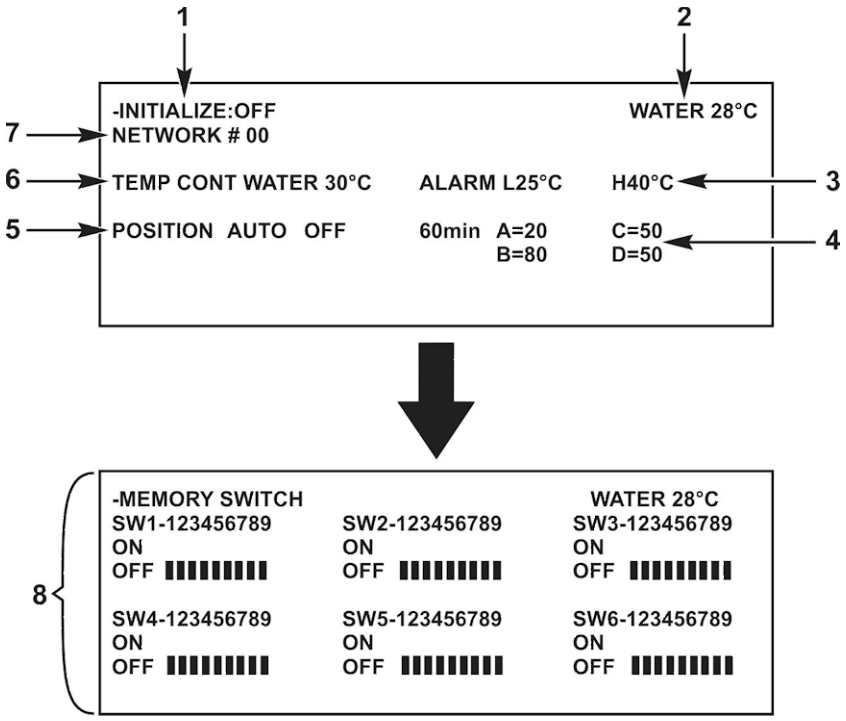
There are five hidden screens in the Laser used to **INITIALIZE**, **SETUP**, and **CONFIGURE** the Laser.

CAUTION: These screens should ***only*** be used by trained personnel. If the parameters on these screens are set incorrectly, the Laser may become inoperable.

Initialization Screen

The **INITIALIZATION** screen is primarily used for the RS-485 communication settings and maintenance functions.

1. Turn ***both*** the **MAIN POWER** switch and Keyswitch to the OFF position.
2. Press ***and hold*** the **MENU** key while turning the **MAIN POWER** switch ON.
3. Continue to hold the **MENU** key until the laser starts the self-check routine, then release the key.
4. The **INITIALIZATION** screen will display automatically.
5. ***After*** making changes, press the **ENTER** key to store the changes. Once all changes have been made, recycle the power on the Laser in order to initialize the Laser with the new settings.



NOTE: Systems with the **ME-1891** PCB will only display three software dipswitch settings. To modify the **LASER START** and **SCHEDULE** signal accept times, see *Appendix B, Electrical and Data Connections, Section IV: Laser Accept Times*.

1. INITIALIZE

Select **ON** to restore the laser factory default settings. When this option is selected ***ALL*** schedule data will be erased. Record or save the Schedule Data before Initializing the Laser to avoid having to re-create all Schedule data.

Example: Use when the Main PCB is re-programmed or replaced, or after the back-up battery on the Main PCB is replaced.

2. WATER

Displays the temperature of the internal cooling water.

3. WATER TEMPERATURE ALARM SETTINGS - L 25°C H 40°C

These fields are used to set the water temperature threshold upper and lower limits. If the temperature exceeds either of these set limits, the Laser will not operate ***until*** the water temperature returns to normal. The **REF TEMP** setting is the optimal temperature point. In order to prevent poor performance, do ***not*** change these setting values.

4. A =20, B = 80, C = 50, D = 50 (Fan Speed Settings)

CAUTION: These are factory set, do ***not*** change these values.

5. POSITION AUTO-OFF 60MIN

This field is used to control the position guide beam. These settings are used to automatically turn the position guide beam **OFF** to extend the life of the diode in the event the guide beam is accidentally left **ON**. This field is adjustable from 01 to 98 minutes.

If the time is set for **00MIN**, the position guide beam will not light.

If the time is set for **99MIN**, the position guide beam will not turn **OFF**.

NOTE: The factory default setting is **60MIN**.

6. TEMP CONT WATER 30°C

TEMP CONT is the water temperature control setting for the Laser. The laser will maintain this set temperature. Do ***not*** change this value, as the efficiency of the Nd:YAG output is directly proportional to the temperature setting.

NOTE: The factory default setting is **30°C**.

7. NETWORK # 00-31

This field is used to select the device (Laser) number for the optional RS-485 communications function. When connecting multiple Lasers together, each Laser needs a unique **NETWORK ID** number. The factory default setting for all lasers is **00.**

8. SOFTWARE SWITCH SETTINGS

The software switches are part of the Initialization Screen and they are used to set-up specific Laser functions. When shipped from the factory, all switches are set in the **OFF** position. If the Laser is re-initialized (by selecting **INITIALIZE: ON** from the previous screen), all of these switch settings will revert back to the factory setting (all **OFF**).

MSW1

Position	Function	ON	OFF
MSW1-1	Automatic High Voltage startup	High Voltage will ***not*** turn ON during start-up	High Voltage will turn ON during start-up
MSW1-2	Enable Start Input on EXT-I/O(1)-20 when in Panel Control mode.	Start Input enabled	Start Input disabled
MSW1-3	*Not Used (leave OFF)*		
MSW1-4	Laser Start Signal Accept Time (Firmware ≥ V50-11N)	Laser will fire on any Input transition ≥ 20 µS.	Input pulse must meet Laser Accept Time setting.
MSW1-5	*Not Used (leave OFF)*		
MSW1-6	Energy Measurement Resolution	00.00 J (x 10) Peak Power ≤ 0.10 kW	000.0 J (x 1)
MSW1-7	Time Setting Resolution	0.05 mS steps Maximum setting ≤ 5 mS	0.1 mS steps
MSW1-8	*Not Used (leave OFF)*		

MSW2

Position	RS-485 Function	ON	OFF (default)
MSW2-1	Data Bit Length	7 bits	8 bits
MSW2-2	Parity Bit	No parity	With parity
MSW2-3	Parity Mode	Odd parity	Even parity
MSW2-4	Stop Bit	1 stop bit	2 stop bits
MSW2-5	RS-485 Communication Baud Rate (*see table below*) Refer to *Appendix D* for communication information.		
MSW2-6			
MSW2-7	*Not Used (leave OFF)*		
MSW2-8	Enable Start Input on EXT-I/O(1)-20 when in RS-485 Communications	Start Input enabled	Start Input disabled

MSW3

Position	Function	ON	OFF
MSW3-1	*Not Used (leave OFF)*		
MSW3-2	Laser Start/Accept Times	*(see table below)*	
MSW3-3			
MSW3-4			
MSW3-5	END signal after Laser fires	Enabled	Disabled
MSW3-6	Trigger Signal Output, EXT-I/O(1)-7 (Firmware ≥ V00-02H)	Trigger Output active	No Trigger Output
MSW3-7	*Not Used (leave OFF)*		
MSW3-8	Dummy Shot visible on SCHED screen	Enabled	Disabled

MSW2 - RS-485 Comm. Baud Rate detail:

Communication Baud Rate	MSW2-5	MSW2-6
9,600 bps (*default*)	OFF	OFF
19,200 bps	OFF	ON
38,400 bps	ON	OFF
9,600 bps	ON	ON

MSW3 - Laser Start/Accept Times detail:

Laser Accept Times	MSW3-4	MSW3-3	MSW3-2
16 mS (*default*)	OFF	OFF	OFF
8 mS	OFF	OFF	ON
4 mS	OFF	ON	OFF
1 mS	OFF	ON	ON
0.1 mS	ON	x	x

x – don't care

MSW4 (see *Appendix B, Section III* for more information on *Independent Control*)

Position	Function
MSW4-1	Branch Shutter 1 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-2	Branch Shutter 2 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-3	Branch Shutter 3 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-4	Branch Shutter 4 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-5	Branch Shutter 5 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-6	Branch Shutter 6 – When in Independent Control mode, turn **ON** if branch shutter is installed.
MSW4-7	*Not Used (leave OFF)*
MSW4-8	*Not Used (leave OFF)*

MSW5 (see *Appendix B, Section III* for more information on *Independent Control*)

Position	Function
MSW5-1	Time-Share 1 – When in Independent Control mode, turn **ON** if time-share shutter 1 is installed.
MSW5-2	Time-Share 2 – When in Independent Control mode, turn **ON** if time-share shutter 2 is installed.
MSW5-3	Time-Share 3 – When in Independent Control mode, turn **ON** if time-share shutter 3 is installed.
MSW5-4	Time-Share 4 – When in Independent Control mode, turn **ON** if time-share shutter 4 is installed.
MSW5-5	Time-Share 5 – When in Independent Control mode, turn **ON** if time-share shutter 5 is installed.
MSW5-6	*Not Used (leave OFF)*
MSW5-7	*Not Used (leave OFF)*
MSW5-8	*Not Used (leave OFF)*

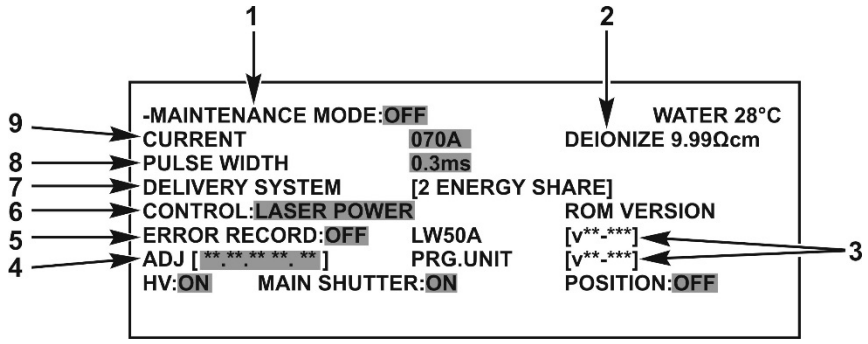
MSW6 – *Not Used (leave OFF)*

Maintenance Mode Screen

The Maintenance Mode Screen is used for maintenance functions such as, checking the status and alignment of the laser. This screen is not typically used by the laser operator. For information on the Maintenance Screen contents, please consult with AMADA WELD TECH.

CAUTION: An incorrect setting in this screen may make the Laser inoperable.

1. On the Program Box, press the **TROUBLE RESET** and ◀ simultaneously to access **MAINTENANCE MODE** screen.
2. To exit the **MAINTENANCE MODE** screen, press the **MENU** key.



1. MAINTENANCE MODE: OFF

To aid in laser alignment, turn Maintenance Mode **ON**. While in Maintenance Mode, the Program Box is the only way of controlling the laser. When Maintenance Mode is **ON**, all fields in the Maintenance Mode screen become active.

2. DEIONIZE

This field displays the resistivity of the internal de-ionized cooling water.

3. ROM VERSION

This field displays the firmware revisions inside the Laser (Main CPU & Program Box). The actual location and layout of this data may differ depending on the firmware revision of the Program Box.

4. ADJ

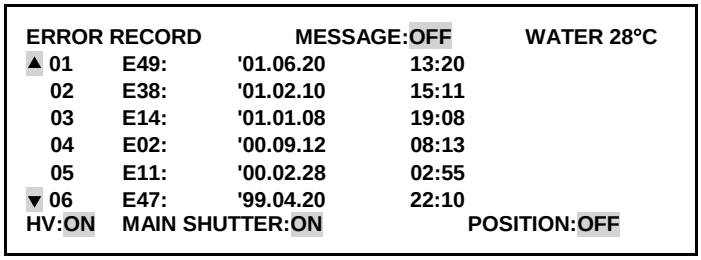
This field is for entering the current date and time (24-Hour clock). Date and time are not needed for normal operation. These fields become important when using the **PRINT** mode. The current date and time will be displayed. If you need to change either the date or time (24 hour clock), move the cursor to the number you want to change and Press the **ON (+)** and **OFF (-)** keys accordingly, followed by **ENTER**.

Format: **['YR.MO.DAY HR:MIN]**

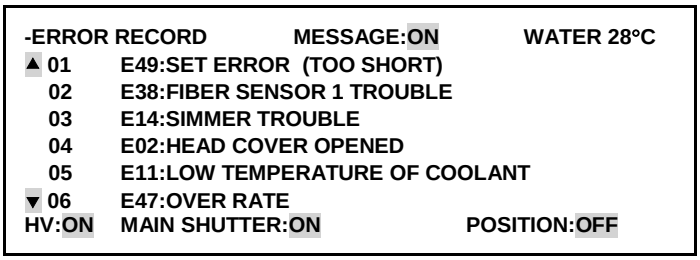
Example: **['10.04.13 14:05]** (April 13, 2010 at 2:05 p.m.)

5. ERROR RECORD

This field is used to view the error log when enabled. The error log will display the last 50 errors with the most recent error listed at the top of the list. Use the **ON/OFF** key to access the error log.



If the **MESSAGE** field is **OFF**, the error log will display only the date and time of the errors. If the **MESSAGE** field is **ON**, the error log will display the description of the actual error.



To exit the Error log screen, press the **MENU** key to return back to the Maintenance mode screen.

6. CONTROL

This field is used to display the status of the feedback control system.

DISPLAY	FEEDBACK STATUS
LASER POWER	POWER FEEDBACK ENABLED (CLOSED LOOP)
CURRENT	POWER FEEDBACK DISABLED (OPEN LOOP)

When set to **LASER POWER**, the power feedback circuit is active. The Laser should always be set to **LASER POWER** mode for normal operation.

CURRENT mode is used to supply a user-defined current through the flashlamp.
CURRENT mode should ***only*** be used during oscillator alignment by factory-trained personnel.

7. DELIVERY SYSTEM

This field is used to display the lasers optical configuration. The output configuration is set by a dipswitch on the Main PCB. See *Appendix B, Section II, Energy-sharing and Time-sharing* for more information.

DISPLAY	OPTICAL CONFIGURATION
SINGLE	Single (One) output
2 ENERGY SHARE	Two Energy-Shared Outputs
3 ENERGY SHARE	Three Energy-Shared Outputs
4 ENERGY SHARE	Four Energy-Shared Outputs
2 WAY TIME SHARE	Two Time-Shared Outputs
3 WAY TIME SHARE	Three Time-Shared Outputs
4 WAY TIME SHARE	Four Time-Shared Outputs
2 ENERGY 2 WAY TIME	Two Time-Shared Outputs with Two Energy Shares each
INDEPENDENT CONTROL	Independent Branch Control

8. PULSE WIDTH

This controls the output pulse width. Used ***only*** when **LASER CONTROL** is set to **CURRENT** mode. This pulse width adjustment must ***only*** be performed by factory-trained personnel.

Range: $0.3\ mS \leq t \leq 5.0\ mS$

9. CURRENT

This is the flashlamp current setting. Used ***only*** when **LASER CONTROL** is set to **CURRENT** mode. The flashlamp current adjustment must ***only*** be performed by factory-trained personnel.

Range: $70\ A \leq I \leq 300\ A$

PASSWORD MODE Screen

The Password Mode screen is used to prevent unauthorized users from changing laser parameters. The **PASSWORD** consists of a user-defined combination of four letters and/or numbers.

On the Program Box, press **TROUBLE RESET** and ▲ simultaneously to access to the **PASSWORD MODE** screen. To exit the **PASSWORD MODE** screen, press the **MENU** key.

NOTES:

- The **CONTROL** key switch must be turned ON.
- The initial (factory-set) password is **REDS**. You will need to enter this in order to gain access to the password edit screen.

1 Use the ▲▼◄► keys to place the cursor over the first digit of the password.

2 Use the **ON (+)** and **OFF (-) -** keys to cycle through the list of numbers and letters. The list starts with the numbers **0 - 9** then goes through the alphabet from **A - Z**. After **Z,** the list starts again with **0**. You can use the **ON (+)** and **OFF (-)** keys to scroll up or down through the list.

```
-PASSWORD MODE                              WATER 28°C

PASSWORD:        [0000]          CHANGE VALUE:ON

HV:ON        MAIN SHUTTER:ON        POSITION:OFF
```

3 ***After*** selecting the number/letter you want, you ***must*** press **ENTER** to accept the number.

4 Use the ◄ ► keys to move the cursor to the next digit and repeat steps 2 and 3 until you have selected a password.

CAUTION: Write the password down for future reference. The Laser is ***not*** capable of displaying the set password. If a password is set and forgotten, the only way to gain access to the laser is to remove the back-up battery from the Main PCB (with the Laser power in the OFF position). Allow the on-board memory capacitor to fully discharge (up to 3 hours), then initialize the laser as described above.

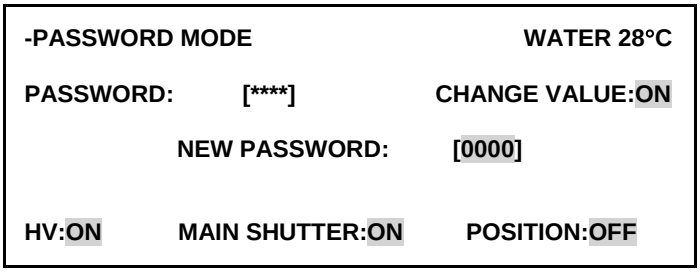
Incorrect Password

If the password is incorrect, ***PASSWORD MISMATCH*** will display. You can return to the first screen by pressing the **TROUBLE RESET** key.

```
-PASSWORD MODE                              WATER 28°C

PASSWORD:        [0000]          CHANGE VALUE:ON

        ********** PASSWORD MISMATCH**********

HV:ON        MAIN SHUTTER:ON        POSITION:OFF
```

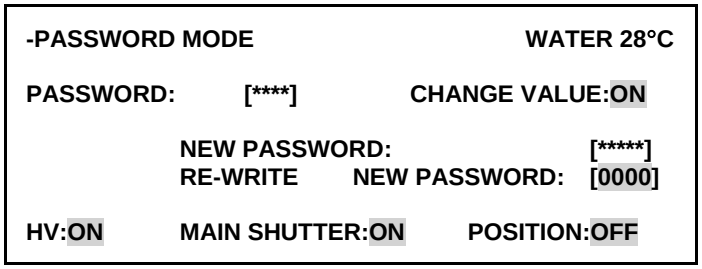
Correct Password

If the password is correct, the screen on the right will appear. The **CHANGE VALUE:** field is used to lock out unauthorized users and is used in conjunction with the **NEW PASSWORD 0000** field. When a password is entered and **CHANGE VALUE:** is ON, any user may change the laser parameters.



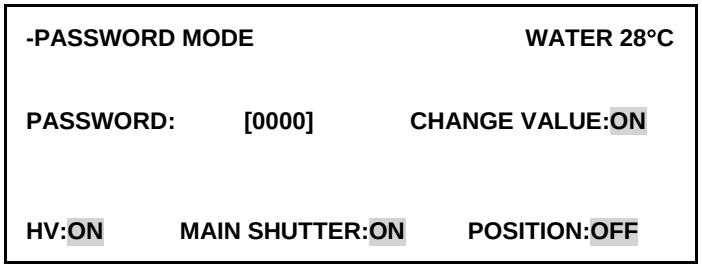
If **CHANGE VALUE:** is OFF, all unauthorized users will be locked out from changing the laser parameters.

If you input a new password into the **NEW PASSWORD 0000** field, the following screen will appear:

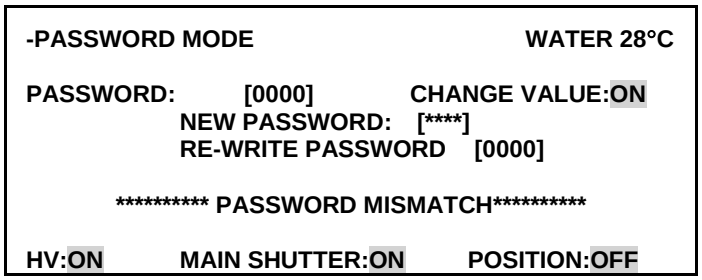


Confirm the password in the **RE-WRITE PASSWORD**: field.

If the **NEW PASSWORD: and RE-WRITE PASSWORD:** fields match, the new password is saved and you will return to the first screen.



If the password entered into the **RE-WRITE PASSWORD:** does not match the password entered into the **NEW PASSWORD:** field, the password will not be saved and ****PASSWORD MISMATCH**** will appear. You can return to screen with **TROUBLE RESET**, or re-enter the password again.



NOTE: The settings/functions that will be password protected are shown in the table on the next page.

Password-Protected Settings & Functions

NETWORK No.	Upper Limit **(HIGH)** of **ENERGY** monitor
FLASH TIME in Maintenance Mode	Lower Limit **(LOW)** of **ENERGY** monitor
PEAK in Maintenance Mode	**REFERENCE SET**
BLINK: ON/OFF of Guide Beam (LD)	**UP SLOPE TIME**
AUTO POWER OFF: ON/OFF of Guide Beam (LD)	**FLASH 1 TIME**
ON Time of Guide Beam (LD)	**FLASH 2 TIME**
OFF Time of Guide Beam (LD)	**FLASH 3 TIME**
MEMORY SWITCH 1 on **INITIALIZATION** screen	**DOWN SLOPE TIME**
MEMORY SWITCH 2 on **INITIALIZATION** screen	**COOL 1 TIME**
MEMORY SWITCH 3 on **INITIALIZATION** screen	**COOL 2 TIME**
MEMORY SWITCH 4 on **INITIALIZATION** screen	**FLASH 1 WATT**
MEMORY SWITCH 5 on **INITIALIZATION** screen	**FLASH 2 WATT**
MEMORY SWITCH 6 on **INITIALIZATION** screen	**FLASH 3 WATT**
TOTAL SHOT COUNT RESET	**FLASH TIME** in point 1 to 20
GOOD SHOT COUNT RESET	**FLASH WATT** in point 1 to 20
FEEDBACK MODE: LASER POWER/CURRENT	Number of Shots 1 to 20 in **SEAM MODE**
FIBER FORM: SI/GI	Power Setting 1 to 20 in **SEAM MODE**
FIBER DIAMETER	**TOTAL SHOT COUNT RESET**
FIX/FLEX mode in Wave Shape Control	**TOTAL GOOD COUNT RESET**
Wave Shape Display **ON/OFF PEAK POWER**	**REPEAT**

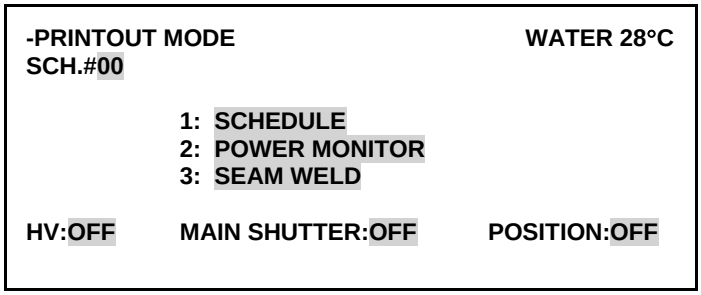
PRINT-OUT MODE Screen

You can print out and view the welding conditions of each schedule using the **PRINTOUT MODE** screen. When activated, the conditions are sent to both RS-485 connectors for printout. The output print protocol is designed for use with a serial printer. Best results are achieved using a *Sanei Electric Inc., BL2-58SNWJC* printer. Due to differences in printer protocols, the generated output may differ from the examples shown on the following pages. The welding conditions are also displayed on the screen in the event a printer is unavailable.

1 On the Program Box, Press **TROUBLE RESET** and ▼ simultaneously to access to the Printout Mode Screen.

2 To exit the Print-out Mode screen, press the **MENU** key

NOTE: The **CONTROL** key switch must be turned ON.



Printing the Welding Conditions of Each Schedule

1. Position the **CURSOR** to **SCH. #00** and input the **SCHEDULE NUMBER** you desire, then press the **ENTER** key.
2. Move the **CURSOR** to **1:SCHEDULE**, then press the **ENTER** key.
3. The schedule conditions will be sent to the printer.

Printing Out the Power Monitor Measurements

1. In order to view the monitored measurements, the field on the **POWER MONITOR** screen must be selected **ON**.
2. Fire the Laser and check the measured waveform graph on the Laser Controller display. If you would like a print-out of this waveform graph, go to the Print-out Mode Screen.
3. Move the **CURSOR** to **2:POWER MONITOR**, then press the **ENTER** key.
4. The monitored values will be sent to the printer.

   NOTE: Each time the laser is fired, the monitored waveform data is updated.

Printing Out the Seam Weld Conditions

1. Position the **CURSOR** to **SCH. #00** and input the Schedule Number you desire, then press the **ENTER** key.
2. Move the **CURSOR** to **3:SEAM WELD**, then press the **ENTER** key.
3. The **SEAM WELD** conditions will be sent to the printer.

Welding Condition Print-Out Examples – Schedule Screen

Example **FORM:FIX**

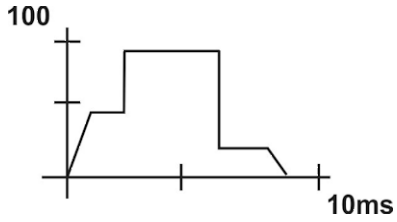
SCHEDULE
-SCH. #00 FORM:FIX

PEAK POWER = 01.00kW

U-SLOPE = 00.5ms
FLASH 1 = 01.5ms 040.0%
FLASH 2 = 03.0ms 080.0%
FLASH 3 = 01.0ms 020.0%
D-SLOPE = 00.3ms

REPEAT = 010PPS
SHOT = 0430

ESTIMATED VALUE = 3.1J



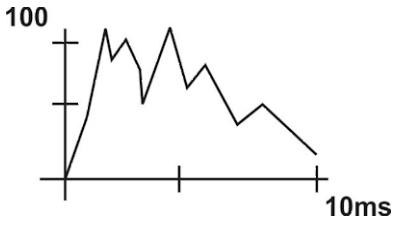
Example **FORM:FLEX**

SCHEDULE
-SCH. #00 FORM:FLEX

PEAK POWER = 02.00kW

Point1 = 00.4ms 032.2%
Point2 = 00.8ms 107.0%
Point3 = 01.1ms 084.1%
Point4 = 01.4ms 094.2%
Point5 = 01.8ms 072.3%
Point6 = 02.1ms 060.4%
Point7 = 02.5ms 036.0%
Point8 = 02.9ms 100.5%
Point9 = 03.4ms 060.0%
Point10 = 03.7ms 102.0%
Point11 = 04.0ms 042.1%
Point12 = 04.5ms 070.3%
Point13 = 04.8ms 062.0%
Point14 = 05.1ms 050.4%
Point15 = 06.1ms 013.0%
Point16 = 06.7ms 011.2%
Point17 = 06.8ms 008.7%
Point18 = 07.2ms 040.0%
Point19 = 08.8ms 012.1%
Point20 = 10.0ms 000.0%

REPEAT = 002PPS
SHOT = 1120



ESTIMATED VALUE = 8.8J

Power Monitor Examples – Power Monitor Screen

Example **FORM:FIX**

POWERMONITOR
-SCH. #00

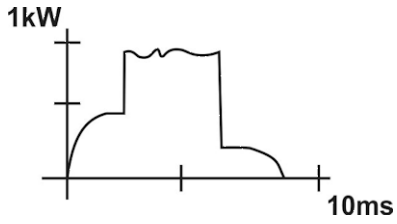
ENERGY
3.1 J

AVERAGE
30.3 J

HIGH = 04.00J
LOW = 00.00J

LAMP INPUT PWR 000%
REFERENCE SET 120%

SHOT COUNT = 000000708
GOOD COUNT = 000000241



Example **FORM:FLEX**

POWERMONITOR
-SCH. #01

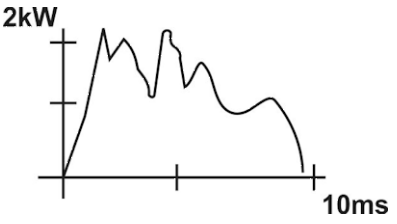
ENERGY
8.8 J

AVERAGE
25.9 W

HIGH = 04.00J
LOW = 00.00J

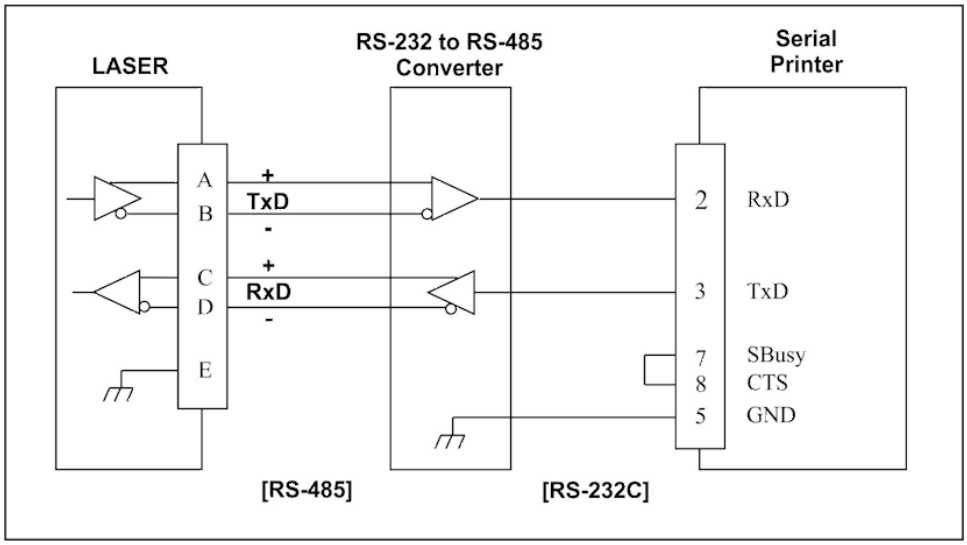
LAMP INPUT PWR 000%
REFERENCE SET 120%

SHOT COUNT = 000000713
GOOD COUNT = 000000246



Connecting the Serial Printer

The serial printer (Sanei Electric Inc., BL2-58SNWJC or equivalent) can be connected to either RS-485 (1) or RS-485 (2).



CHAPTER 5:
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. For more information, see *the Programming Functions described in Chapter 3 or Chapter 4*. Follow the section that applies to the Laser Controller you are using.

General Operator Safety

WARNING

Be sure to wear protective glasses for Nd:YAG with an optical density of ***at least 7+*** at a 1,064 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. Welding using the MLE-118A

Prepare Processing Point and Set Weld Schedule (MLE-118A)

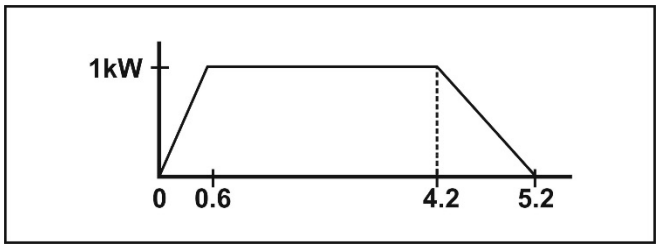
1. Turn the High Voltage **OFF** so the laser will ***cannot*** emit (The high voltage is automatically initialized during power-up). Rotate the **ENCODE** button to highlight the **HV** field, select the **ENCODE** button and rotate the **ENCODE** knob to highlight **OFF**, select the **ENCODE** button once more to turn off the high voltage.
2. Adjust the position of the laser beam output unit (focus head). Set the proper working distance for each installed laser beam output unit (focus head).
3. Using the **ENCODE** button and navigate to the **SCHEDULE** screen.

Example:

Sample Settings:	• **SCH to #05**	• **↘ SLOPE to 01.0ms**
FORM: FIX	• **↗ SLOPE to 00.6ms**	• **REPEAT = 10pps**
	• **FLASH1 to 04.2ms**	• **PEAK = 2.00kW**
	• **FLASH2 to 00.0ms**	• **OUTPUT VALUE = 50%**
	• **FLASH3 to 01.0ms**	**(FLASH1)**

1. Rotate the **ENCODE** button and highlight **SCH #**. Change each number to SCH #05 by rotating and selecting the **ENCODE** button.
2. Rotate the **ENCODE** button and highlight **PEAK**. Change each number to 02.00 kW by rotating and selecting the **ENCODE** button.
3. Rotate the **ENCODE** button and highlight **FLASH1**. Change the value of each number to 04.2 ms by rotating and selecting the **ENCODE** button.
4. Rotate the **ENCODE** button and highlight **FLASH1 04.2 ms 000%**. Change each number to 050 % by rotating and selecting the **ENCODE** button.
   (Note: 50% of 2.00 kW is a peak setting of 1.0 kW)
5. Rotate the **ENCODE** button and highlight **↗ SLOPE**. Change the value of each number to 00.6 ms by rotating and selecting the **ENCODE** button.
6. Rotate the **ENCODE** button and highlight **FLASH2**. Change the value of each number to 00.0 ms by rotating and selecting the **ENCODE** button.
7. Rotate the **ENCODE** button and highlight **FLASH3**. Change the value of each number to 01.0 ms by rotating and selecting the **ENCODE** button.
8. Rotate the **ENCODE** button and highlight **↘SLOPE**. Change the value of each number to 01.0 ms by rotating and selecting the **ENCODE** button.
9. Rotate the **ENCODE** button and highlight **REPEAT**. Change the value of each number to 010 pps by rotating and selecting the **ENCODE** button.

If the programmed data in the above example were plotted over time, it would appear as follows:



Welding Using the MLE-118A Laser Controller

1. Verify that **PANEL CONTROL** is displayed on the **STATUS** screen.
2. Turn the High Voltage **ON**. Rotate the **ENCODE** button to the **HV** field and select the **ENCODE** button. Rotate and select **ON** from the pop-up window.
3. Open the Shutters.
   - Use the **ENCODE** button to open to select (open) the **MAIN** and **BEAM** (branch shutters). For example, in an Energy-Shared delivery system, each output branch shutter needs to be opened.
   - Select the **SCHEDULE #** (from the previous example, select **SCH #05**.)
4. Check the Processing Site.
   - Use the **ENCODE** button to select and turn the **POSITION** (Guide beam) to **ON**.
   - 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.
5. Perform Laser Processing.
   - Press the **LASER START/STOP** button on the Laser Controller.
   - Verify an output response on the **POWER MONITOR** screen.

Shutdown using the MLE-118A Laser Controller

1. Turn **OFF** the high voltage and close all shutters using the methods described above.
2. Turn the Control key switch to the **OFF** position.
3. Turn off the main power switch.

Section III. Welding using the MLE-115A

Prepare Processing Point and Set Weld Schedule (MLE-115A)

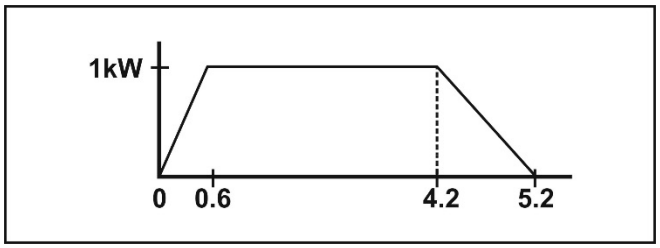
1. Turn the High Voltage **OFF** so the laser ***cannot*** emit.
   (The high voltage is automatically initialized during power-up).
2. Adjust the position of the laser beam output unit (focus head). Set the proper working distance for each installed laser beam output unit (focus head).
3. Navigate to the **SCHEDULE** screen using the **MENU** key.
4. If a waveform is displayed on the right portion of screen, set the  field to **OFF**, then input the desired welding parameters.

Example:

Sample Settings:	• **SCH to #05**	• **↘ SLOPE to 01.0ms**
FORM: FIX	• **↗ SLOPE to 00.6ms**	• **REPEAT = 10pps**
	• **FLASH1 to 04.2ms**	• **PEAK = 2.00kW**
	• **FLASH2 to 00.0ms**	• **OUTPUT VALUE = 50%**
	• **FLASH3 to 01.0ms**	**(FLASH1)**

5. Move the cursor to **SCH #** and change each number to SCH # 05 by pressing the **ON(+)/OFF(-)** keys, followed by **ENTER**.
6. Move the cursor to **PEAK** and change each number to 02.00 kW by pressing the **ON(+)/OFF(-)** keys, followed by **ENTER**.
7. Move the cursor to **FLASH1** and change the value of each number to 04.2 ms by pressing the **ON(+)/OFF(-)** keys, followed by **ENTER**.
8. Move the cursor to **FLASH1 04.2 ms 000%** and change each number to 050 % by pressing the **ON(+)/OFF(-)** keys, followed by **ENTER**. (Note: 50% of 2.00 kW is a peak setting of 1.0 kW)
9. Move cursor to **↗ SLOPE** and change the value of each number to 00.6 ms by pressing the **ON(+)/OFF(-)** keys, followed by **ENTER**.
10. Move cursor to **FLASH2** and change the value of each number to 00.0 ms by pressing the **ON(+)/OFF(-)** keys, followed by **ENTER**.
11. Move cursor to **FLASH3** and change the value of each number to 01.0 ms by pressing the **ON(+)/OFF(-)** keys, followed by **ENTER**.
12. Move cursor to **↘SLOPE** and change the value of each number to 01.0 ms by pressing the **ON(+)/OFF(-)** keys, followed by **ENTER**.
13. Move cursor to **REPEAT** and change the value of each number to 010 pps by pressing the **ON(+)/OFF(-)** keys, followed by **ENTER**.

If the programmed data in the above example were plotted over time, it would appear as follows:



Welding Using the MLE-115A Laser Controller

1. Verify that **PANEL CONTROL** is displayed on the **STATUS** screen.
2. Turn the High Voltage **ON**. Move cursor to **HV: OFF** and select **ON** with **ON(+)** key to turn on the high voltage, followed by **ENTER**. Once the **READY** light turns on, proceed to the next step.
3. Open the Shutters.
   - Move cursor to **MAIN SHUTTER: OFF** and open the main shutter with **ON(+)** key, followed by **ENTER**.
   - Move the cursor to the **BEAM-X** you are using and open the branch shutter(s) for each configured output, followed by **ENTER**. For example, in an Energy-Shared delivery system, each output branch shutter needs to be opened.
   - Select the **SCHEDULE #** on either the **SCHEDULE** screen or the **POWER MONITOR** screen. (From the previous example, select **SCH. #05**.)
4. Check the Processing Site.
   - On the **STATUS** screen, select **ON** for **POSITION** (Guide beam), followed by **ENTER**.
   - 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.
5. Perform Laser Processing.
   - Press the **LASER START/STOP** button on the Laser Controller.
   - Verify an output response on the **POWER MONITOR** screen.

Shutdown using the MLE-115A Laser Controller

1. Turn **OFF** the high voltage and close all shutters using the methods described above.
2. Turn the Control key switch to the **OFF** position.
3. Turn off the main power switch.

Section IV. Welding Using External I/O

1. Program the welding parameters using one of the methods described above (using the MLE-118A or MLE-115A Program Box).
2. Close the **CONTROL CHANGEOVER** signal on the **EXT-I/O (1)** Connector and verify that **EXTERNAL CONTROL** is displayed on the **STATUS** Screen.
3. Turn the High Voltage **ON**. Close the **HV-ON/OFF** signal on **EXT. I/O (1).**
4. Open all Shutters.
   - Close the **MAIN SHUTTER** signal on **EXT. I/O (1).**
   - Close the **BEAM SELECT(s)** on all configured outputs (**EXT. I/O (1)** and **EXT. I/O (2)**).
5. 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
6. Select **SCHEDULE No**. Input the Schedule Number on **EXT. I/O (1)** by combining input signals; SCHEDULE 1, 2, 4, 8, and 16.
7. 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 the External I/O

1. Open all I/O connections by turning **OFF** the high voltage and closing all shutters using the signals described above.
2. Turn the Control key switch to the **OFF** position.
3. Turn off the main power switch.

CHAPTER 6
MAINTENANCE

Section I: Precautions

WARNING: ***Before*** starting any maintenance, carefully read ***all*** instructions, **Warnings**, and **Cautions**

DANGER

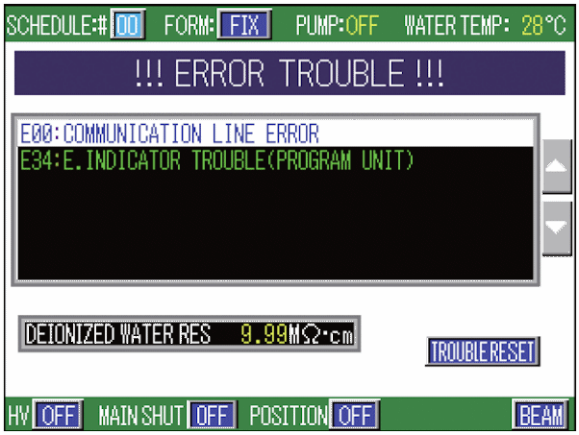
To prevent eye injury, service personnel, or anyone who may be exposed to Nd:YAG laser beams, ***must*** wear safety goggles having a minimum optical density of 7+ at a 1,064 nanometer wavelength.

- Turn the power to the laser **OFF** and disconnect it from the A.C. source ***before*** performing any maintenance work.
- Do ***not*** modify the Laser without prior written approval from AMADA WELD TECH.
- If the high voltage was **ON**, wait 5 minutes for the capacitors to discharge after turning the power **OFF** before starting any work. ***The capacitors store a lethal amount of energy***.
- When turning power **ON** to check operation during any maintenance procedure:
  - Make sure that everyone who may be exposed to the Nd:YAG laser beam during maintenance, is wearing laser protective glasses.
  - Never put more than one hand inside of the Laser at any time.
  - When high voltage is turned **ON**, the Nd:YAG laser oscillator is enabled.
  - ***Use extreme caution while performing any work on the laser.***
- To operate the laser without the top cover, release the safety interlock switches by pulling them outward until they are locked in the bypass position. The Interlock bypass lamp (LED) will light when the top cover safety interlock has been overridden.
- Use the appropriate tools for terminating the connection cables, being careful not to nick the wire conductors.
- 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.

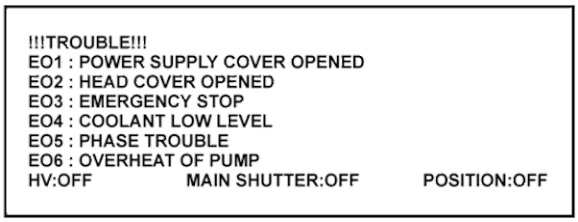
Section II. Troubleshooting

Error Codes

Any malfunction occurring in the unit is indicated on the control unit display, for example:



MLE-118A Error Code Screen



MLE-115A Error Code Screen

The LCD screen can display up to six faults at a time. The most recent error detected is listed first, followed by previously detected error codes (in reverse chronological order). The Error Code Number consists of **E** for "*Error*" and a 2-digit code which correspond to the specific problem. For example an **E03** signifies an **Emergency Stop**. Follow the troubleshooting instructions listed in the *Error Codes and Corrective Actions* table below, correct the problem, then select **Trouble Reset** to clear the error.

Error Codes and Corrective Actions

The error codes listed below are the most probable causes for the displayed error. Eliminate each cause for the associated error. If the error still exists, contact AMADA WELD TECH. If an error code number is not listed, then it is either (1) not used or (2) reserved for factory testing.

Code	LCD Screen	HV	Alarm	Corrective Actions
00	Communication Line Error	–	–	A communication error exists between the Program Box and the Laser CPU. Recycle power, then check for each of the these possible causes: – RF noise source near the laser (isolate laser). – Bad/loose cable connection between the Program Box and the Main PCB. – Faulty Power Supply (+24 V). – Faulty Main PCB or Program Box. – Incorrect transmission mode and setting. – CPU needs to be initialized.

Code	LCD Screen	HV	Alarm	Corrective Actions
01	Power Supply Cover Opened	OFF	ON	A side, rear or front panel is removed. Check to be sure all laser panels are installed. If panels are removed, verify Interlock switches are bypassed. Possible causes: – Laser cover is loose or removed. – Faulty Interlock Switch. – Faulty Interlock PCB, power supply, or CPU.
02	Head Cover Opened	OFF	ON	The head cover or flashlamp access cover is removed. Check to be sure all panels are installed. If panels are removed, verify Interlock switches are bypassed. Possible causes: – Laser cover is loose or removed. – Faulty Interlock Switch. – Faulty Interlock PCB, power supply, or CPU.
03	Emergency Stop (220 VAC models only)	OFF	ON	An Emergency Stop signal is present. Check condition of both Emergency Stop switches on the Control Panel and the E-Stop input on the Interface panel. [EXT I/O (3) and EXT I/O (4)].
04	Coolant Low Level	OFF	ON	The quantity of secondary cooling water is low. Add Steam-distilled water to the water tank (to the level indicated on the water level label). If the problem persists, look for leaks. Possible causes: – The water level is too low – Leak in cooling system – Faulty water level sensor – Faulty heat Exchanger – Faulty Interlock PCB.
05	Phase trouble	OFF	ON	The phase order of the input AC is incorrect. If this error occurs, check the A.C. service for proper phasing (X, Y, Z, or R, S, T) and exchange two of the phases. Possible causes: – Incorrect A.C. power installation – Faulty phase detection circuit.
06	Overheat of Pump	OFF	ON	The temperature of the water pump is excessive. Measure the A.C. line voltage and verify the laser is set to run at this input voltage. Possible causes: – Laser not correctly tapped for the A.C. supply voltage. – Faulty pump (usually accompanied with noise) – Faulty temperature sensor
07	DSP Unit Missing	OFF	ON	The Laser Controller (Program Box) is not connected to the Laser. This error appears when the Main PCB cannot communicate with the Laser Controller. Verify connection. Possible causes: – Faulty Laser Controller (bad communication driver) – Faulty Main CPU (bad communication driver)

Code	LCD Screen	HV	Alarm	Corrective Actions
08	Discharge Resistor Temperature	OFF	ON	The temperature of the Discharge Resistor is high. Turn the Laser off for 10 minutes and allow the heat in the discharge resistor to dissipate. Possible causes: – The High Voltage is cycled on and off too frequently. – Faulty thermal switch.
09	Oscillator Temperature	OFF	ON	A high temperature has been detected on the Oscillator base plate. Turn the Laser off for 10 minutes and allow the heat to dissipate. Possible causes: – The Laser is fired repeatedly into a closed shutter. – An optical component is overheated. – High ambient temperature.
10	High Temperature of Coolant	OFF	ON	The secondary cooling water temperature is >104 ºF (40 ºC). Verify temperature with a thermometer. Possible causes: – Dirty air filters – High ambient temperature – Poor or no primary water (chiller) flow – Stuck or plugged solenoid (regulator) valve – Faulty temperature sensor – Faulty Main PCB
11	Low Temperature of Coolant	OFF	ON	The secondary cooling water temperature is < 77 ºF (25 ºC). Verify temperature with a thermometer. Allow at least 30 minutes for laser to warm up before troubleshooting. Possible causes: – Low ambient temperature – Primary cooling water lines connected in reverse – Solenoid valve incorrectly adjusted or faulty – Faulty heat exchanger – Improperly adjusted regulator
12	Low Flow Rate of Coolant	OFF	ON	Flow rate of the secondary cooling water is low. Possible causes: – Clogged Ion exchange filter or water filter – Broken flashlamp (causing blockage in oscillator) – Bad Flow Sensor – Bad water pump – Faulty Main PCB
13	Deionize Trouble (****MΩ/cm)	OFF	ON	The Resistivity of the secondary cooling water is < 2 MΩ. Allow laser to run and verify resistivity increases over time. Possible causes: – Old Ion Exchange Resin – Contaminated water – Short circuit or leakage across sensor probes – Faulty Main PCB
14	Simmer Trouble	OFF	ON	Flashlamp will not simmer (stay on). Possible causes: – Faulty flashlamp – Low AC voltage (change Transformer taps) – Resistivity of secondary cooling water is low – Faulty Trigger or Simmer PCB

Code	LCD Screen	HV	Alarm	Corrective Actions
15	Charge Trouble	OFF	ON	The Capacitor Bank is not charging in the allotted time or the charge voltage is too high. Possible causes: – AC voltage out of spec (change Transformer taps) – Blown fuse in Charge Unit (due to faulty component) – Faulty Charge Unit or Capacitor Bank.
16	Capacitor Bank Alarm	OFF	ON	The capacitor bank charge voltage is not correct (undercharge, overcharge, or no voltage). Possible causes: – Cap Bank Balance circuit needs to be reset. If problem persists, the Cap Bank is faulty. – Blown fuse in Charge Unit (due to faulty component) – Faulty Charge Unit or Capacitor Bank
18	Main Shutter Trouble	OFF	ON	Main Shutter position not detected or does not change position within 20 ms. Possible causes: – External Interlock open during Power-Up Self Test – Incorrect External I/O implementation – (do not send Laser Start while shutters are opening) – If Laser is equipped with a Multi-Workstation Interlock option, all branch shutters/workstation doors must be closed prior to the Power-up Self Test – Faulty Shutter, Interlock PCB, or Main PCB
19 20 21 22	Branch Shutter 1 Trouble Branch Shutter 2 Trouble Branch Shutter 3 Trouble Branch Shutter 4 Trouble	OFF OFF OFF OFF	ON ON ON ON	Branch Shutter position not detected or does not change position within 20 ms. Possible causes: – External Interlock open during Power-Up Self Test – Incorrect External I/O implementation (do not send Laser Start while shutters are opening) – If Laser is equipped with a Multi-Workstation Interlock option, all branch shutters / workstation doors must be closed prior to the Power-Up Self-Test – Faulty Shutter, Interlock PCB, or Main PCB
27	No Current	OFF	ON	No/Low current detected in flashlamp. Possible causes: – Broken flashlamp or faulty flashlamp cable – Faulty Power Supply or Hall Sensor
28	Discharge Unit Over-current	OFF	ON	Excessive Current in Discharge Unit. Possible causes: – Faulty Discharge Unit (due to bad IGBT) – Short Circuit in Capacitor Bank Wiring
29	Discharge Unit Temperature	ON	ON	A high temperature has been detected in the Discharge Unit. Possible causes: – Low level of secondary cooling water – Faulty cooling fan(s) – Faulty temperature sensor – Faulty Discharge Unit
30	Discharge Unit Overpower	OFF	ON	Flashlamp is drawing excessive power. Possible causes: – Old flashlamp – Improper beam alignment – Faulty Nd:YAG rod – Faulty Hall Sensor

Code	LCD Screen	HV	Alarm	Corrective Actions
31	Branch Unit Cover Opened	OFF	ON	The branch unit cover is removed. If panels are removed, verify interlock micro-switches are defeated. Possible causes: – Branch Unit cover is loose or removed – Faulty Interlock Microswitch – Faulty Interlock PCB
32	Fiber Switch Trouble (*used on hard-wired fiber interlock systems only*)	OFF	ON	Optical Fiber connection not detected. The possible causes of this error are: – ME-1955 dipswitch set incorrectly – Fiber Optic Cable is disconnected or faulty – Incorrect wiring to the fiber connector – Faulty focus head connection switch
33 34	E. Indicator Trouble (Output Unit – Focus Head) E. Indicator Trouble (Program Unit)	OFF	ON	No current is detected through the *Emission* Indicator(s). Verify the condition of the *Emission* lamps and replace as necessary. Possible causes: – Faulty Emission lamp in Start/Stop switch (E34) – Faulty Emission lamp in Focus Head (E33) – Faulty wiring – ME-1955 dipswitch set incorrectly
35	Battery Low	–	ON	Back-up memory lithium battery is low. Possible causes: – Low (or dead) battery (on Main PCB) – Faulty Main PCB
38 39 40 41	Fiber Sensor 1 Trouble Fiber Sensor 2 Trouble Fiber Sensor 3 Trouble Fiber Sensor 4 Trouble	OFF OFF OFF OFF	ON ON ON ON	IR not detected at focus head. Possible causes: – Faulty IR sensor in focus heads – Faulty wiring – ME-1955 dipswitch set incorrectly
44	External Interlock Opened	–	ON	Safety Interlock circuit is open. Possible causes: – Faulty remote Interlock connection – External Interlock connector not connected to the laser – Faulty Interlock PCB
45	Laser Start is not Ready	–	ON	A process error has been detected. Possible causes: – Issuing a start command before branch shutters are fully open (wait at least 20 mS after sending shutter command) – Issuing a start command before the laser is “ready" – Faulty branch shutter
46	Power Monitor Temperature	–	ON	Power Monitor temperature is out of specification (45~46 °C). If this error occurs, the Power Monitor Assembly is faulty.
47	Overrate	–	ON	The programmed laser settings exceed the capacity of the Laser. Error usually appears after the laser has fired. Possible causes: – Programmed energy/power too high – Programmed pulse width is too long – Repetition rate set too high – Faulty Power Monitor

Code	LCD Screen	HV	Alarm	Corrective Actions
48	Fiber Overrate	–	ON	The programmed laser settings exceed the capacity of the Fiber Optic Cable. Error usually appears after the laser has fired. Possible causes: – Programmed energy/power too high – Programmed pulse width is too long – Repetition rate set too high – Faulty Power Monitor
49	Setting Error (duration too short)	–	ON	Pulse width setting ≤ 00.2 ms. Error usually appears before the laser has fired. Set pulse width to > 00.2 ms.
50	Setting Error (overlimit of Max Pwr)	–	ON	The programmed laser settings exceed the capacity of the Laser. Error appears before the laser has fired. Once this error is present, all laser settings will revert back to the settings before the change. Lower the process settings.
51	Fiber Setting Error	–	ON	The programmed laser settings exceed the capacity of the Optical Fiber. Error appears before the laser has fired. Once this error is present, all laser settings will revert back to the settings before the change. Lower the process settings.
52	Memory Trouble	–	ON	CPU memory trouble. Possible causes: – CPU back-up battery is low on Main PCB – Re-initialize Laser (all settings will be erased) – Bad/loose connection on Main PCB – Faulty Main PCB
53	Power Feedback Trouble	–	ON	Problem with laser power feedback system. Possible causes: – Faulty Power Monitor – Faulty Discharge Unit – Faulty Main PCB
54	Deionize Caution (****MΩ/cm)	–	–	Resistivity of secondary cooling water (2 MΩ < ρ_r ≤ 3 MΩ) is low. If this error does not clear after 50 ~ 60 minutes, replace the Ion Exchange Resin. Possible causes: – Old Ion Exchange Resin – Short circuit across sensor probes – Water leakage in sensor – Faulty Main PCB
56	Overlimit of Laser Power	–	–	Output Energy exceeds “high” set point. Verify the **ENERGY HIGH** value is correct.
57	Underlimit of Laser Power	–	–	Output Energy falls below the “low” set point. Verify the **ENERGY LOW** value is correct.
59 60 61	Time-Share 1 Trouble Time-Share 2 Trouble Time-Share 3 Trouble	OFF OFF OFF	ON ON ON	Time-Share Shutter position not detected or does not change position within specified time. Possible causes: – External Interlock open during Power-Up Self-Test – Incorrect External I/O implementation (do not send Laser **Start** while Main Shutter is opening) – Faulty Time-share Shutter – Faulty Interlock PCB – Faulty Main Board

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 or Occasion			Reference Paragraph
	Daily	Semi-Annually	Other	
Air Filter Procedures				
Inspect air filter	•		As required when inspected	*Cleaning the Air Filter*
Vacuum air filter			As required when inspected	*Cleaning the Air Filter*
Clean air filter with detergent		•	As required	*Cleaning the Air Filter*
Cooling Water Procedures				
Inspect cooling water level	•		As required when inspected	*Checking Water Level and Adding Water*
Add cooling water			As required when inspected	*Checking Water Level and Adding Water*
Partially drain secondary cooling water			Replacement of ion exchange resin or cartridge, water filter replacement, long-term storage; shipment	*Draining the Secondary Cooling Water*
Completely drain primary and secondary cooling water		•	Long periods of non-use, possibility of freezing.	*Draining Primary Cooling Water* *Draining Secondary Cooling Water*
Partially drain Primary Cooling Water			Clean Solenoid Valve Strainer	*Draining the Primary Cooling Water*
Replace Ion exchange cartridge			When necessary (Roughly every 3 years)	*Refilling Ion Exchange Resin and replacing Ion-Exchanger*
Replace ion-exchange resin			When necessary (Roughly every 6 months)	*Refilling Ion Exchange Resin and replacing Ion-Exchanger*
Lithium Battery Procedure				
Replace lithium battery (BIOS program storage battery)			Every 30 months (2-1/2 years)	*Replacing Back-up Battery*

Section IV: Maintenance Procedures

Overview

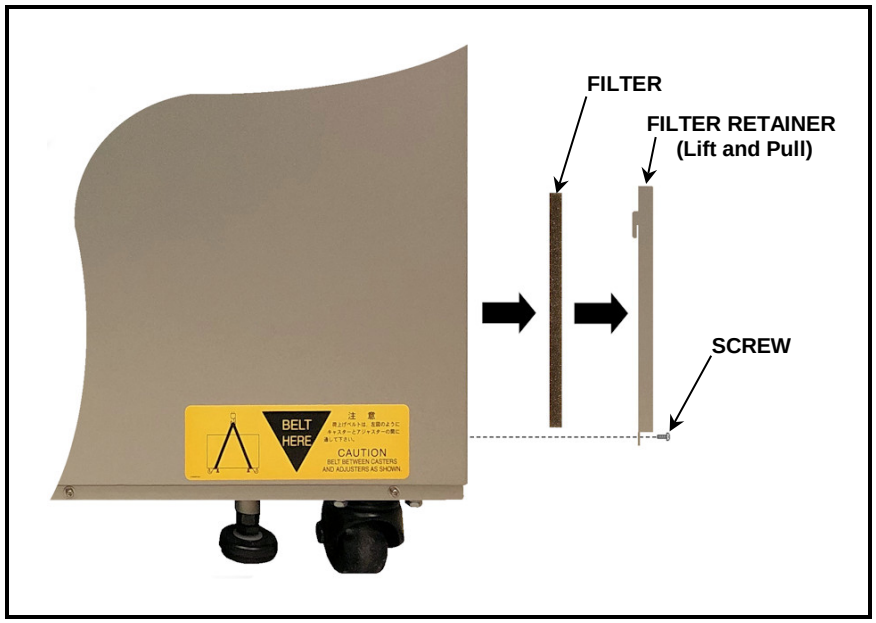
The maintenance procedures in this section are grouped based on their degree of difficulty to perform.

Cleaning the Air Filter

Required Items

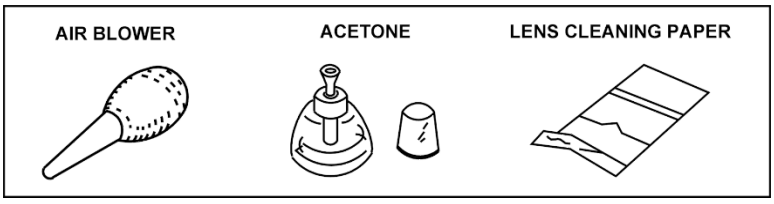
- Phillips screwdriver

1. Remove the filter retainer from the rear of the Laser.
2. Take out the filter and wash it with tap water. If the filter is badly stained, use a neutral detergent to clean it.
3. Air-dry the filter naturally and then install the filter back into the Laser.

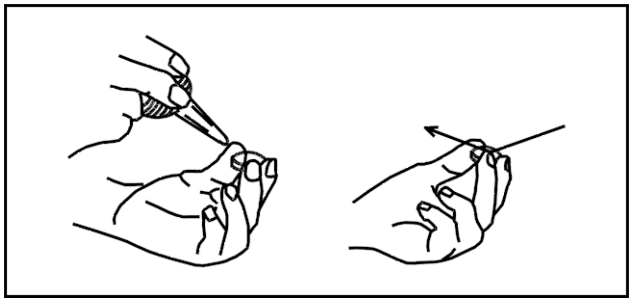


Cleaning Optical Parts – Removing Dirt, Dust, Etc. from Optics

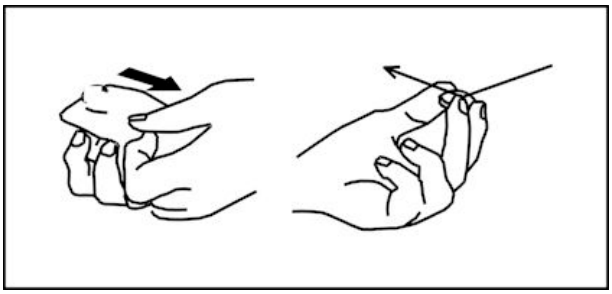
Required Items



1. Hold the optical part horizontally by the sides.
2. Blow off any dirt and dust using an air blower.
3. Check that no dirt or dust remains. Repeat process until all visible dirt is removed.

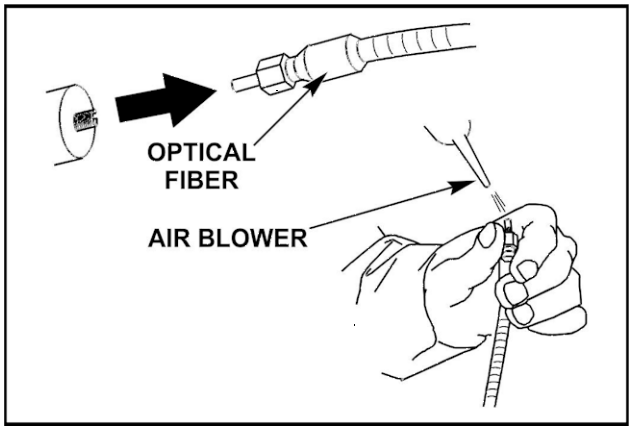


Cleaning Optical Parts – Fogging and Staining



1. Hold the optical part horizontally by the sides and place a drop of acetone on the center of the lens cleaning paper.
2. Holding one end of the cleaning paper, pulling the wet part of the paper across the optic in a constant speed from one side to the other. Avoid air gaps and excess acetone as this may prevent the optic from being properly cleaned.
3. Check that no dirt or dust remains. Repeat process until all visible dirt is removed. If the optical part cannot be cleaned, it must be replaced.

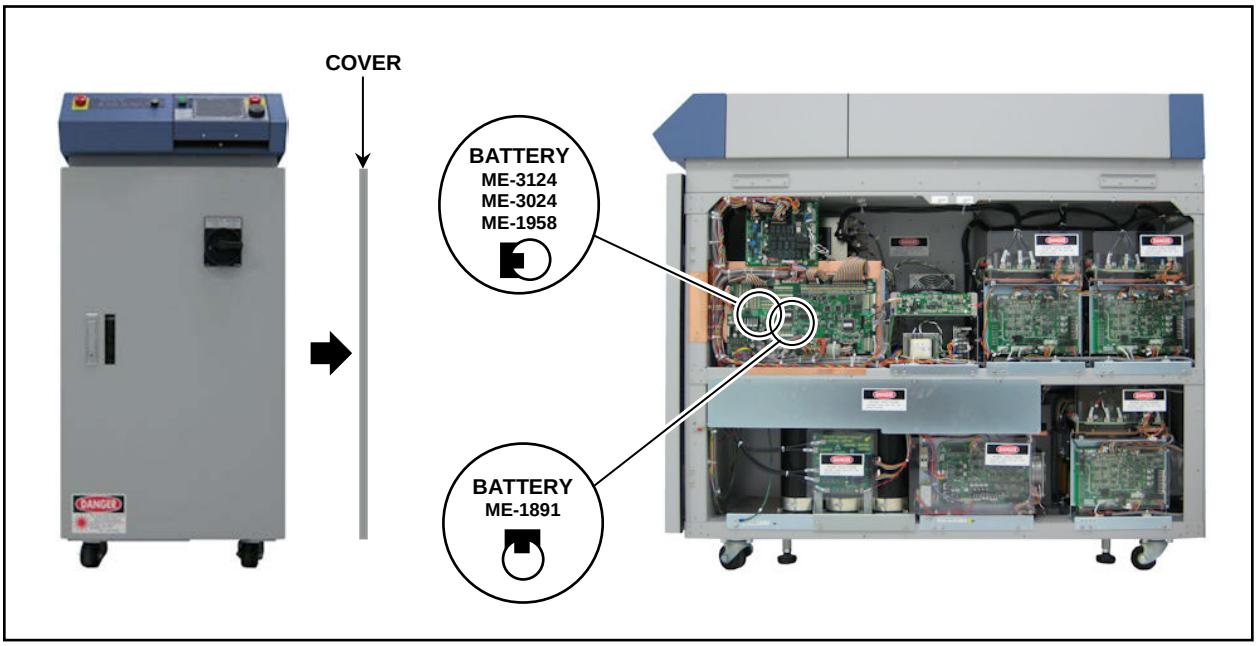
Cleaning Optical Parts – Optical Fiber



1. Remove the optical fiber from the Laser system and blow the dust off the end face of the optical fiber with an air blower.
2. If dust cannot be removed by performing the step above, lightly wipe it with lens cleaning paper. To avoid scratching the end face, never press the cleaning paper againat the end face of the fiber.
3. Check the end face for dust and stains. Use a fiber inspection tool (AWTA # 4-60091-01) to check the end face of the optical fiber for flaws, dust, and burns.

Power Supply – Replacing the Backup Battery

Location of battery depends on the Main PCB that is installed in the Laser.



NOTE: The service life of the backup lithium battery is about 2½ to 3 years. When the battery is replaced, all schedule data will be erased. Make sure to record the schedule information before starting this procedure.

1. Turn the **MAIN POWER** switch OFF.
2. Wait for at least 5 minutes and then remove the right side cover.
3. Remove the battery from the Control PC board (non-conductive tweezers can be used to simplify the extraction process).
4. Install a new battery, making sure the polarity is correct.
5. Re-install the right side cover.
6. Reinitialize the Laser as described in:
   Chapter 3: MLE-118A Operation, Section III or
   Chapter 4: MLE-1185 Operation, Section III depending on which Laser Controller is used.

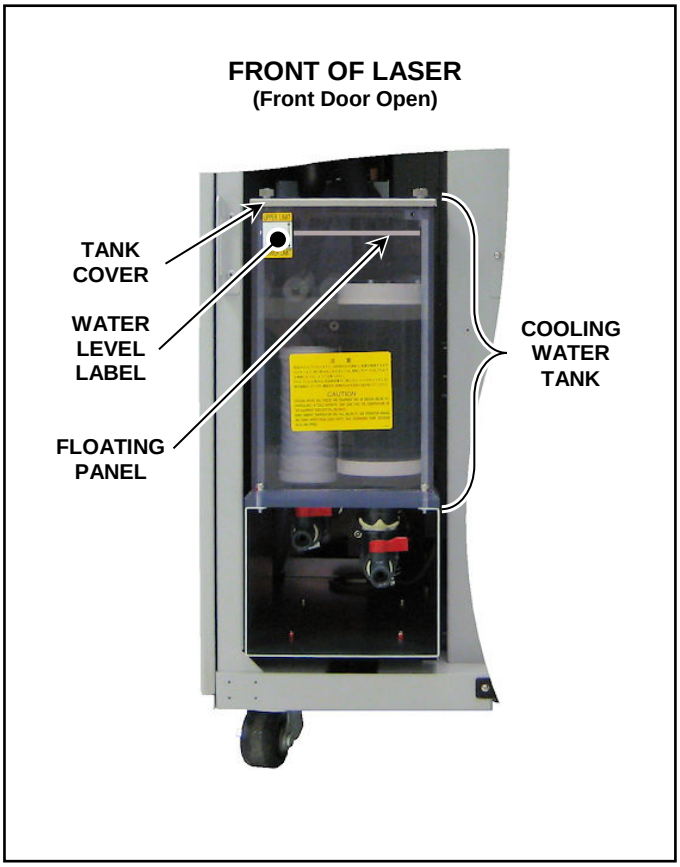
Cooler Maintenance – Checking Water Level and Adding Water

The water level should be checked ***each day before operation***.

NOTE: If the water level is low, add water. If you need to add water daily, check for leaks.

Required Items

- PH-10 hand pump
- Latex Gloves (powder free)
- Eye Protection
- Steam-distilled Water (as required)



1. Open the Front Door of the Laser.
2. Inspect the water level inside the Cooling Water Tank. The water level should be between the HIGH and LOW line on the water level label.
3. Remove the tank cover.
4. Remove the floating panel (keep the panel clean).
5. Add steam-distilled water using the hand pump until the water is at the HIGH line on the water level label. If this is an initial filling, or a lot of water is needed, the level may again drop after the unit has been running for a few minutes. Recheck the level and add additional water as necessary.
6. Replace the floating panel.
7. Replace the cover on the cooling water tank.
8. Close the front door.

Cooler Maintenance – Draining the Primary Cooling Water

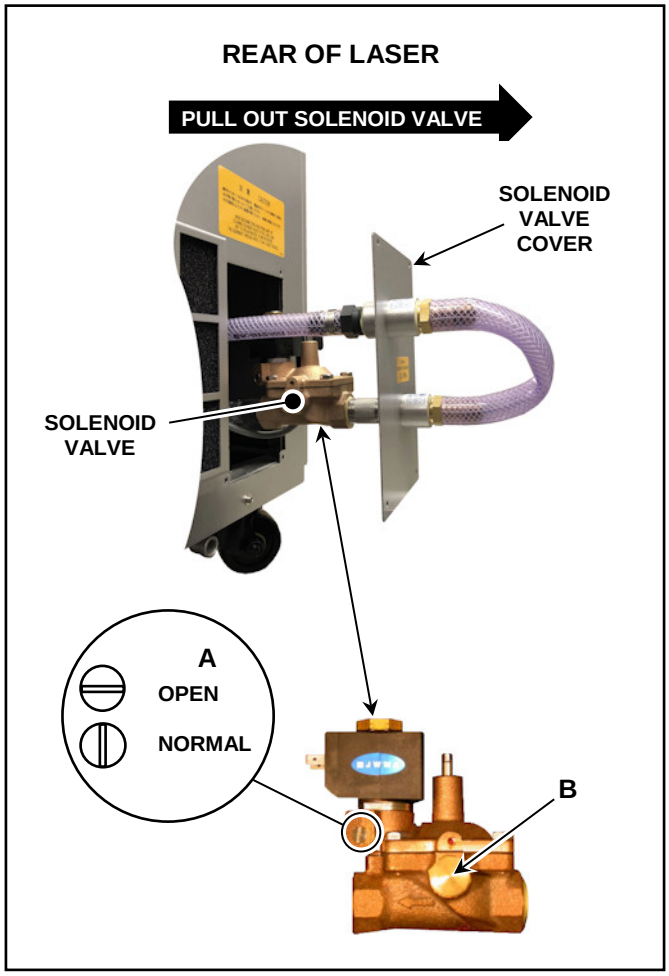
Drain the water when marked with a "**•**" on the following occasions:

Maintenance work	Draining
Replacing Ion-Exchange resin refill	Not necessary
Replacing Ion-Exchange Cartridge	Not necessary
Replacing water filter	Not necessary
Replacing secondary cooling water	Not necessary
Shift and transportation	•
Long period of non-use	•

Required Items

- Clean bucket or similar container
- Flat-blade screwdriver

1. Disconnect the two externally connected hoses to drain the water. If you splash water on the equipment, wipe it off with a clean cloth.
2. Open the solenoid valve cover on the back of the Laser and pull out the solenoid valve.
3. Open the solenoid valve. Push and turn screw **A** shown at right to the "Open" (horizontal) position with a flat-blade screwdriver.
4. Remove valve plug **B**.
5. Blow clean compressed air (42 psi or 294 kPa maximum) into the pipes to drain the water.
6. Return the valve plug **B**. Return screw **A** to "Normal" position (vertical).
7. Return the solenoid valve cover.
8. Connect a small piece of hose between the cooling water inlet and outlet and secure each end with a hose band to keep dirt out of the laser.



Cooler Maintenance – Draining Secondary Cooling Water

Drain the water when marked with a "**•**" on the following occasions:

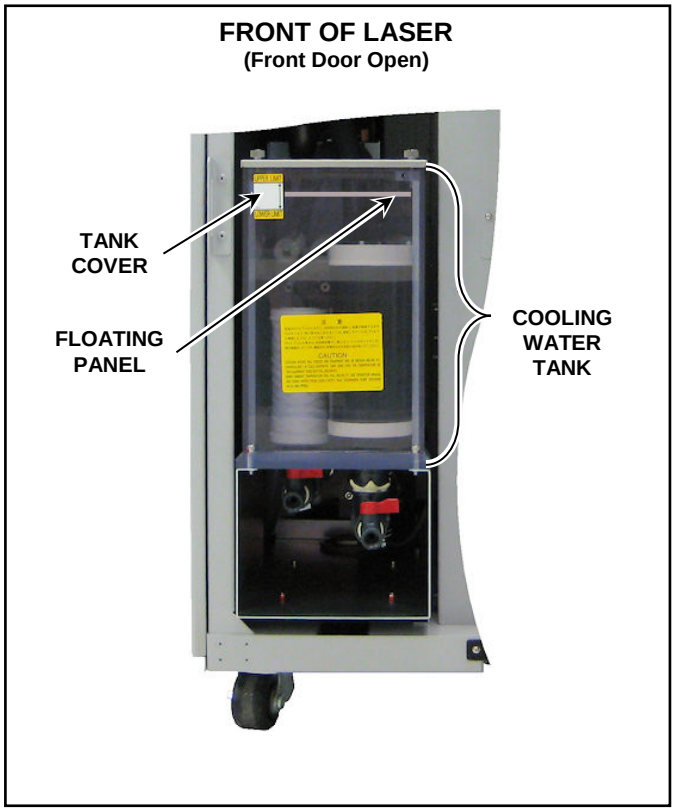
Maintenance work	Secondary cooling water
Replacing Ion-Exchange resin refill	•
Replacing Ion-Exchange Cartridge	•
Replacing water filter	•
Replacing secondary cooling water*	•
Shift and transportation	•
Long period of non-use	•

* Replace secondary cooling water once every 6 months.

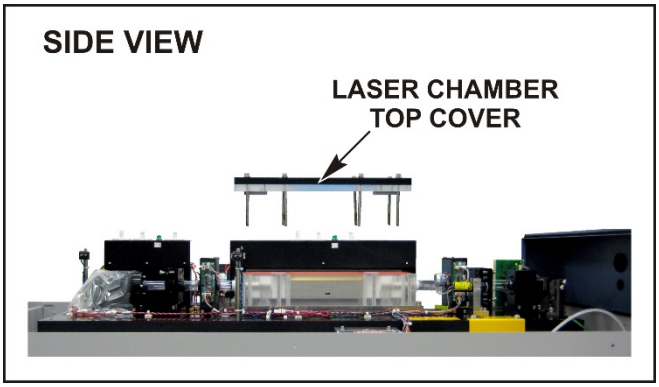
Required Items

- PH-10 hand pump
- Clean container, such as a bucket
- Latex gloves (powder-free)

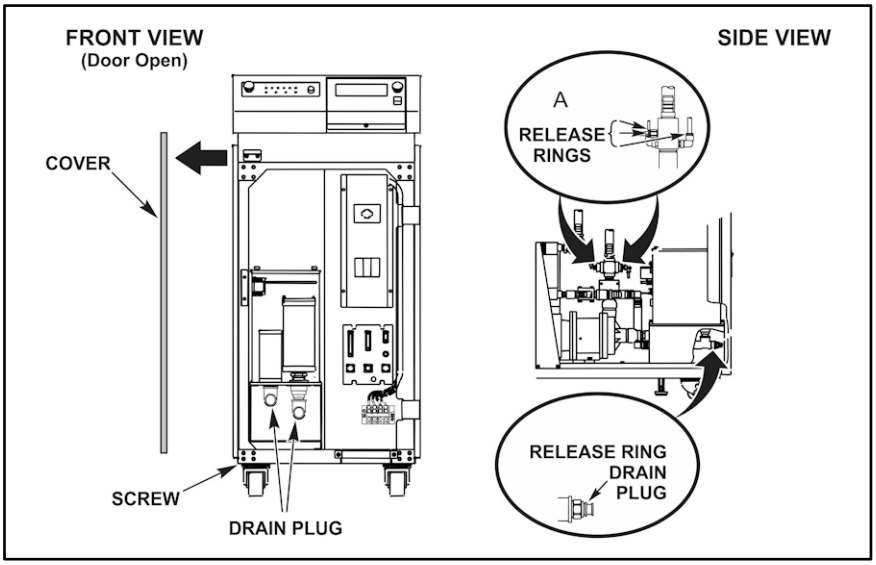
1. Open the front door.
2. Open the cover of the cooling water tank and remove the floating panel. (keep the floating panel clean)
3. Pump the water out of the cooling tank using a hand pump.
4. Return the floating panel in the tank. Return and secure the tank cover.



Cooler Maintenance – Draining the Cooling Water when Laser Is Not Used for Long Periods of Time or when the Ambient Temperature is below 0 °C



1. Remove the Left Side panel.
2. Drain the Primary Cooling Water (*see Draining the Primary Cooling Water*).
3. Drain the Secondary Cooling Water (*see Draining the Secondary Cooling Water*).
4. Remove the flashlamp access cover and the top cover of the laser chamber.
5. Allow the water in the chamber to drain into the cooling water tank.
6. Return and secure the top cover of the laser chamber and the flashlamp access cover in reverse order.
7. Place a pan under the Drain Plugs under the front of the Laser.
8. Open both drain plugs to drain remaining water from secondary cooling water tank. When removing the plug, press the release ring evenly and pull the plug straight toward you. If you do not press the ring hard enough, the plug may not come out or the adapter and plug may be damaged, which can cause a water leak.



9. Disconnect the tube at location **A** (noted above) and blow clean compressed air (42 psi or 294 kPa maximum pressure) into the pipes to force the excess water out.
10. After draining all the water, return the drain plugs and tubes.
11. Return and secure the left side cover.

Cooler Maintenance – Replacing the Water Filter

Required items

- PH-10 hand pump
- Clean container, such as a bucket
- Latex Gloves (powder-free)
- Secondary Cooling Water (or steam-distilled water)

NOTE: Replace the water filter and secondary cooling water every 6 months.

1. Remove the cover of the cooling water tank.
2. Remove the floating panel (keep the panel clean).
3. Pump the water out of the tank using the hand pump.
4. Pull the water filter up and out. (The water filter is pressed into the bottom of the cooling water tank.) Depending on the date of manufacture, the water filter may be in a slightly different location.
5. Insert a new water filter and then supply the secondary cooling water with the hand pump, until it reaches the **HIGH** line on the water level label.
6. Return the floating panel in the tank. Return and secure the tank cover.

Cooler Maintenance – Refilling and/or replacing Ion Exchange Cartridge

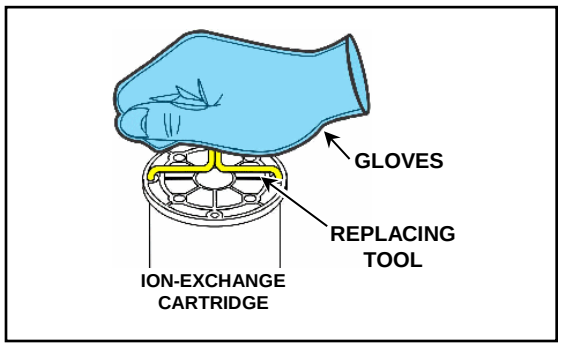
- The Laser uses an economical ion-exchange cartridge. You can use it repeatedly by refilling its contents, i.e., ion-exchange resin. Service life of the cartridge housing is about 3 years.
- Our high performance Ion-Exchange Resin is exclusively blended, so that it purifies more effectively than conventional resin and has a longer service life.

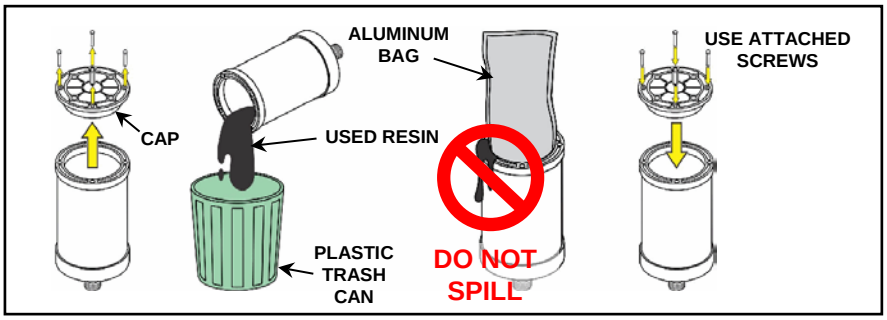
TIPS
• Life expectancy of the ion-exchange resin is approximately 6 months. Generally it's best to replace the ion-exchange resin before the old resin becomes non-effective. • If the ion-exchange resin is exposed to air, it will deteriorate. When opening the bag, put the resin into the cartridge immediately and put back the cartridge into cooling water tank. • Do not expose ion-exchange resin to direct sunlight; keep it in a cool place but do not freeze it. • When replacing the Ion-Exchange Cartridge, use the proper replacement tool. Do not over-tighten, or damage to the threads will occur. • You can use the floating panel repeatedly. As the floating panel is made of polyethylene foam, dispose according to all relevant regulations.

Required items

- Ion-exchange replacement tool
- Secondary cooling water
- PH-10 hand pump
- Ion-exchange resin refill
- Phillips screwdriver
- Latex Gloves (powder free)
- Clean container, such as a bucket.

1. Remove the cover of the cooling water tank and take out the floating panel. (Keep it clean).
2. Use a hand pump to remove water from the cooling water tank.
3. Turn the ion-exchange cartridge in the tank to the left (CCW) with the replacement tool (AWTA # 451-082) to remove it. The ion-exchange cartridge screws into the base of the cooling water tank. Depending on the date of manufacture, the ion-exchange cartridge may be in a slightly different location.
4. Remove the four screws (M4 x 16 mm, stainless steel) from the cap of the cartridge and pull up on the cap.
5. Discard the used resin. Dispose the used resin in a plastic trash can.





6. Put the resin refill into the cartridge taking care not to spill it.
7. Wipe off the excess resin on the edge of the cartridge. Reinstall the cap, and screw it down.
8. Insert the ion-exchange resin cartridge into the cooling water tank and turn it to the right (CW) with the replacement tool to tighten. Do ***not*** over-tighten.
9. Supply the secondary cooling water, with the hand pump, until it reaches the **HIGH** line on the water level label.
10. Return the floating panel in the cooling water tank. Return and secure the cooling water tank cover.

Cooler Maintenance – Cleaning the Solenoid Valve Strainer

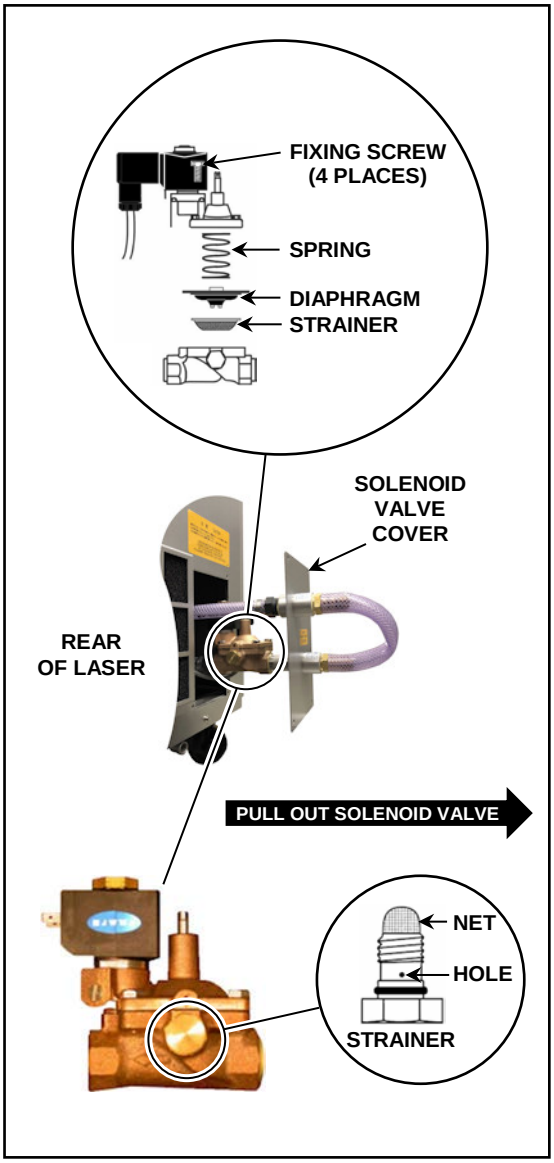
CAUTION

The Laser may overheat if the solenoid valve is clogged with dirt or the flow rate of the primary cooling water is lowered. Supply clean tap water or water for industrial use as the primary cooling water. Clean the solenoid valve once a year.

Required Items

- Brush
- 10 mm and 17 mm wrenches
- Philips screwdriver
- Clean container (such as a bucket)

1. Turn off the primary cooling water, disconnect the hoses from the cooling water inlets, and drain the water (see *Draining the Primary Cooling Water*).
2. Open the solenoid valve cover on the back of the Laser and pull out the solenoid valve assembly.
3. Remove the four fastening screws on the top of the solenoid valve.
4. Remove the upper portion of the solenoid valve, and then slowly pull out the spring and diaphragm (assembly is under spring tension).
5. Take the strainer out of the solenoid valve, and carefully clean it.
6. Return the strainer, diaphragm, spring, and upper portion of the solenoid valve.
7. Secure them with the four fastening screws.
8. If the net or the small hole at the bolt end of the solenoid valve is clogged, the valve will not close, causing the primary cooling water to keep flowing. Check and clean periodically.
9. Return the disconnected primary cooling water hoses and secure them with a hose band.



Power Detector Adjustment

The power detector is used to measure the output power/energy of the laser. The measured power/energy is displayed on the Laser Controller each time the laser is fired. This laser is equipped with a real-time power feedback system. The power detector is used as the primary feedback device for output control. The procedure below describes how to adjust the power detector. This procedure should be performed every six months for application critical processes, or once a year for normal use.

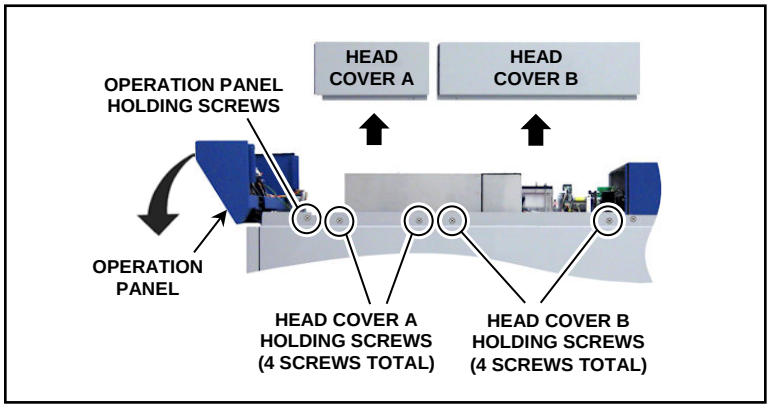
WARNING: ***Only authorized personnel should perform the following procedure.*** Nd:YAG safety goggles with a minimum optical density of 7+ at 1064 nm wavelength must be worn at all times during this procedure. Do not attempt this procedure without knowledge of Laser alignment.

Required Items:

- Phillips screwdriver
- Potentiometer adjustment tool
- DMM (digital multi-meter)
- Beam Expander
- External IR Power Detector + Meter
- Nd:YAG safety glasses.

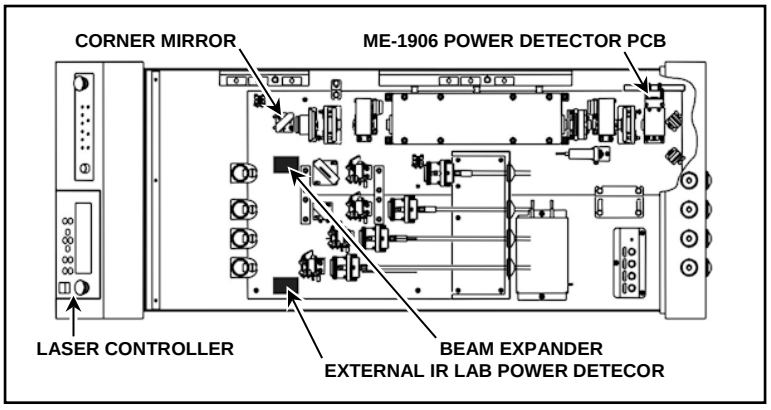
Remove the Head and Branch Unit covers.

1. Remove the Head and Branch Unit covers and disable all Interlock Switches.
2. Locate the ME-1906 Power Detector PCB and remove the plastic cover (4 screws) that protects the ME-1906 PCB.
3. Connect a DMM on the ME-1906 PCB; (+) to TP6 (SIG) and (-) to TP1 (GND).



4. Place a beam expander and IR Power Meter somewhere in the optical beam path after the corner mirror (as shown on the right). The purpose of the beam expander is to decrease the energy density on the face of the IR Detector. If any optical components are removed, it will be necessary to re-align the Laser after this procedure.

   Proceed with caution.



5. Turn the Laser ON. Once the **SCHEDULE** screen appears, turn the High Voltage (HV) OFF.
6. Adjust VR2 (OFFSET) on the ME-1906 PCB for a reading of 0.01 to 0.03 volts on the DMM.
7. Turn the High Voltage (HV) ON and allow the Laser to reach the **READY** state.
8. Open the Main Shutters.
9. Put the Laser in to **MAINTENANCE** mode (see *Chapter 3, Section III* for details using the MLE-118A Controller, or *Chapter 4, Section III* for details using the MLE-115A Controller).
10. Navigate to the **CONTROL** field and change the mode to **CURRENT**.
11. Exit the **MAINTENACE** mode and navigate to the **SCHEDULE** screen.
12. Enter the operating parameters according to the table below:

Laser Model	Peak Power (A)	Power (%)	Pulse Width	Ideal Output Energy
ML-2551A(-CE) / LW300A(E)	300 A	100%	10 mS	40 J
ML-2550A(-CE) / LW400A(E)	400 A	100%	10 mS	60 J

13. Turn the Guide Beam ON momentarily to verify all light is hitting the center of the IR Power Detector in a wide pattern (≥ 50% coverage is recommended). If necessary, re-position the beam expander or IR Power Detector.
14. Fire the Laser and increase or decrease the Peak Power (A) until the Ideal Output Energy (defined in the table above) is measured by the IR Power Meter.
15. Adjust VR1 on the ME-1906 Power Detector PCB until the measured energy on the Laser LCD screen equals the measured value on the IR Power Meter.

    NOTE: turning VR1 clockwise **decreases** the LCD energy value, likewise turning VR1 counter-clockwise **increases** the LCD energy value).
16. If VR1 is adjusted, repeat steps 6 – 16 until no further adjustments are necessary.
17. Get back into the **MAINTENANCE** mode screen and set the **CONTROL** method back to **LASER POWER**.
18. Remove the Beam Expander and IR Power Detector.
19. Remove the DMM and reinstall the ME-1906 plastic protective cover.
20. If any optical components were removed during this process, re-align the Laser.
21. Re-install the Branch Unit and Head covers back on to the Laser.

Replacing the Flashlamp

DANGER

To avoid electrical shock, turn the laser power to the OFF position and wait for at least 5 minutes when replacing the flashlamp.

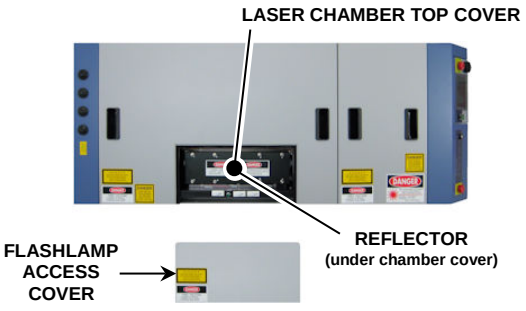
CAUTION

- Place the removed top cover, reflector, and the other parts on a clean cloth to protect them from oil and dust. Do ***not*** scratch the inside surface of the reflector (reflector panel) or a reduced laser output may occur.
- When replacing the flashlamp, do ***not*** reverse the polarity of the flashlamp. If you do, the lifetime of the flashlamp will be significantly reduced.
- Do ***not*** touch or scratch the glass portions of the flashlamp or flowtube with bare hands. If they are scratched or oil from the hands is deposited on the flashlamp, it may break during operation.
- ***Before*** turning the power **ON**, check that the eight mounting bolts on the top cover of the laser chamber are tightened securely. Do ***not*** overtighten the bolts or damage will occur to the sealing O-ring.
- Check for leaks after replacing the flashlamp during the first power-up sequence.

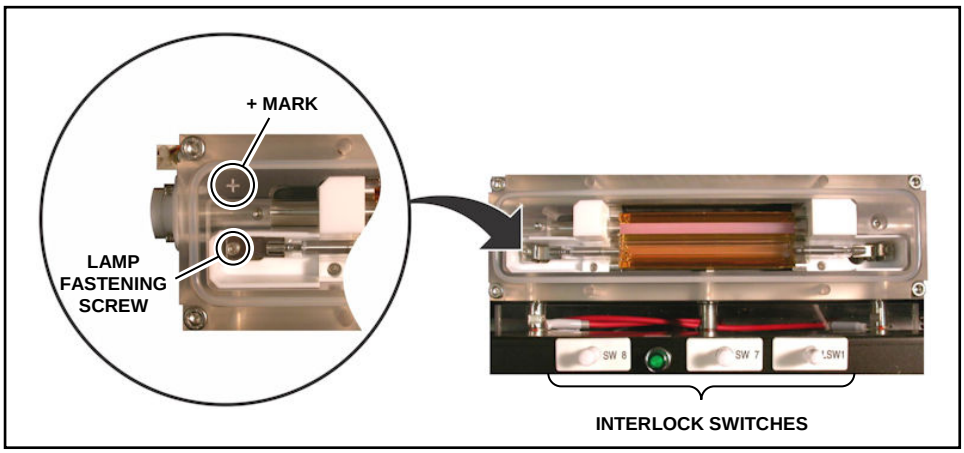
Required Items

- Ballpoint hexdriver: 2.5 mm, 5 mm
- Phillips screwdriver
- Alcohol
- Flashlamp (new)
- Powder-free latex gloves (***Must*** be worn for the ***entire*** procedure.)

1. Turn the Laser power **OFF**. If high voltage was on, wait for at least five minutes before starting this procedure.
2. Remove the flashlamp access cover.
3. Loosen the bolts on the laser chamber and remove the top cover, store in a clean area.
4. Remove the reflector by slowly lifting up on the top portion of the reflector, store in a clean area. Do ***not*** damage the inner surface of the reflector.



5. Loosen the bolts at both ends of the flashlamp.
6. Using two hands, hold both ends of the flowtube (glass tube) and lift it up together with the flashlamp.
7. Place the flashlamp on a clean lint-free cloth.
8. Carefully pull the flashlamp out of the flowtube. Straighten the flashlamp leads as necessary.
9. Clean the new flashlamp with alcohol and pass the cleaned flashlamp through the flowtube.



10. Carefully place the flashlamp so that it's "**+**" aligns with the "**+**" in the chamber. Make sure that the flashlamp is securely placed inside the guide groove of the chamber.
11. Center the flowtube inside the chamber.
12. Secure the flashlamp tightly with the bolts.
13. Carefully replace the top portion of the reflector.
14. Install the top cover on the chamber and tighten the bolts.

    NOTE: Make sure that the O-ring between the top cover and chamber is pressed evenly.
15. Pull up on the end of the flashlamp access cover interlock switches to bypass them, then turn on the power.
16. Turn the **CONTROL** key switch **ON**.
17. Verify that there are no water leaks and the Laser operates normally, then turn the power **OFF**.

    NOTE: If you detect a leak, turn the **CONTROL** key switch ***and*** the **MAIN SWITCH OFF** immediately. ***Wait for 5 minutes***, then wipe off the leaking water and fix the cause of leak.
18. Install the flashlamp access cover.

Section V: Parts Lists

Accessories

Name	AMADA WELD TECH AMERICA Part Number
EXT. I/O (1) connector (37 pin male)	250-409
37 pin D-sub Backshell	250-537
EXT. I/O (2) connector (25 pin male)	250-479
EXT. I/O (4) connector (25 pin female)	250-480
25 pin D-sub Backshell	250-536
EXT. I/O (3) E-STOP connector (9 pin male)	250-193
9 pin D-sub Backshell	250-535
RS-485 connector (1) or (2)	451-052
REMOTE INTERLOCK connector	451-035
Fiber interlock connector	520-139
Ion-exchange resin replacing tool	451-082
Nd:YAG laser-protective glasses	475-118
Ball point hex screwdriver 2.5 mm	770-035
Ball point hex screwdriver 3 mm	770-036
Ball point hex screwdriver 4 mm	770-037
Water feed hand pump	PH-10
Operation manual	990-538
Fiber Scope	FOS-04

Consumable Parts

Name	AMADA WELD TECH AMERICA Part Number
Flashlamp (MLD-0602)	435-138
Flow tube, Flashlamp	Z-01981-002
Flow tube, Nd:YAG rod	Z-01981-001
Ion-exchange resin refill	318-026
Ion-exchange cartridge	318-025
Ion-exchange resin cartridge kit (With one bag of ion-exchange resin)	318-027
Cooling water (Distilled water)	900-241
Water filter	318-019
Floating Panel	Z-01463-001
Lithium battery	145-014
Fan Filter (350 mm x 250 mm x 20 mm)	451-049

Section VI: Repair Service

Repair Service

If you have problems with your Laser that you cannot resolve, please contact our laser service department at the address, phone number, or e-mail address listed in **CONTACT US** in the front of this manual.

APPENDIX A.
Technical Specifications

Section I. Specifications

ML-2551A / ML-2550A SPECIFICATIONS (220 VAC Models)			
	Parameter	**ML-2551A LW300A**	**ML-2550A LW400A**
Oscillator	Maximum Rated Output	300 W	400 W
	Maximum Output Energy	50 J/P (at 10 ms)	80 J/P (at 10 ms)
	Pulse Width	Standard: 0.3 – 99.9 mS (0.1 mS increment) Fine Setting: 0.25 – 5.00 mS (0.05 mS increment)	
	Pulse Repetition Speed	1 to 500 pps	
	Oscillator Wavelength	1.064 μm	
	Resonator Shutter	With open/close sensor	
	Positioning Guide Beam	Built-in visible laser (Red)	
	Output stability	± 3 % (with output pulse ≥ 5 J/pulse and peak power ≥ 1 kW)	
Power Supply	Power Supply	220 VAC + 10%/-15%, 3-phase, 50/60 Hz (Jumper selectable for 200 / 240VAC. Consult with AMADA WELD TECH)	
	Max. Input Current	43 A (at 220 VAC)	
	Max. apparent power	14.9 kVA (at 220 VAC)	
	Breaker rated current	50 A	
	Power Consumption	11.82 kW Maximum (0.9 kW Stand-by)	
Cooler	Heat Exchanger Method	Water-Water	
	Pressure(maximum) Water Temperature Flow Rate Differential Pressure	42.6 psi (or 294 kPa) 5 – 35 °C (41 – 95 °F) 16 liters/min at 30 °C / 86 °F 25 liters/min at 35 °C / 95 °F 14.2 ~ 42.6 psi (98 ~ 294 kPa)	
	Chiller requirements	3.36 Ton (40, 252 BTU/h, 10,150 kcal/h)	
	Inner diameter of hose	ϕ15 mm	
Laser Controller	Schedule Setting	Up to 32 schedules	
	Monitor	Energy Monitor (J) Average Power (W)	
	Counter	9-digit TOTAL counter 9-digit GOOD counter	
	Alarm indication	Messages are displayed on liquid crystal display	
	Length of Cable	Remote control through standard 3 m cable (9.8 ft.)	
Physical Properties	Mass (approximately)	Approximately 882 lb. (400 kg)	
	Outline dimensions	46.1" (H) x 20.9" (W) x 53.0" (D) 1170 mm (H) x 530 mm (W) x 1347 mm (D)	

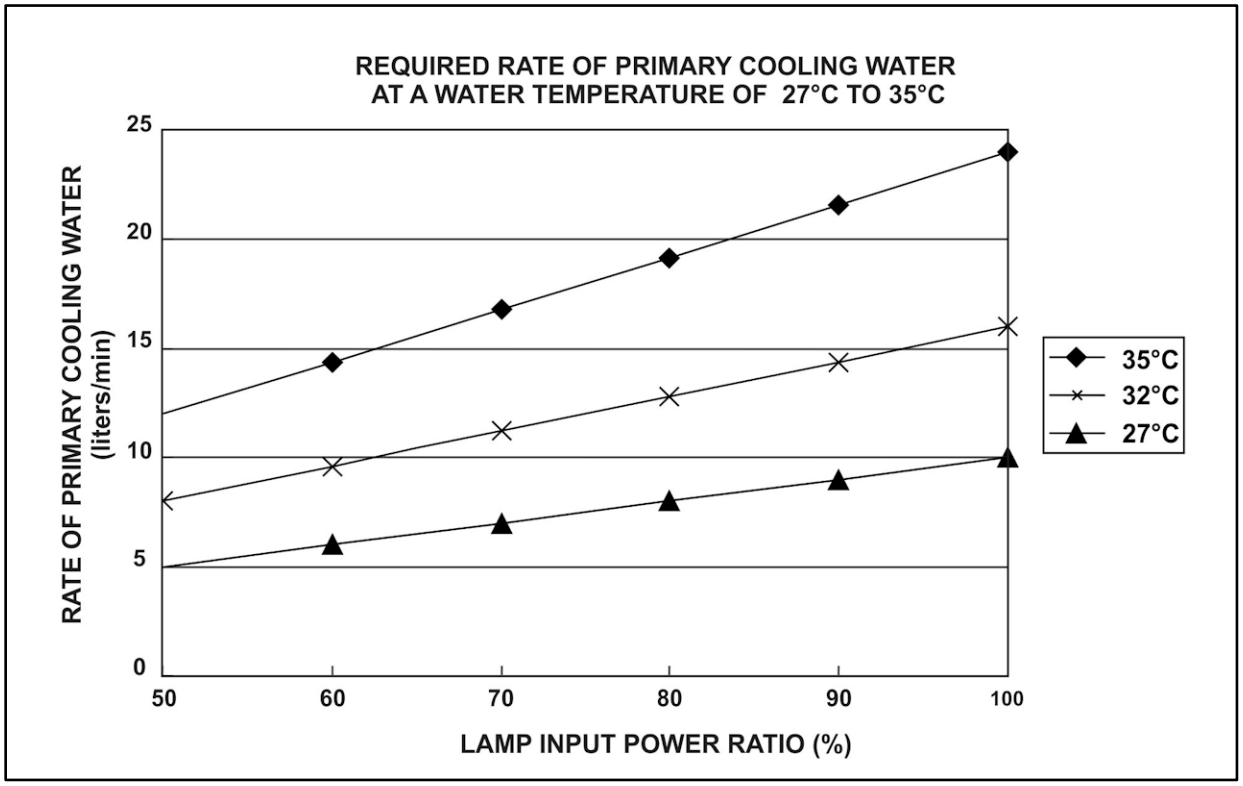
ML-2551A-CE / ML-2550A-CE SPECIFICATIONS (400 VAC Models)			
	Parameter	**ML-2551A-CE LW300AE**	**ML-2550A-CE LW400AE**
Oscillator	Maximum Rated Output	300 W	400 W
	Maximum Output Energy	50 J/P (at 10 ms)	80 J/P (at 10 ms)
	Pulse Width	Standard: 0.3 – 99.9 mS (0.1 mS increment) Fine Setting: 0.25 – 5.00 mS (0.05 mS increment)	
	Pulse Repetition Speed	1 to 500 pps	
	Oscillator Wavelength	1.064 μm	
	Resonator Shutter	With open/close sensor	
	Positioning Guide Beam	Built-in visible laser (Red)	
	Output stability	± 3 % (with output pulse ≥ 5 J/pulse and peak power ≥ 1 kW)	
Power Supply	Power Supply	400 VAC ± 10%, 3-phase, 50/60 Hz (Jumper selectable for 380 VAC. Consult with AMADA WELD TECH)	
	Max. Input Current	22 A (at 400 VAC)	
	Max. apparent power	15.3 kVA (at 400 VAC)	
	Breaker rated current	30 A	
	Power Consumption	11.82 kW Maximum (0.9 kW Stand-by)	
Cooler	Heat Exchanger Method	Water-Water	
	Pressure(maximum) Water Temperature Flow Rate Differential Pressure	42.6 psi (or 294 kPa) 5 – 35 °C (41 – 95 °F) 16 liters/min at 30 °C/86 °F 25 liters/min at 35 °C/95 °F 14.2 ~ 42.6 psi (98 ~ 294 kPa)	
	Chiller requirements	3.36 Ton (40, 252 BTU/h, 10,150 kcal/h)	
	Inner diameter of hose	ϕ15 mm	
Laser Controller	Schedule Setting	Up to 32 schedules	
	Monitor	Energy Monitor (J) Average Power (W)	
	Counter	9-digit TOTAL counter 9-digit GOOD counter	
	Alarm indication	Messages are displayed on liquid crystal display	
	Length of Cable	Remote control through standard 3 m cable (9.8 ft.)	
Physical Properties	Mass (approximately)	Approximately 992 lb. (450 kg)	
	Outline dimensions	46.1" (H) x 20.9" (W) x 53.0" (D) 1170 mm (H) x 530 mm (W) x 1347 mm (D)	

Section II. Cooling Capacity

Overview

In order to maintain good laser performance, the Laser ***must*** operate within a certain operating temperature range. In order to maintain the designed temperature, a certain flow rate of primary cooling water is required and is based on the temperature of the primary cooling water. The graph below shows the flow rate of primary cooling water required at specific temperatures when operating the Laser at 100% capacity.

ML-2551A(-CE) / ML-2550A(-CE) and LW300A(E) / LW400A(E) Models



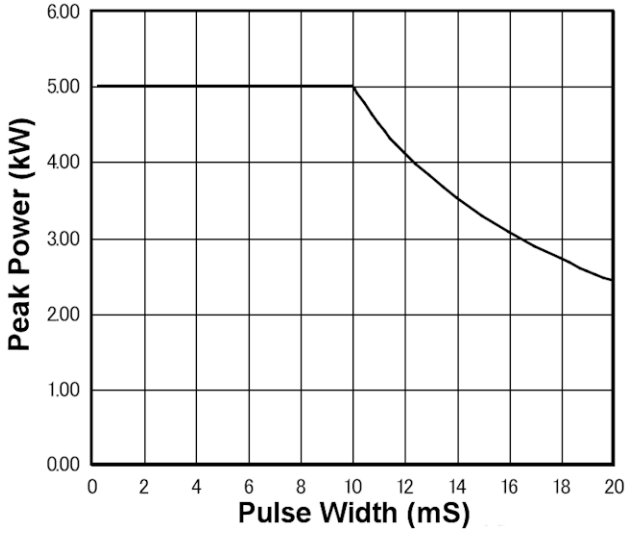
Section III. Maximum Peak Power

Overview

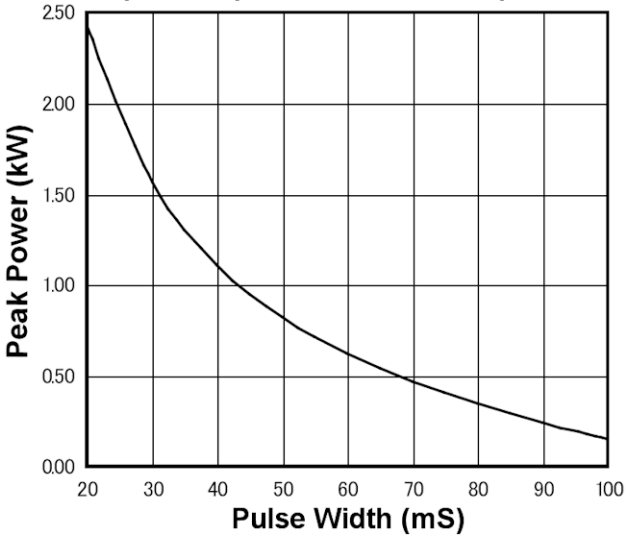
There is a limit to the peak power available in each Laser. A limiting factor is the output pulse width. The graphs below show the maximum peak power available and how it relates to the output pulse width.

ML-2551A(-CE) and LW300A(E) Lasers (0.3 ms ≤ pulse width ≤ 100 ms)

(0.3 ms ≤ pulse width ≤ 20 ms)

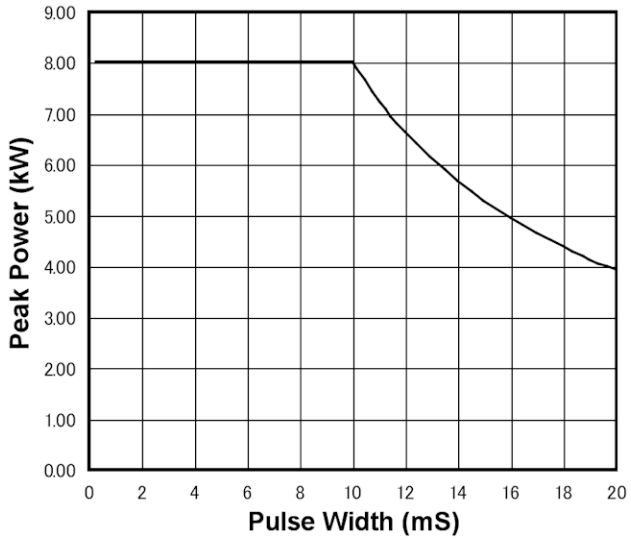


(20 ms ≤ pulse width ≤ 100 ms)

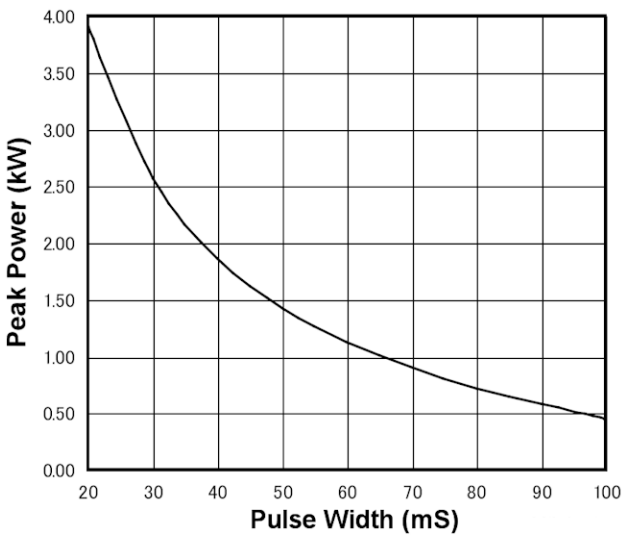


ML-2550A(-CE) and LW400A(E) Lasers (0.3 ms ≤ pulse width ≤ 100 ms)

(0.3 ms ≤ pulse width ≤ 20 ms)



(20 ms ≤ pulse width ≤ 100 ms)



Section IV. Optical Configurations

Standard Laser Configurations

MODEL NUMBER	OPTICAL CONFIGURATION	SPECIFICATIONS
ML-255__A-1E(-CE) LW300A (E)-1E LW400A (E)-1E	Single Output (1E)	Outputs through a single fiber
ML-255__A-2E(-CE) LW300A (E)-2E LW400A (E)-2E	2 energy share (2E)	Outputs through two fibers simultaneously
ML-255__A-3E(-CE) LW300A (E)-3E LW400A (E)-3E	3 energy share (3E)	Outputs through three fibers simultaneously
ML-255__A-4E(-CE) LW300A (E)-4E LW400A (E)-4E	4 energy share (4E)	Outputs through four fibers simultaneously
ML-255__A-2T(-CE) LW300A (E)-2T LW400A (E)-2T	2 time share (2T)	Selects 1 of 2 fibers and outputs
ML-255__A-3T(-CE) LW300A (E)-3T LW400A (E)-3T	3 time share (3T)	Selects I of 3 fibers and outputs
ML-255__A-4T(-CE) LW300A (E)-4T LW400A (E)-4T	4 time share (4T)	Selects 1 of 4 fibers and outputs
ML-255__A-2E2T(-CE) LW300A (E)-2E2T LW400A (E)-2E2T	2 time share / 2 energy share (2E2T)	2 time shared outputs with 2 energy shares each.

NOTE: The __ in the Model Number is either **0** or **1**

Optical Fiber

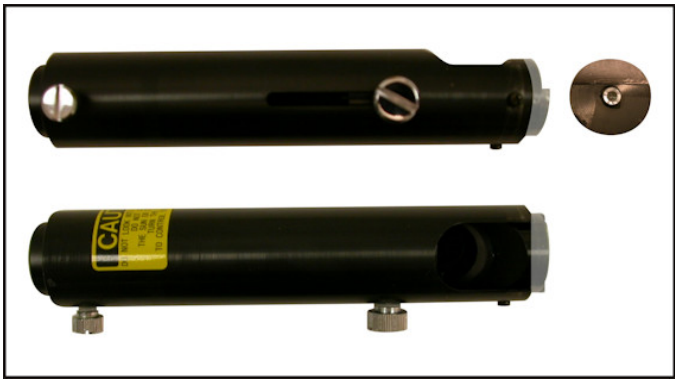
Note: Even though GI Fibers are specified in the table below, they are not recommended.
GI fiber data is for legacy systems only and not recommended for new applications.
Other lengths available by special order. Contact AMADA WELD TECH for more details.

AMADA WELD TECH AMERICA PART NUMBER	TYPE	CORE DIAMETER (µM)	ALLOWABLE BENDING RADIUS (mm)	LENGTH (m)
4-60255-01	SI	300	175	5
4-60099-01		400	175	
4-60001-01		600	255	
4-60093-01		800	305	
4-60118-01		1000	355	
4-60087-01	GI	400	175	5
4-60002-01		600	255	
4-60128-01		800	305	
4-60133-01		1000	355	
4-60256-01	SI	300	175	10
4-60085-01		400	175	
4-60086-01		600	255	
4-60115-01		800	305	
4-60119-01		1000	355	
4-60088-0I	GI	400	175	10
4-60089-01		600	255	
4-60131-01		800	305	
4-60134-01		1000	355	

Fiber Alignment Scope

Model FOS-04

When performing an alignment with the FOS-04 Alignment Scope, make sure the shaded (▭) area is attached to the FOS-04 Fiber Alignment Scope. This attachment is necessary to keep the alignment scope orthogonal to the optical axis.



Section V. Output Units (Focus Heads)

Introduction

In order for the Laser Welder to perform a welding function, the output laser beam must be focused on to the workpiece through the use of a Focus Head. The purpose of the Focus Head is to maximize the energy density into a small spot. AMADA WELD TECH offers many different Focus Head options with various performance characteristics. The tables below show all standard Focus Heads compatible with the ML-2551A(-CE) / ML-2550A(-CE) / LW300A(E) / LW400A(E) Laser Welders. Please consult AMADA WELD TECH for the availability of non-standard combinations.

NOTE: The Working Distance of the output units are typically 0.5" ~ 0.6" (13 ~ 15 mm) less than the Output Focal Length (FL).

∅ 50 mm Focus Heads

Straight Heads (Standard Products)

AWTA Pt #	Description	Collimating FL (mm)	Output FL (mm)	Optics
8-661-01-01	Straight 120/50HS focussing assembly	120	50	High Performance
8-661-01-02	Straight 100/75SS focussing assembly	100	75	Standard
8-661-01-03	Straight 200/50HS focussing assembly	200	50	High Performance
8-661-01-04	Straight 120/70HS focussing assembly	120	70	High Performance
8-661-01-05	Straight 100/100HS focussing assembly	100	100	High Performance
8-661-01-06	Straight 120/100HS focussing assembly	120	100	High Performance
8-661-01-07	Straight 120/120HS focussing assembly	120	120	High Performance
8-661-01-08	Straight 100/70HS focussing assembly	100	70	High Performance

CCTV Heads (Standard Products)

AWTA Pt #	Description	Collimating FL (mm)	Output FL (mm)	Optics
8-660-01-01	FX 100/70HC CCTV focussing assembly	100	70	High Performance
8-660-01-02	FX 100/75SC CCTV focussing assembly	100	75	Standard
8-660-01-03	FX 120/50HC CCTV focussing assembly	120	50	High Performance
8-660-01-04	FX 120/70HC CCTV focussing assembly	120	70	High Performance
8-660-01-05	FX 200/50HC CCTV focussing assembly	200	50	High Performance
8-660-01-06	FX 120/100HC CCTV focussing assembly	120	100	High Performance
8-660-01-07	FX 120/120HC CCTV focussing assembly	120	120	High Performance
8-660-01-08	FX 100/100HC CCTV focussing assembly	100	100	High Performance
8-660-01-09	FX 120/125SC CCTV focussing assembly	120	125	Standard

Replacement Cover Glass Options

AWTA Pt #	Description
475-107	50 mm Protective Lens, Cover Glass, uncoated, Pyrex (Standard Issue)
475-108	50 mm Protective Lens, Cover Glass, AR coated, Pyrex
475-516	50 mm Protective Lens, Cover Glass, uncoated, fused silica
475-334	50 mm Protective Lens, Cover Glass, AR coated, fused silica
475-351	50 mm Cover Glass Retainer (threaded ring)

Output Unit Camera Systems

Contact AMADA WELD TECH for the latest cameras and supplies.

Section VI. Spot Size (μm)

The table below shows the theoretical spot sizes of the imaged IR laser beam impinging upon the welding surface. The actual weld spot diameter on the surface will always be larger than shown in the table. At high power levels, the spot size will be significantly larger. The weld spot diameter is a function of the material type, laser settings, penetration depth, and desired weld strength. Not all lens combinations are available as standard products. Please consult AMADA WELD TECH for availability and pricing.

We encourage you to use our laser applications laboratory to help you determine the best process and equipment for your specific application.

FOCUS HEAD LENS COMBINATION		FIBER DIAMETER (μm)				
Collimating Focal Length	Output Focal Length	300 μm	400 μm	600 μm	800 μm	1000 μm
70	50	214	286	429	571	714
70	70	300	400	600	800	1000
70	100	429	571	857	1143	1429
70	120	514	686	1029	1371	1714
100	50	150	200	300	400	500
100	70	210	280	420	560	700
100	100	300	400	600	800	1000
100	120	360	480	720	960	1200
120	50	125	167	250	333	417
120	70	175	233	350	467	583
120	100	250	333	500	667	833
120	120	300	400	600	800	1000
200	50	75	100	150	200	250
200	70	105	140	210	280	350
200	100	150	200	300	400	500
200	120	180	240	360	480	600

Section VII. Fiber Limits

Due to laser beam divergence, there is a physical limit to which optical fibers can be used with a particular laser (note: if a fiber diameter is not listed, it is not recommended). The maximum energy/power you can expect to get out of each output is listed in the tables below. To avoid fiber damage, do not exceed the output energy or power of the 1E configuration for any specified Fiber Diameter and Laser Model.

ML-2551A(-CE) / LW300A(E)

Fiber Diameter	1E Delivery	2E Delivery	3E Delivery	4E Delivery
300 µm	50 J, 200 W	25 J, 100 W	16 J, 66 W	12 J, 50 W
400 µm – 1000 µm	50 J, 300 W	25 J, 150 W	16 J, 100 W	12 J, 75 W

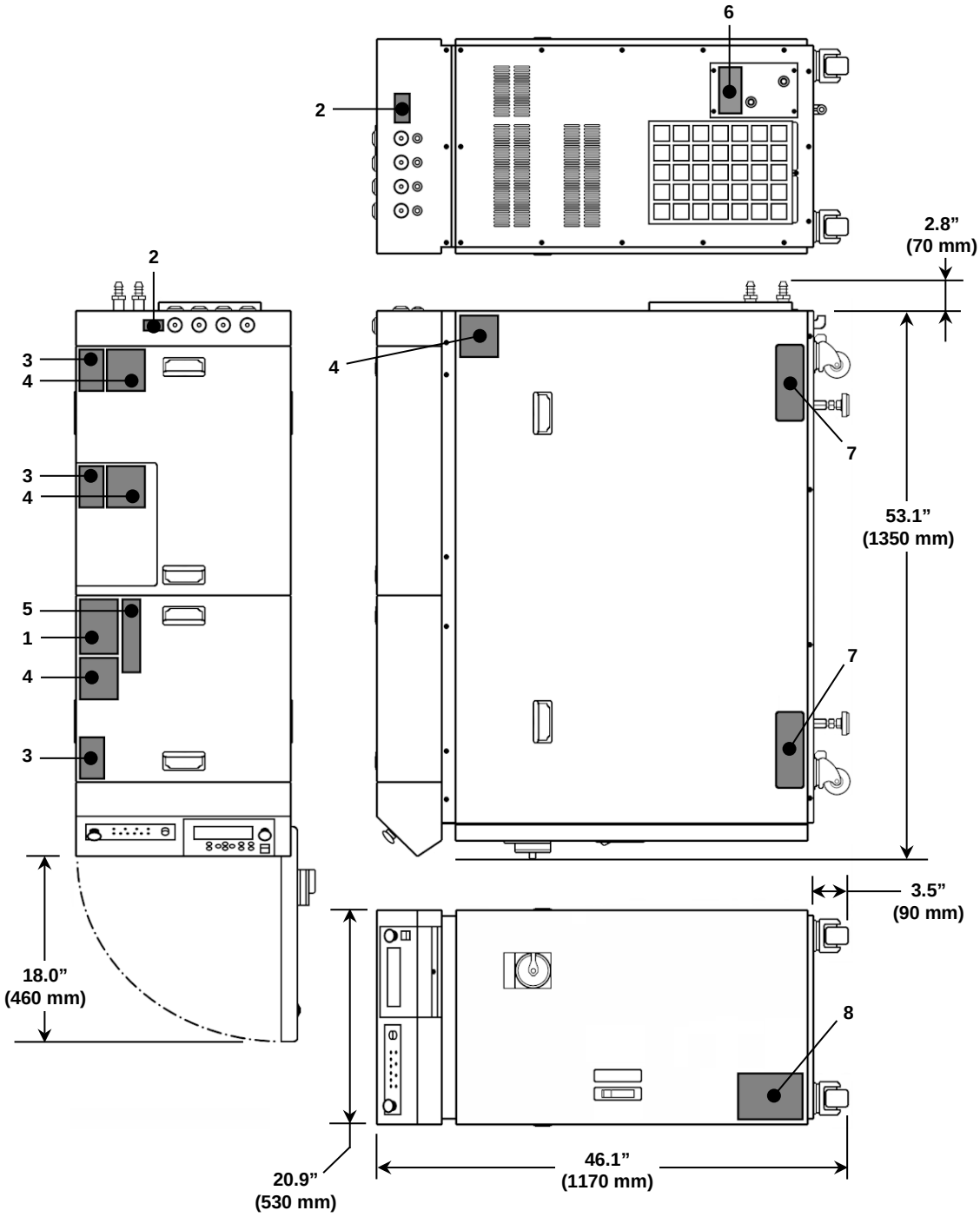
ML-2550A(-CE) / LW400A(E)

Fiber Diameter	1E Delivery	2E Delivery	3E Delivery	4E Delivery
400 µm	80 J, 200 W	40 J, 100 W	26 J, 66 W	20 J, 50 W
600 µm – 1000 µm	80 J, 400 W	40 J, 200 W	26 J, 133 W	20 J, 100 W

Section VII. Dimensions and Labels

Outline Dimensions and Warning Label Locations – Current Model

Both CE and non-CE Laser Models are labeled the same per FDA Laser Notice No. 56.



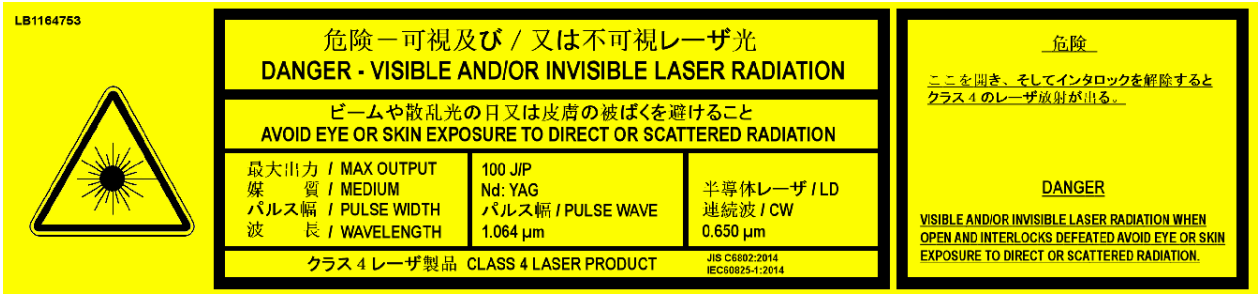
Warning Label Identification – Current Model

Label 1 (both CE and non-CE Models)

Label 2 (both CE and non-CE Models)

Label 3 (both CE and non-CE Models)

Label 4 (both CE and non-CE Models)

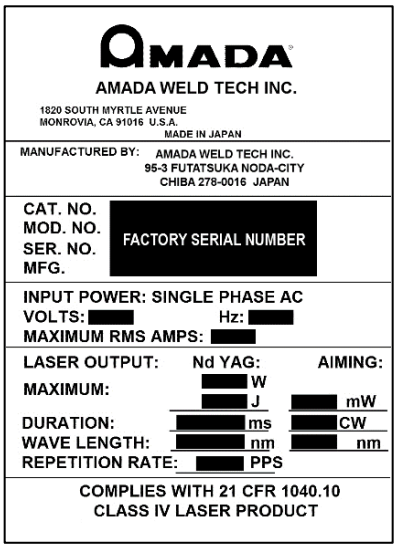


Label 5 (both CE and non-CE Models)

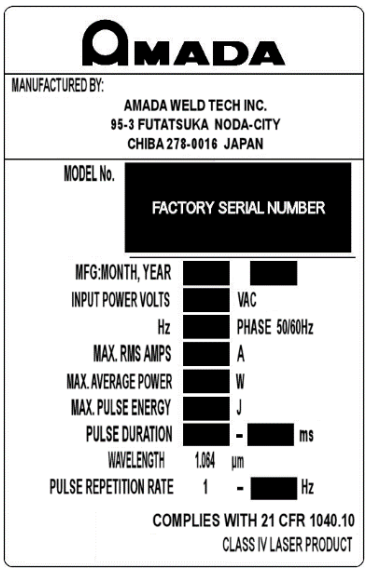
Label 6 (both CE and non-CE Water-Cooled Models)

Label 7 (both CE and non-CE Models)

Note: Air-Cooled Models only have one of these labels on the Left Side

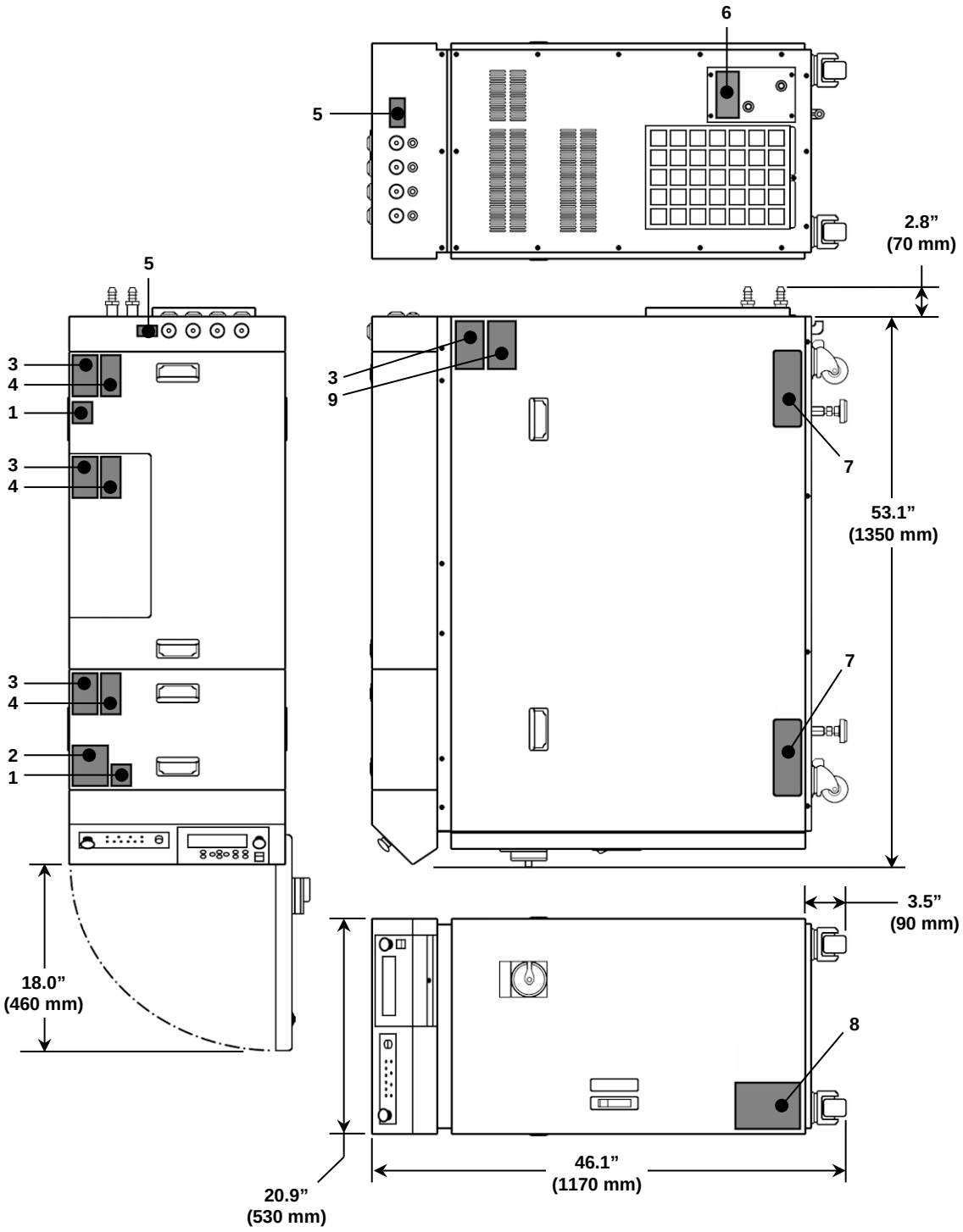


Label 8 (AWTA Label)



Label 8 (AWT Japan)

Outline Dimensions and Warning Label Locations – Legacy Models

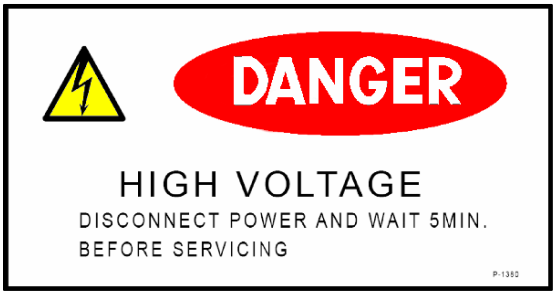


Warning Label Identification – Legacy Models

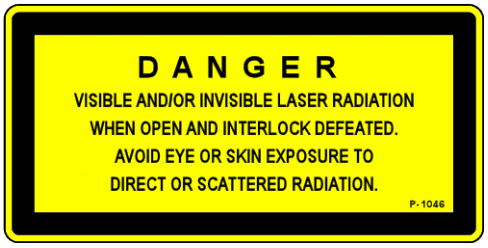
Label 1

Label 2 (both CE and non-CE Models)

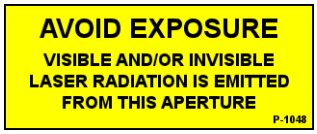
Label 3 (non-CE Models)



Label 3 (CE Models)



Label 4

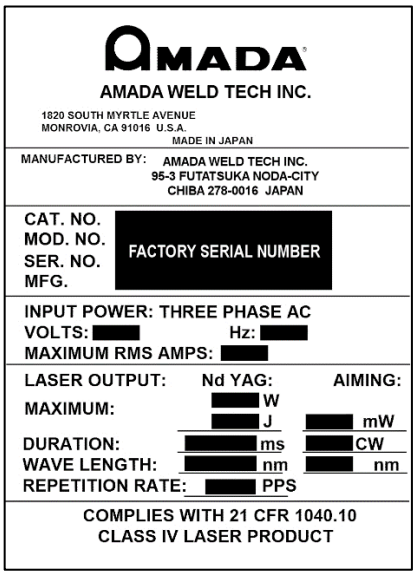


Label 5

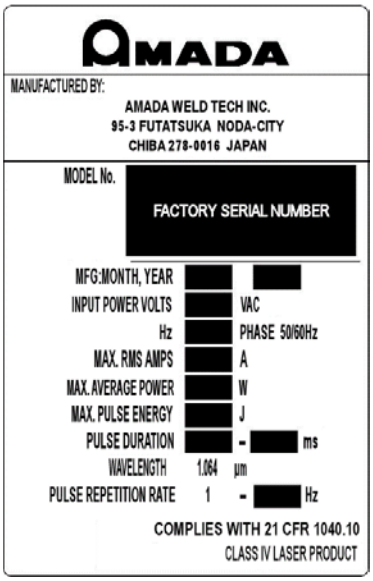
Label 6

Warning Label Identification – Legacy Models (continued)

Label 7



Label 8 (AWTA Label)

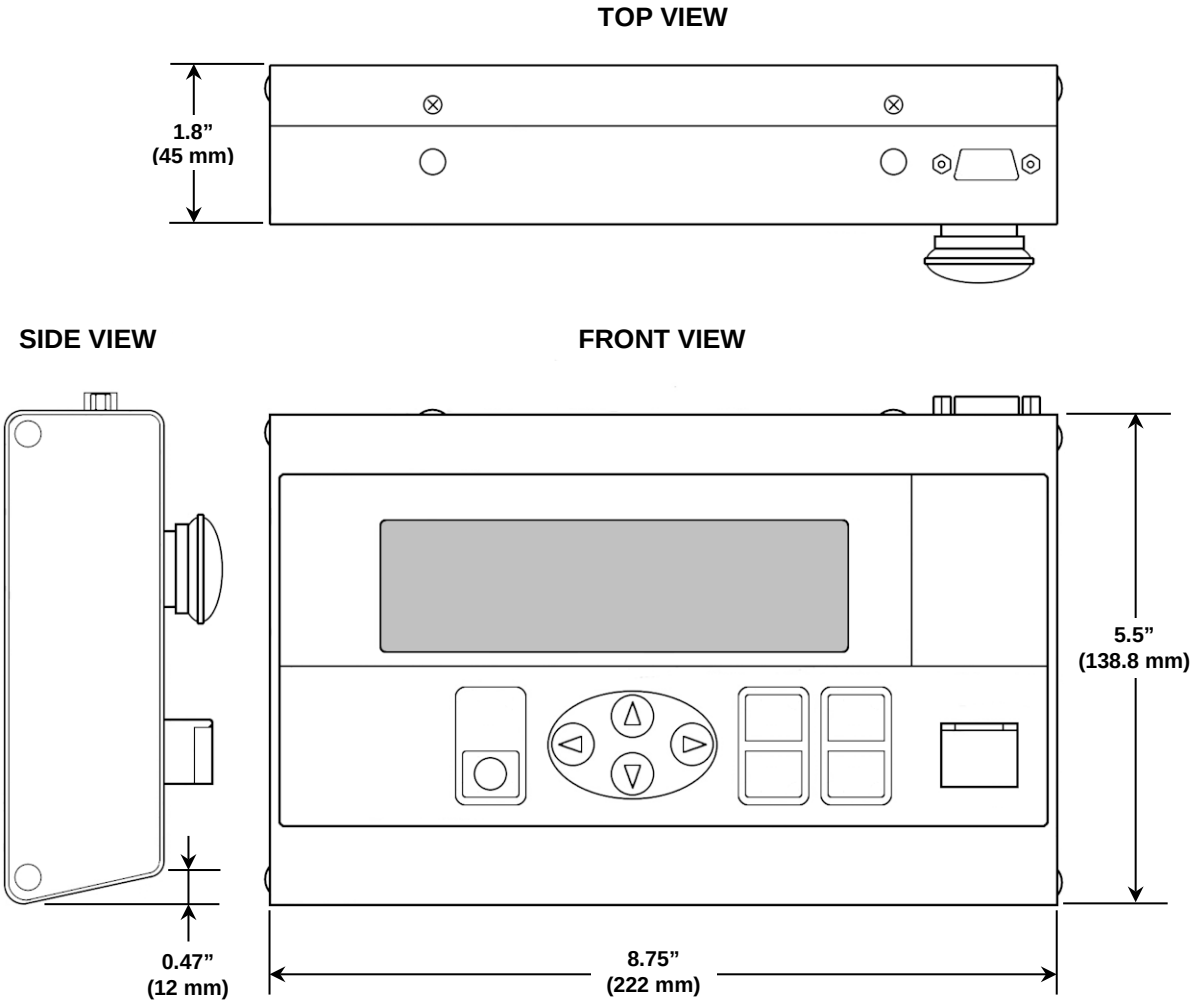


Label 8 (AWT Japan)

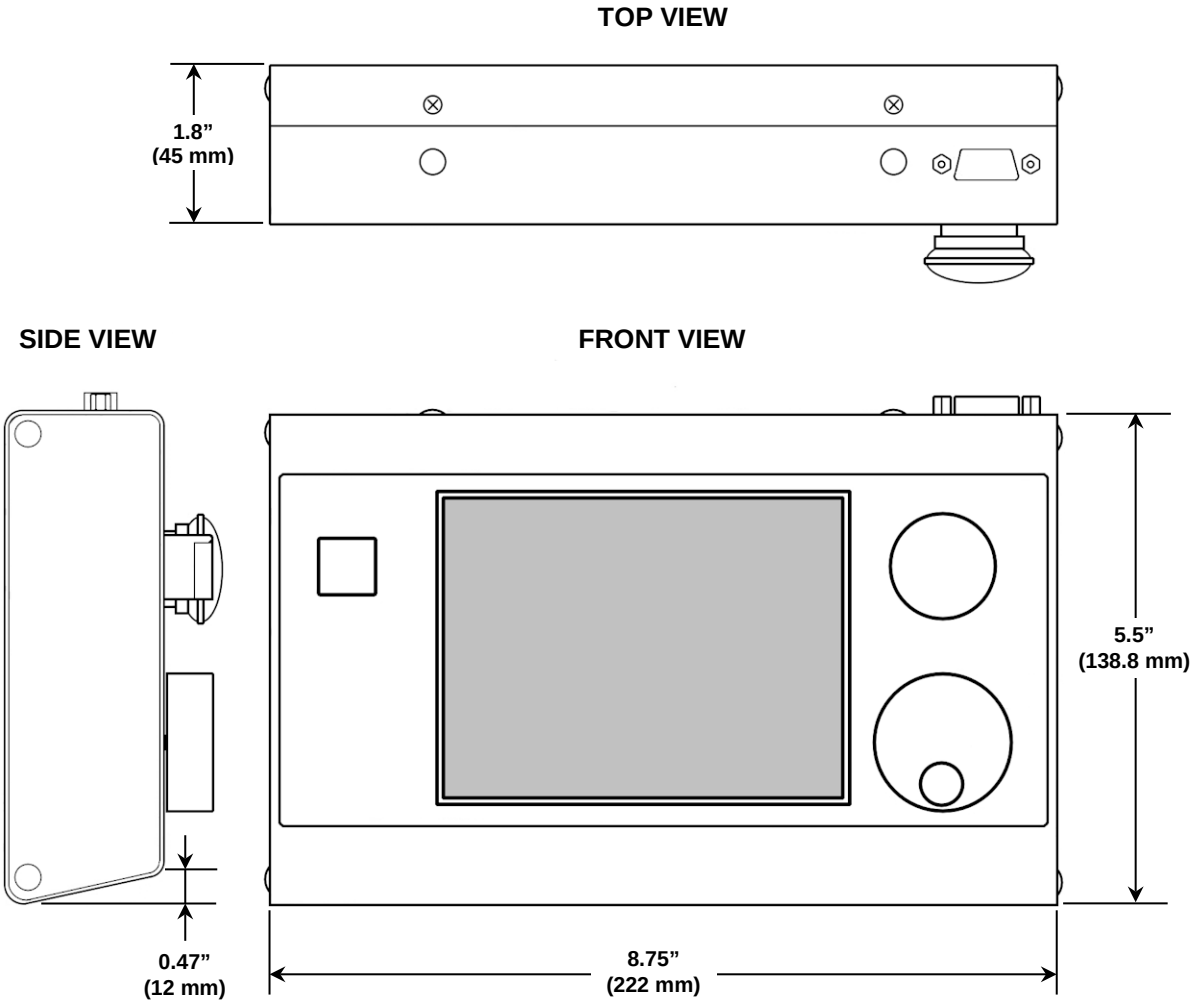
Note: Depending on Date of Manufacture, the company name may appear different.

Label 9 (CE Models only)

MLE-115A – Laser Controller Dimensions



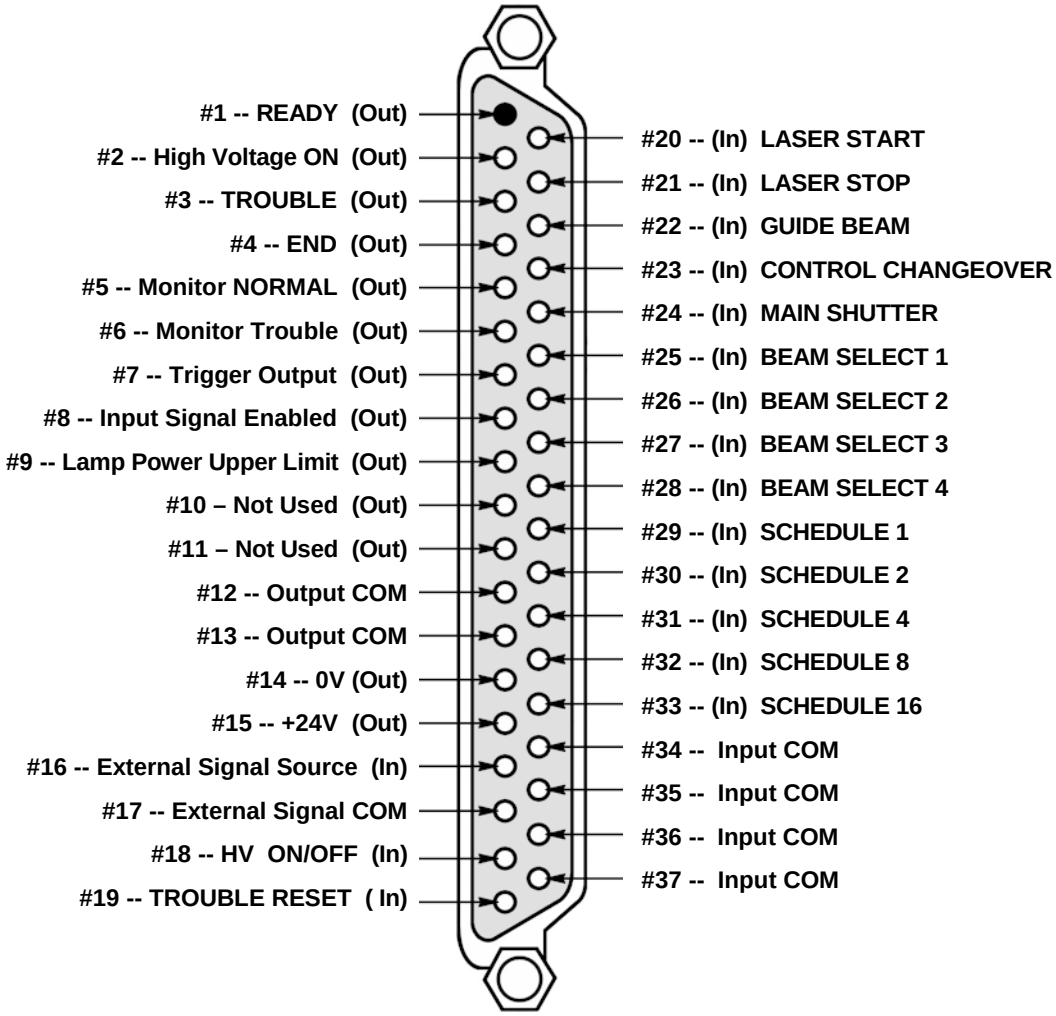
MLE-118A – Laser Controller Dimensions



APPENDIX B
ELECTRICAL AND DATA CONNECTIONS

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

EXT. I/O (1) – External Input / Output Signals



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	**HV-ON/OFF.** When the circuit between this pin and COM is closed, the high voltage is turned ON. When the circuit is opened, the high voltage is turned OFF.	
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 40 ms. When the signal is input repeatedly, make sure that the circuit is left open for at least 40 ms 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.	
24	**MAIN SHUTTER.** When the circuit between this pin and COM is closed, the main shutters open and the Laser becomes ready for laser oscillation. When the circuit is opened, the main shutters close.	
25	**BEAM SELECT 1.** When the circuit between this pin and COM is closed, laser beam input unit 1 is selected and the unit becomes ready to project a laser beam.	
26	**BEAM SELECT 2.** When the circuit between this pin and COM is closed, laser beam input unit 2 is selected and the unit becomes ready to project a laser beam.	
27	**BEAM SELECT 3.** When the circuit between this pin and COM is closed, laser beam input unit 3 is selected and the unit becomes ready to project a laser beam.	
28	**BEAM SELECT 4.** When the circuit between this pin and COM is closed, laser beam input unit 4 is selected and the unit becomes ready to project a laser beam.	
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 Output Signal Connections

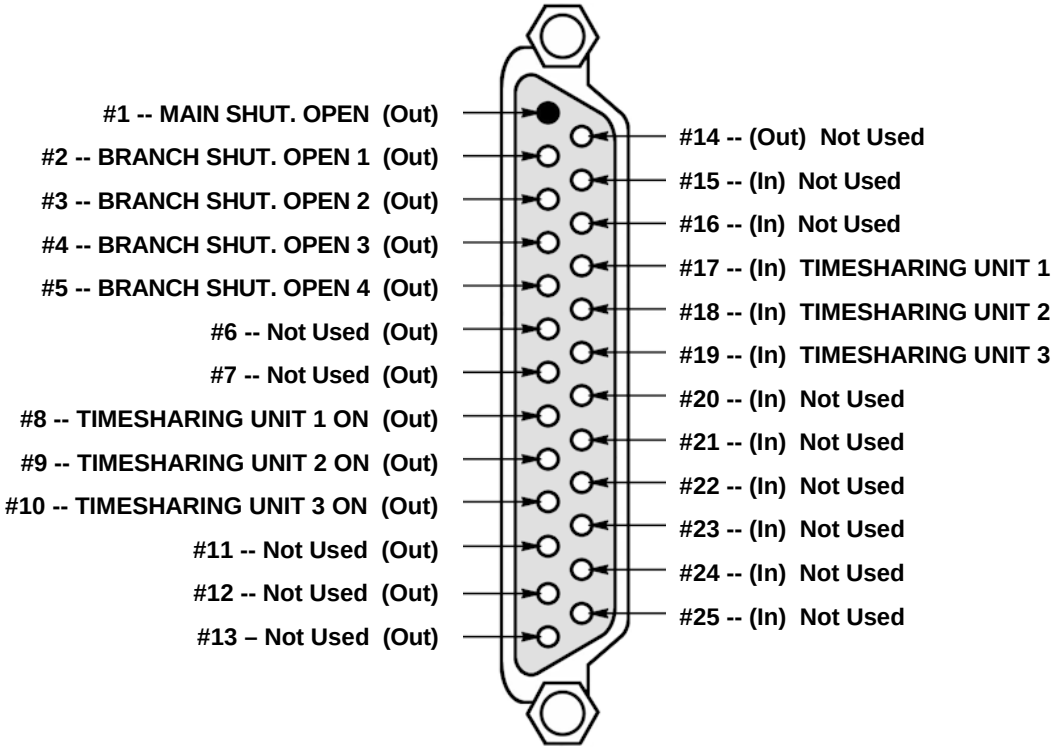
Description of EXT I/O (1) Connector OUTPUT Pins

I_{LIMIT} = 20 mA (per output)

Pin No.	Description
1	**Ready.** When the high voltage is turned on and the capacitor bank is fully charged, the circuit is closed and the Ready signal is active.
2	**High Voltage ON**. When the high voltage is enabled, the circuit is closed and the signal stays active until the HV 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 40 ms.
5	**Monitor Normal.** When the monitored laser energy is within the range set by the ENERGY HIGH-LOW limits, the circuit is closed for 40 mS, unless the **Monitor No-Light** is activated.
6	**Monitor Trouble.** When the monitored laser energy is outside the range set by the ENERGY HIGH-LOW limits, the circuit is closed for 40 ms.
7	**Trigger Output.** When initialization switch SW3-6 is ON, the output trigger signal will be present on this pin. Effective with firmware code V00-02H or newer.
8	**Input Signal Enabled.** This Laser can simultaneously receive external input signals while sending external output signals. At times, the laser will be busy processing. If an external input is applied to the laser and the **Input Signal Enabled** signal is not present, the incoming command will be ignored.
9	**Lamp Power Upper Limit.** The output will go low when the lamp input power exceeds its upper limit or user-defined reference set value.

All Lasers shipped from AMADA WELD TECH are equipped with a connector on **EXT I/O (1)**. If a replacement connector is needed, please refer to *Chapter 6: Maintenance, Section V* for part numbers. In general there are no connections needed on **EXT I/O (1)** in order to operate the Laser in a stand-alone condition. However, older Laser configurations require that the **LASER STOP** input signal be terminated on **EXT I/O (1)** in order for the Laser to operate in a stand-alone condition. Refer to *Section V: Loop-Back Connections* later in this *Appendix* for more information.

EXT. I/O (2) – External Input / Output Signals



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

Pin #	Description
17	**TIMESHARING UNIT 1.** (Valid only when the optional "branch shutter independent control" is used). When the circuit between this pin and COM is closed, optical path switching mirror moves to make laser beam input unit 1 ready to project a laser beam.
18	**TIMESHARING UNIT 2.** Same as Timesharing Unit 1.
19	**TIMESHARING UNIT 3.** Same as Timesharing Unit 1.

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

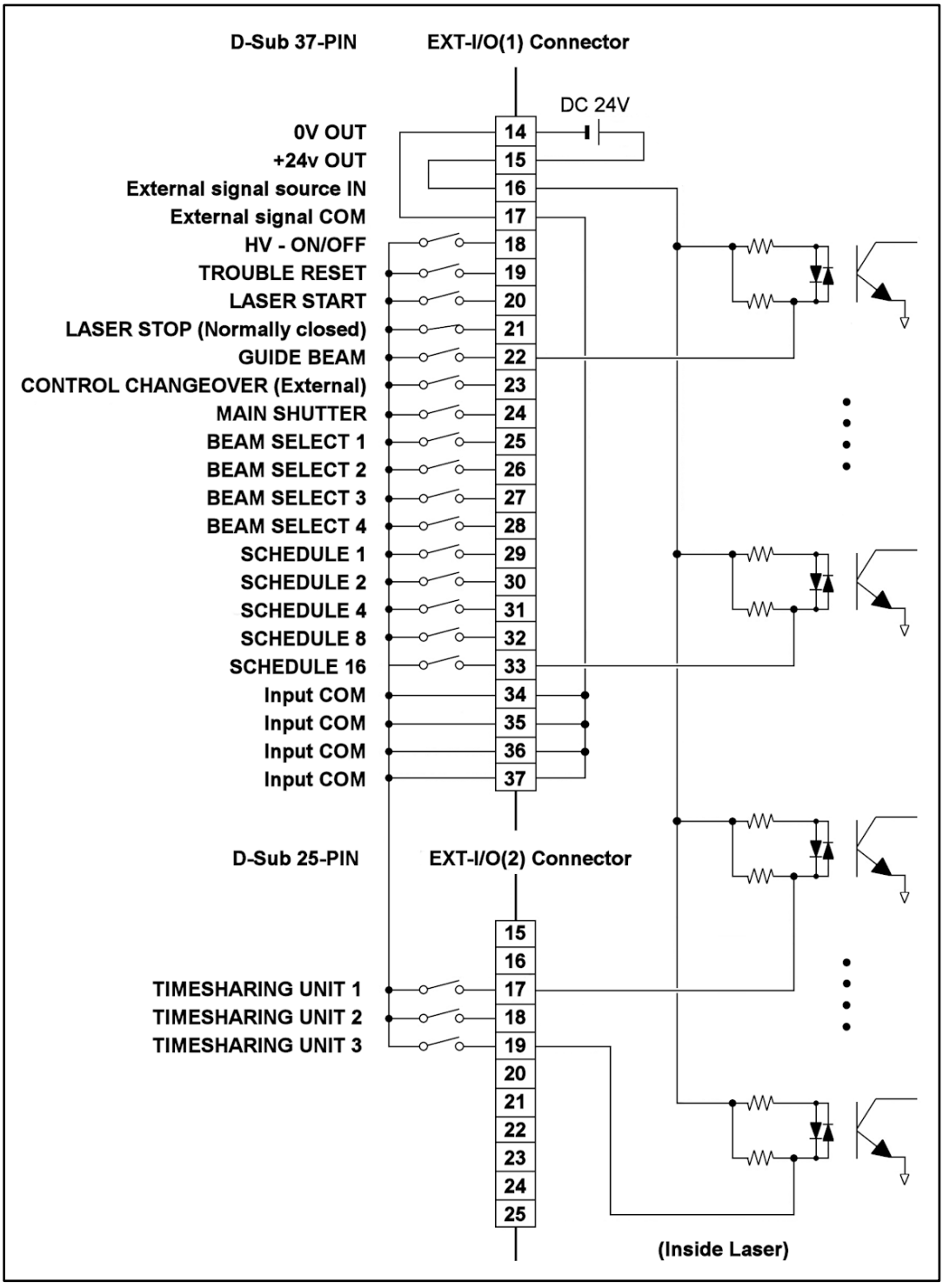
I_{LIMIT} = 20 mA (per output)

Pin No.	Description
1	**Main Shutter Open.** While the main shutters are open, the circuit is closed and the signal is active.
2	**Branch Shutter 1 Open.** While branch shutter 1 is open, the circuit is closed and the signal is active.
3	**Branch Shutter 2 Open**. While branch shutter 2 is open, the circuit is closed and the signal is active.
4	**Branch Shutter 3 Open.** While branch shutter 3 is open, the circuit is closed and the signal is active.
5	**Branch Shutter 4 Open.** While branch shutter 4 is open, the circuit is closed and the signal is active.
8	**TIMESHARING UNIT 1 ON.** While timesharing unit 1 is on, the circuit is closed and the signal is active.
9	**TIMESHARING UNIT 2 ON**. While timesharing unit 2 is on, the circuit is closed and the signal is active.
10	**TIMESHARING UNIT 3 ON**. While timesharing unit 3 is on, the circuit is closed and the signal is active.

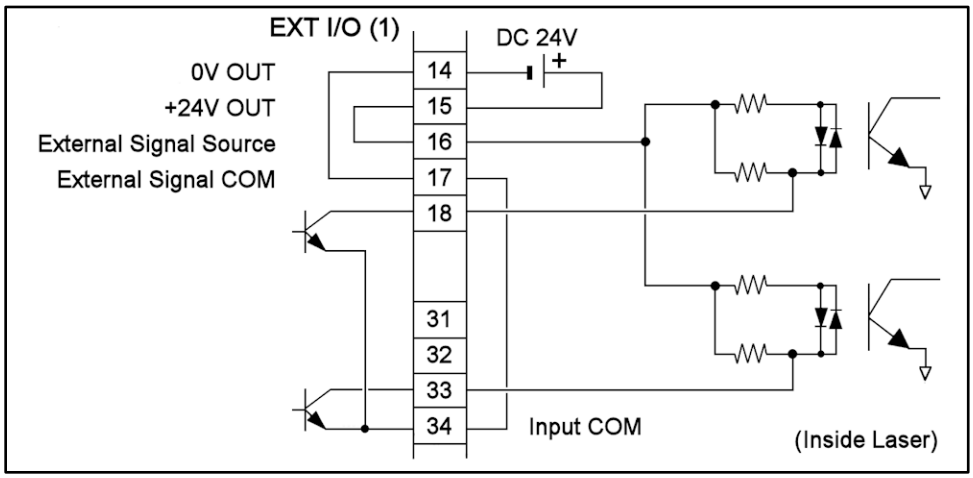
All Lasers shipped from AMADA WELD TECH are equipped with a connector on **EXT I/O (2)**. If a replacement connector is needed, please refer to *Chapter 6: Maintenance, Section V* for part numbers. There are no connections needed on **EXT I/O (2)** in order to operate the Laser in a stand-alone condition.

External Input Signal Connections

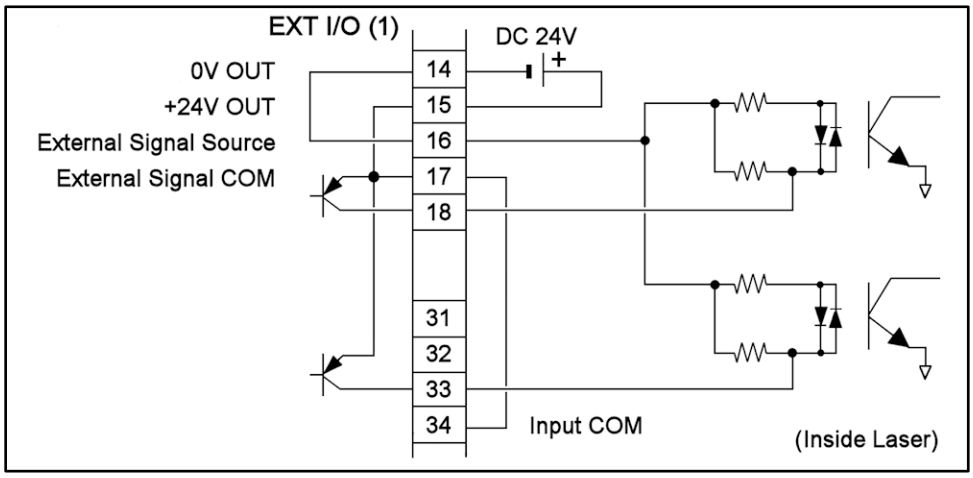
When External Inputs are Contacts



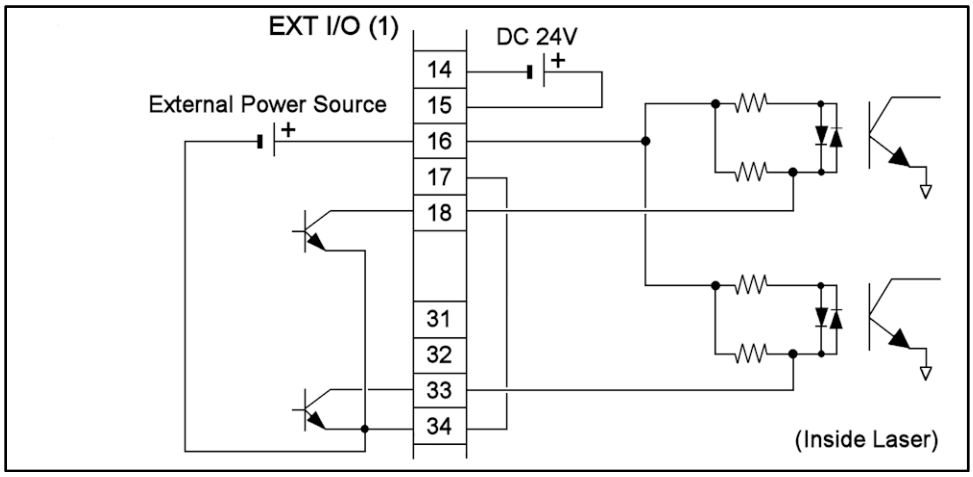
When External Inputs are NPN Transistors



When External Inputs are PNP Transistors

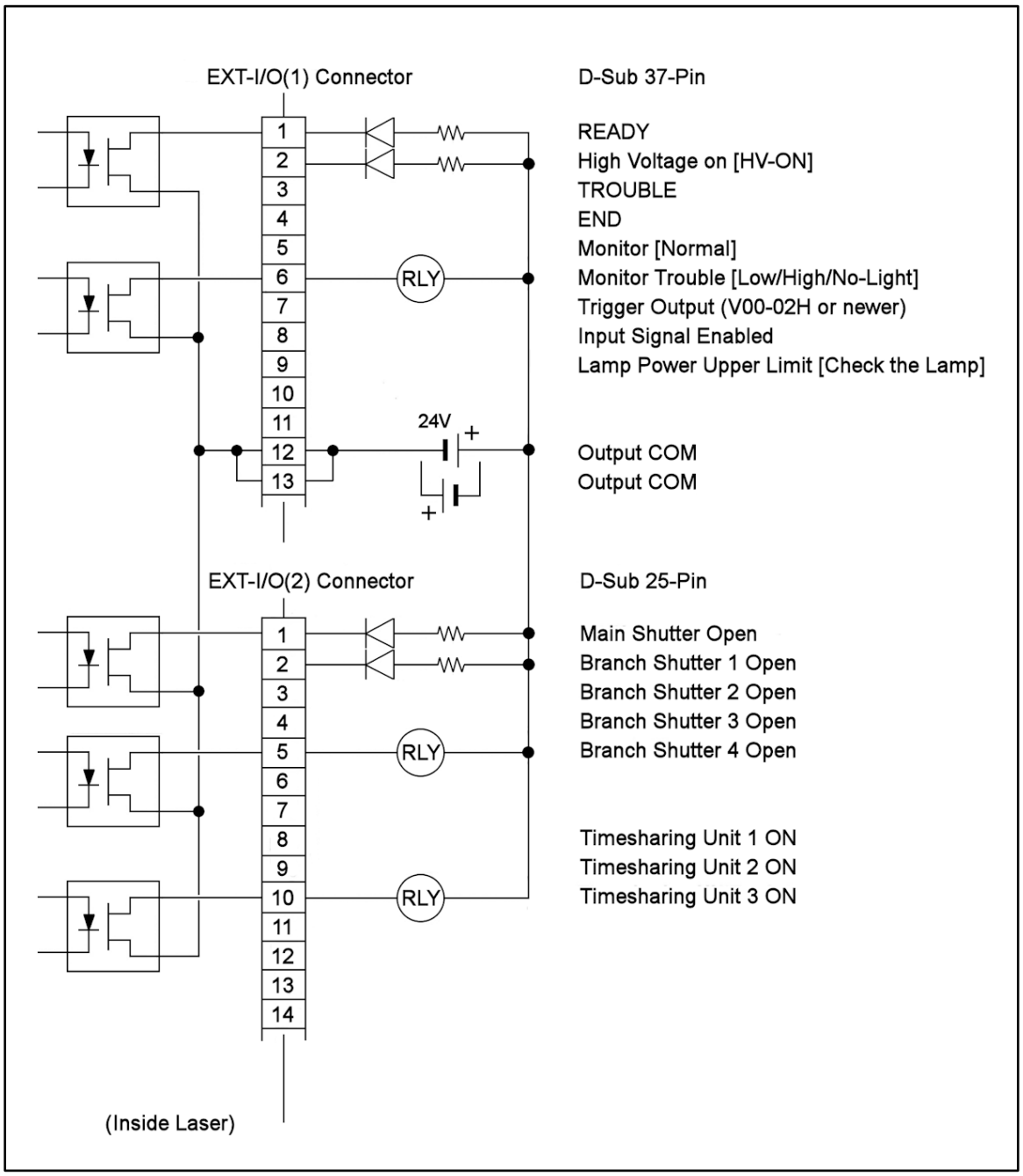


When External Power Source is supplied

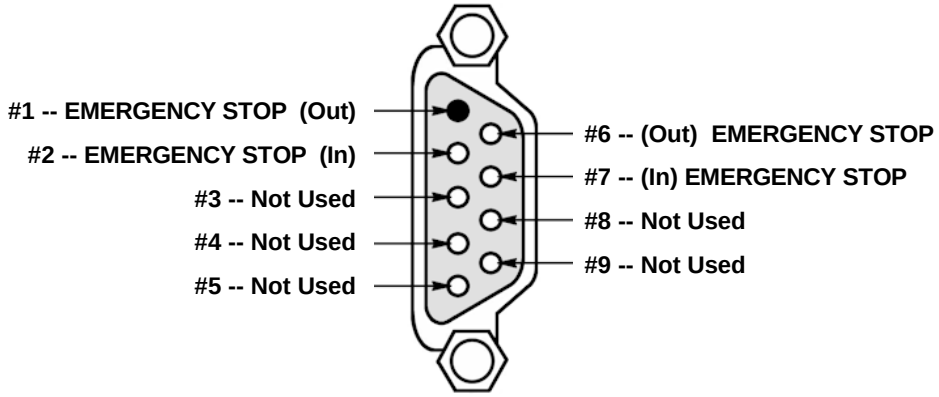


Connection of External Output Signals

The outputs can be configured to operate external LED's, relays, or other electronic devices that draw a maximum of 20 mA (each output). Typically the output signals are biased using an external Power Supply (typically 24 VDC). Since the outputs are bi-directional, the polarity of the external Power Supply can be biased either way in order to source or sink the outputs.



EXT. I/O (3) – Emergency Stop Connector (single channel)



The Emergency Stop (also called *E-Stop*) input on **EXT I/O (3)** operates the same as the E-Stop switches on the front panel of the Laser regardless of the Laser Control method. The function of the E-Stop is to render the Laser completely safe by shutting down all systems and disabling the Laser. To recover from any E-Stop condition, the E-Stop must be cleared and the Laser must be manually reset.

EXT I/O (3) is ideal for use in simple systems and operates independently from the Dual E-Stop function of **EXT I/O (4)** (if equipped). If implementing a dual-channel E-Stop, please refer to the **EXT I/O (4)** section below for more details. When the Emergency Stop Input connection between Pins 2 & 7 (via an external E-Stop switch) is opened, the Laser is put into an Emergency Stop condition. Simultaneously, the contacts between Pins 1 & 6 will open (Emergency Stop Output) to indicate an E-Stop condition.

NOTE: Use the E-Stop ***only*** for emergencies. Frequently initiating E-Stops may damage the Laser.

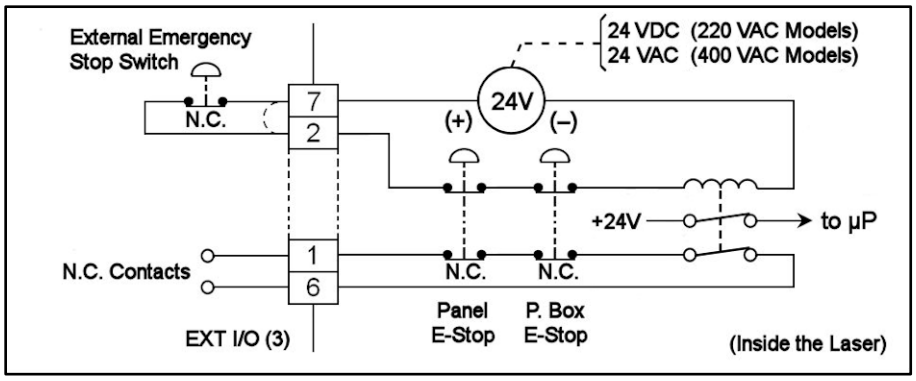
Ext I/O (3) - Emergency Stop Function (by model type)

Model	Operating Voltage	E-Stop Function
8-830-0x-xx (ML-2551A / LW300A) 8-840-0x-xx (ML-2550A / LW400A)	220 VAC	When an E-Stop is activated, the high voltage turns OFF and all Laser operations stop (operates like the Control Key Switch).
8-895-0x-xx (ML-2551A-CE / LW300AE) 8-896-0x-xx (ML-2550A-CE / LW400AE)	400 VAC	When an E-Stop is activated, the Laser is turned OFF but the internal power supply remains active (Laser will appear to be powered OFF).

All 8-xxx-02-xx and newer Lasers contain both the **EXT-I/O (3)** (single E-Stop/Interlock) and **EXT-I/O (4)** (dual E-Stop/Interlock) connectors. The functionality of **EXT-I/O (4)** is described later in this *Appendix*. If the Laser is equipped with the **EXT-I/O (4)** connector and your workstation is using a single channel E-Stop, we recommend upgrading your workstation to implement dual E-Stop functionality. Contact AMADA WELD TECH for more information. However the **EXT-I/O (3)** E-Stop described in this section will still work as long as **EXT-I/O (4)** is looped-back (see *Section V: Loop-Back Connections* later in this *Appendix* for more information).

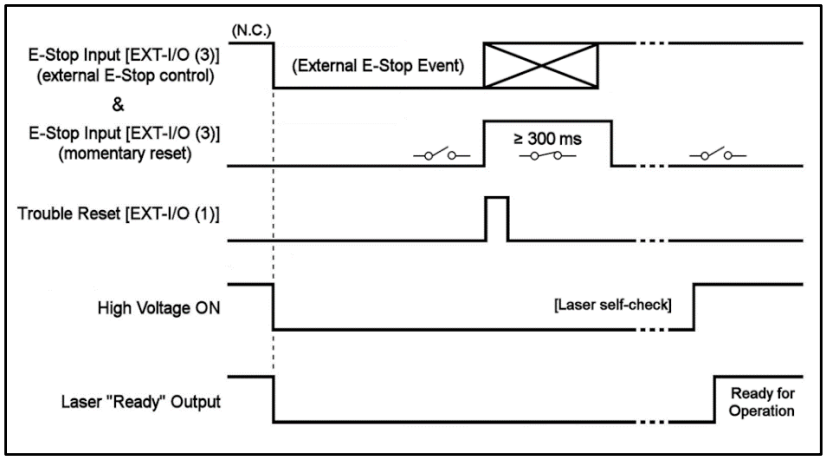
Ext I/O (3) - Emergency Stop connections

All Lasers shipped from AMADA WELD TECH are equipped with a loop-back connector on **EXT I/O (3)**. If a replacement connector is needed, please refer to *Chapter 6: Maintenance, Section V* for part numbers. In order to integrate the E-Stop functionality on **EXT I/O (3)**, remove the factory supplied jumper between pins 2 – 7 and connect a normally closed E-Stop switch. A basic representation of the connections are shown below:

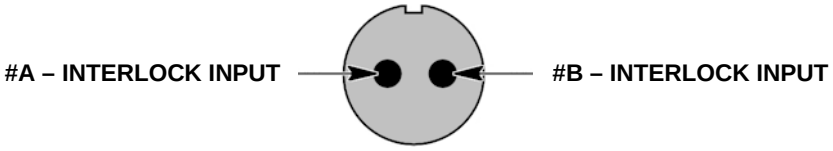


Ext I/O (3) - Emergency Stop Integration with Ext I/O (4) present

On Lasers that have the **EXT I/O (4)** dual E-Stop/Interlock connector present, special attention must be given in order to properly reset an external E-Stop condition on **EXT I/O (3)**. When the Laser is connected to an external control process, such as a PLC, the complete system can get into a "race" condition where the Laser and external E-Stop control are both waiting for each other to reset/clear. To prevent this from happening, the external E-Stop input must be closed for ≥ 300 mS (typical) at the beginning of the Laser reset period to allow enough time for the Laser to complete its reset cycle. This applies to the Laser during the power-up sequence as well as when the Laser is operating normally and then put into an E-Stop state. The easiest way to accomplish this is to parallel a set of relay contacts across the external E-Stop Input that turn on for ≥ 300 ms (typical) during the Laser Trouble Reset period. Lasers without the **EXT I/O (4)** connector do not have any time restrictions.



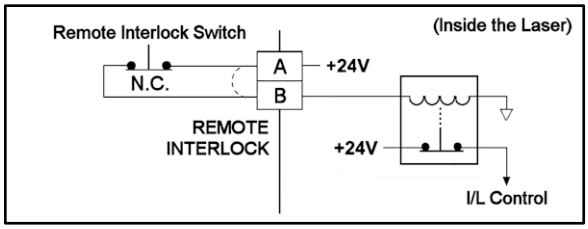
REMOTE INTERLOCK Connector (single channel)



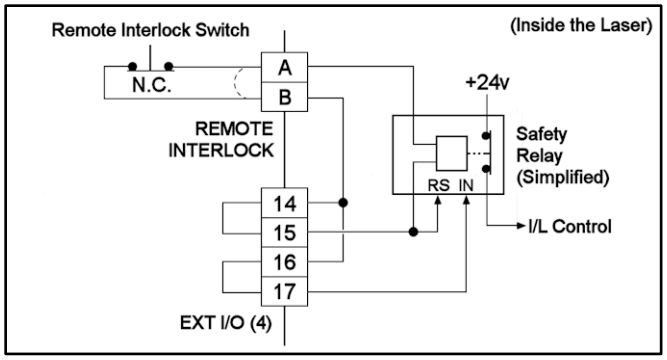
The Remote Interlock function is designed to render the Laser safe for material handling without having to shut the Laser down. A typical application for the Remote Interlock is when a Laser is used with a Workstation. Typically the workstation doors would be safety interlocked, such that when the doors are opened the Laser is put into a safe condition and prevented from firing. This action makes the work area completely safe for the Laser Operator, allowing time to safely remove or position a part to be welded. Once the workstation doors are closed, the Laser will be ready for operation once again (if the Remote Interlock Auto-Reset feature is enabled). If the Laser is firing when the remote interlock connection is opened, a fault condition will occur which has to be manually Reset by the Laser Operator.

All Lasers shipped from AMADA WELD TECH are shipped with the 2-pin Remote Interlock connector with a jumper wire soldered between both connector pins. If a replacement connector is needed, please refer to *Chapter 6: Maintenance, Section V* for part numbers. To implement the Remote Interlock feature, simply replace the jumper wire with a normally closed interlock switch. If multiple interlock switches are used, connect the switches in series. If the Laser is equipped with an **EXT I/O (4)** connector, this connector must be looped-back for normal operation (see *Section V: Loop-Back Connections* later in this *Appendix* for more information). In all cases, if the 2-pin Interlock connector is opened for Lasers equipped with the **EXT I/O (4)** connector, it must be manually reset each time the Interlock is opened.

The 2-pin Interlock circuit topology differs depending on the Laser model:



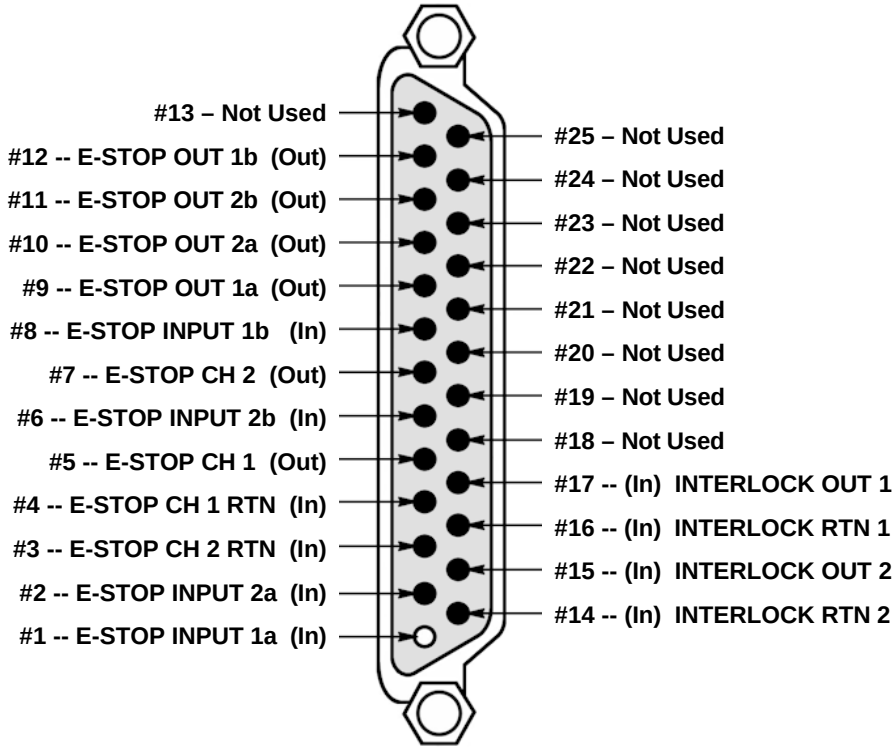
All "8-xxx-01-xx" Laser Models



All "8-xxx-02-xx to 8-xxx-04-xx" Laser Models

The 2-pin Remote Interlock connector described above is used for simple systems. In areas of Europe, the IEC60825-1 compliance standard is required. This specification requires the use of a redundant interlock system in an IEC60825-1 compliant enclosure. In cases where a redundant interlock system is used, all interlock functions must be connected to **EXT I/O (4)** (if equipped) and the 2-pin interlock connector must be looped-back and installed (see *Section V: Loop-Back Connections* later in this *Appendix* for more information). The Remote Interlock function described above functions independently from the redundant interlock system connections on **EXT I/O (4)**.

EXT. I/O (4) – Emergency Stop / Interlock Connector (dual channel)



NOTE: The **EXT I/O (4)** connector is ***not*** available in Lasers manufactured prior to 2013.

EXT I/O (4) is designed to connect to a robust safety interface common in areas of Europe. A robust safety interface, often found in complex systems, may include either a dual E-Stop and/or dual Safety Interlock. The functions of **EXT I/O (4)** are independent from the **EXT I/O (3)** (E-Stop) and **REMOTE INTERLOCK** connector functions. If your integration does not use redundant safety features, then use **EXT I/O (3)** and the **REMOTE INTERLOCK** connections instead. If connecting to **EXT I/O (4)**, both **EXT I/O (3)** and the **REMOTE INTERLOCK** connectors must be looped-back and installed (see *Section V: Loop-Back Connections* later in this Appendix for more information).

It is the responsibility of the end user to properly implement all safety features for compliance. When implemented properly the safety features on **EXT I/O (4)** will satisfy both the IEC60825-1 standard for enclosure safety and IEC13849-1 for Emergency Stop safety. Refer to the circuit examples further in this section to aid in proper implementation.

All Lasers shipped from AMADA WELD TECH are equipped with a connector on **EXT I/O (4)**. If a replacement connector is needed, please refer to *Chapter 6: Maintenance, Section V* for part numbers. If operating the Laser stand-alone without being connected to a workstation, **EXT I/O (4)** must be looped-back and installed (see *Section V: Loop-Back Connections* later in this Appendix for more information). If integrating with a workstation, replace the loop-back jumpers on **EXT I/O (4)** with wired connections to the workstation.

External Input Signal Connections

Description of EXT I/O (4) Connector INPUT Pins

NOTE: All inputs should be controlled by dry contacts only. ***Do Not apply any voltage or current.***

Pin No.	Description
1	**Emergency Stop Input 1.** When the circuit between Pins 1 and 8 is opened, an E-Stop will be activated. When activated the High Voltage and water pump are turned off and all optical shutters will close. For normal operation, both Emergency Stop Input connections (1 & 2) must be closed. If either E-Stop is activated, the Laser will go into Emergency Stop mode and must manually be reset by the Laser Operator.
8	
2	**Emergency Stop Input 2.** When the circuit between Pins 2 and 6 is opened, an E-Stop will be activated. When activated the High Voltage and water pump are turned off and all optical shutters will close. For normal operation, both Emergency Stop Input connections (1 & 2) must be closed. If either E-Stop is activated, the Laser will go into Emergency Stop mode and must manually be reset by the Laser Operator.
6	
14	**External Interlock Input 2.** When the circuit between Pins 14 and 15 is opened, the branch shutters will close. For normal operation, both External Interlock Input connections (1 & 2) must be opened and closed simultaneously. If only one Interlock is activated, the Laser must manually be reset by the Laser Operator.
15	
16	**External Interlock Input 1.** When the circuit between Pins 16 and 17 is opened, the branch shutters will close. For normal operation, both External Interlock Input connections (1 & 2) must be opened and closed simultaneously. If only one Interlock is activated, the Laser must manually be reset by the Laser Operator.
17	

Description of EXT I/O (4) Connector OUTPUT Pins

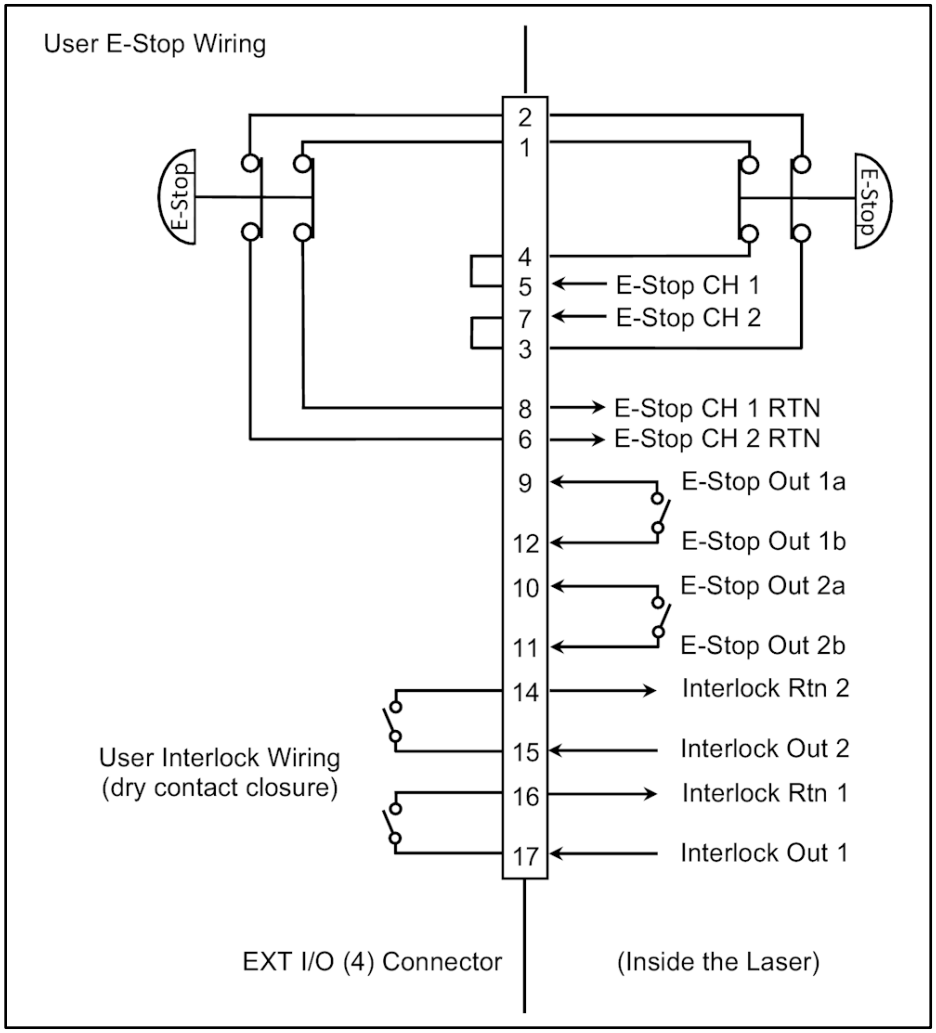
Pin No.	Description
9	**Emergency Stop Output 1.** When the Laser is put into an Emergency Stop condition, the contacts between Pins 9 and 12 will open. Both Emergency Stop Output 1 and Emergency Stop Output 2 operate the same.
12	
10	**Emergency Stop Output 2.** When the Laser is put into an Emergency Stop condition, the contacts between Pins 10 and 11 will open. Both Emergency Stop Output 1 and Emergency Stop Output 2 operate the same.
11	
5	**E-Stop CH1.** Output terminals used to connect to an external Safety PLC. In certain applications, it may be necessary to have a "Host" Safety PLC control all safety features. If unused, tie pins 4 and 5 together.
4	
7	**E-Stop CH2.** Output terminals used to connect to an external Safety PLC. In certain applications, it may be necessary to have a "Host" Safety PLC control all safety features. If unused, tie pins 7 and 3 together.
3	

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.

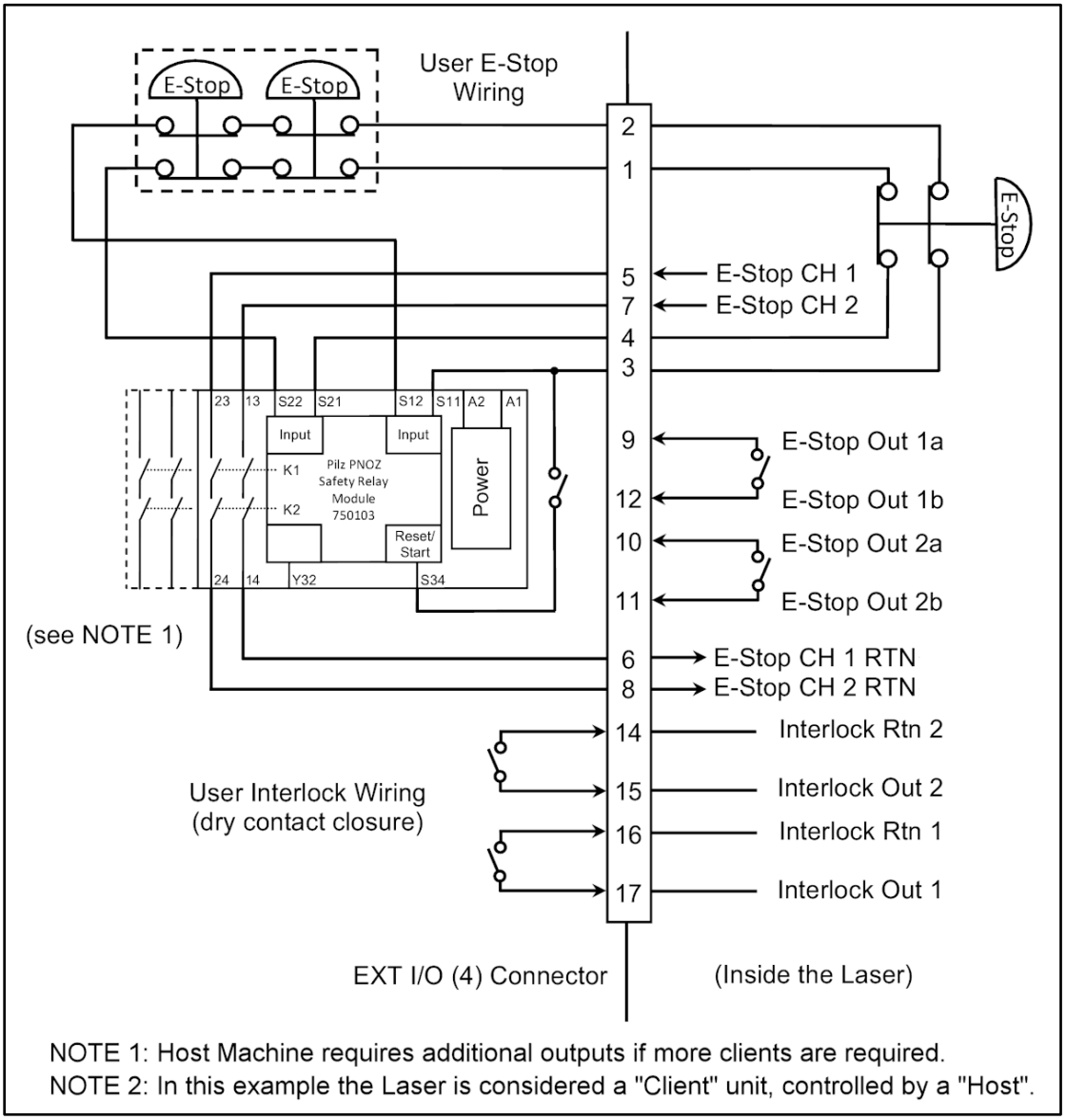
Dual E-Stop / Interlock Wiring Example # 1

The wiring example shown below is typical of a system where more than one E-Stop may be present in a system. An example of this would be a system with a Laser, parts handler, PLC, and conveyor belt. By design all devices should stop when the E-Stop button is pressed. To implement multiple E-Stop switches, replace the single E-Stop switch shown below with multiple switches connected in Series. ***To avoid damaging the Laser, do not apply any voltage or current to the E-Stop or Interlock Inputs.*** All inputs should be controlled by dry contacts only.



Dual E-Stop / Interlock Wiring Example # 2

The wiring example shown below is typical of a complex system where a safety relay module is used to control the Laser and interface with two external E-Stop buttons. In this example a Pilz PNOZ relay module is chosen because of its ability to control additional E-Stop functions using expansion contacts. However, any suitable IEC13849-1 compliant safety relay may be used as long as it is implemented as shown below. It is the responsibility of the end user to verify compliance of the machine as a whole. ***To avoid damaging the Laser, do not apply any voltage or current to the E-Stop or Interlock Inputs.*** All inputs should be controlled by dry contacts only.



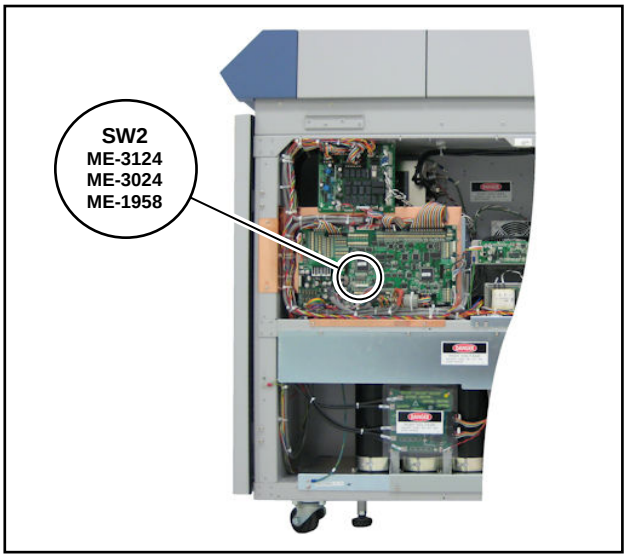
NOTE 1: Host Machine requires additional outputs if more clients are required.
NOTE 2: In this example the Laser is considered a "Client" unit, controlled by a "Host".

Section II: Energy-sharing and Time-sharing

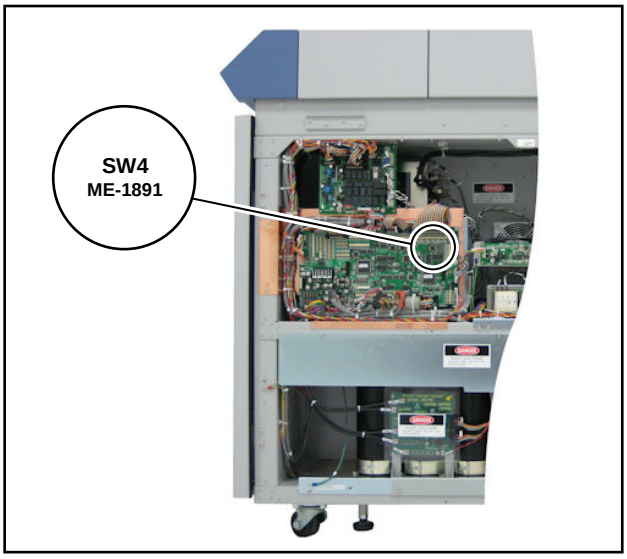
Overview

The Laser can be configured with energy shared and/or time-shared outputs. The configuration is set by dipswitch SW2 on the ME-3124 / ME-3024 / ME-1958 Main PCB or dipswitch SW4 located on the ME-1891 Main PCB. The Main PCB is located behind the right side panel. The switch positions shown below are considered "standard" configurations. The Laser can also be set-up with a non-standard configuration (see *Section III, Branch Shutter Independent Control* for an explanation of "Independent Control").

ME-3124 / ME-3024 / ME-1958 Main PCB



ME-1891 Main PCB

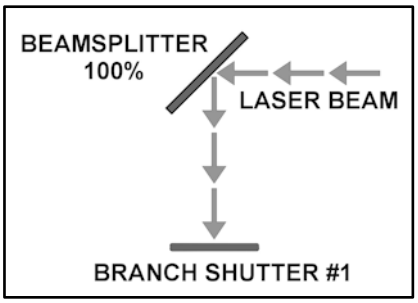


Sharing Method	SW2 Setting (ME-3124 / ME-3024 / ME-1958) SW4 Setting (ME-1891)			
	5	6	7	8
Single Output	OFF	OFF	OFF	OFF
2 Energy-shared outputs	OFF	OFF	OFF	ON
3 Energy-shared outputs	OFF	OFF	ON	OFF
4 Energy-shared outputs	OFF	OFF	ON	ON
2 Time-shared outputs	OFF	ON	OFF	OFF
3 Time-shared outputs	OFF	ON	OFF	ON
4 Time-shared outputs	OFF	ON	ON	OFF
2 Time-shared of 2 Energy-shared deliveries	OFF	ON	ON	ON
Independent Control	ON	OFF	ON	ON

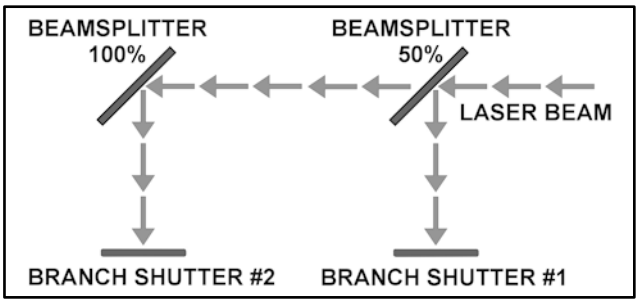
Energy-Shared Outputs (1 to 4)

You can project the output from one to four outputs simultaneously. For more than one laser output, the total energy is shared equally between all outputs.

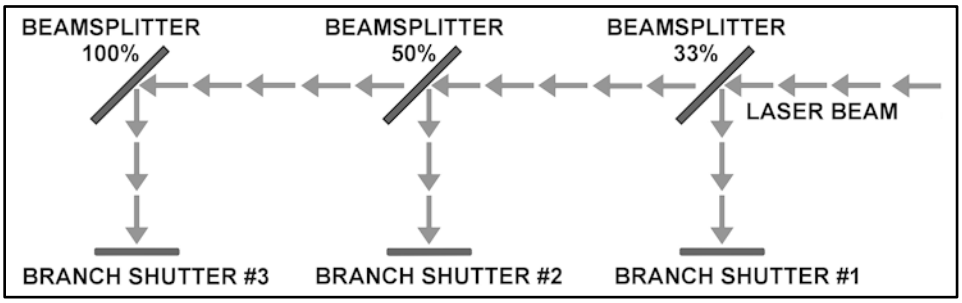
For example, in the case of 4 Energy-Shared deliveries (4E), four laser beams are projected simultaneously when all the branch shutters are opened (25% output power projected on to each output).



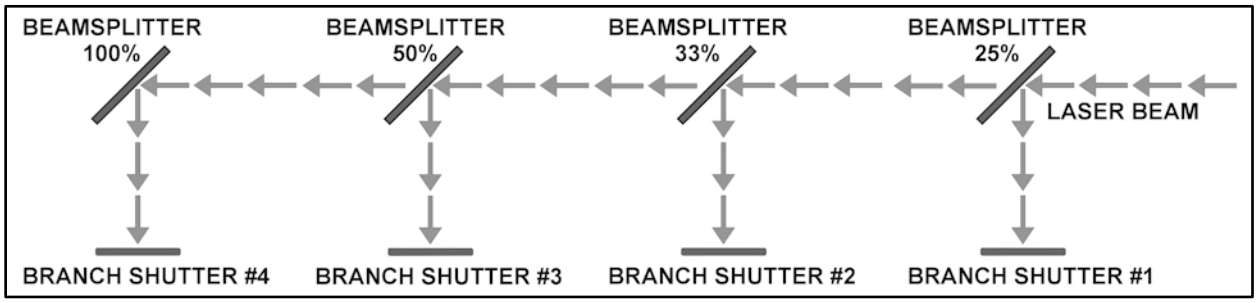
Single Output (1E)



2-Energy-Shared Outputs (2E)



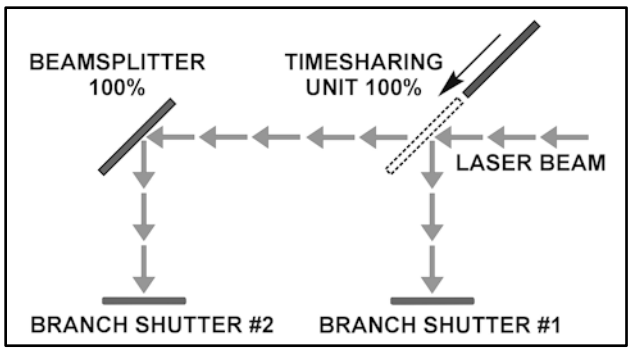
3 Energy-Shared Outputs (3E)



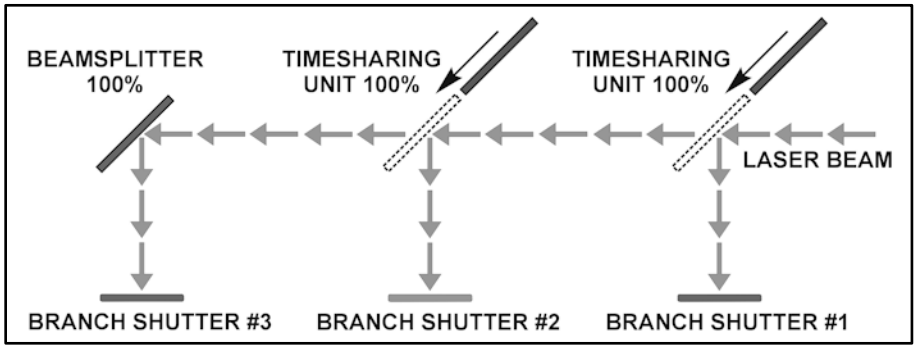
4 Energy-Shared Outputs (4E)

Time-Shared Outputs (2 to 4)

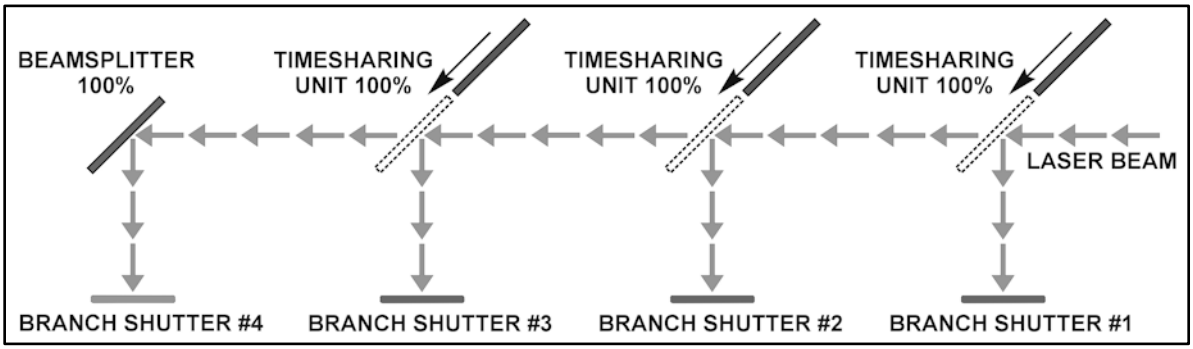
You can select one branch shutter out of the specified number of deliveries to project a laser beam. Unlike Energy-Shared mode, only one laser beam is projected at a time. For example, if branch shutter 2 is turned on during a Time-Shared delivery, the laser beam will project onto optical fiber output # 2. If more than one branch shutter is turned on, only the branch shutter with the lowest number will produce the laser beam.



2 Time-Shared Outputs (2T)



3 Time-Shared Outputs (3T)

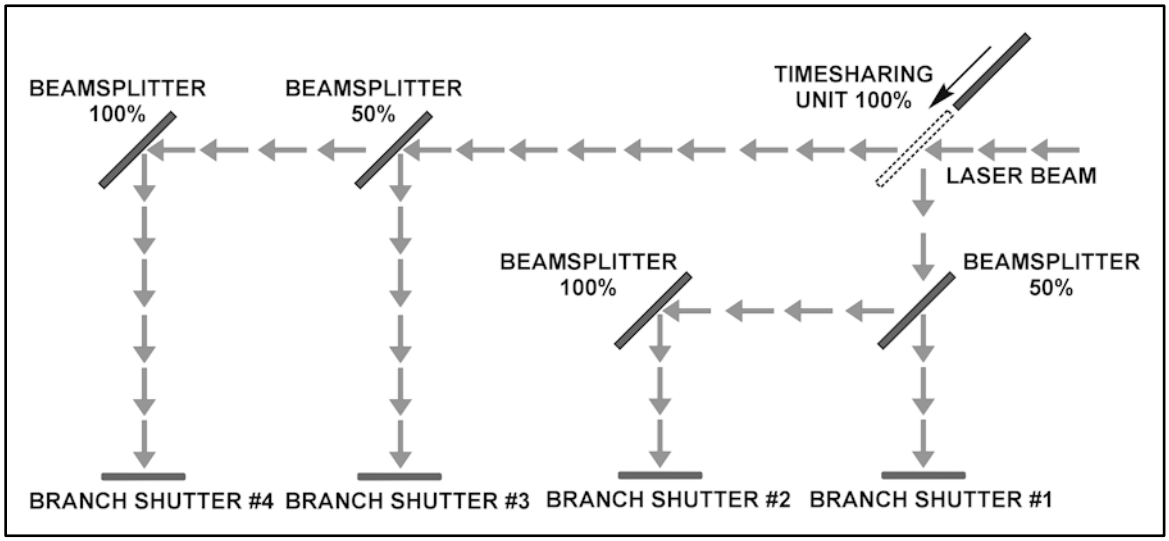


4 Time-Shared Outputs (4T)

Combination Shared Outputs

In addition to simple Energy-Shared and Time-Shared outputs, the laser can also be configured to deliver combination outputs. Specifically the Laser is designed to produce a 2E2T configuration which consists of two Time-Shared outputs of two Energy-Shared deliveries each.

2 Time-shared Outputs of 2 Energy-shared Deliveries (Two sets of 2 energy shared Outputs)



2 Time-Shared Outputs of 2 Energy-Shared deliveries each (2E2T)

When the Laser is configured in one of the 8 standard configurations, the Branch Shutters and Time-Shared Shutters move *automatically* when **BEAM-1 (SHUTTER-1)** through **BEAM-4 (SHUTTER-4)** are turned **ON**.

Section III. Branch Shutter Independent Control

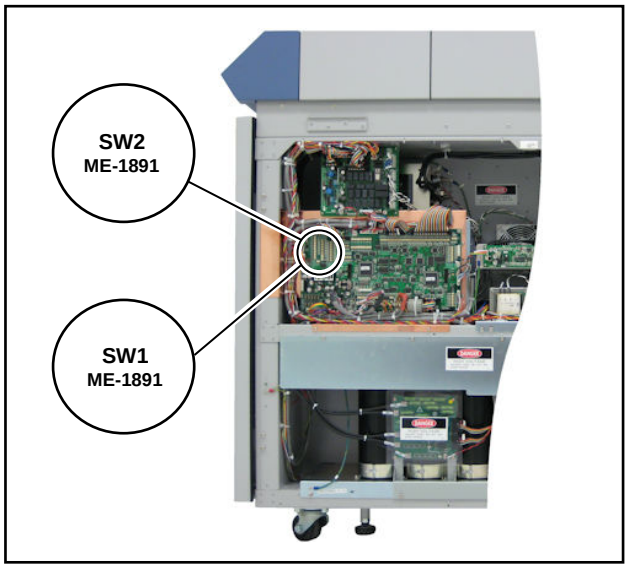
In addition to the 8 standard types of sharing methods described in *Section II* above, an *Independent Control* method may also be used. This function allows for custom combinations of energy-shared and time-shared outputs, with a combined total of up to 4 outputs maximum.

ME-3124 / ME-3024 / ME-1958 Main PCB – Independent Control Configuration

1. Configure the laser for Independent Control as described in *Section II, Energy-sharing and Time-sharing.* (i.e. set SW2-5, SW2-7 and SW2-8 to ON and SW2-6 to OFF)
2. In order for the Laser to know what optical components are installed, they must be specified on the Memory Switch (MSW) screen from within the Initialization Screen.
   - For the MLE-118A Program box: see *Chapter 3, Section III, Initialization Screen.*
   - For the MLE-115A Program box: see *Chapter 4, Section III, Initialization Screen*.

ME-1891 Main PCB – Independent Control Configuration

1. Configure the laser for Independent Control as described in *Section II, Energy-sharing and Time-sharing*.
2. In order for the Laser to know what optical components are installed, they must be specified with **SW1** and **SW2** on the ME-1891 Main PCB. The location of SW1 and SW2 are shown in the illustration below:



For each optical component that is installed, the corresponding ME-1891 dipswitch setting must be turned ON.

SW-2 - Branch Shutter Control

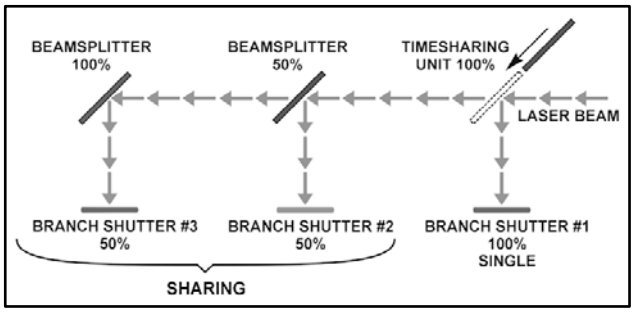
Branch Shutter	Dipswitch Control
Shutter 1	SW2-1
Shutter 2	SW2-2
Shutter 3	SW2-3
Shutter 4	SW2-4
Shutter 5	SW2-5
Shutter 6	SW2-6

SW-1- Time-shared Unit Control

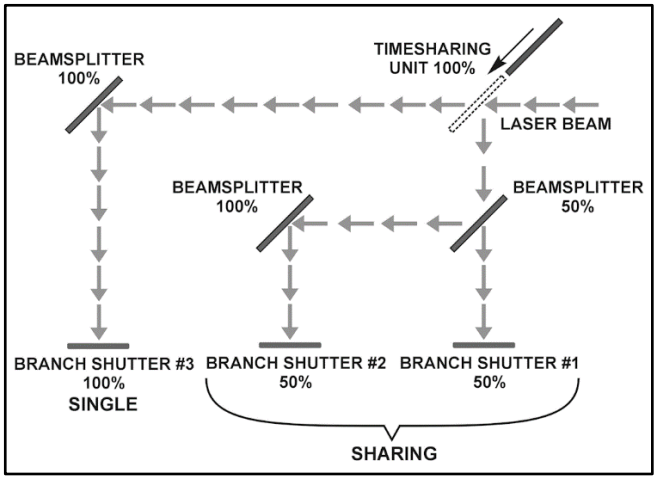
Time-Shared Unit	Dipswitch Control
Mirror 1	SW1-1
Mirror 2	SW1-2
Mirror 3	SW1-3
Mirror 4	SW1-4
Mirror 5	SW1-5

If using External I/O to control the laser, you can use Pins 17 through 19 on the **EXT-I/O (2)** to control the Time-Shared shutters.

Below are two typical examples of an *Independent Control* Configuration:



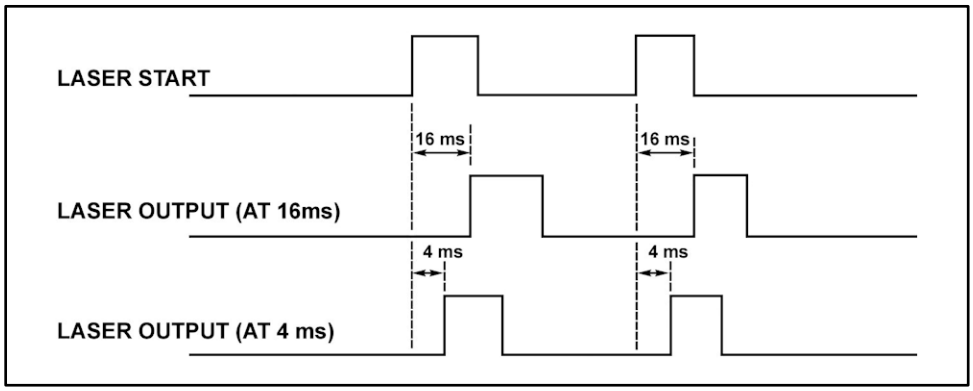
Single + 2 Energy-Shared Outputs (1E + 2E)



2 Energy-Shared Outputs + Single Output (2E + 1E)

Section IV: Laser Accept Times

The **ACCEPT** times for the Laser **START** signal and **SCHEDULE** select can be configured to 0.1 mS, 1 mS, 4 mS, 8 mS or 16 mS. When changing the **ACCEPT** times, both signals will be changed to the same value, they ***cannot*** be set independently. The accept time relationship is shown below.



ME-3124 / ME-3024 / ME-1958 Main CPU Board – Laser Accept Time Setting

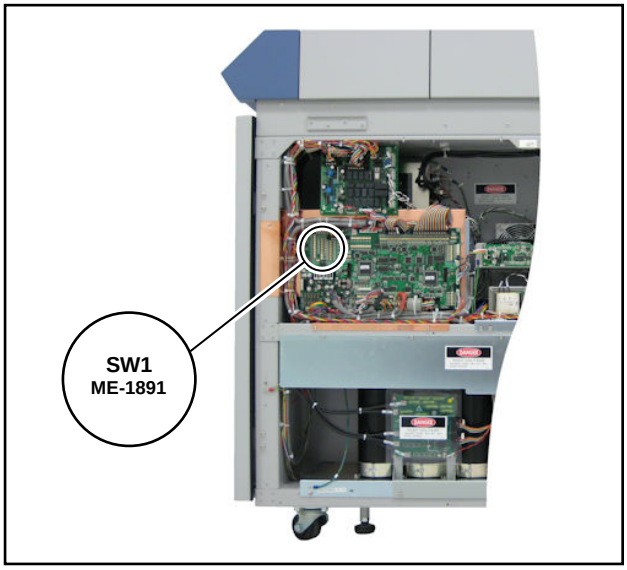
The Laser Accept Times are set in the Memory Switch screen from within the Initialization Screen.

- For the MLE-118A Program box: see *Chapter 3, Section III, Initialization Screen.*
- For the MLE-115A Program box: see *Chapter 4, Section III, Initialization Screen*.

ME-1891 Main CPU Board – Laser Accept Time Setting

The Laser Accept Times are set using SW1 on the ME-1891 Main PCB.

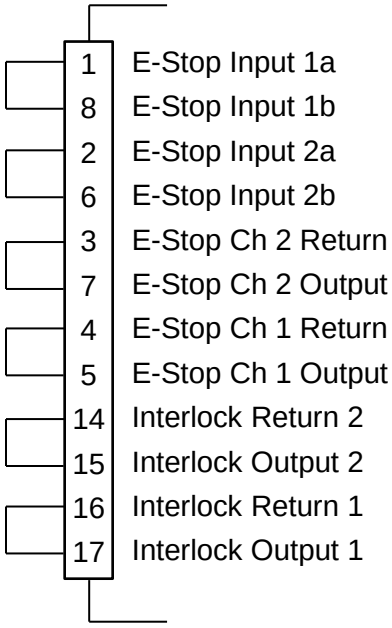
SW1-6	SW1-7	SW1-8	ACCEPT TIME
ON/OFF	ON/OFF	ON	0.1 ms –0/+1 µS
ON	ON	OFF	1 ms –0/+15 µS
OFF	ON	OFF	4 ms –0/+15 µS
ON	OFF	OFF	8 ms –0/+15 µS
OFF	OFF	OFF	16 ms –0/+15 µS



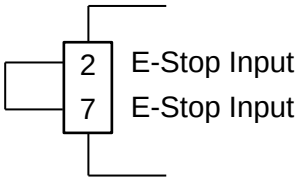
Section V: Loop-Back Connections

All Lasers shipped from AMADA WELD TECH include the mating connectors for all External I/O connections. If a replacement connector is needed, please refer to *Chapter 6: Maintenance, Section V* for a list of mating connector part numbers. Some External I/O connectors need to be looped-back in order for the Laser to operate in a stand-alone condition.

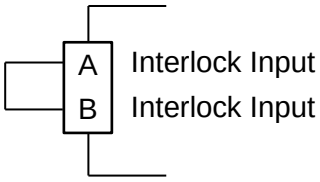
In general there are no loop-back connections needed for **EXT I/O (1)**, **EXT I/O (2)**, **RS-485 (1)** and **RS-485 (2)**. However the **EXT I/O (3)**, **EXT I/O (4)** (if equipped) and **REMOTE INTERLOCK** connectors require loop-back connections in order to operate the Laser in a stand-alone condition. The factory loop-back connections are as follows:



EXT-I/O (4) loop-back
(DB-25F)

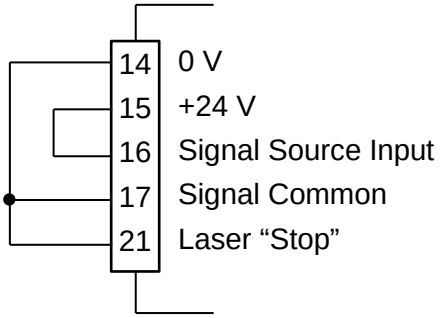


EXT-I/O (3) loop-back
(DB-9M)



REMOTE INTERLOCK
loop-back

As noted above, there are typically no connections needed on **EXT I/O (1)** in order to operate the Laser in a stand-alone condition. However, older Laser configurations require that the **LASER STOP** input signal be terminated on **EXT I/O (1)**. In these cases a loop-back connector was needed in order for the Laser to operate in a stand-alone condition. The factory supplied loop-back connector is wired as follows:



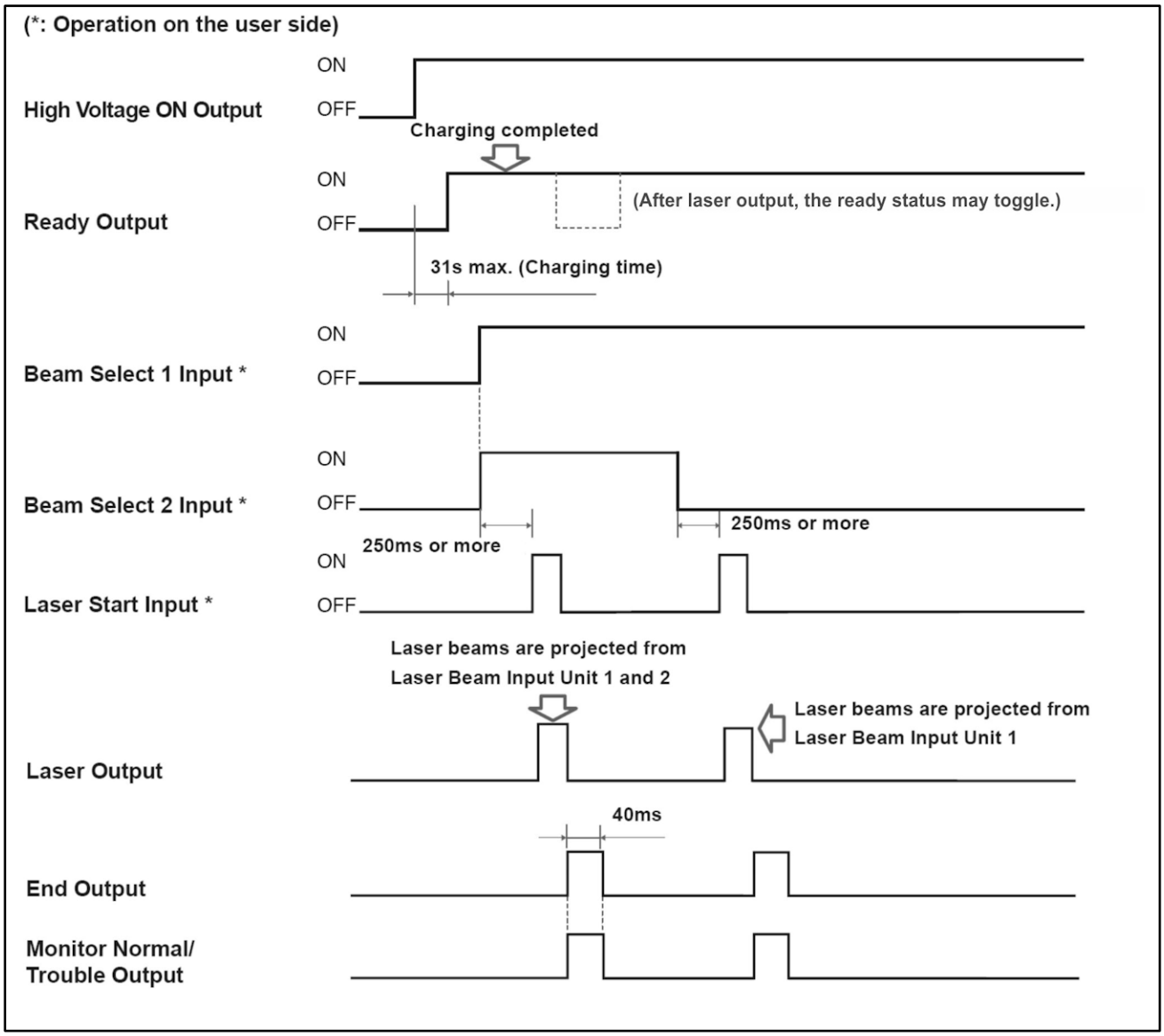
EXT-I/O (1) loop-back
(DB-37M)

APPENDIX C
SYSTEM TIMING

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

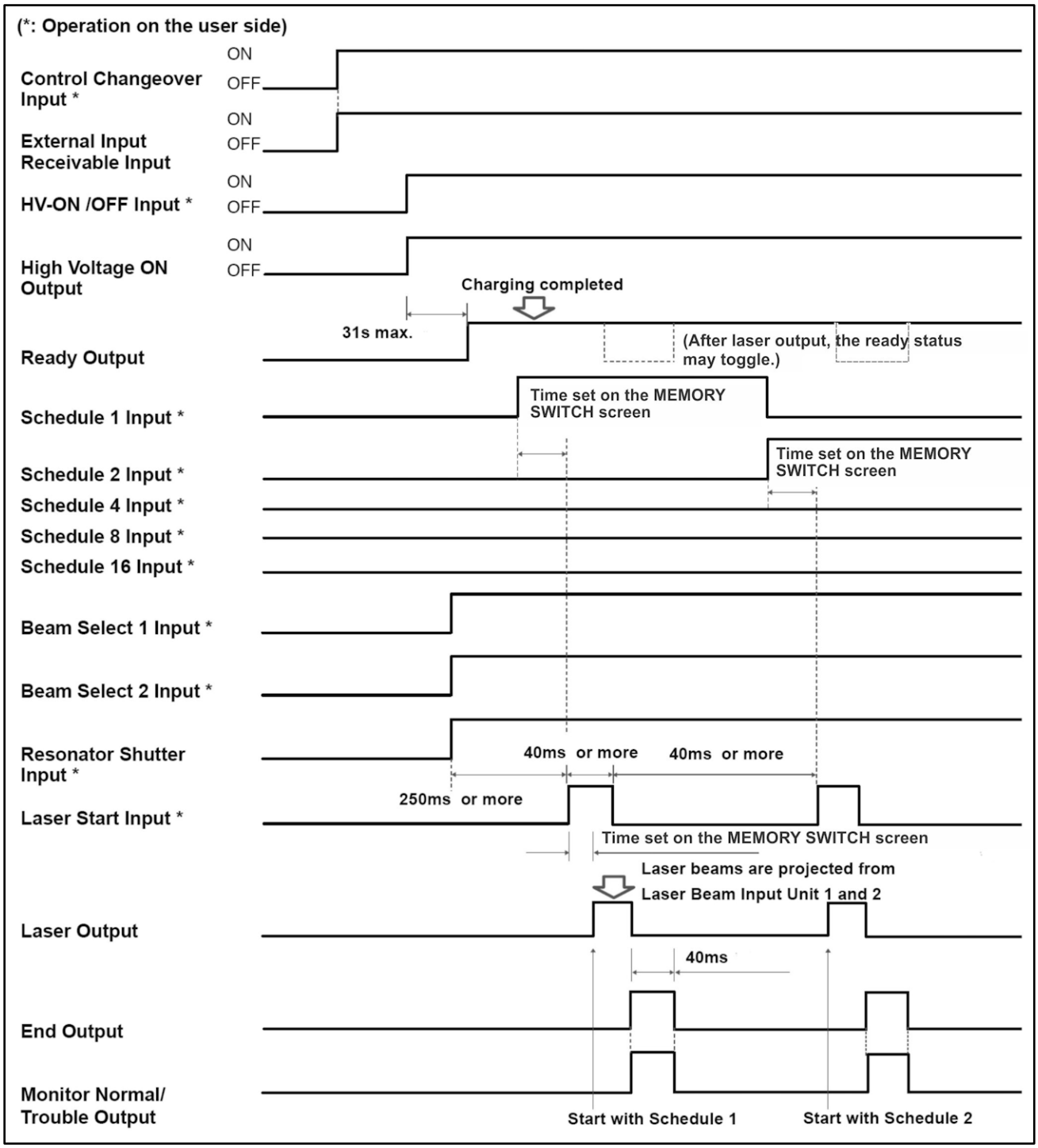
Operation with Laser Controller - 2 Energy-Shared Outputs

This timing diagram shows a typical laser operation with 2 Energy-Shared outputs controlled by the Laser Controller.



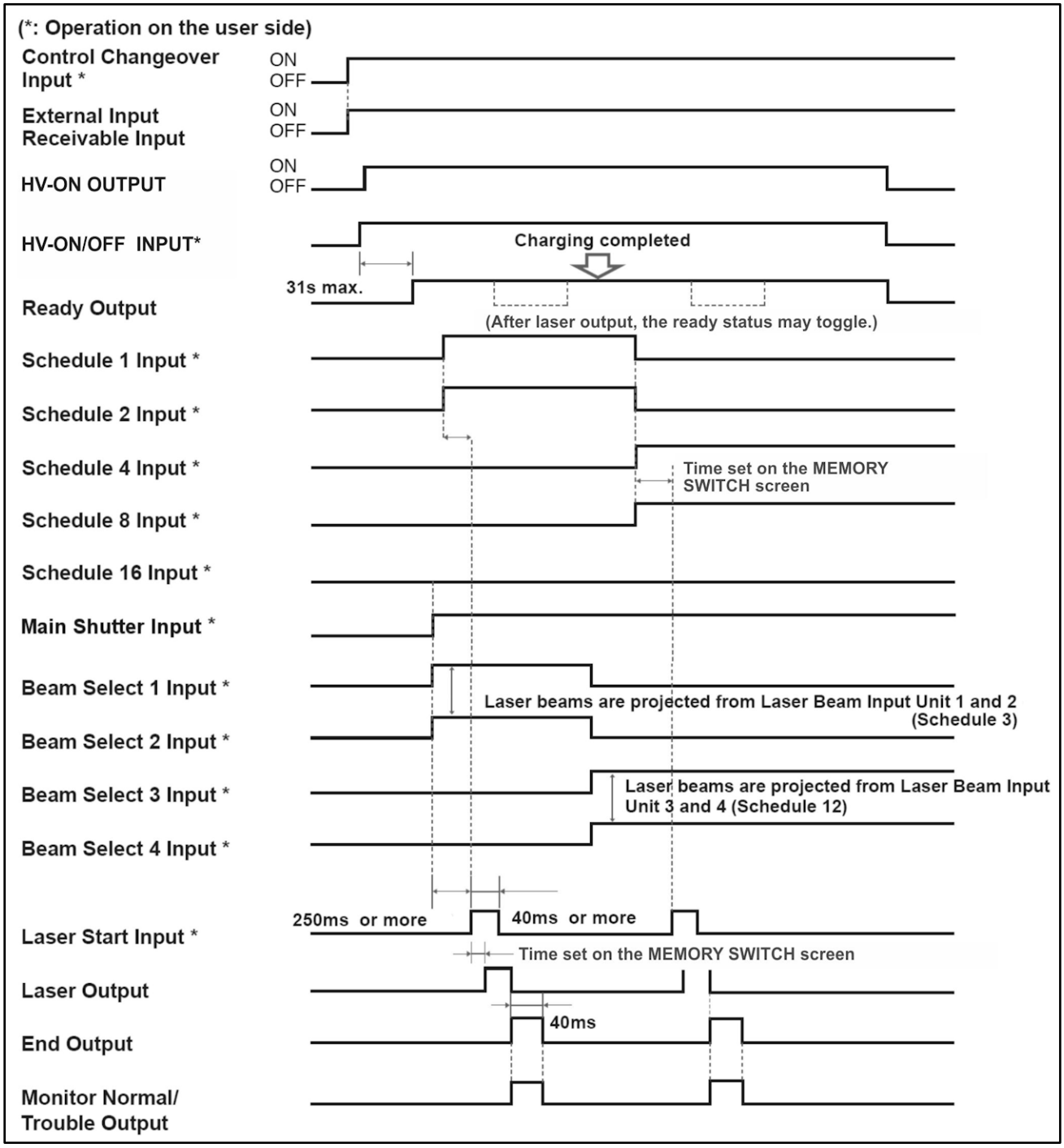
Operation by External I/O Control – 2 Energy-Shared Outputs (2E2T)

This timing diagram shows a typical laser operation with 2 Energy-Shared outputs by External I/O.

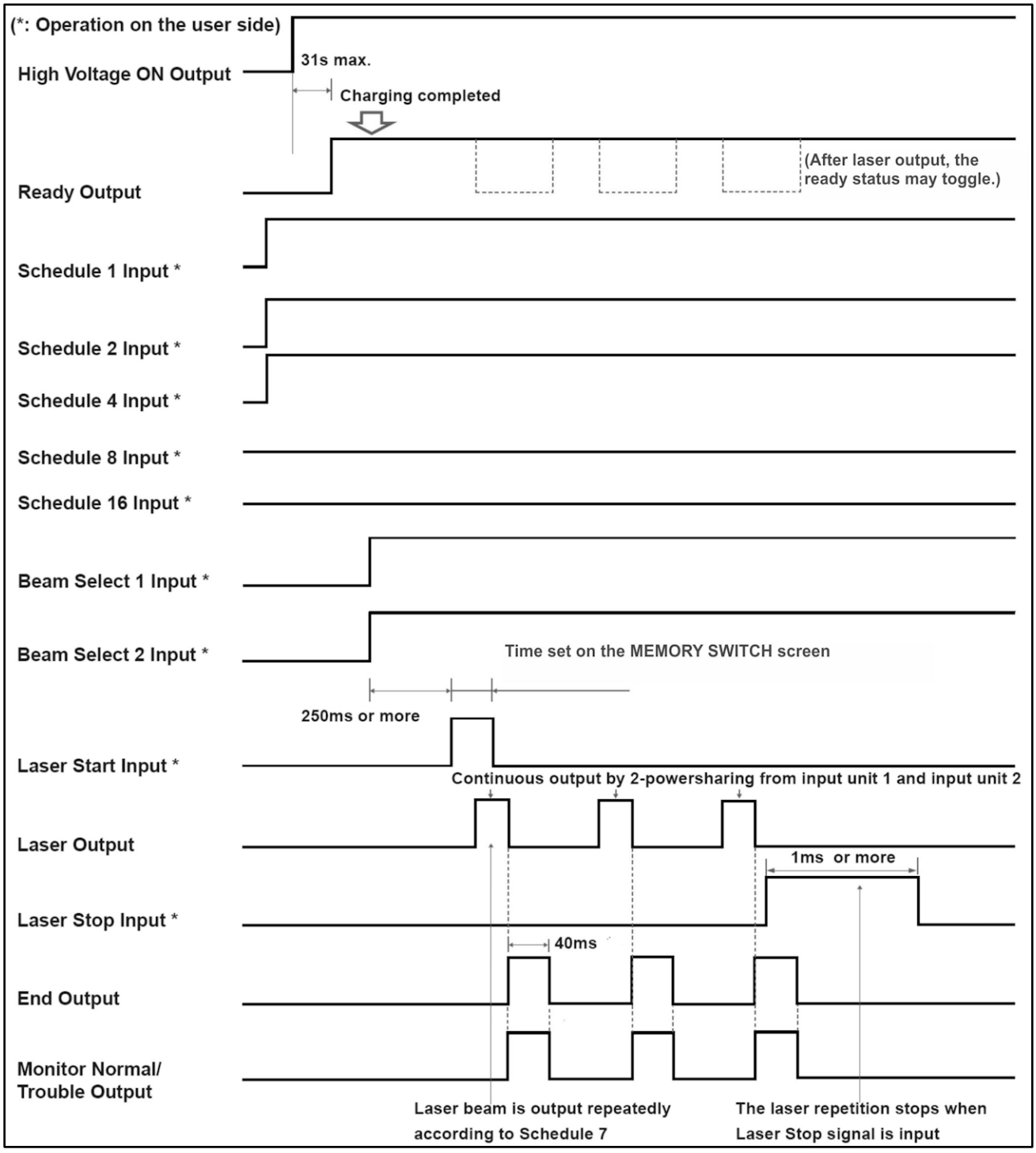


Operation by External I/O Control - 2Time-Sharing of 2 Energy-Shared Outputs (2E2T)

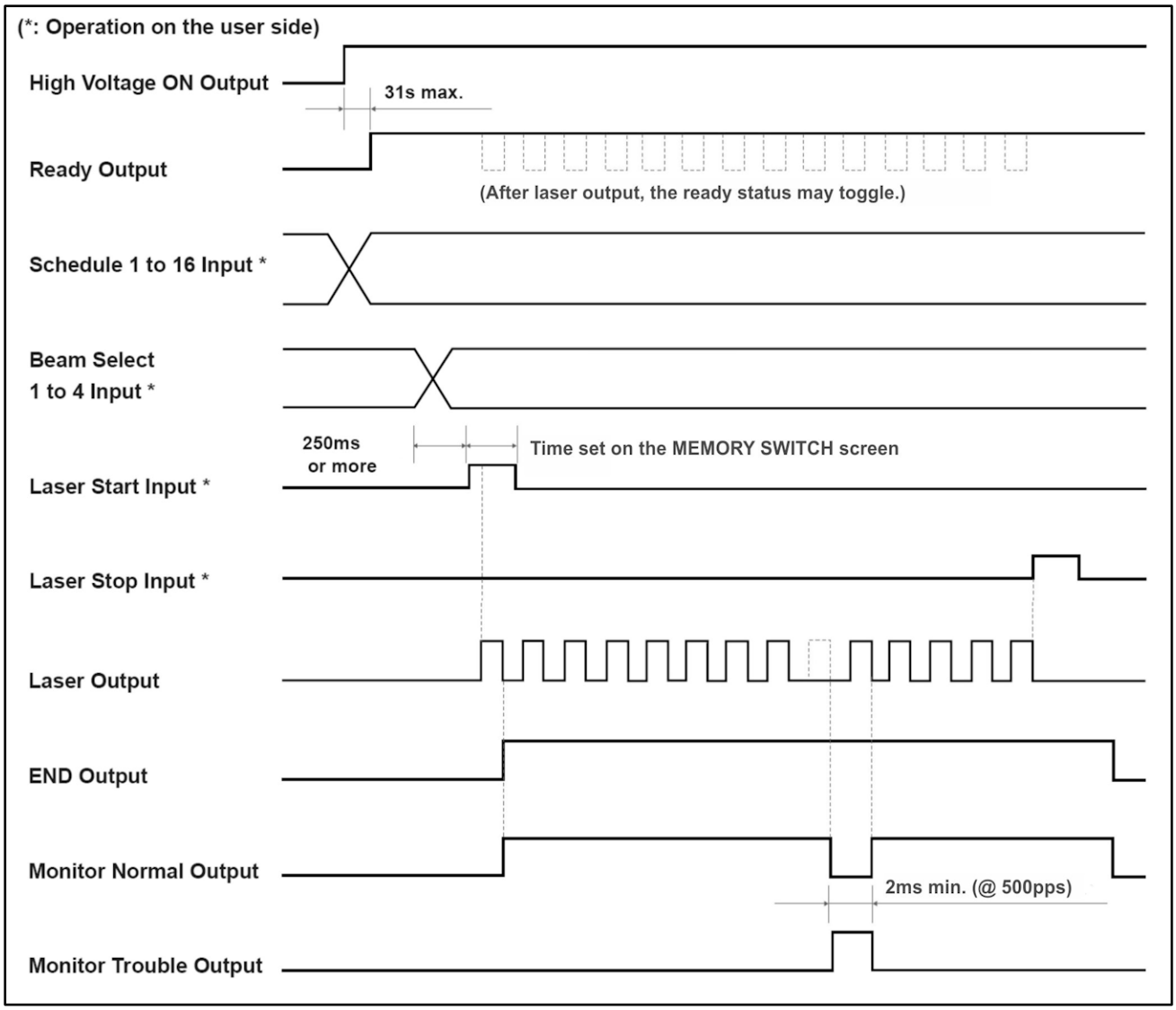
This timing diagram shows a typical laser operation with 2 Time-Shared outputs with 2 Energy-Shares each controlled by the External I/O.



Operation by External I/O Control – Repeated Operation, 2 Energy-Shared Outputs



Operation by External I/O Control – High Repetition Operation (≥ 25pps)



CAUTION

When controlled by External I/O, the Laser will stop if the Laser Stop signal input is opened. The Laser will start when closed. When controlled by the Laser Controller (i.e. Program Unit), the **LASER START/STOP** button will start and stop the Laser.

APPENDIX D
RS-485 EXTERNAL COMMUNICATION SPECIFICATIONS

The "External Communications Specification" can be used to externally read and write settings, monitor data and display system status of a laser from an external computer. Communication is achieved between the RS-485 communications port on the laser and the serial port of the external computer. The command structure is the same for ***all*** A-Series Laser models.

Data Transfer Options

1.	Transmission Mode:	RS-485 compliance, asynchronous, full-duplex
2.	Baud Rate	9,600 (factory default), 19,200, 38,400 bps
3.	Data Format	Start bit: 1 Data bit: 8 (factory default) or 7 Stop bit: 2 (factory default) or 1 Parity bit: Even (factory default) / Odd / none
4.	Character Code:	ASCII

Factory Settings:
- 9,600 bps
- (1) start bit
- (8) data bits
- (2) stop bits
- Even Parity

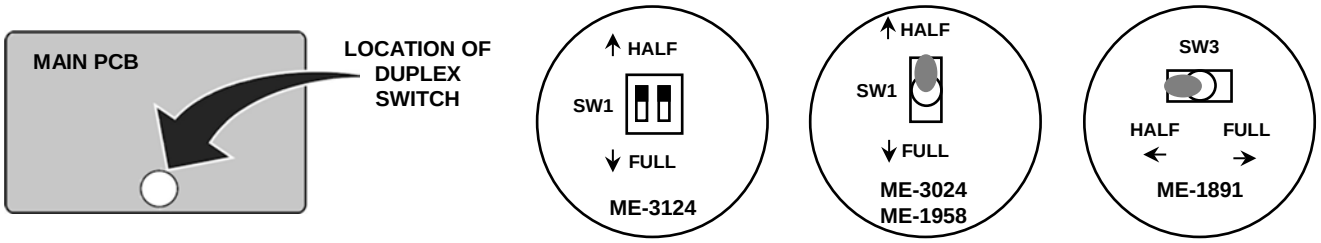
Communication Settings

The RS-485 communication settings are set in soft switches of the Memory Switch screen from within the *Initialization* Screen.

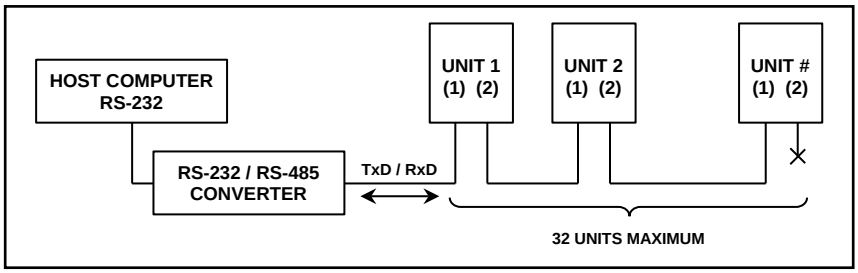
- For the MLE-118A Program box: see *Chapter 3, Section III, Initialization Screen.*
- For the MLE-115A Program box: see *Chapter 4, Section III, Initialization Screen.*

Transmission Mode Settings

The transmission mode (half-duplex or full-duplex) is controlled by a switch on the Main PCB.



Half-Duplex (Multi-drop) Configuration (RS-485) – Connecting Multiple Lasers Together



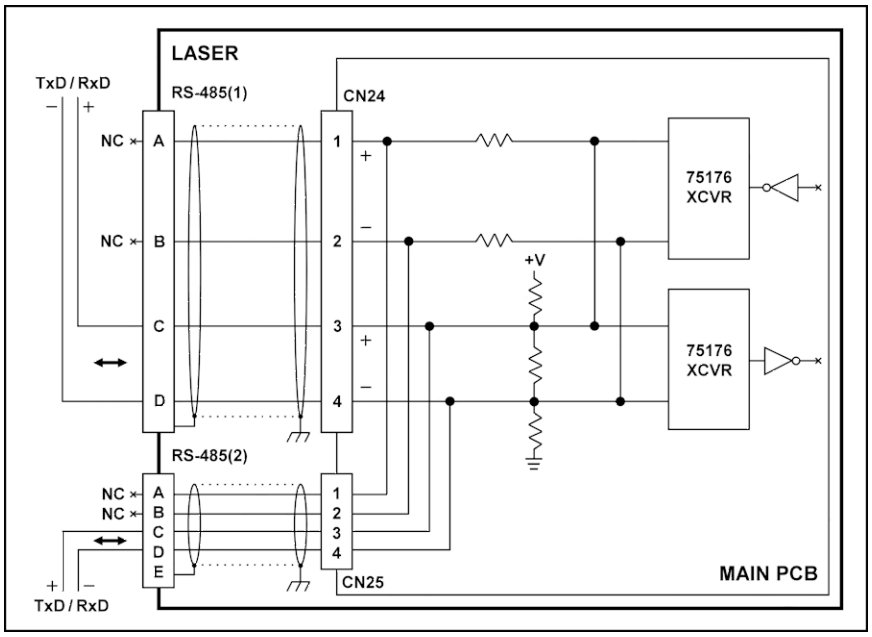
NOTES:

- The **Unit #** (Laser Unit address) is set on the *Initialization* Screen under **NETWORK** #. To avoid communication conflicts, each Laser needs its own unique Unit # (Laser Unit address).

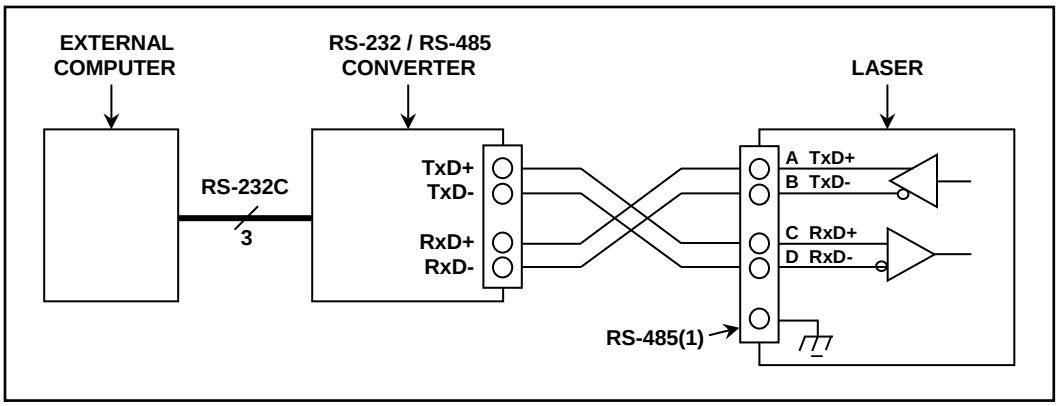
  For the MLE-118A Program box: see *Chapter 3, Section III, Initialization Screen.*

  For the MLE-115A Program box: see *Chapter 4, Section III, Initialization Screen.*
- The RS-232C / RS-485 conversion adapter is not supplied with the Laser.
- There is a 120 Ω termination resistor located on each Main CPU Board. When daisy chaining multiple Lasers together, only the last Laser in the chain needs to have the termination resistor "in circuit". All other Lasers should have the TxD Resistor set in the OFF position or removed.
  - **ME-3124 Main CPU Board** – dipswitch **SW3-1** (**ON =** in circuit, **OFF =** out of circuit).
  - **ME-3024 Main CPU Board** – dipswitch **SW3-1** (**ON =** in circuit, **OFF =** out of circuit).
  - **ME-1958 Main CPU Board** – dipswitch **SW3-1** (**ON =** in circuit, **OFF =** out of circuit).
  - **ME-1891 Main CPU Board** – R61 (*present* = in circuit, *removed* = out of circuit).

Half-Duplex Schematic



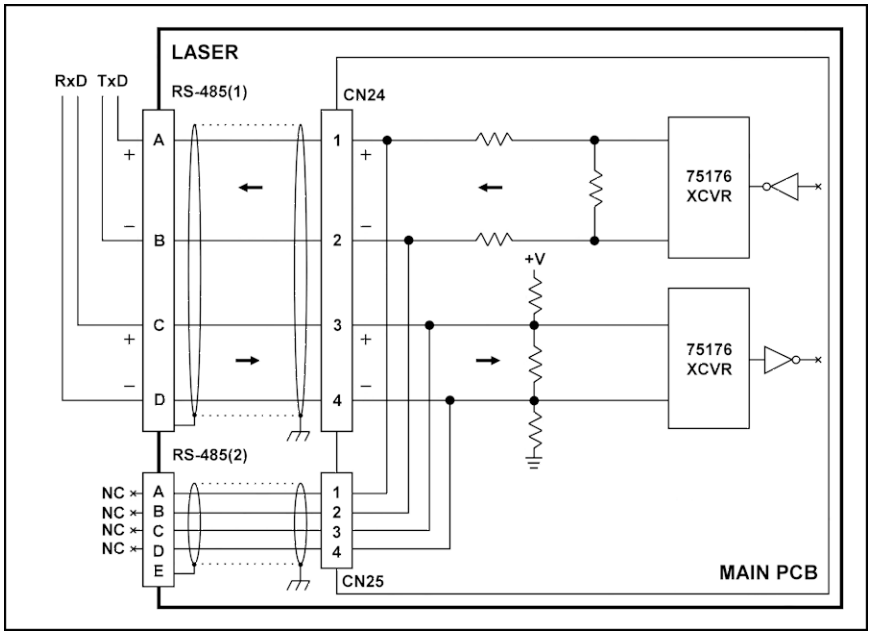
Full-Duplex (Point-to-Point) Configuration (RS-422) Communicating with a Single Laser



NOTES:

- Depending on the RS-232/RS-422 converter, the "+" and "–" designations may be reversed. If there is trouble communicating with the laser, try reversing the TxD+ and TxD- and/or the RxD+ and RxD- wires on one end only.
- The RS-232C/RS-422 conversion adapter is ***not*** supplied with the Laser.

Full-Duplex Schematic



Data Write Command (W)

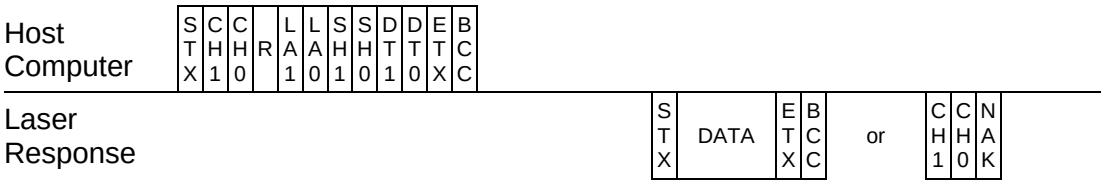
The Setting Data command (code: W) is used to set weld schedule parameters.

Host Computer	STX	CH1	CH0	W	LA1	LA0	SH1	SH0	DT1	DT0	:	DATA	ETX	BCC	
Laser Response	CH1	CH0	ACK	or	CH1	CH0	NAK								

CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).
LA1 / LA0	Classification Number (LA1 = tens, LA0 = ones). Enter a classification number based on the task you want to perform. Refer to page D-6 through D-11 for classification details. Valid Classifications for the **W** command: 99 Cooler Settings (Note: set Schedule Number [SH1 / SH0] to 00). 84 Common Schedule settings for both FIX and FLEX modes. 85 Schedule settings for FIX mode. 86 Schedule settings for FLEX mode, TIME 01 to 10 87 Schedule settings for FLEX mode, TIME 11 to 20 88 Schedule settings for FLEX mode, POWER 01 to 10 89 Schedule settings for FLEX mode, POWER 11 to 20 75 SEAM ON/OFF setting 76 SEAM setting value, SHOT 01 to 10 77 SEAM setting value, SHOT 11 to 20 78 SEAM setting value, POWER 01 to 10 79 SEAM setting value, POWER 11 to 20
SH1 / SH0	(Welding) Schedule Number (SH1 = tens, SH0 = ones). Valid data range = 00 to 31 Use two spaces (□□) to keep the current Schedule Number (no change)
DT1 / DT0	Data No. (DT1 = tens, DT0 = ones). Enter the appropriate Data No. (data value) for the specified Classification Number. Refer to Page D-6 through D-11 for Data No. details. Use Classification 99 to write data in a batch: data: (Data No. 1),(Data No. 2),(Data No. 3),… (Note: insert comma between values). When writing a 99 command, all monitor data values (noted with an *****) will not be written.
ACK / NAK	ACK = Transmitted data is valid. NAK = Transmitted data is not valid or Laser is not in Communication control mode.

Data Read Command (R)

The Reading Data command (code: R) is used to read weld schedule and monitor parameters.



CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).
LA1 / LA0	Classification Number (LA1 = tens, LA0 = ones). Enter a classification number based on the task you want to perform. Refer to page D-6 through D-11 for classification details. Valid Classifications for the **R** command: 99 Cooler Settings (Note: set Schedule Number [SH1 / SH0] to 00). 84 Common Schedule settings for both FIX and FLEX modes. 85 Schedule settings for FIX mode. 86 Schedule settings for FLEX mode, TIME 01 to 10 87 Schedule settings for FLEX mode, TIME 11 to 20 88 Schedule settings for FLEX mode, POWER 01 to 10 89 Schedule settings for FLEX mode, POWER 11 to 20 75 SEAM ON/OFF setting 76 SEAM setting value, SHOT 01 to 10 77 SEAM setting value, SHOT 11 to 20 78 SEAM setting value, POWER 01 to 10 79 SEAM setting value, POWER 11 to 20 95 Laser Power Monitor – Shot Count, Good Count, Average 00 Laser Power Monitor – Energy, number of waveform data, etc. 01 Laser Power Monitor – Waveform data 000 to 004 : : : : : : : : 22 Laser Power Monitor – Waveform data 105 to 109
SH1 / SH0	(Welding) Schedule Number (SH1 = tens, SH0 = ones). Valid data range = 00 to 31 Use two spaces (□□) to keep the current Schedule Number (no change)
DT1 / DT0	Data No. (DT1 = tens, DT0 = ones). Enter the appropriate Data No. (data value) for the specified Classification Number. Refer to Page D-6 through D-11 for Data No. details. If Classification 99 is entered, data will be read in a batch: data: (Data No. 1),(Data No. 2),(Data No. 3),… (Note: there is a comma between values).
ACK / NAK	ACK = Transmitted data is valid. NAK = Transmitted data is not valid or Laser is not in Communication control mode.

Classifications – for Read & Write Commands

Choose a Classification (task), then a corresponding Data No. (sub-task), followed by the DATA value.

99 Cooler Settings (Note: set Schedule Number [SH1 / SH0] to 00)

DATA No.	ITEM	DATA RANGE
01*	Coolant Temperature (*can be read but not set*)	000 – 999 (x 1 °C)
02	Operating Temperature [REF TEMP] on the [INITIALIZE] screen	00 – 99 (x 1 °C)
03	Water [HIGH] Temperature Alarm on the [INITIALIZE] screen	00 – 99 (x 1 °C)
04	Water [LOW] Temperature Alarm on the [INITIALIZE] screen	00 – 99 (x 1 °C)
05*	Water Resistivity (*can be read but not set*)	000 – 999 (x 0.01 MΩ)

84 Common Schedule Settings for both FIX and FLEX modes

DATA No.	ITEM	DATA RANGE
01	Waveform Setting, [FORM] on the [SCHEDULE] screen	0: FIX 1: FLEX
02	Turn ON/OFF Waveform Display on the [SCHEDULE] screen	0: OFF 1: ON
03	Peak Power Setting on the [SCHEDULE] screen ML-2551A: / ML-2550A:	0000 – 0500 (x 0.01 kW) / 0000 – 0800 (x 0.01 kW)
04	Pulse Repition Rate, [REPEAT] on the [SCHEDULE] screen	000 – 500
05	Number of consecutive shots, [SHOT] on the [SCHEDULE] screen	0000 – 9999
06	Upper Energy Monitor Setting, [HIGH] on [MONITOR] screen	0000 – 9999 (x 0.1 J)
07	Lower Energy Monitor Setting, [LOW] on [MONITOR] screen	0000 – 9999 (x 0.1 J)
08	Turn ON/OFF Power Monitor Waveform on the [MONITOR] screen. If using the MLE-118A Controller + firmware V50-05L, set to 1.	0: OFF 1: ON
09	[REFERENCE SETTING] on the [MONITOR] screen	000 – 100 (x 1%)

85 Schedule Settings for FIX mode

DATA No.	ITEM	DATA RANGE
01	Set [↑ SLOPE] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
02	Set [FLASH 1] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
03	Set [FLASH 2] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
04	Set [FLASH 3] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
05	Set [↓ SLOPE] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
06	Not Used	Fixed to 0000
07	Set [FLASH 1] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
08	Set [FLASH 2] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
09	Set [FLASH 3] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
10	Not Used	Fixed to 0000

Note 1: The resolution (x 0.1 ms) or (x 0.01 ms) depends on the position of SW1-7 in the Initialization Screen.

85 Schedule Settings for FIX mode (continued)

DATA No.	ITEM	DATA RANGE
11*	Reads approximate Laser Output Energy [REFERENCE VALUE] on the [SCHEDULE] screen. Can only be read, cannot be set.	0000 – 9999 (x 0.1 J)
12	Set [COOL 1] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
13	Set [COOL 2] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]

Note 1: The resolution (x 0.1 ms) or (x 0.01 ms) depends on the position of SW1-7 in the Initialization Screen.

86 Schedule Settings for FLEX mode – Time (01 – 10)

DATA No.	ITEM	DATA RANGE
01	Set [POINT 01] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
02	Set [POINT 02] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
03	Set [POINT 03] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
04	Set [POINT 04] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
05	Set [POINT 05] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
06	Set [POINT 06] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
07	Set [POINT 07] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
08	Set [POINT 08] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
09	Set [POINT 09] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
10	Set [POINT 10] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
11*	Reads approximate Laser Output Energy [REFERENCE VALUE] or [~] on the [SCHEDULE] screen (*can be read but not set*).	0000 – 9999 (x 0.1 J)

Note 1: The resolution (x 0.1 ms) or (x 0.01 ms) depends on the position of SW1-7 in the Initialization Screen.

87 Schedule Settings for FLEX mode – Time (11 – 20)

DATA No.	ITEM	DATA RANGE
01	Set [POINT 11] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
02	Set [POINT 12] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
03	Set [POINT 13] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
04	Set [POINT 14] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
05	Set [POINT 15] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
06	Set [POINT 16] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
07	Set [POINT 17] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
08	Set [POINT 18] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
09	Set [POINT 19] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
10	Set [POINT 20] Time on the [SCHEDULE] screen	000 – 999 (x 0.1 ms/0.01 ms)[1]
11*	Reads approximate Laser Output Energy [REFERENCE VALUE] or [~] on the [SCHEDULE] screen (*can be read but not set*).	0000 – 9999 (x 0.1 J)

Note 1: The resolution (x 0.1ms) or (x 0.01ms) depends on the position of SW1-7 in the Initialization Screen.

88 Schedule Settings for FLEX mode – Power (01 – 10)

DATA No.	ITEM	DATA RANGE
01	Set [POINT 01] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
02	Set [POINT 02] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
03	Set [POINT 03] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
04	Set [POINT 04] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
05	Set [POINT 05] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
06	Set [POINT 06] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
07	Set [POINT 07] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
08	Set [POINT 08] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
09	Set [POINT 09] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
10	Set [POINT 10] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
11*	Reads approximate Laser Output Energy [REFERENCE VALUE] or [~] on the [SCHEDULE] screen (*can be read but not set*).	0000 – 9999 (x 0.1 J)

89 Schedule Settings for FLEX mode – Power (11 – 20)

DATA No.	ITEM	DATA RANGE
01	Set [POINT 11] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
02	Set [POINT 12] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
03	Set [POINT 13] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
04	Set [POINT 14] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
05	Set [POINT 15] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
06	Set [POINT 16] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
07	Set [POINT 17] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
08	Set [POINT 18] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
09	Set [POINT 19] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
10	Set [POINT 20] Power on the [SCHEDULE] screen	0000 – 2000 (x 0.1%)
11*	Reads approximate Laser Output Energy [REFERENCE VALUE] or [~] on the [SCHEDULE] screen (*can be read but not set*).	0000 – 9999 (x 0.1 J)

75 SEAM Weld Setting – ON / OFF

DATA No.	ITEM	DATA RANGE
01	Turn ON/OFF the [SEAM] Weld function (fade IN / OUT)	0: OFF 1: ON

76 SEAM Weld Settings – Shot (01 – 10)

DATA No.	ITEM	DATA RANGE
01	Set [POINT 01] Shot on the [SEAM] screen	0000 – 9999
02	Set [POINT 02] Shot on the [SEAM] screen	0000 – 9999
03	Set [POINT 03] Shot on the [SEAM] screen	0000 – 9999
04	Set [POINT 04] Shot on the [SEAM] screen	0000 – 9999
05	Set [POINT 05] Shot on the [SEAM] screen	0000 – 9999
06	Set [POINT 06] Shot on the [SEAM] screen	0000 – 9999
07	Set [POINT 07] Shot on the [SEAM] screen	0000 – 9999
08	Set [POINT 08] Shot on the [SEAM] screen	0000 – 9999
09	Set [POINT 09] Shot on the [SEAM] screen	0000 – 9999
10	Set [POINT 10] Shot on the [SEAM] screen	0000 – 9999

77 SEAM Weld Settings – Shot (11 – 20)

DATA No.	ITEM	DATA RANGE
01	Set [POINT 11] Shot on the [SEAM] screen	0000 – 9999
02	Set [POINT 12] Shot on the [SEAM] screen	0000 – 9999
03	Set [POINT 13] Shot on the [SEAM] screen	0000 – 9999
04	Set [POINT 14] Shot on the [SEAM] screen	0000 – 9999
05	Set [POINT 15] Shot on the [SEAM] screen	0000 – 9999
06	Set [POINT 16] Shot on the [SEAM] screen	0000 – 9999
07	Set [POINT 17] Shot on the [SEAM] screen	0000 – 9999
08	Set [POINT 18] Shot on the [SEAM] screen	0000 – 9999
09	Set [POINT 19] Shot on the [SEAM] screen	0000 – 9999
10	Set [POINT 20] Shot on the [SEAM] screen	0000 – 9999

78 SEAM Weld Settings – Power (01 – 10)

DATA No.	ITEM	DATA RANGE
01	Set [POINT 01] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
02	Set [POINT 02] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
03	Set [POINT 03] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
04	Set [POINT 04] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
05	Set [POINT 05] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
06	Set [POINT 06] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
07	Set [POINT 07] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
08	Set [POINT 08] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
09	Set [POINT 09] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
10	Set [POINT 10] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)

79 SEAM Weld Settings – Power (11 – 20)

DATA No.	ITEM	DATA RANGE
01	Set [POINT 11] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
02	Set [POINT 12] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
03	Set [POINT 13] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
04	Set [POINT 14] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
05	Set [POINT 15] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
06	Set [POINT 16] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
07	Set [POINT 17] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
08	Set [POINT 18] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
09	Set [POINT 19] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)
10	Set [POINT 20] Power on the [SEAM] screen	0000 – 1500 (x 0.1%)

95 Laser Power Monitor functions

DATA No.	ITEM (can be read but not set)	DATA RANGE
01*	Reads the total [SHOT COUNT] on the [MONITOR] screen	000000000 – 999999999
02*	Reads the total [GOOD COUNT] on the [MONITOR] screen	000000000 – 999999999
03*	Reads the [AVERAGE] power on the [MONITOR] screen	0000 – 9999 (x 0.1 W)

00 Laser Power Monitor functions

DATA No.	ITEM (can be read but not set)	DATA RANGE
01*	Reads the current Schedule number	00 – 31
02*	Reads the [LAMP INPUT POWER] on the [MONITOR] screen	000 – 999 (x 1%)
03*	Reads the [ENERGY] on the [MONITOR] screen	0000 – 9999 (x 0.1 J)
04*	Reads the total number of laser power monitor waveforms with Classification number (between 00 and 22)	000 – 108
05*	Reads the Flash Pulse Width	0000 – 1000 (x 0.1 ms)

01 Laser Power Monitor – Waveform data 000 to 004

: : : : : : : : :

22 Laser Power Monitor – Waveform data 105 to 109

DATA No.	ITEM (can be read but not set)	DATA RANGE
01*	Reads the current Schedule number	00 – 31
02*	Laser Power Monitor waveform data 1/5	0000 – 9999 (x 0.1 kW)
03*	Laser Power Monitor waveform data 2/5	0000 – 9999 (x 0.1 kW)
04*	Laser Power Monitor waveform data 3/5	0000 – 9999 (x 0.1 kW)
05*	Laser Power Monitor waveform data 4/5	0000 – 9999 (x 0.1 kW)
06*	Laser Power Monitor waveform data 5/5	0000 – 9999 (x 0.1 kW)

Notes: 1. The Power Monitor waveform data is limited to a maximum of 108 points.
As the pulse width gets longer, the sampling interval will also increase:
- when the output pulse width is 00.5 ms $\leq t \leq$ 05.0 ms, data in 0.05 ms increments are returned
- when the output pulse width is 05.1 ms $\leq t \leq$ 10.0 ms, data in 0.10 ms increments are returned
- when the output pulse width is 10.1 ms $\leq t \leq$ 20.0 ms, data in 0.20 ms increments are returned
- when the output pulse width is 20.1 ms $\leq t \leq$ 40.0 ms, data in 0.40 ms increments are returned
- when the output pulse width is 40.1 ms $\leq t \leq$ 80.0 ms, data in 0.80 ms increments are returned
- when the output pulse width is 80.1 ms $\leq t \leq$ 99.9 ms, data in 1.00 ms increments are returned

2. The data [R00 nn 04] controls the number of Laser Power Monitor waveforms to read. Since a maximum of 5 data values can be sent each time, it will be necessary to change the Classification No. after reading 5 pieces of data.

Status, Control Mode and Schedule No. Settings (WS)

The Status Write command (code: WS) is used to change the control method and basic Laser functions.

Host Computer	STX	CH1	CH0	W	S	SH1	SH0	CNT	S1	S2	S3	S4	S5	S6	S7	S8	S9	MON	ETX	BCC	
Laser Response	CH1	CH0	ACK																		or
	CH1	CH0	NAK																		

CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).
SH1 / SH0	(Welding) Schedule Number (SH1 = tens, SH0 = ones). Valid data range = 00 to 31 Use two spaces (☐☐) to keep the current Schedule Number (no change)
CNT	CNT sets the Control method. The Laser can be controlled by any of the following methods: 0: Laser Controller (Program Box) 1: External I/O (Schedules set on Laser Controller) 2: Remote Communications (RS-485) 3: Maintenance Mode 4: Not Used 5: External I/O (Schedules set through personal computer) Notes: - Only commands CNT=0 and CNT=2 can be set through a personal computer. - Maintenance Mode is primarily used by Field Service for maintenance functions. - When in Maintenance mode, the Control method cannot be changed. - If the Key Switch is turned OFF, all control reverts back to the Laser Controller - The EXT I/O (1) Control Change Over signal has priority over other control methods. The effect of the Control Changeover is outlined in the table below:

EXT I/O (1) – Pin 23 Control Changeover	**CNT**		**Control Method setting**
OFF	0	→	0: Control by Laser Controller
	2	→	2: Control through RS-485 Communications
ON	0	→	1: Control through External I/O (Output schedules set on Laser Controller)
	2	→	5: Control through External I/O (Output schedules set on Personal computer)

Notes: - If Control Changeover is turned OFF while in "1: External I/O (Controller)" mode, the Control method will revert back to "0: Laser Controller" mode.
- If Control Changeover is turned OFF while in "5: External I/O (Computer)" mode, the Control method will revert back to "2: RS-485 Control" mode.

S1	Turns High Voltage (HV) ON/OFF 0: OFF 1: ON ☐: no change

Status, Control Mode and Schedule No. Settings (WS) – (continued)

S2	Turns Guide Beam (LD) ON/OFF	0: OFF	1: ON	☐: no change
S3	Controls Main Shutters	0: OFF (closed)	1: ON (open)	☐: no change
S4	Controls Branch Shutter 1	0: OFF (closed)	1: ON (open)	☐: no change
S5	Controls Branch Shutter 2	0: OFF (closed)	1: ON (open)	☐: no change
S6	Controls Branch Shutter 3	0: OFF (closed)	1: ON (open)	☐: no change
S7	Controls Branch Shutter 4	0: OFF (closed)	1: ON (open)	☐: no change
S8	Unused (fixed to ☐)			
S9	Unused (fixed to ☐)			
MON	Sets automatic transmission of monitor data. Each time the Laser is fired, the "00 Laser Power Monitor – Waveform" data will be sent. If the Control method is changed when the automatic data transmission is turned ON, data transmission will continue until the Power Supply is turned off. For high repetitions, the data will be sent in periodic intervals.	0: OFF	1: ON	☐: no change
ACK / NAK	ACK = Transmitted data is valid. NAK = Transmitted data is not valid or Laser is not in Communication control mode.			

Time-Share Shutter Write Command (WM)

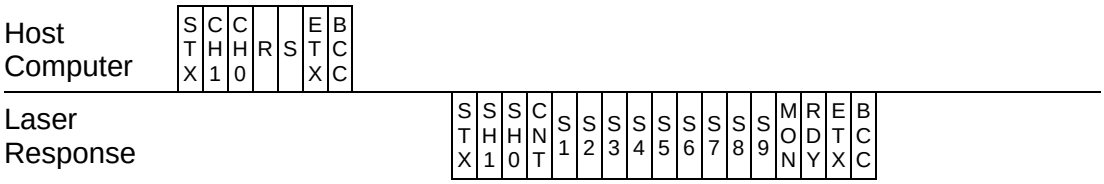
The Time-Share Shutter Write command (code: WM) is used to control the Time-Share Shutters.

Host Computer	STX	CH1	CH0	W	M	M1	M2	M3	M4	M5	ETX	BCC				
Laser Response													CH1	CH0	ACK	or CH1 CH0 NAK

CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).			
M1	Time-Share Shutter 1 control	0: OFF	1: ON	☐: no change
M2	Time-Share Shutter 2 control	0: OFF	1: ON	☐: no change
M3	Time-Share Shutter 3 control	0: OFF	1: ON	☐: no change
M4	Unused (fixed to ☐)			
M5	Unused (fixed to ☐)			
ACK / NAK	ACK = Transmitted data is valid. NAK = Transmitted data is not valid or Laser is not in Communication control mode.			

Laser Control Read Command (RS)

The Laser Control Read command (code: RS) is used to read the status of the basic Laser functions.



CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).		
SH1 / SH0	Displays the current (Welding) Schedule Number (SH1 = tens, SH0 = ones).		
CNT	Displays the current control method. Refer to the Status Setting command **WS** for details. 0: Laser Controller (Program Box) 1: External I/O (Schedules set on Laser Controller) 2: Remote Communications (RS-485) 3: Maintenance Mode 4: Not Used 5: External I/O (Schedules set through personal computer)		
S1	High-Voltage status	0: OFF	1: ON
S2	Guide Beam (LD) status	0: OFF	1: ON
S3	Main Shutter status	0: OFF (closed)	1: ON (open)
S4	Branch Shutter 1 status	0: OFF (closed)	1: ON (open)
S5	Branch Shutter 2 status	0: OFF (closed)	1: ON (open)
S6	Branch Shutter 3 status	0: OFF (closed)	1: ON (open)
S7	Branch Shutter 4 status	0: OFF (closed)	1: ON (open)
S8	Unused (fixed to 0)		
S9	Unused (fixed to 0)		
MON	Displays if the "automatic transmission of monitor data" option is active.	0: OFF	1: ON
RDY	Laser READY status	0: Laser Start disabled	1: Laser Start enabled

Time-Share Shutter Read Command (RM)

The Time-Share Shutter Read command (code: RM) is used to read the status of the Time-Share shutters.

Host Computer	STX	CH1	CH0	R	M	ETX	BCC								
Laser Response	STX	SH1	SH0	CNT	M1	M2	M3	M4	M5	ETX	BCC				

CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).		
SH1 / SH0	Displays the current (Welding) Schedule Number (SH1 = tens, SH0 = ones).		
CNT	Displays the current control method. Refer to the Status Setting command **WS** for details. 0: Laser Controller (Program Box) 1: External I/O (Schedules set on Laser Controller) 2: Remote Communications (RS-485) 3: Maintenance Mode 4: Not Used 5: External I/O (Schedules set through personal computer)		
M1	Time-Share Shutter 1 status	0: OFF	1: ON
M2	Time-Share Shutter 2 status	0: OFF	1: ON
M3	Time-Share Shutter 3 status	0: OFF	1: ON
M4	Unused (fixed to 0)		
M5	Unused (fixed to 0)		

Laser Fire Command ($0)

The Laser Fire command (code: $0) will cause the Laser to fire.

Host Computer	STX	CH1	CH0	$		0	ETX	BCC			
Laser Response	CH1	CH0	ACK		or		CH1	CH0	NAK		

H1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).
ACK / NAK	ACK = Transmitted data is valid. NAK = Transmitted data is not valid or Laser not in Communication control mode. If a NAK is returned make sure the Laser is Ready to fire. All of the following conditions must be valid before the Laser can be fired: - Laser must not be in an alarm condition. - High-Voltage must be ON - Laser must be in the READY state. - The Laser must be set to External Communications mode (RS-485).

Laser Stop Command ($9)

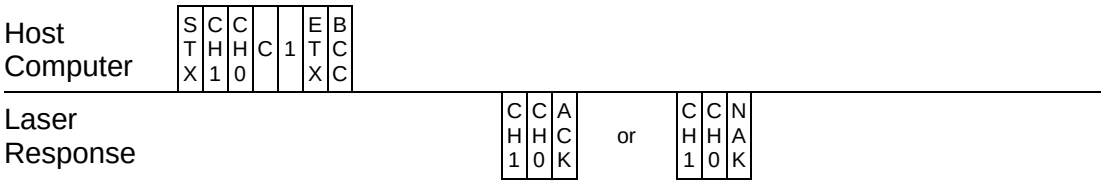
The Laser Stop command (code: $9) will stop all Laser output.

Host Computer	STX	CH1	CH0	$		9	ETX	BCC			
Laser Response	CH1	CH0	ACK		or		CH1	CH0	NAK		

CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).
ACK / NAK	ACK = Transmitted data is valid. NAK = Transmitted data is not valid or Laser is not in Communication control mode.

Shot Count Reset Command (C1)

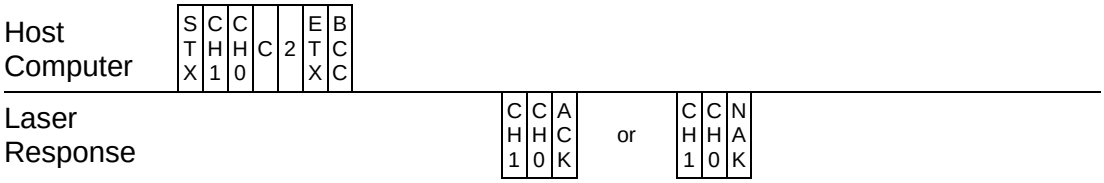
The Shot Count Reset command (code: C1) will reset the SHOT COUNT to 000000000.



CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).
ACK / NAK	ACK = Transmitted data is valid. NAK = Transmitted data is not valid or Laser is not in Communication control mode.

Good Count Reset Command (C2)

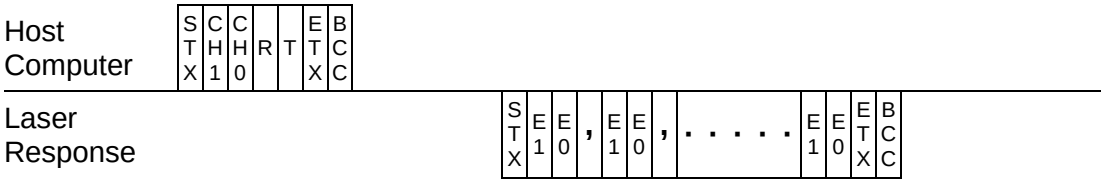
The Good Count Reset command (code: C2) will reset the GOOD COUNT to 000000000.



CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).
ACK / NAK	ACK = Transmitted data is valid. NAK = Transmitted data is not valid or Laser is not in Communication control mode.

Trouble Read Command (RT)

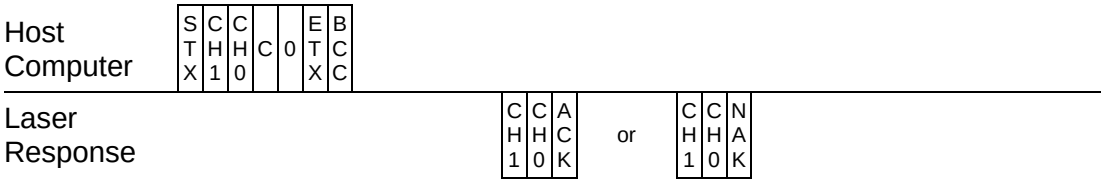
If Laser trouble occurs, there will usually be an associated Error Code displayed on the Laser Controller. The Trouble Read command (code: RT) will read the Laser Alarm (Error) code.



CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).
E1 / E0	Error code (E1 = tens, E0 = ones) All error codes are transmitted when the RT command is sent. If no error occurs, a 00 response will be given.

Trouble Reset Command (C0)

The Trouble Reset command (code: C0) will reset an Laser Alarm condition (Error code).
If the cause for the alarm condition is not corrected, the Laser will continue to go into an Alarm condition. All errors must be cleared before the Laser will operate.



CH1 / CH0	The Laser Unit (CH1 = tens, CH0 = ones). Valid data range = 00 to 31 (default = 00). Each Laser needs its own unique network address (when connected serially). Refer to page D-2 for details on setting the Network # (i.e. Laser Unit address).
ACK / NAK	ACK = Transmitted data is valid. NAK = Transmitted data is not valid or Laser is not in Communication control mode.

Fault List

Refer to *Chapter 6, Section II, Troubleshooting* for troubleshooting steps.

#	CONTENTS	#	CONTENTS	#	CONTENTS
00	Communication Line Error	22	Branch shutter 4 trouble	44	External Interlock opened
01	Power Supply cover open	23	Unused	45	Laser Start is not Ready
02	Head cover open	24	Unused	46	Power monitor Temp
03	Emergency Stop (220VAC)	25	Unused	47	Overrate
04	Low Level of Coolant	26	Unused	48	Fiber Overrate
05	Phase Trouble	27	No Current (Lamp current not detected)	49	Setting Error (duration too short)
06	Over Heat of Pump	28	Discharge Unit – Over Current	50	Setting Error (overlimit of max power)
07	Unused	29	Discharge Unit – High Temperature	51	Fiber Setting error
08	Discharge resistor temp	30	Discharge Unit – Over Power	52	Memory trouble
09	Oscillator temperature	31	Branch unit cover opened	53	Power Feedback Trouble
10	High temperature of coolant	32	Fiber Switch Trouble	54	Deionize caution (2 MΩ < Resistivity ≤ 3 MΩ)
11	Low temperature of coolant	33	Emission indicator trouble (Focus Head)	55	Unused
12	Low flow rate of coolant	34	Emission indicator trouble (Program Box)	56	Overlimit Laser Power
13	Deionize trouble (Resistivity ≤ 2 MΩ)	35	Memory Battery Low	57	Underlimit Laser Power
14	Simmer trouble	36	Unused	58	Unused
15	Charge trouble	37	Unused	59	Time-Share Shutter 1 Trouble
16	Cap Bank Alarm	38	Fiber Sensor 1 trouble	60	Time-Share Shutter 2 Trouble
17	Unused	39	Fiber Sensor 2 trouble	61	Time-Share Shutter 3 Trouble
18	Main Shutter Trouble	40	Fiber Sensor 3 trouble	62	Unused
19	Branch shutter 1 trouble	41	Fiber Sensor 4 trouble	63	Unused
20	Branch shutter 2 trouble	42	Unused	64	Unused
21	Branch shutter 3 trouble	43	Unused	65	Unused

CODE	DESCRIPTION	SYNTAX (FROM HOST COMPUTER)	RESPONSE FROM LASER	PAGE
W	Write data	STX CH1 CH0 W LA1 LA0 SH1 SH0 DT1 DT0 : DATA ETX BCC	CH1 CH0 ACK OR CH1 CH0 NAK	D-4
R	Read data	STX CH1 CH0 R LA1 LA0 SH1 SH0 DT1 DT0 ETX BCC	STX DATA ETX BCC OR CH1 CH0 NAK	D-5
WS	Write status, control mode, and schedule	STX CH1 CH0 W S SH1 SH0 CNT S1 S2 S3 ••• S8 S9 MON ETX BCC	CH1 CH0 ACK OR CH1 CH0 NAK	D-12
WM	Write Time-Share Shutter	STX CH1 CH0 W M M1 M2 M3 M4 M5 ETX BCC	CH1 CH0 ACK OR CH1 CH0 NAK	D-13
RS	Read Status, Control Mode, and schedule	STX CH1 CH0 R S ETX BCC	STX SH1 SH0 CNT S1 S2 S3 S4 S5 S6 S7 S8 S9 MON RDY ETX BCC	D-14
RM	Read Time-Share Shutter	STX CH1 CH0 R M ETX BCC	STX SH1 SH0 CNT M1 M2 M3 M4 M5 ETX BCC	D-15
$0	Laser Start Command	STX CH1 CH0 $ 0 ETX BCC	CH1 CH0 ACK OR CH1 CH0 NAK	D-16
$9	Laser Stop Command	STX CH1 CH0 $ 9 ETX BCC	CH1 CH0 ACK OR CH1 CH0 NAK	D-16
C0	Trouble Reset Command	STX CH1 CH0 C 0 ETX BCC	CH1 CH0 ACK OR CH1 CH0 NAK	D-18
C1	Shot Count Reset Command	STX CH1 CH0 C 1 ETX BCC	CH1 CH0 ACK OR CH1 CH0 NAK	D-17
C2	Good Count Reset Command	STX CH1 CH0 C 2 ETX BCC	CH1 CH0 ACK OR CH1 CH0 NAK	D-17
RT	Read Trouble (Error Code)	STX CH1 CH0 R T ETX BCC	STX E1 E0 , E1 E0 , ••••• E1 E0 ETX BCC	D-18

C#.Net code example

In the following code example, the PC will connect serially to the Laser (basic control) and put the Laser in RS-485 and/or Control Panel mode.

```
using System;

private void Form1_Load(object sender, EventArgs e)
{
        System.IO.Ports.SerialPort serialPort1
        serialPort1.Parity = System.IO.Ports.Parity.Even;
        serialPort1.StopBits = System.IO.Ports.StopBits.Two;
        serialPort1.BaudRate = 9600;
        serialPort1.PortName = "COM1"
        serialPort1.DataBits = 7;

        serialPort1.Open();
        string sTransmitData = "00";
        //Put the laser into External - 485 Mode format
        sTransmitData = sTransmitData + "WS  2          ";

        // or if to put laser in internal mode format
        //sTransmitData = sTransmitData + "WS  0          ";

        // invoke to send string
        fTransmitData();


        //Close the serial port
        serialPort1.Close();
}


private void fTransmitData()
{
        char cSTX, cETX, cBCC;
        char[] cBCCArray;

        //Clear the receieved data textbox.
        tboReceived.Text = "";
        sDataReceived = "";

        cSTX = Convert.ToChar(0x02);
        cETX = Convert.ToChar(0x03);

        //Attach ETX and BCC to end of the string
        sTransmitData = string.Concat(sTransmitData, cETX);
        cBCCArray = sTransmitData.ToCharArray();
        //Calculate the BCC for the string
        cBCC = fBCCCalculate(cBCCArray);
        sTransmitData = string.Concat(sTransmitData, cBCC);
        //Attach STX to front of the string
```

```
        sTransmitData = string.Concat(cSTX, sTransmitData);

        if (serialPort1.IsOpen == true)
        {
            try
            {
                serialPort1.Write(sTransmitData);
            }
            catch
            {
                MessageBox.Show("Error: Could not write data to port", "Transmit Error", MessageBoxButtons.OK,
MessageBoxIcon.Error);
            }
        }
        else
        {
            MessageBox.Show("Error: Please open a Comm Port", "Failure to Connect",
                MessageBoxButtons.OK, MessageBoxIcon.Error);
        }
}

private void serialPort1_DataReceived(object sender, System.IO.Ports.SerialDataReceivedEventArgs e)
{
        //When data is sitting in the buffer, concat it to the sDataReceieved string.
        //  Also search and replace for ACK, NAK, STX, ETX
        sDataReceived = string.Concat(sDataReceived, serialPort1.ReadExisting());
        sDataReceived = sDataReceived.Replace(Convert.ToString(Convert.ToChar(0x06))," ACK");
        sDataReceived = sDataReceived.Replace(Convert.ToString(Convert.ToChar(0x15))," NAK");
        sDataReceived = sDataReceived.Replace(Convert.ToString(Convert.ToChar(0x02)), "(STX) ");
        sDataReceived = sDataReceived.Replace(Convert.ToString(Convert.ToChar(0x03)), " (ETX)");
        tboReceived.Text = sDataReceived;
}

private char fBCCCalculate(char[] cBCCArray)
{
        //Purpose: In order to calculate the BCC character used for error
        //         checking one must exclusive or every element in the
        //         character array

        int iCounter, iArrayLength;
        char cBCC;

        iArrayLength = cBCCArray.GetLength(0);
        cBCC = cBCCArray[0];

        //XOR all elements in the array for error checking
        for (iCounter = 1; iCounter < iArrayLength; iCounter++)
        {
            cBCC ^= cBCCArray[iCounter];
        }
        return cBCC;
}
```

APPENDIX E
Schedule Data Tables

The tables in this Appendix are useful for keeping track of stored welding schedule data. For your convenience, they are printed on one-side only so you may easily remove them from this manual and make as many copies as you like.

Schedule Data Table (ML-2551A / ML-2550A) – FIX

ITEM		SETTING RANGE	UNIT	SCHEDULE															
				00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
↑ SLOPE	TIME	00.0 – 99.9	ms																
FLASH1	TIME	00.0 – 99.9	ms																
	%	000.0 – 200.0	%																
COOL1	TIME	00.0 – 99.9	ms																
FLASH2	TIME	00.0 – 99.9	ms																
	%	000.0 – 200.0	%																
COOL2	TIME	00.0 – 99.9	ms																
FLASH2	TIME	00.0 – 99.9	ms																
	%	000.0 – 200.0	%																
↓ SLOPE	TIME	00.0 – 99.9	ms																
PEAK (ML-2550A)		00.00 – 08.00	kW																
PEAK (ML-2551A)		00.00 – 05.00	kW																
PPS		000 – 500	Hz																
SHOT		0000 – 9999																	
ENERGY	HIGH	000.0 – 999.9	J																
	LOW	000.0 – 999.9	J																

NETWORK # _____

Schedule Data Table (ML-2551A / ML-2550A) – FIX

ITEM		SETTING RANGE	UNIT	SCHEDULE															
				16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
↑ SLOPE	TIME	00.0 – 99.9	ms																
FLASH1	TIME	00.0 – 99.9	ms																
	%	000.0 – 200.0	%																
COOL1	TIME	00.0 – 99.9	ms																
FLASH2	TIME	00.0 – 99.9	ms																
	%	000.0 – 200.0	%																
COOL2	TIME	00.0 – 99.9	ms																
FLASH2	TIME	00.0 – 99.9	ms																
	%	000.0 – 200.0	%																
↓ SLOPE	TIME	00.0 – 99.9	ms																
PEAK (ML-2550A)		00.00 – 08.00	kW																
PEAK (ML-2551A)		00.00 – 05.00	kW																
PPS		000 – 500	Hz																
SHOT		0000 – 9999																	
ENERGY	HIGH	000.0 – 999.9	J																
	LOW	000.0 – 999.9	J																

NETWORK # _____

Schedule Data Table (ML-2551A / ML-2550A) – FLEX

ITEM		SETTING RANGE	UNIT	SCHEDULE															
				00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
POINT	TIME	00.0 – 99.9	ms																
	POWER	000.0 – 200.0	%																
POINT	TIME	00.0 – 99.9	ms																
	POWER	000.0 – 200.0	%																
POINT	TIME	00.0 – 99.9	ms																
	POWER	000.0 – 200.0	%																
POINT	TIME	00.0 – 99.9	ms																
	POWER	000.0 – 200.0	%																
POINT	TIME	00.0 – 99.9	ms																
	POWER	000.0 – 200.0	%																
PEAK (ML-2550A)		00.00 – 08.00	kW																
PEAK (ML-2551A)		00.00 – 05.00	kW																
PPS		000 – 500	Hz																
SHOT		0000 – 9999																	
ENERGY	HIGH	000.0 – 999.9	J																
	LOW	000.0 – 999.9	J																

NETWORK # ____________________

Schedule Data Table (ML-2551A / ML-2550A) – FLEX

ITEM		SETTING RANGE	UNIT	SCHEDULE															
				16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
POINT	TIME	00.0 – 99.9	ms																
	POWER	000.0 – 200.0	%																
POINT	TIME	00.0 – 99.9	ms																
	POWER	000.0 – 200.0	%																
POINT	TIME	00.0 – 99.9	ms																
	POWER	000.0 – 200.0	%																
POINT	TIME	00.0 – 99.90	ms																
	POWER	000.0 – 200.0	%																
POINT	TIME	00.0 – 99.9	ms																
	POWER	000.0 – 200.0	%																
PEAK (ML-2550A)		00.00 – 08.00	kW																
PEAK (ML-2551A)		00.00 – 05.00	kW																
PPS		000 – 500	HZ																
SHOT		0000 – 9999																	
ENERGY	HIGH	000.0 – 999.9	J																
	LOW	000.0 – 999.9	J																

NETWORK # _____

Schedule Data Table (ML-2551A / ML-2550A) – SEAM WELD MODE

ITEM		SETTING RANGE	UNIT	SCHEDULE															
				00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																

NETWORK # ____________________________

Schedule Data Table (L ML-2551A / ML-2550A) – SEAM WELD MODE

ITEM		SETTING RANGE	UNIT	SCHEDULE															
				16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																
No.	SHOT	0000 – 9999																	
	POWER	000.0 – 150.0	%																

NETWORK # ____________________

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