YAG LASER WELDER

ML-2350A/2351A-CDRH

OPERATION MANUAL

AMADA®

M0599E

(ML-2350A ML-2351A)-CDRH-E36-202308

How to Use This Document

ATTENTION

In this manual, ML-2350A denotes ML-2350A-CDRH, and ML-2351A denotes ML-2351A-CDRH.

Thank you for purchasing our product.

This operation manual explains its method of operation and precautions for use.

Before using, read this operation manual carefully; after reading, save it in a proper place for your future reference.

This document is composed of the 4 parts of "Introduction Part", "Installation and Preparation Part", "Operating Part", and "Maintenance Part", and "Appendixes."

We recommend inexperienced users to read through the whole contents starting from "Introduction Part."

This document allows the user to understand the whole equipment image, basic configuration, and how to use the laser.

Experienced users can refer to the desired page from the table of contents.

Organization of This Document and Its Contents

Introduction Part:	Explains the outline and functions of the laser. Regarding the YAG Laser, this part explains the basic configuration and functional outline of this product including options so that the user can know the configuration of the laser and equipment composition, and also the name and function of each component section.
Installation and Preparation Part:	Explains the installation of the laser and preparatory operations such as connections of its respective sections.
Operating Part:	Explains how to operate the laser. First, this part explains how to perform each setting and how to operate the laser. Three types of control (Control by the laser controller, control by external input/output signals, and control by external communication control) are explained in the operating method for laser welding.
Maintenance Part:	Explains how to perform maintenance and how to handle trouble.
Appendixes:	For reference materials, specifications, dimensional outline drawing, available output, timing chart, and list of terminology are available. In the output schedule data entry table, the user can enter registered laser output schedule data for use.

Contents

For Use in Safety

Safety Precautions

Before using, read "Safety Precautions" carefully to understand the correct method of use.

These precautions are shown for safe use of our products and for prevention of damage or injury to operators or others. Be sure to read each of them, since all of them are important for safety.

A meaning of a figure sign

DANGER	Denotes operations and practices that may imminently result in serious injury or loss of life if not correctly followed.
WARNING	Denotes operations and practices that may 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.
	Denote "prohibition." They are warnings about actions out of the scope of the warranty of the product.
	Denote actions which operators must take.
	Denotes that the content gives notice of DANGER, WARNING or CAUTION to the operator.

DANGER

Do not touch the inside of the Laser unnecessarily.
Since source voltage of 3-phase 220 V/380 V AC is applied to the Laser, high voltages are applied to its inside. 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 operation manual.

Do not look at or touch the beam.
Both direct laser beams and scattered laser beams are highly dangerous. If the beam enters the eye directly, it can cause blindness.

Never burn, destroy, cut, crush or chemically decompose the Laser.
This product incorporates parts containing gallium arsenide (GaAs).

WARNING

Wear protective glasses.
Be sure to wear protective glasses having an optical density of at least 7 while using the Laser. Even if you wear them, you may lose your sight if the laser beam enters your eyes directly through protective glasses. Protective glasses attenuates the laser beam, but does not block it.

Do not expose your skin to the laser beam.
Your skin may be severely burnt.

Do not touch any processed workpiece during and just after processing finished.
The processed workpieces are very hot.

Use only specified cables.
Use of a cable of insufficient capacity or loose connection can cause electric shock fire.

Do not damage the power cable or connecting cables.
Do not tread on, twist or tense any cable. The power cable and connecting cables may be broken, and that can cause electric shock and fire. If any part needs to be repaired, consult us or your distributor.

Stop the operation if any trouble occurs.
Continuous operation after occurrence of a trouble such as burning smell, abnormal sound, abnormal heat, smoke, etc. can cause electric shock and fire. If such a trouble occurs, immediately consult us or your distributor.

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

Use a stopper.
The laser beam is dangerous to human bodies. Prevent emission through the air by using a stopper (a heat-resistant, laser beam-absorbing, -scattering material).

Persons with pacemakers must stay clear of the Laser.
Those who use a pacemaker must not approach the Laser or walk around the welding shop while the Laser is in operation, without being permitted by his/her medical doctor. The Laser generates a magnetic field and has effects on the operation of the pacemaker while it is turned ON.

CAUTION

Do not splash water on the Laser.

Water splashed over the electric parts, can cause electric shock and short circuits.

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

Do not cut the wire conductor. A fire or electric shock will occur.

Install the Laser on a firm and level surface.

If the Laser falls or drops, injury may result.

Do not place a water container on the Laser.

If water spills, insulation of the Laser will deteriorate, and that can cause electric leaks and fire.

Keep combustible matter away from the Laser.

Surface flash and expulsion can ignite combustible matter. If it is impossible to remove all combustible matter, cover it with non-combustible material.

Do not apply the laser beam to combustible materials.

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

Do not cover the Laser with a blanket, cloth, etc.

Do not cover the Laser with a blanket, cloth, etc. while you are using it. The cover may be overheated and burn.

Do not use this Laser for purposes other than metal processing.

Use of the Laser in a manner other than specified can cause electric shock and fire.

Protective gear must be worn.

Put on protective gear such as protective gloves, long-sleeve jacket, leather apron, etc. Surface flash and expulsion can burn the skin if they touch the skin.

Keep a fire extinguisher nearby.

Keep a fire extinguisher in the processing shop in case of fire.

Maintain and inspect the Laser periodically.

Maintain and inspect the Laser periodically, and repair any damage before starting operation.

Precautions for Handling

Laser Safety Supervisor

⇒ Appoint a safety supervisor for all laser work.
The appointed safety supervisor must have sufficient knowledge and experience regarding both lasers and laser work.

⇒ The supervisor must control the keyswitch of the Laser, and must be responsible for instructing operators in safety aspects of the Laser as well as directing the laser work.

⇒ Establish and control a laser operation area.
The responsible person must isolate the laser operation area from other areas and control it by fences and display signs indicating that the area is off-limits to unauthorized personnel.

Routine Handling

⇒ Perform inspection periodically referring to the Maintenance Part, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection/Replacement" on page 177.

⇒ If the outside of the Laser is stained, wipe it with a dry cloth or a moistened cloth. If it is badly stained, use neutral detergent or alcohol to clean it. Do not use paint thinner, benzine, etc. which can discolor or deform the parts.

⇒ Do not put screws, coins, etc. in the Laser, since they can cause a malfunction.

⇒ Operate the switches and buttons carefully by hand. If they are operated roughly or with the tip of a screwdriver, a pen, etc. they may be broken.

⇒ Operate the switches and buttons one at a time. If two or more of them are operated at a time, the Laser may have trouble or may be broken.

⇒ The outer panels and the covers are electrically connected to the main unit by connecting cables. When the panels, covers and connecting cables are removed and installed again, make sure that all these components 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.

⇒ To prevent damage, do not bend the optical fiber beyond its minimum bending radius or apply any forms of shock to it. For the fiber's minimum bending radius, see the table below.

Minimum bending radius of the optical fiber

Core Diameter	Minimum Bending Radius
φ 0.2, 0.3, 0.4mm	100mm
φ 0.6mm	150mm
φ 0.8mm	200mm
φ 1.0mm	250mm

⇒ When a supervisor or operator enters the area where the laser is used, protective measures not to exceed the MPE* level must be taken.

* MPE: The maximum level of permissible exposure of the eyes or skin to laser beams. Abbreviation of Maximum Permissible Exposure.

* For other information on managing laser equipment or the MPE level, refer to the following standards.

CDRH Standards Part 1040 Sec. 1040.10 "Radiation safety standards for laser equipment"

For Transportation

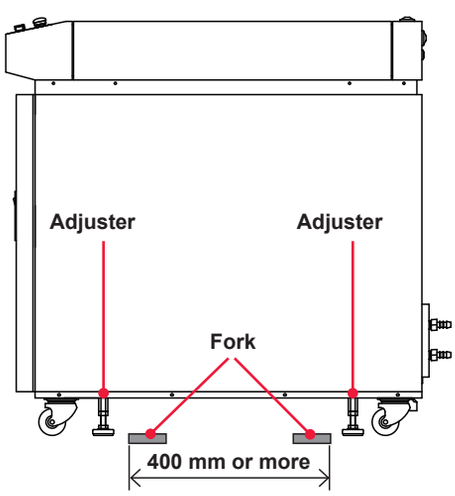
When transporting the laser, observe the following precautions to avoid hazards.

- ⇒ Package the Laser when transporting it.
- ⇒ 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., of at least 300 kg allowable load.
- ⇒ Retract the level adjuster fully when transporting the Laser.

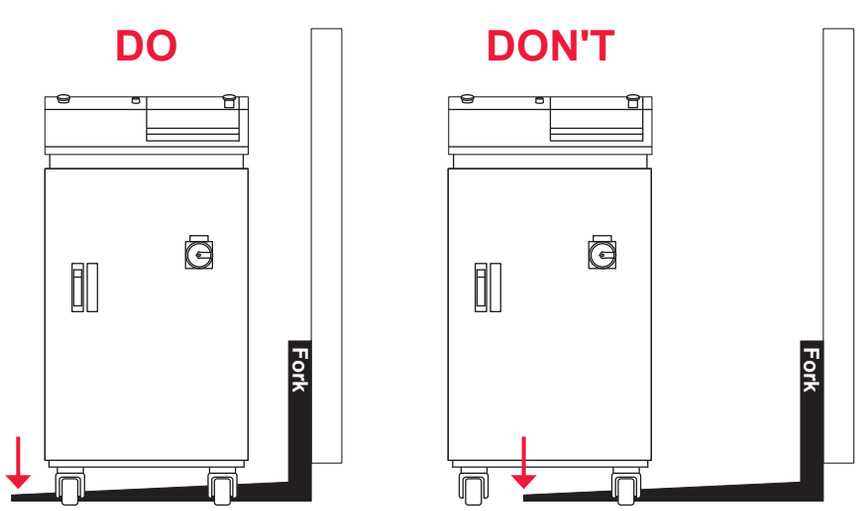
Precautions for using a fork lift

The following figure shows fork inserting positions.

- ⇒ As shown at right, adjust the distance between the forks; distance between the outer sides of the forks must be at least 400 mm, but the fork must not hit the level adjuster.
- ⇒ When transporting, belt the Laser to fix and keep it horizontal.

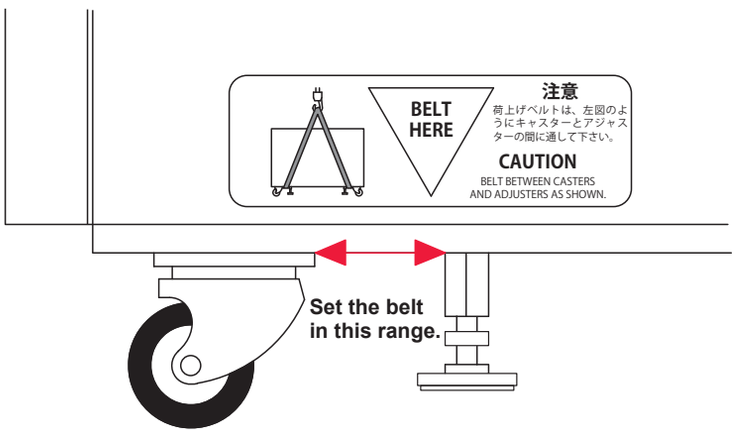


Figures below show example forking; insert the forks fully till the points appear from under the Laser.



Precautions for using a crane

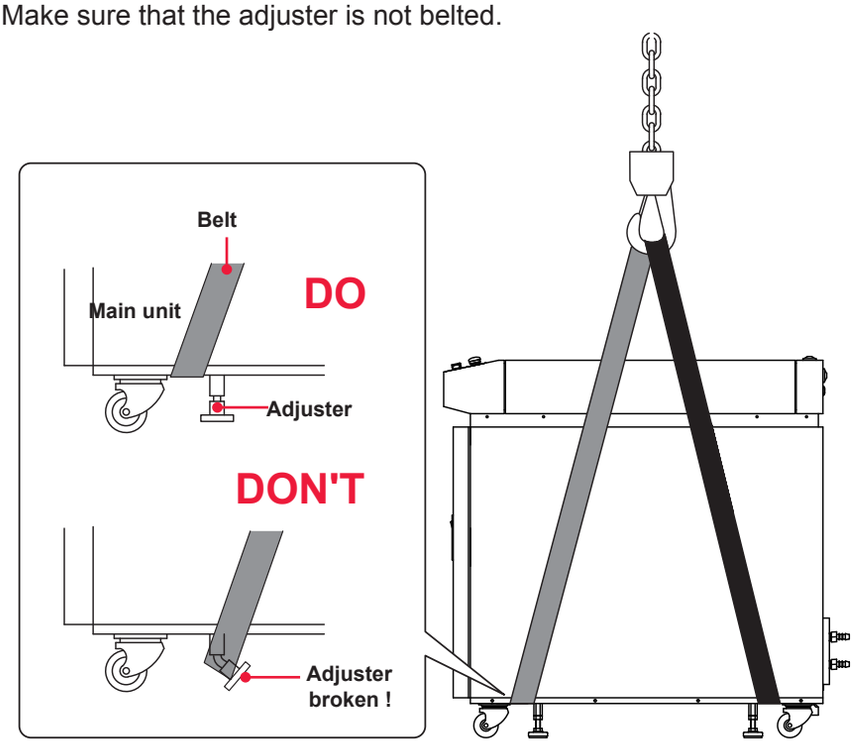
⇒ When lifting the Laser, belt it between the caster and level adjuster observing a “BELT HERE” label.



⇒ Use two belts together.

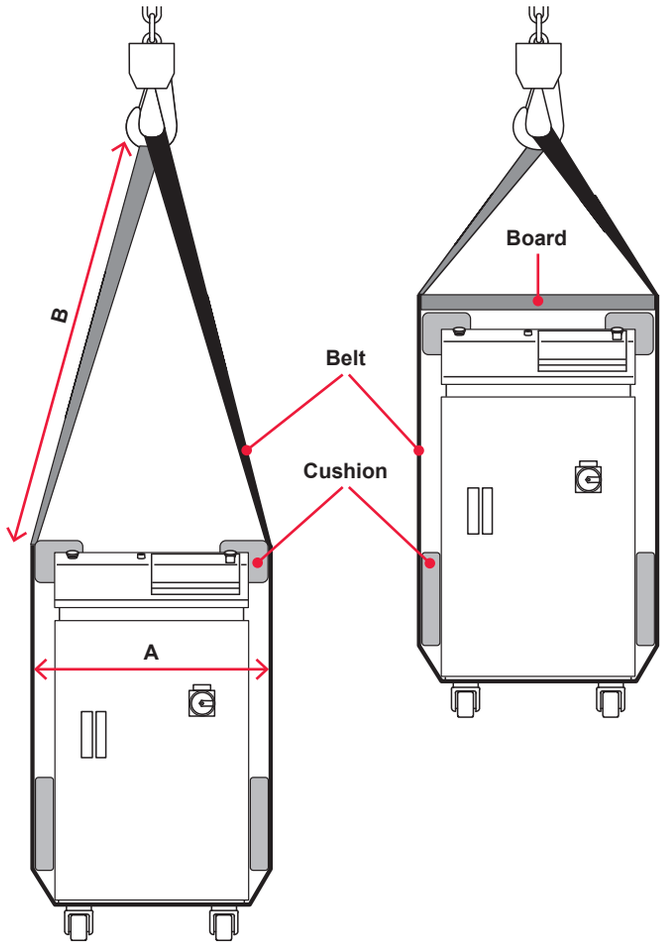
⇒ During transportation, keep the Laser horizontal.

⇒ Make sure that the adjuster is not belted.



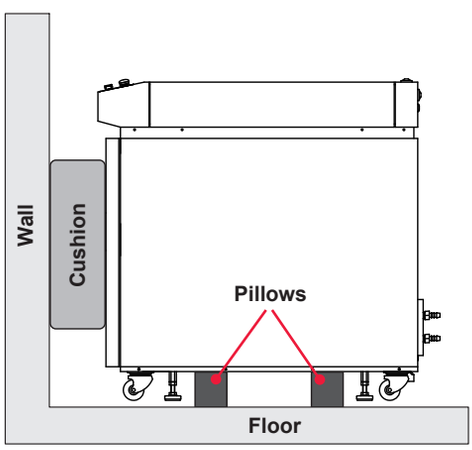
⇒ For transportation using a crane, insert a buffer material such as blanket, sponge, and rubber material between the laser welder and the belt, and to have the belts press the Laser evenly.

⇒ Have the distance (Figure B on page 13) between the top corner of the Laser and the crane hook is at least 1.5 times the Laser width including the cushion. When the belt is not long enough as shown, insert a board (plywood, angle plate, etc.) on the Laser not to hurt the top surface of the Laser.

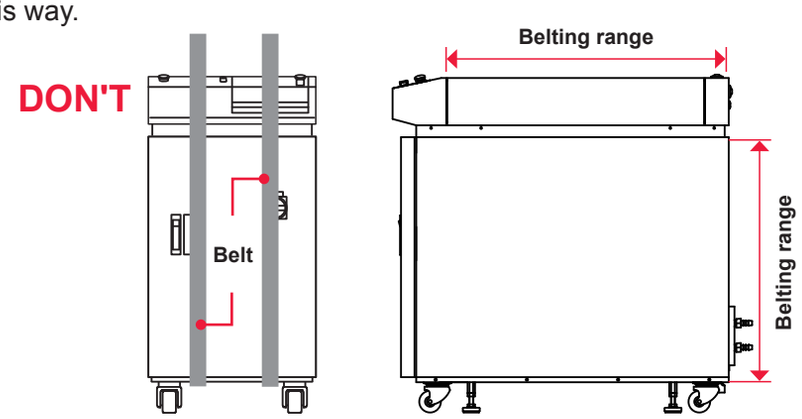


Precautions for transportation

- ⇒ Fix it firmly using belts, cushions, etc., to prevent a fall, damage due to vibration.
- ⇒ Retract the level adjuster fully when freighting the Laser.
- ⇒ Insert a broad 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 pillows such as timber between the bottom of the Laser and floor to balance the Laser. For positioning the pillows, refer to that for the forks of lift truck.

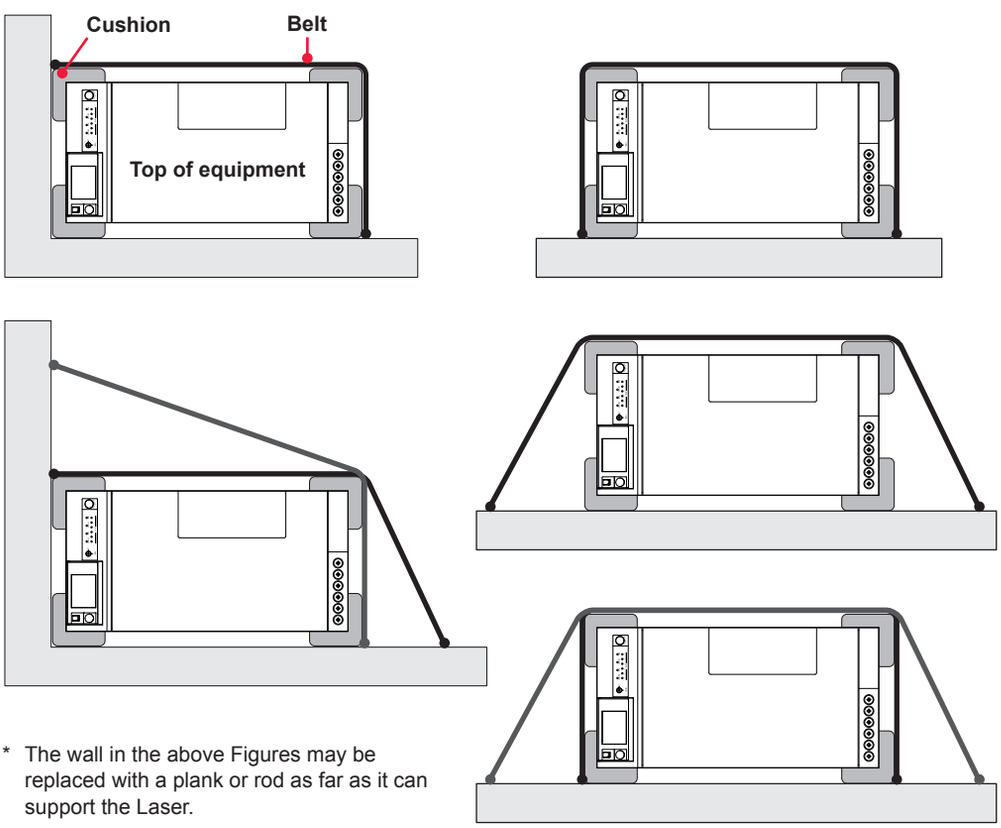


⇒ Set the belt for fixing the laser welder within the effective range of belt setting shown in the following figure. If the belt is set from the lower part of the front side, the front door may be out of position or deformed. Avoid setting the belt in this way.



⇒ Put the laser welder in close contact with the two surfaces of floor and wall and fix it securely with a belt. Be sure to use cushion between the Laser and belt not to hurt the Laser.

Example belting (Top view)



* The wall in the above Figures may be replaced with a plank or rod as far as it can support the Laser.

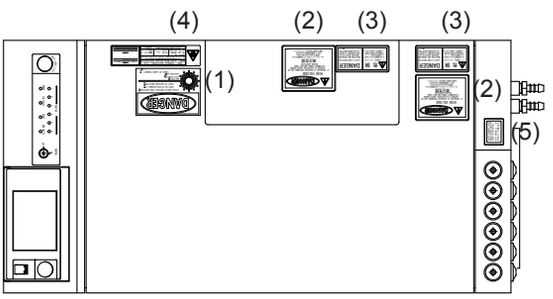
⇒ When it is expected that the Laser may bounce during transportation, belt the Laser longitudinally.

For Disposal

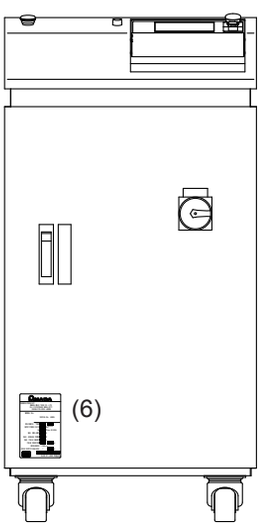
This product incorporates parts containing gallium arsenide (GaAs). At the time of disposal, separate it from general industrial waste or domestic waste and carry out the disposal in accordance with applicable laws and regulations.

Sticking Warning/Danger Labels

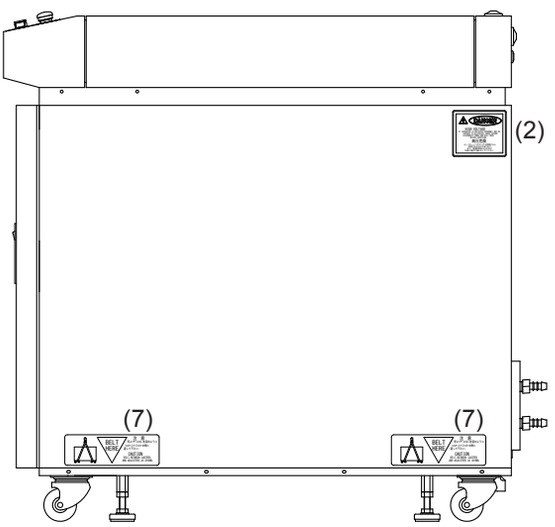
Warning/danger labels are struck on the laser. Read the precautions provided on each label for correct use. The numbers correspond to the label figure numbers on the next page.



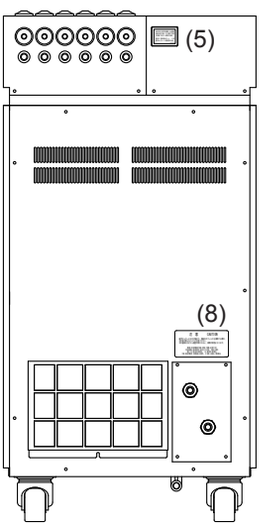
Top view



Front view

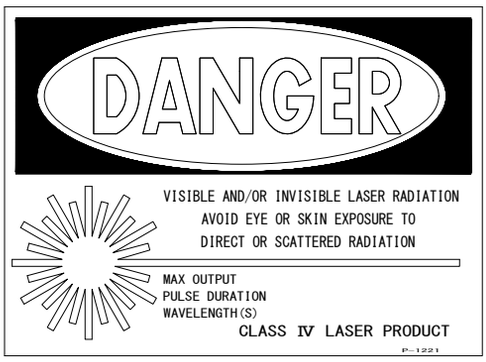


Right side view



Rear view

(1)



(2)

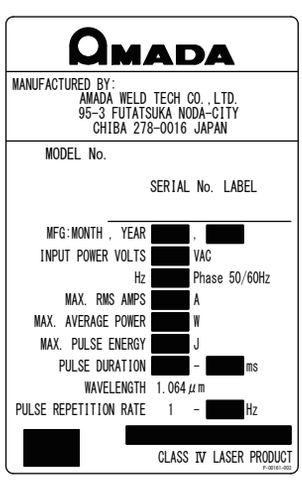
(Also stuck on the reverse side)

(3)

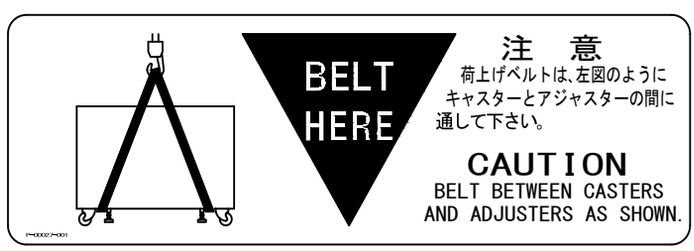
(4)

(5)

(6)

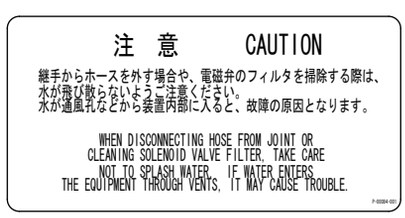


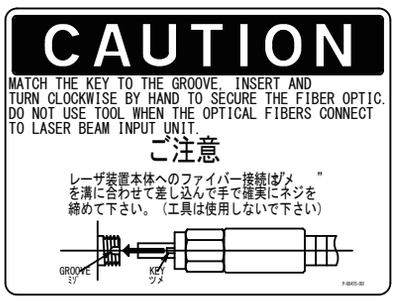
(7)



(Also stuck on the reverse side)

(8)



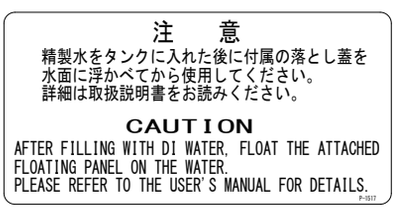


Inside of the top surface of the main unit
(top surface of the branch unit cover)

Inside of the front surface of the main unit
(front surface of the cooling water tank)

Inside of the top surface of the main unit
(top surface of the branch unit cover)

Inside of the main unit
(top surface of the trigger unit in the branch unit)
(under the interlock board)
(side surface of the board cover of the balance board)
(side surface of the simmer unit)
(side surface of the capacitor unit)
(side surface of the high voltage cover of the charge unit)
(side surface of the discharge unit)



Inside of the front surface of the main unit
(top surface of the cooling water tank)

Inside of the main unit
(side surface of the high voltage cover (2 places))
(inside of the front surface of the main unit)

Inside of the top surface of the main unit
(top surface of the acrylic chamber in the branch unit)

Introduction Part

Introduction Part

Chapter 1

Overview of the YAG Laser Welder

1. YAG Laser

Laser means the equipment to generate powerful light by amplifying light (electromagnetic wave) or means this light itself. Laser can be classified into various types by light generating material. Among these types, the typical type as welding laser in the industrial field is Nd: YAG laser, which is generally called YAG laser. The name of Nd: YAG laser originates from the fact that this laser is generated by doping Neodymium with the Yttrium Aluminum Garnet crystal.

The YAG laser wavelength is 1064 nm of near infrared rays that are invisible to man. Most of laser equipment for laser welding belongs to class 4 laser that is the most hazardous in the classification of laser products specified in JIS. When YAG laser light greets the eye, it is focused by crystalline lens and reaches the retina, thereby inviting a loss of eyesight. Do not look at the YAG laser light in any case. Because both beams and scattered light are hazardous, do not touch or look at them.

To check where invisible laser is irradiated on the workpiece, red guide light is generally mounted in the laser equipment. When the output unit is provided with a CCD camera, cross lines are generally displayed on the monitor and the cross point of these cross lines is an irradiation point. In this laser, a red point appears on the workpiece when guide light is output.

2. Mechanism of the YAG Laser

The YAG Laser for welding consists of a power supply, cooler, oscillator, optical fiber, output unit, etc. Laser light can be transferred to a place remote from the main unit by optical fiber, so that only the optical fiber and output unit can be mounted in the manufacturing line for welding. Multiple beams of laser light can be split from single laser equipment to multiple optical fibers.

Powersharing

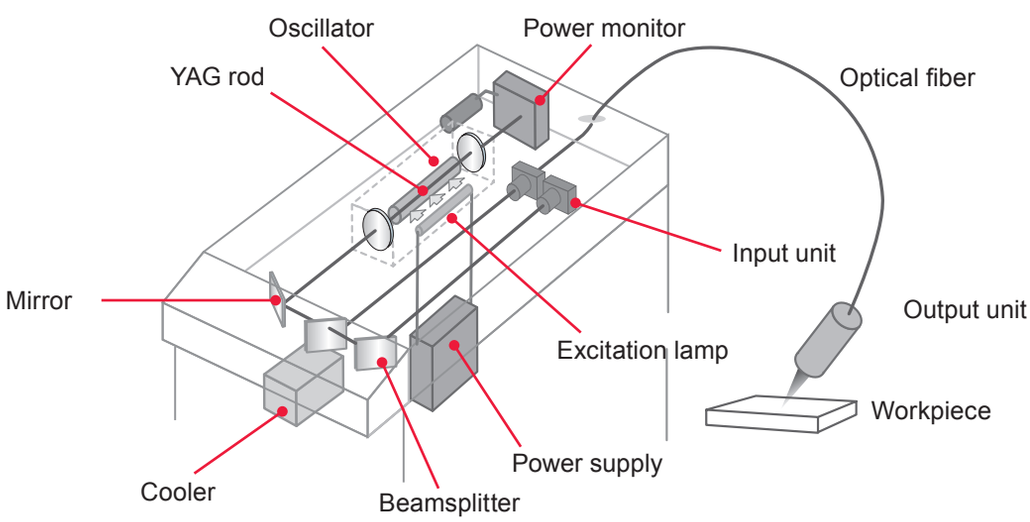
When single laser light is split into multiple beams by using a beamsplitter, multiple workpieces (or multiple positions of a single workpiece) can be simultaneously welded. This method is called "powersharing."
Supposing that the energy of a single laser light beam is 100%, 50% laser light is simultaneously irradiated when the number of deliveries is 2, or 33% laser light is simultaneously irradiated when the number of deliveries is 3. Up to 4 deliveries are available for this laser equipment at powersharing.

Timesharing

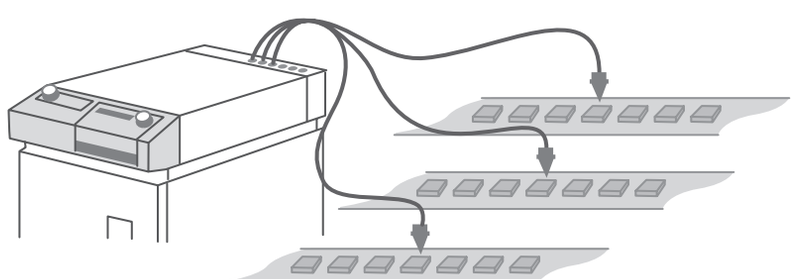
100% energy is applied to multiple workpieces by changing the reflection angle with the mirror of the timesharing unit without splitting single laser light. This welding method for multiple workpieces is called "timesharing."

For example, if when the number of deliveries is 3, laser light is irradiated once each from 3 optical fibers. Up to 6 deliveries are available for this laser equipment at timesharing.

Common Laser Equipment Configuration



Example of 3 deliveries



3. Functions of the ML-2350A/2351A

⇒ Laser power feedback control and optional waveform control functions

- The Laser can handle a wide variety of workpieces. Up to 32 different settings for weld schedules using waveform control are available.
- High-repetition laser output (200 pps max.) supports high-speed seam welding.
- The welding schedule can be momentarily switched. This permits high-speed and high-quality welding.
- The ML-2351A uses very thin optical fiber that makes it suitable for welding with a small spot diameter.
- For seam welding, output can be set to fade in at the start and fade out at the end also to smooth overlaps at both ends of the weld.
- Up to 6 deliveries of laser output, including powersharing and timesharing, are available. (The beamsplitter and branch shutter are options.)
- Powersharing permits obtaining uniform outputs for each delivery without energy loss.

⇒ Simple operations and maintenance

- For greater convenience, the Laser is designed to allow the operator to work on the Laser from the front for cumbersome tasks such as wiring and filter replacement.
- Remote control is available because the Laser Controller is detachable.
- As welding schedules are entered on the liquid crystal display, the user can perform operations easily and accurately.
- A variety of input and output signals allow the Laser to be connected to automatic machines.
- Both the laser energy (J) and its mean power (W) are monitored. If the desired energy range has been preset and the laser energy is out of the range, the trouble signal is output. This function is provided for quality control purposes.
- Use of high-precision optical fiber eliminates the optical axis adjustment usually needed every time the fiber is removed and reinstalled.
- Optical fiber detection is available to check fiber connection and breakage. (An optional output unit with fiber sensor is required.)
- Using the external communication function permits managing data such as welding schedules and monitor values in centralized form.

⇒ The factory environment can be improved by space saving.

- The laser power supply, oscillator, and cooler are integrated into a single piece for easy transport and installation of the Laser.

⇒ The Laser conforms to the following standards.

Certified to be in compliance with CDRH Standards Part 1040 Sec. 1040.10 “Radiation safety standards for laser equipment”

4. Product Composition

Packaging

The product is divided into the main unit and accessories and these are packed in 2 packages. The respective dimensions and mass are as follows.

	Dimensions	Mass (including packaged products)
Package for main unit	Approx. 990(H)×495(W)×995(D) mm	Approx. 210 kg (220 V AC) or approx. 240 kg (380 V AC)
Package for accessories	Approx. 580(H)×330(W)×460(D) mm	Approx. 27 kg

Checking the Packaged Products

Make sure that all the packaged products are included.

⇒ The model numbers of accessories are subject to change without notice. Depending on the part to be changed, the mounting screw shape may change and anecessary tool may be different. For the latest parts information, contact a nearestsales office.

Package for main unit

Product name	Model No.	Q'ty
YAG Laser Welder	ML-2350A/2351A	1

Package for accessories

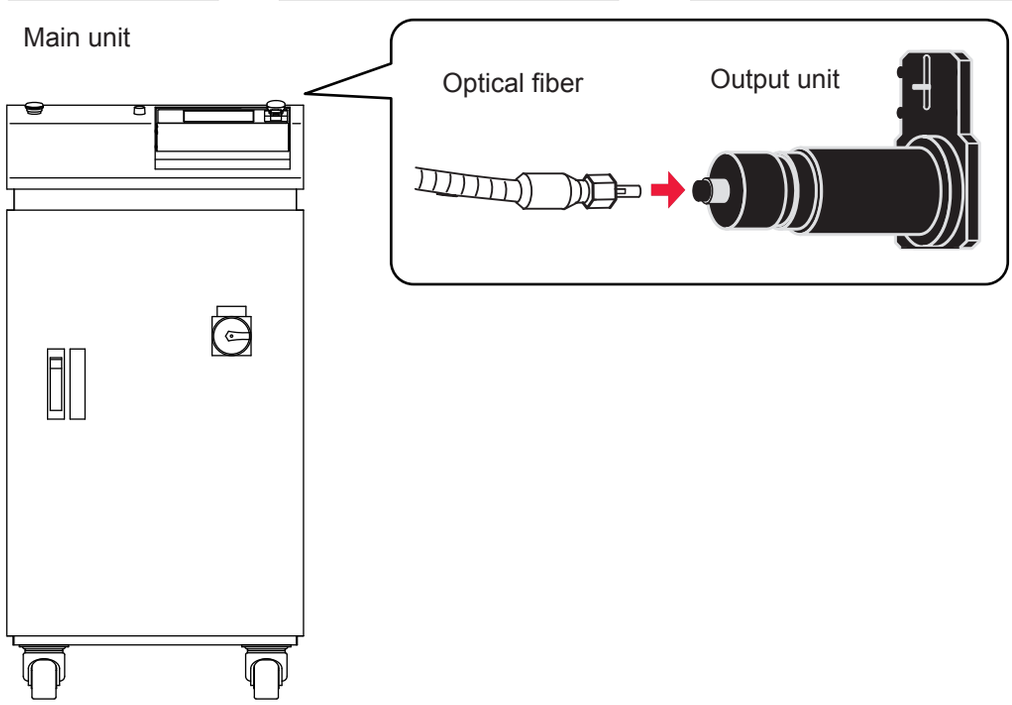
Product name	Model No.	Q'ty
Flashlamp	A-02914-001	1
Flowtube for lamp	PC1204453	1
Ion-exchange resin refill	MLF-0021	1
Water filter	CW-5PM-H	1
Ion-exchange resin replacing tool	MLF-0005	1
Secondary cooling water (Purified water, 20L)	MLU-0604-00	1
Adjuster pressure plate	KC-1275C-3	4
Protective glasses	CE YL-717S	1
Ball point screwdriver	BSL 3mm	1
	BS 4mm	1
	BS 5mm	1
T-shaped hollow wrench (2.5 mm)	TH-25	1
Braided hose (10 m)	φ15 × φ22	1

Product name		Model No.	Q'ty
Hose band (Hose clip)		HS-10 or SGT-W4/9 16-25	4
Water feed hand pump		TP-0002	1
Gloves		Emboss L	2
Danger, warning, caution labels		P-00374-001	2
		P-00474-001	2
		P-0211	2
		P-0212	2
		P-0213	2
		P-00377-001	2
		P-1213	1
Operation manual		AS1011519(M0599E)	1
Power cable (5 m)	220V	A-03315-001	1
	380V	A-03315-003	1

Main Unit, Optical Fiber, and Output Unit

This product is used in combination with the optical fiber and output unit as shown below.

Main unit x 1 + Optical fiber x Number of deliveries + Output unit x Number of deliveries



Main unit

Provided with the number of safety shutters with open-close sensor based on the number of deliveries.

Model	Sharing method	Specification
ML-235□A-010	Single delivery	Output to a single fiber
ML-235□A-020	2-powersharing	Simultaneous output to 2 fibers
ML-235□A-030	3-powersharing	Simultaneous output to 3 fibers
ML-235□A-040	4-powersharing	Simultaneous output to 4 fibers
ML-235□A-002	2-timesharing	Output to one optionally selected from 2 fibers
ML-235□A-003	3-timesharing	Output to one optionally selected from 3 fibers
ML-235□A-004	4-timesharing	Output to one optionally selected from 4 fibers
ML-235□A-005	5-timesharing	Output to one optionally selected from 5 fibers
ML-235□A-006	6-timesharing	Output to one optionally selected from 6 fibers
ML-235□A-022	2 timesharings of 2-powersharing deliveries	Output to 2 optical fibers of an optionally selected block after 4 fibers are divided into 2 blocks, namely, front 2-fiber block and rear 2-fiber block
ML-235□A-023	3 timesharings of 2-powersharing deliveries	Output to 2 optical fibers of an optionally selected block after 6 fibers are divided into 3 blocks, namely, front 2-fiber block, intermediate 2-fiber block, and rear 2-fiber block
ML-235□A-032	2 timesharings of 3-powersharing deliveries	Output to 3 optical fibers of an optionally selected block after 6 fibers are divided into 2 blocks, namely, front 3-fiber block and rear 3-fiber block

Optical fiber

Any optical fiber of the followings is connected to the main unit depending on the specification that you selected at the time of purchase. The model No. differs according to the length.

Model	Type	Core diameter	Length
SIH-02CA□□m	SI	φ 0.2mm	3m, 5m, 10m, 15m, or 20m
SIH-03CA□□m		φ 0.3mm	
SIH-04CA□□m		φ 0.4mm	
SIH-06CA□□m		φ 0.6mm	
SIH-08CA□□m		φ 0.8mm	
ST-1000-MT □□m		φ 1.0mm	

⇒ There are limitations to the maximum laser energy and power that can be input into the optical fiber. For details, refer to the Appendixes, "Specifications" on page 208.

Output unit

The output unit with the specification that you selected at the time of purchase is connected to the main unit. For details, refer to the Operation Manual or Specification for the output unit.

Options

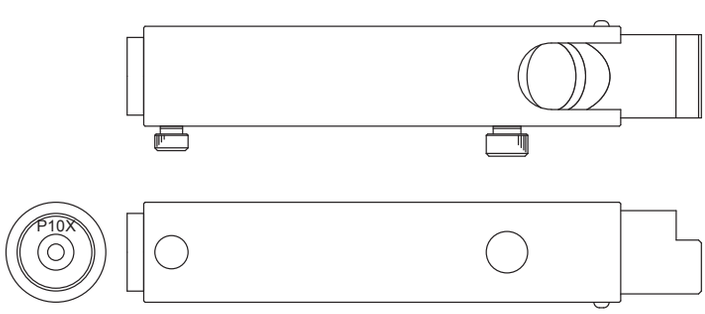
The following goods are options separately sold. Purchase them as required.

Part name	Model No.
Fiber scope	FOS-04
Printer	BL2-58SNWJC
RS-232C/RS-485 conversion adapter	MSC-08S
AC adapter for RS-232C/RS-485 conversion adapter	Exclusively for MSC-08
RS-485 cable, 10 m	A-05391-001
RS-232C cable, 0.2 m	KRS-9F25F02K
End face checker	EC-02(LED)(50)
Output unit with fiber sensor	Please contact us for information.

⇒ For the maintenance parts separately sold, refer to the Maintenance Part, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection/ Replacement" on page 177.

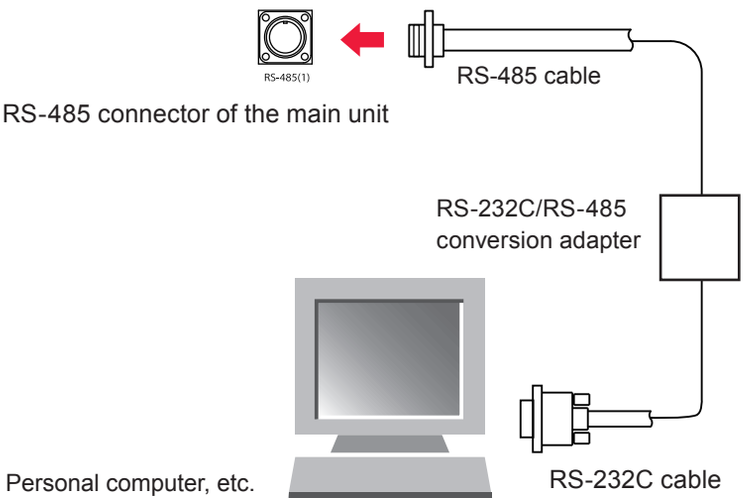
Fiber Scope

This fiber scope is used to check the incident status to the optical fiber. Purchase it as required.



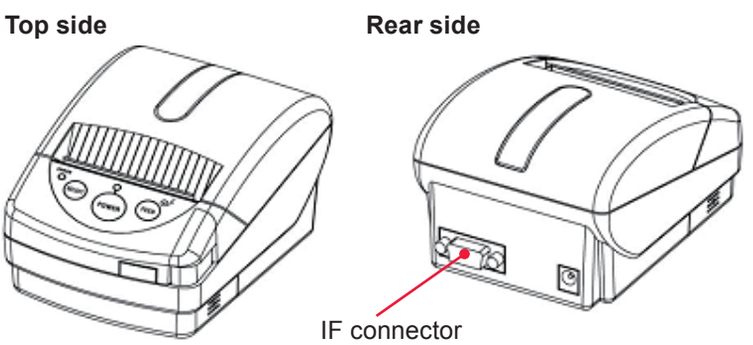
RS-232C/RS-485 Conversion Adapter

This conversion adapter is used to control equipment by external communication. Output signals (RS-232C) of the personal computer are converted into RS-485 signals and then output to the main unit.



Printer

When the printer (BL2-58SNWJC : SANEI ELECTRIC INC.) is connected by RS-485 cable, the output schedules of each schedule and measured values on the monitor screen can be printed out. Purchase the printer as required.



Introduction Part

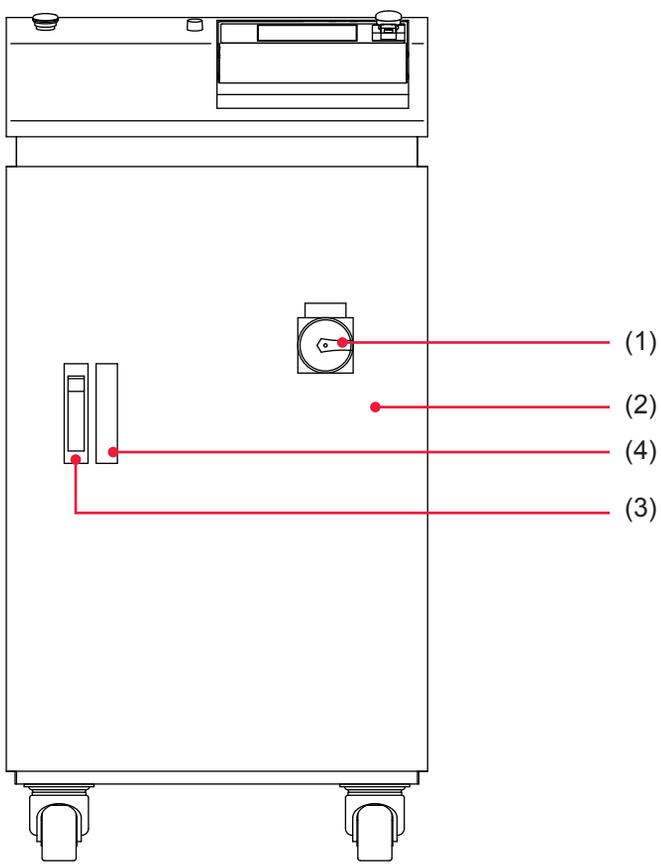
Chapter 2

Name and Functions of Each Section

1. Name and Function of Each Section on the Front Side

Front Cover Section

This section explains each section of the front cover of the main unit.

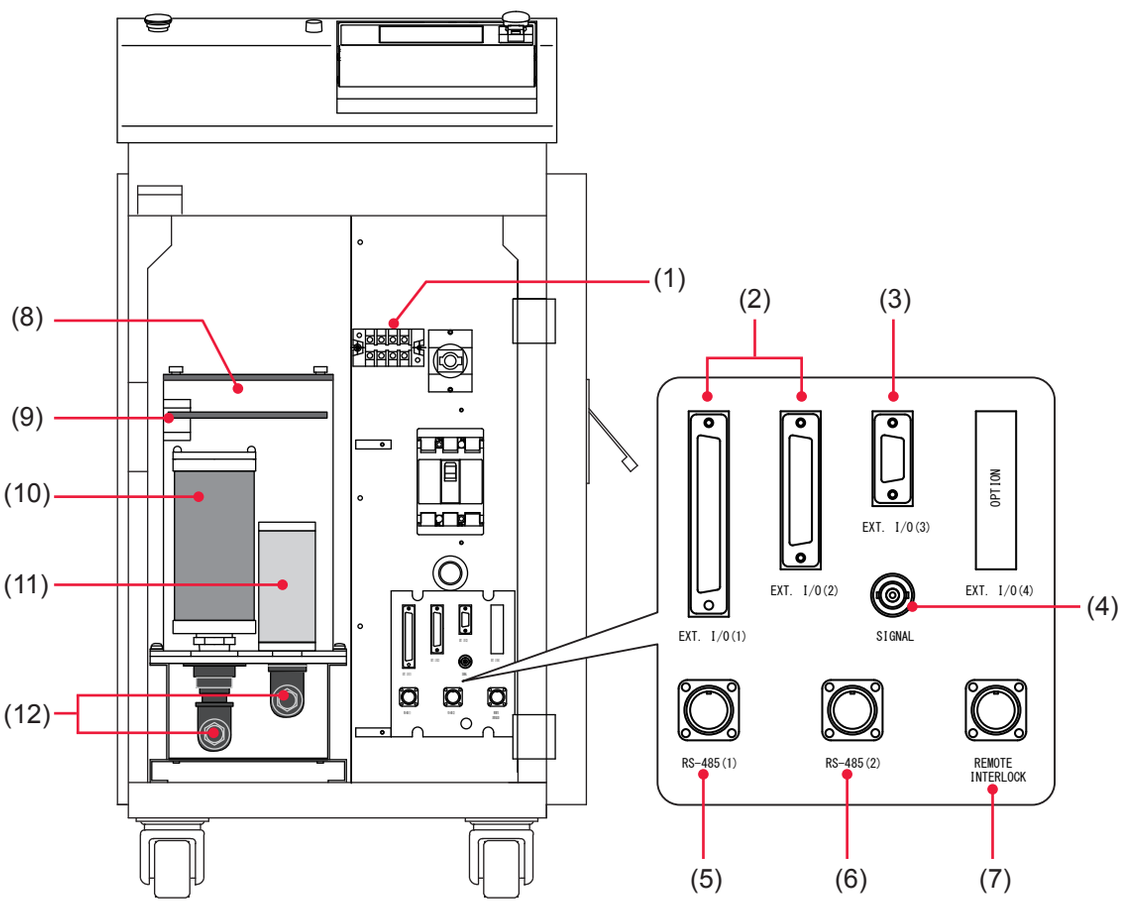


Function of Each Section on the Front Cover

(1) MAIN POWER Switch	Turns ON and OFF the power supply.
(2) Front Door	This door is opened to perform maintenance including cable connections.
(3) Front Door Handle	Used to open the front door. Press the button under the handle and the handle will pop out. After closing the door, put back the handle into place and the door will lock.
(4) Water Level Viewing Windows	For viewing the cooling water level in the cooling water tank.

Inside of the Front Side

The front door is opened to perform maintenance. Each section of the inside is explained below.



Function of Each Section inside the Front Side

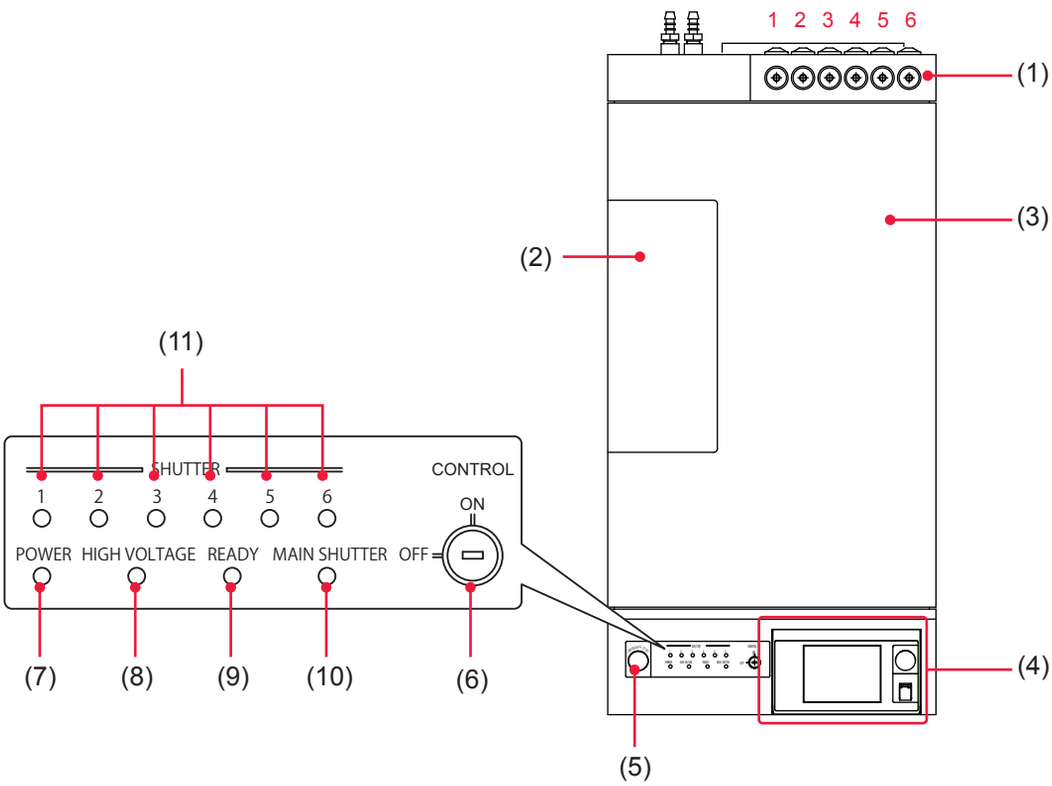
(1) Power Supply Terminals	Connects the 3-phase power supply of 220 V AC/380 V AC (depending on the specification), and the grounding conductor. Remove the plastic cover before use.
(2) EXT. I/O (1)(2) Connectors	Used to output signals, e.g., alarm signals and monitor judgment signals; and to input signals, e.g., start signal and schedule signals.
(3) EXT. I/O (3) Connector	Used to input and output Emergency signals.
(4) SIGNAL Connector	BNC connector used to output an analog signal representing the monitor waveform of laser power. When viewing the waveform of laser output, connect to an oscilloscope.
(5) RS-485 (1) Connector	Connects a personal computer or printer to use the external communication function.
(6) RS-485 (2) Connector	Connects a personal computer or printer to use the external communication function.

(7) REMOTE INTERLOCK Connector	Connect it to the Remote Interlock for emergency stop. When this connector is closed, the resonator shutter and branch shutter of the laser welder are closed to shut off the laser light output.
(8) Cooling Water Tank	Holds secondary cooling water used for cooling the YAG rod, flashlamp and its power supply.
(9) Water Level Label	Shows proper level of the secondary cooling water.
(10) Ion-Exchanger	Increases purity of the secondary cooling water.
(11) Water Filter	Removes fur and other contaminants from secondary cooling water.
(12) Drains	For draining water in the piping to prevent freeze.

2. Name and Function of Each Section on the Top Side

Top Cover Section

This section explains each section of the top cover of the main unit.



Function of Each Section on the Top Cover

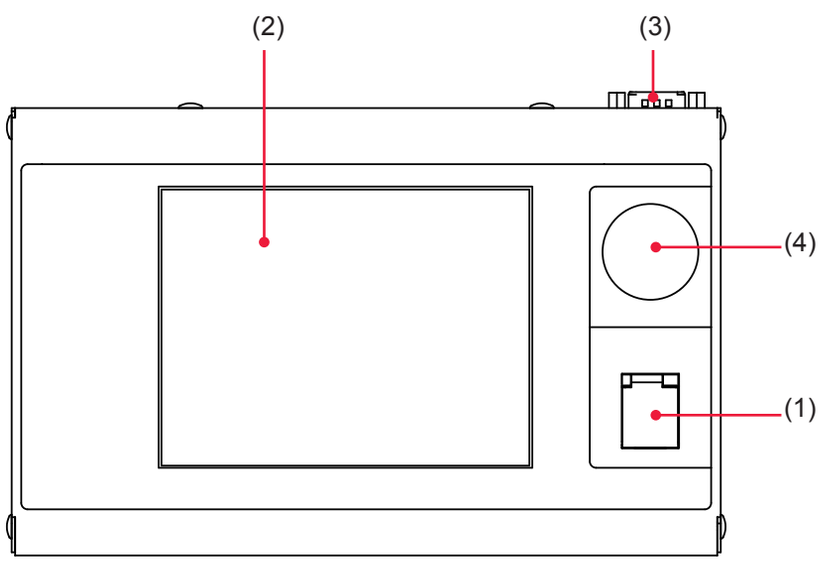
(1) Optical Fiber Inlets	Make the required number (number of deliveries) of holes in the rubber cap. Pass the optical fibers through these holes and connect them to the laser beam input units. These inlets are on the top and rear side. The output units connected to the optical fiber input ports are numbered as 1, 2, 3, 4, 5, and 6 from the left.
(2) Lamp-Replacing Cover	This is a cover of the flashlamp portion. Before replacing the flashlamp, open this cover.
(3) Head Cover	This is a cover for the laser oscillator section.
(4) Laser Controller	This controller sets welding conditions and operates the laser welder. The setting items and set values are displayed on the liquid crystal display.
(5) EMERGENCY STOP Button	This is an emergency stop button. With this button pressed, the laser welder operation is stopped and the same state as that provided by turning OFF the CONTROL keyswitch is provided. The same state as that provided by turning OFF the MAIN POWER switch is provided in the case of CE. However, the power supply circuit is alive. When the pressed button is turned in the direction of RESET (clockwise), the button is reset to the initial state.
(6) CONTROL Keyswitch	When the CONTROL keyswitch is turned ON with the MAIN POWER switch ON, this keyswitch is operable. When the laser is not used, turn OFF the CONTROL keyswitch and then pull out the key. The laser safety supervisor should take charge of the keyswitch.

(7) POWER Lamp	When the MAIN POWER switch is turned ON, the POWER lamp comes on so that the operator can check that the power supply has been turned ON.
(8) HIGH VOLTAGE Lamp	Indicates that high voltage is being supplied to the laser oscillator.
(9) READY Lamp	Lights up when charging of the capacitor bank has been completed.
(10) MAIN SHUTTER Lamp	While the resonator shutter is open, this lamp lights.
(11) SHUTTER Lamp (1 to 6)	Stay(s) on while some (one) of the branch shutters 1 to 6 are (is) open.

Laser Controller (MLE-124A)

In the following, the buttons and keys of the laser controller are explained.

The laser controller is accommodated in the control panel on the top surface of the main unit and used to set welding conditions and performs operations to output laser light. If a circuit cable is connected, operations can be performed in a remote place from the laser welder.



Function of Each Section on the Laser Controller

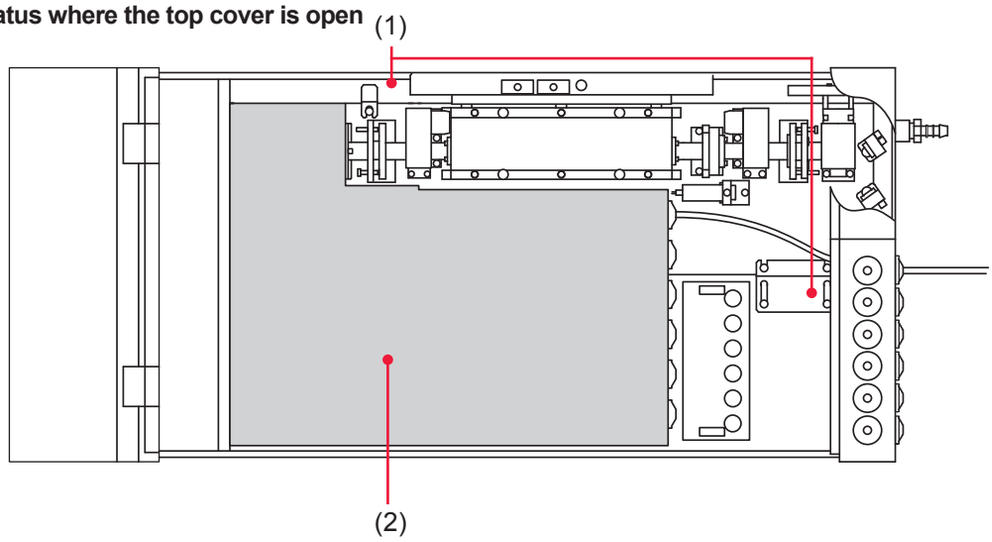
(1) LASER START/STOP (Button)	If you press the button when a laser light output becomes ready (*), laser light is output. If the button is pressed again while laser light is repeatedly output, the repeated output is stopped. * Pin No.23 (control switching) of the EXT.I/O (1) connector is in a closed circuit, a high voltage is supplied, and the branch shutter is open.
EMISSION (Lamp)	When a high voltage is applied to the laser oscillator section, the EMISSION lamp comes on.
(2) Liquid Crystal Display	This is a touch panel type liquid crystal color display. This unit displays setting items, setting buttons, set values, monitor data, and windows and keyboard required for settings.

(3) Circuit Cable Connector	Connect the supplied circuit cable to this connector. Connect the other end of the cable to the Laser.
(4) EMERGENCY STOP (Button)	This is an emergency stop button. With this button pressed, the laser welder operation is stopped. When the pressed button is turned in the direction of RESET (clockwise), the button is reset to the initial state. This button functions in the same way as the EMERGENCY STOP button of the main unit.

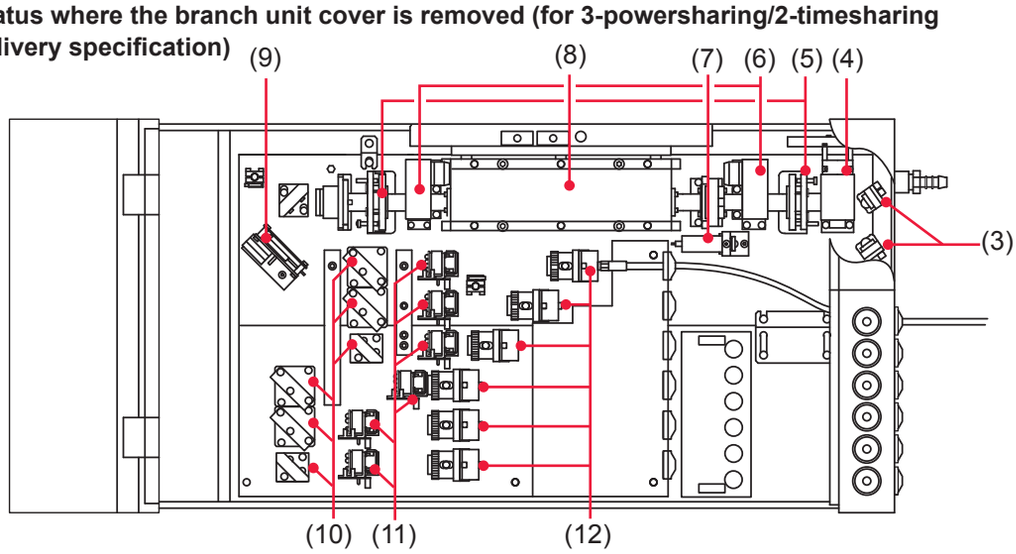
Laser Oscillator Section

The laser oscillator section that makes its appearance after the top cover is opened, and the inside that makes its appearance after branch unit cover is removed, are explained below.

Status where the top cover is open



Status where the branch unit cover is removed (for 3-powersharing/2-timesharing delivery specification)



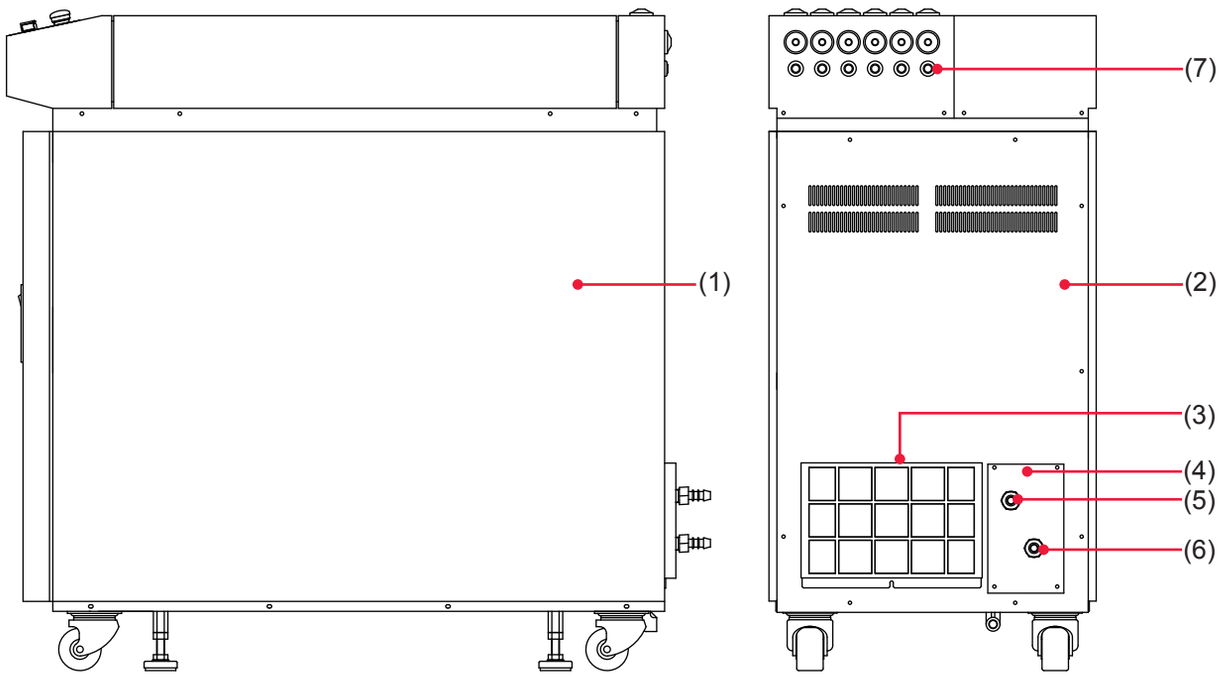
Function of Each Section on the Laser Oscillator

(1) Fixtures	The yellow fixtures used to lock the laser oscillator to prevent any damage or dislocation during transportation. Be sure to remove these two fixtures before starting operations.
(2) Branch Unit Cover	Do not remove this cover except when installing and removing the optical fiber.

(3) Guide Beam Reflecting Mirror	Adjusts the guide beam (visible laser beam) so that this beam passes down the center of the YAG laser beam's optical path.
(4) Power Monitor Unit	Detects the YAG laser beam and measures its power.
(5) Resonator Mirror Holder	Holds the resonator mirror. Light excited in the Laser Chamber is amplified between the two resonator mirrors and output as a laser beam.
(6) Resonator Shutter	This shutter is used to intercept laser light. When this shutter is closed, no laser light is output even if the flashlamp comes on.
(7) Guide Light Oscillator	This oscillator outputs guide light (red visible laser). Because YAG laser for welding is invisible, red guide light is used to perform oscillation adjustment, incident adjustment, welding point positioning, etc.
(8) Laser Chamber	Contains the flashlamp and the YAG rod. The flashlamp lights up to excite the YAG rod and emit laser beam.
(9) Timesharing Unit (Only for timesharing version)	Mirror to reflect the laser light. This optical-path-switching mirror directs the laser light to the selected optical fiber.
(10) Beamsplitter (Up to 6 optional deliveries)	Splits a laser beam into the number of deliveries and reflects them onto each laser beam input unit. Depending on the specification, 1 to 6 beamsplitters are installed.
(11) Branch Shutter (Up to 6 optional deliveries)	When closed, the laser light is blocked not to output. Depending on the specification, 1 to 6 branch shutters are installed.
(12) Laser Beam Input Unit (Up to 6 optional deliveries)	Connect the optical fiber to this unit. The Laser Beam Input Unit projects a laser beam from the laser chamber into the optical fiber. Depending on the specification, 1 to 6 laser beam input units are installed.

3. Name and Function of Each Section on the Lateral Side and Rear Side

This section explains each section on the lateral side and rear side.



Function of Each Section on the Lateral Side and Rear Side

(1) Side Covers	For both sides of the Laser. Power supply and cooler are beyond the cover.
(2) Rear Cover	For rear side of the Laser. Power supply and cooler are beyond this cover.
(3) Air Filter	At the intake of air. Prevents the Laser from dust and dirt. Cooling fan is beyond this filter.
(4) Solenoid Valve Cover	This is a cover for the portion in which the solenoid valve to adjust the quantity of primary cooling water is provided.
(5) Cooling Water Outlet	For the primary cooling water.
(6) Cooling Water Intake	For the primary cooling water.
(7) Cable Inlet	This is a hole through which the cable (option) for mounting the optical fiber or detecting fiber breakage is passed.

Installation and Preparation Part

Installation and Preparation Part

Chapter 1

Installation

This chapter explains where to install the laser welder, how to fix it, and cooling water.

⇒ At installation of this laser welder, our engineer will take charge of adjustments. Accordingly, this Operation Manual does not describe the adjusting method at a startup. When the laser is transferred to another installation place, it may be necessary for our engineer to perform inspection and re-adjustments.

1. Installation Place

The space required for installing the laser welder and the environment suitable for the installation are explained below.

Install laser welder in a sure place at a level with the ground surface. If the product is operated in inclined or fallen form, a failure will occur.

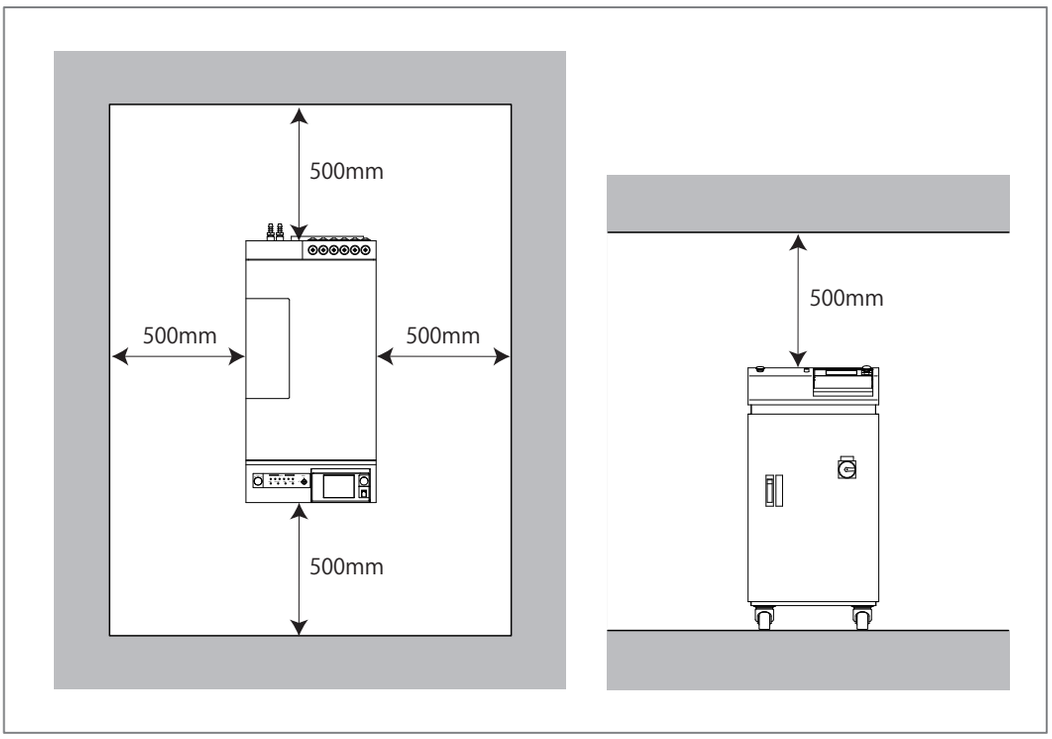
⇒ For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 20 A or more (for 220 V) or 10 A or more (for 380 V), which is applicable to harmonics and surges.

⇒ Perform class D grounding work (for 220 V) or class C grounding work (for 380 V) (Ministry of Economy, Trade and Industry "Technical Standards for Electric Equipment").

Space Required for Installation

In the installation place of this product, at least 500 mm of space is required in front, back, right, left and upper sides to cool the internal parts.

Install the product in a place remote from the wall as shown in the figure on the next page.

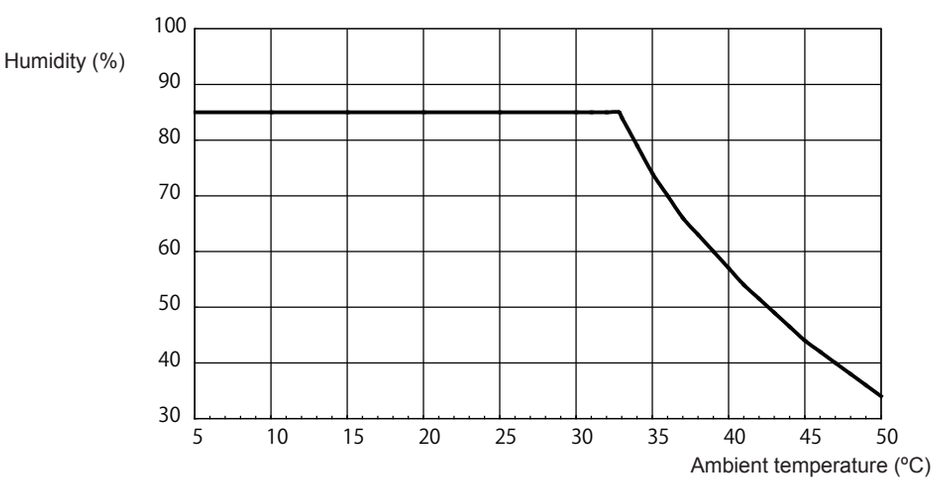


Environment Suitable for Installation and Precautions

⇒ In laser processing, dust and fumes are generated from workpiece. Depending on the kind of workpiece, they may adversely affect a human body. Also, dust and fumes from workpiece may cause staining and burning of optical parts and lower the laser output. Furthermore, if conductive dust enters the laser equipment, a short circuit accident may occur to cause malfunction. Therefore, in laser processing, be sure to install an exhaust device such as dust collector and blower in a proper position to keep a clean environment.

⇒ Use the product in a place where the ambient temperature is 5 to 35ºC and the ambient humidity is 85%RH or less and yet a sudden temperature change does not occur. If the humidity is higher than values shown below, condensation may occur.

Upper limit of ambient humidity



⇒ Avoid operating the product in the following places because a failure may occur.

- Place where there is considerable dirt, dust, or oil mist,
- where the Laser may be subjected to vibration or impact,
- where the Laser may be exposed to chemicals,
- where there is a nearby high noise source,
- where moisture may be condensed on the surface of the Laser,
- where the concentration of CO_2, NOx or SOx is high. (Air containing more than 0.1% CO_2 may shorten the life of the ion-exchange resin.)

⇒ If the temperature falls below 0°C in winter, the cooling water will be frozen and the Laser may be broken. Particularly in cold districts, take care that the temperature of the Laser does not fall below 0°C. When the product is not operated for one month or longer or the temperature is 0ºC or less, bleed the equipment of cooling water completely. For bleeding, refer to the Maintenance Part, Chapter 1 "2. Maintenance of the Cooler Unit Section" on page 188.

⇒ When a sudden temperature change occurs, for example, at a start of heating, condensation will be caused to the end face of the YAG rod and the surface of the mirror, thereby sticking dust there. Avoid such a sudden temperature change if possible. When there is a possibility of condensation, turn ON the power supply of the laser. In about 2 hours, start to operate the laser.

2. Fixing the Laser Welder

In this laser welder, fixtures are installed to protect the oscillator against vibrations and shocks during transportation. This section explains how to fix the laser welder on the floor after clearing the fixturea of the laser oscillator.

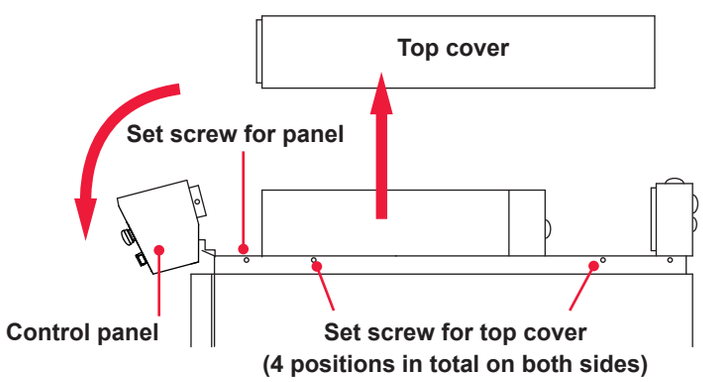
Item required

Phillips screwdriver, adjuster pressure fixture, and anchor, etc.

1 Clearing the Fixture

(1) Remove the set screws for panel provided in the upper part of the side surface of the main unit and bring down the control panel forward.

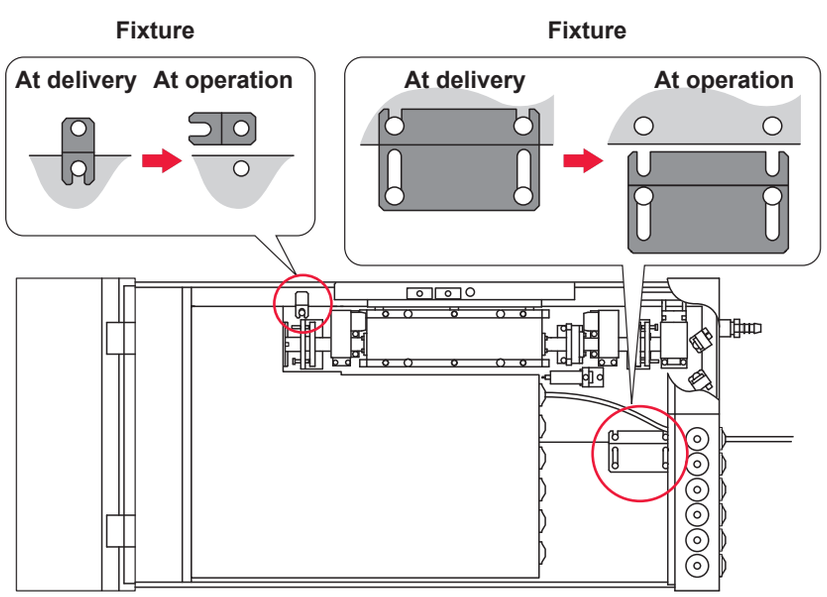
(2) Remove the top cover.
Remove the set screws for top cover provided on both sides and pull up the top cover straight upward.



(3) Loosen the screws to clear the fixture, so that the laser oscillator is put in a remote place from the oscillator base.

⇒ After the fixture is cleared, the laser oscillator is put to a floating status with a rubber legs. Slight vibrations are absorbed. However, take care not to give a strong shock.

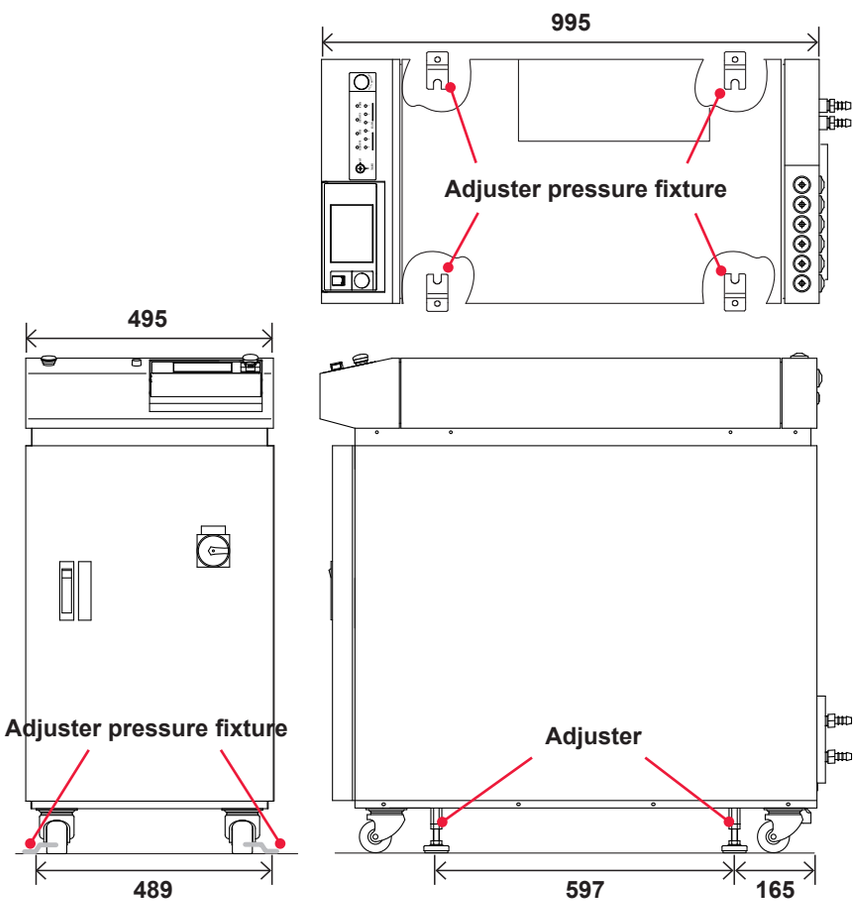
Top surface of the main unit (when the cover is open)



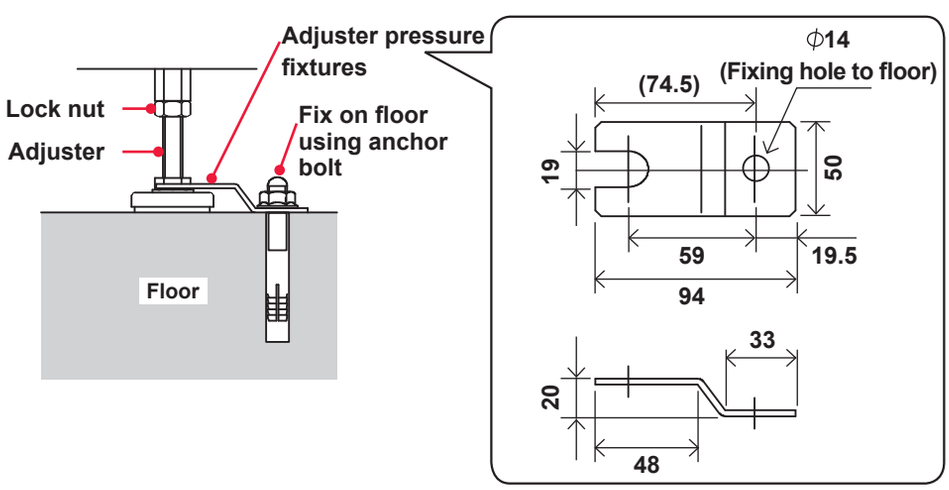
⇒ For moving the laser welder after it is installed, fix the laser oscillator with the fixture to put it to the same status as when it is delivered.

2 Fixing the Laser Welder

(1) Install the attached adjusters pressure fixtures on the adjusters provided in 4 positions in the lower part of the main unit.



(2) Fix each adjuster on the floor by using a connecting apparatus such as anchor.



⇒ The connecting apparatus is not attached as an accessory. Prepare it on the customer side.

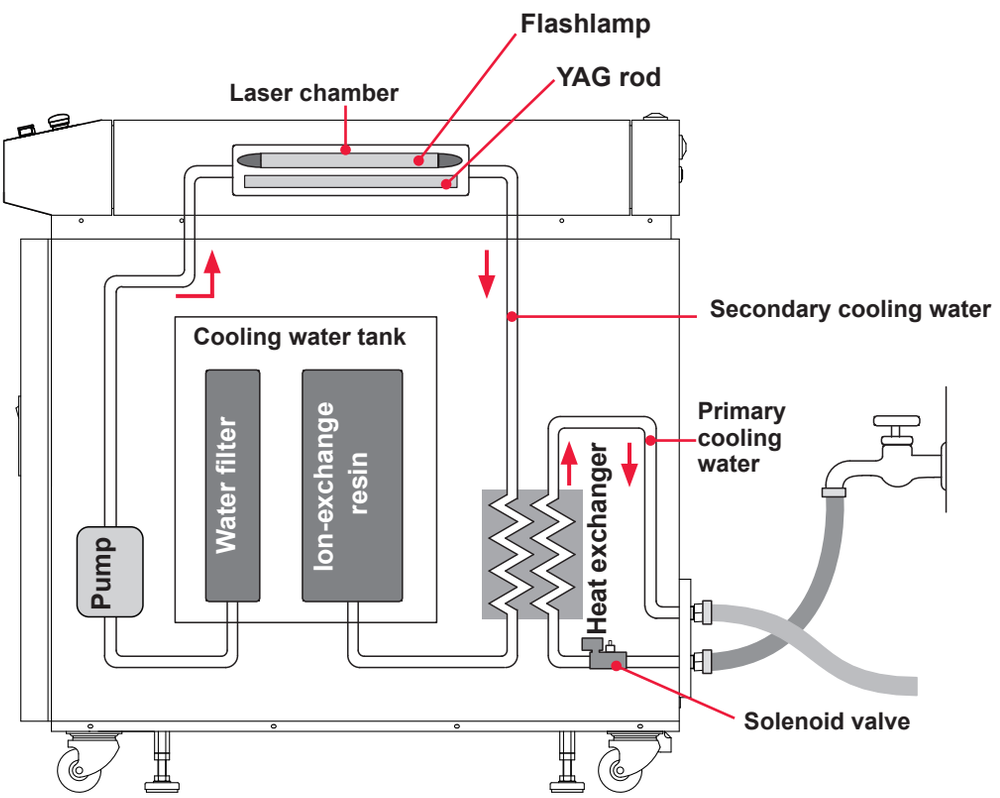
3. Cooling Water

To cool the flashlamp and YAG rod in the laser chamber of the laser oscillator, two types of cooling water are used.

The primary cooling water is used to cool the secondary cooling water. Use city or industrial water for the primary cooling water.

The secondary cooling water is used to cool the flashlamp and YAG rod. Use deionized water or purified water for the secondary cooling water.

Tap water, industrial water, ground water, or ultra pure water (16 MΩ·cm minimum resistivity) may cause corrosion or clogging, resulting in fault of the equipment.

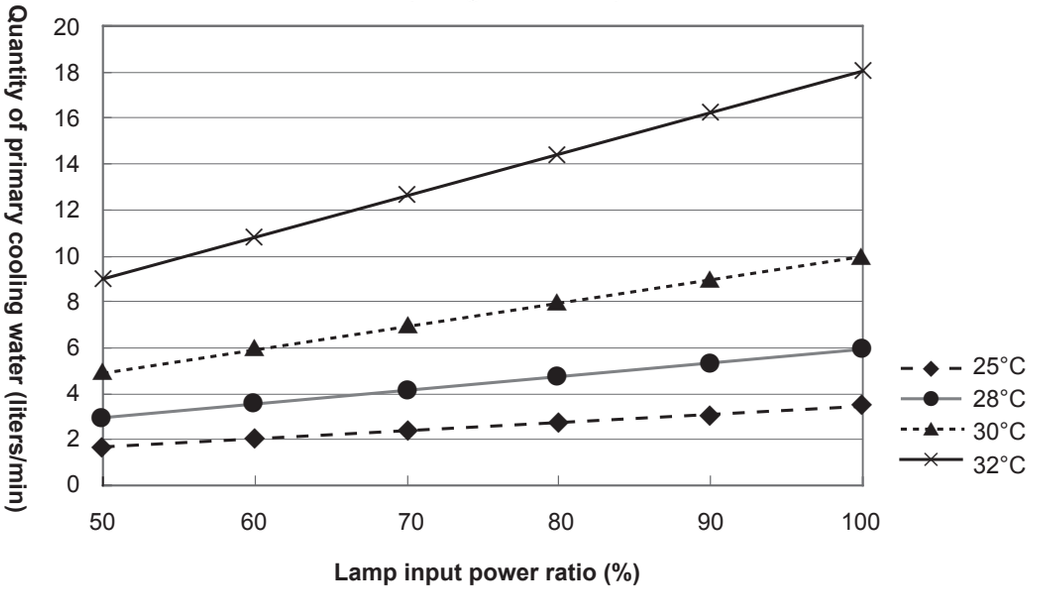


Required Quantity of Primary Cooling Water

The following graph shows the required quantity of primary cooling water at each water temperature of 25ºC, 28ºC, 30ºC and 32ºC when the using ratio is 100%.

As the lamp input power ratio becomes higher, the required quantity of primary cooling water is increased more.

Required quantity of primary cooling water at a water temperature of 25ºC to 32ºC (Using ratio: 100%)



Water Quality Standard for Primary Cooling Water

To avoid corrosion of the heat exchanger and the water piping, the water quality must be according to following table:

	Item	Unit	Reference value
Standard item	pH (25°C)	-	6.0 to 8.0
	Electric conductivity (25°C)	mS/m	Up to 30
	Chloride ion	mgCl^-/L	Up to 50
	Sulfate ion	mgSO_4^{2-}/L	Up to 30
	Acid consumption (pH4.8)	mg$CaCO_3$/L	Up to 50
	Total hardness	mg$CaCO_3$/L	Up to 70
	Calcium hardness	mg$CaCO_3$/L	Up to 50
	Ionized silica	mgSiO_2/L	Up to 30
Reference item	Total iron	mgFe/L	Up to 0.3
	Total copper	mgCu/L	Up to 0.1
	Sulfide ion	mgS^{2-}/L	Not to be detected
	Ammonium ion	mgNH_4^+/L	Up to 0.1
	Residual chlorine	mgCl/L	Up to 0.3
	Free carbon dioxide	mgCO_2/L	Up to 4.0

Installation and Preparation Part

Chapter 2

Connections and Preparations of Each Section

1. Connecting the Power Supply

CAUTION

Your qualified electrician must carry out the electrical connection to main power supply. (Also follow your local accident prevention regulations, such as the German Regulation, BGVA2.)

CAUTION

For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 20 A or more (for 220 V) or 10 A or more (for 380 V), which is applicable to harmonics and surges.

***This equipment uses a single-phase pump. Do not connect to the output of the inverter power supply.**

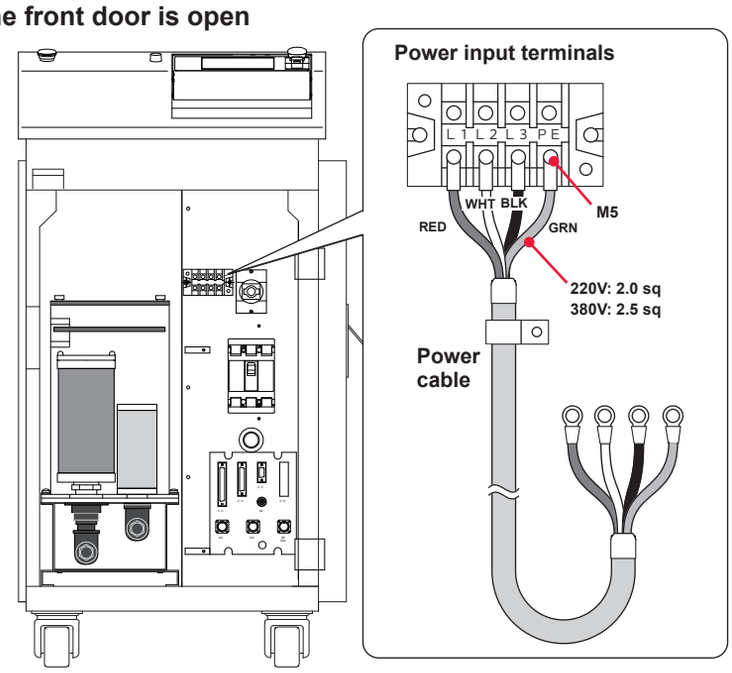
Item required

Phillips screwdriver

Operating Procedure

(1) Open the front door and remove the plastic cover on the power input terminal 220 V AC/380 V AC (depending on the specification).
(2) Lead the attached power cable inward from the hole on the bottom plate of the main unit.
(3) While confirming the terminal colors of the power cable, connect the power cable to the L1, L2, L3, and PE power input terminals.

When the front door is open



2. Connecting the Hose for Primary Cooling Water

This section explains how to connect the hose for primary cooling water to the primary cooling water inlet and the primary cooling water outlet.

⇒ Use city water or industrial water, as the primary cooling water, with a pressure of 0.1 MPa (approx. 3 kgf/cm^2) max. and a differential pressure of 0.1 to 0.3 MPa (approx. 1 to 3 kgf/cm^2).

⇒ The required flow rate of primary cooling water varies depending on the temperature of the cooling water. Refer to "Required Quantity of Primary Cooling Water" on page 45.

Item required

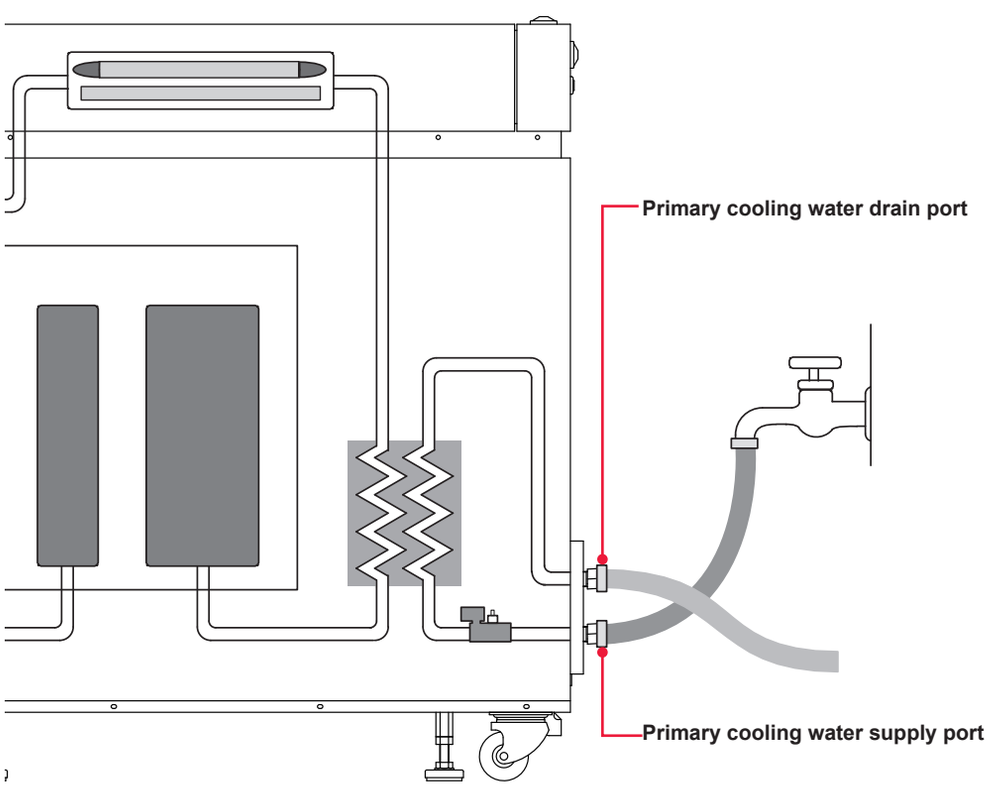
Braided hose (Internal diameter: φ15 mm) and hose band

Operating Procedure

(1) Connect the attached braided hose to the primary cooling water supply port on the rear surface of the main unit. Connect one end of the hose to a primary cooling water inlet such as tap water plug.

⇒ Connect the braided hose by using the attached hose band so that it may not be disconnected.

(2) Connect the attached braided hose to the primary cooling water discharge port. Put one end of the hose into the drain port of the installation place.



3. Preparing the Secondary Cooling Water

⚠ CAUTION

Use deionized water or purified water as secondary cooling water. Tap water, industrial water, ground water, or ultra pure water (16 MΩ•cm minimum resistivity) may cause corrosion or clogging, resulting in fault of the equipment.

Item required

Secondary cooling water (12 liters) and water feed pump

Operating Procedure

(1) Open the front door and remove the lid of the cooling water tank.

(2) Take out the floating panel in the tank.

⇒ Take care not to attach dirt onto the floating panel.

(3) Feed cooling water up to the line under the water level label "HIGH" by using the attached water feed pump.

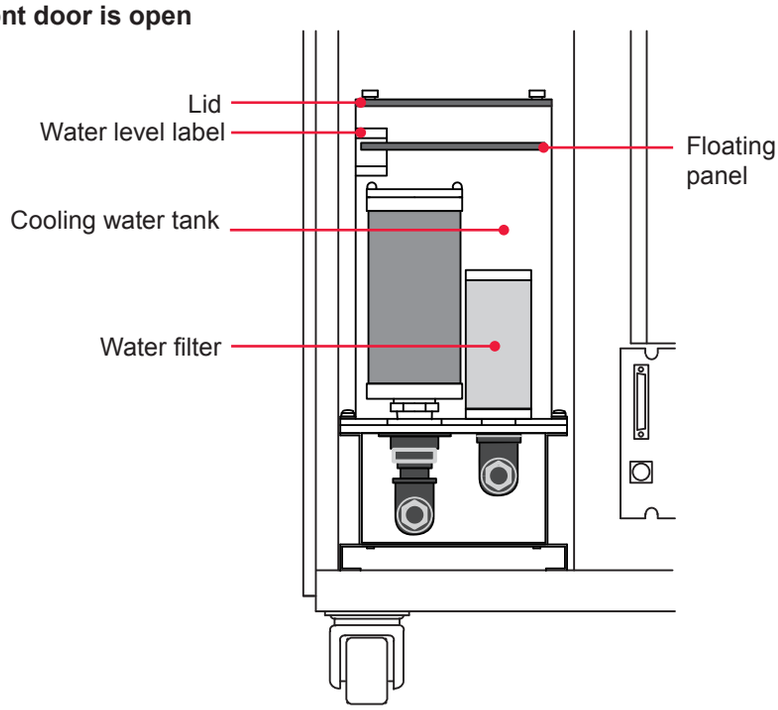
⇒ Use the water feed pump only for secondary cooling water and do not use other uses including kerosene.

(4) Float the floating panel on the water and install the lid of the cooling water tank as before.

⇒ The floating panel can be repeatedly used. When it is stained, wash it lightly in tap water with a soft sponge and lastly rinse it in deionized water or purified water for use.

⇒ When the cooler is operated for the first time after water feeding, the water level may a little lower. In this case, replenish cooling water again. Before feeding cooling water, be sure to take out the floating panel.

When the front door is open



4. Connecting the Optical Fiber

This section explains the method of connecting the optical fiber.

In this laser, a high-precision type optical fiber is adopted. Once the incident optical axis is adjusted, this optical axis does not need to be adjusted again after the fiber is mounted.

⚠ WARNING

- **Be sure to receive education for this work from our engineer.**
- **Before starting work, be sure to turn OFF the power supply.**

Before Connection

Before making a connection, check the end face of the optical fiber. If it is stained or dust is attached, blow it off by air blow or wipe it out with lens cleaning paper.

For how to clean the optical fiber, refer to the Maintenance Part, Chapter 1, "3. Maintenance of the Laser Oscillator Section" on page 195.

⇒ For a check for stain, use the optional end face checker.

⇒ Use such an air blow dedicated to cameras as shown at right. If rubber is deteriorated, dust may enter the optical fiber. Use a clean air blow.

Precautions during Operation

⇒ During operation, take care not to give shocks to the optical fiber or bend it below the minimum bending radius (in the following table).

Minimum bending radius of the optical fiber

Core diameter	Minimum bending radius
φ 0.2, 0.3, 0.4mm	100mm
φ 0.6mm	150mm
φ 0.8mm	200mm
φ 1.0mm	250mm

⇒ Do not tighten the ring of fiber plug too firmly; otherwise the incident laser beam may be dislocated. Tighten the ring by hand without using a tool.

Standard Values of Maximum Incident Laser Energy and Power of the Optical Fiber

The following table shows the standard values of maximum laser energy and power that can be input into the optical fiber. Take care not to exceed these values when using the optical fiber.

For single-delivery or timesharing

The value becomes 1/2 at 2-powersharing, 1/3 at 3-powersharing, and 1/4 at 4-powersharing.
The value when the beam expander (option) is installed is shown in ( ).

Core dia. \ Model	ML-2350A	ML-2351A
SI φ 0.2mm	- (30J, 30W)	- (50J, 50W)
SI φ 0.3mm	50J, 30W (70W)	50J, 50W
SI φ 0.4mm	70J, 50W (70W)	
SI φ 0.6, 0.8, 1.0mm	70J, 70W	

⇒ Fiber of less than φ 0.4 mm is suitable for ML-2351A.
⇒ Use the SI optical fiber. The GI optical fiber cannot be used.

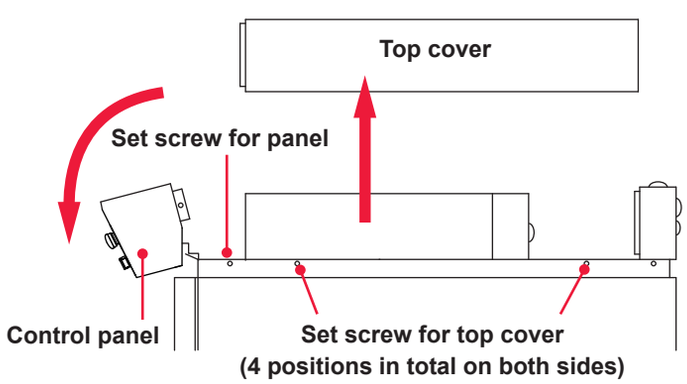
Item required

Phillips screwdriver and air blow

1 Connecting to Laser Beam Input Unit

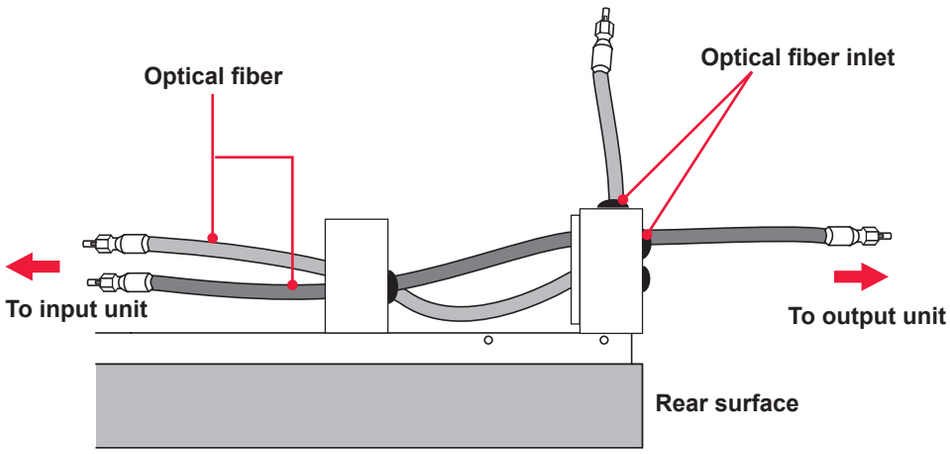
(1) Remove the fixing screws at the upper front of both sides, and turn the operation panel toward you.

(2) Remove the fixing screws of both sides.
Remove the set screws for top cover provided on both sides and pull up the top cover straight upward.



(3) Remove the branch unit cover.

(4) Put the end of the optical fiber into the optical fiber inlet with the cap mounted.



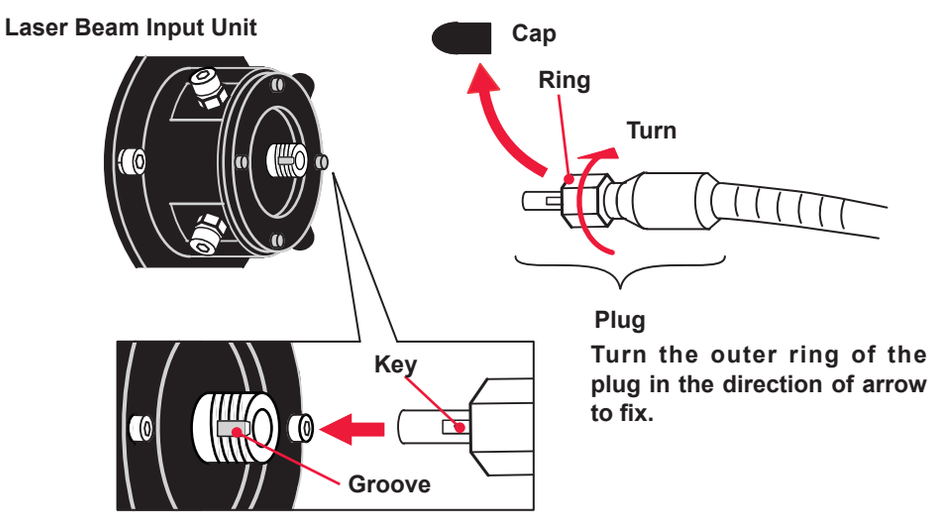
There are 2 optical fiber inlets, namely, one on the top surface and the other on rear surface of the main unit.

(5) Remove the cap from the end of the passed fiber and blow off any dust using an air blow.

(6) Connect the fiber to the laser beam input unit, with the key of the fiber plug aligned with the groove of the unit.

(7) Turn the outer-side ring of the plug in the direction of the arrow to fix the optical fiber.

⇒ Tighten the ring by hand without using a tool.



Turn the outer ring of the plug in the direction of arrow to fix.

(8) Install the branch unit cover and top cover as they were.

(9) Return the control panel to the initial position and fix it.

2 Connecting to Laser Beam Output Unit

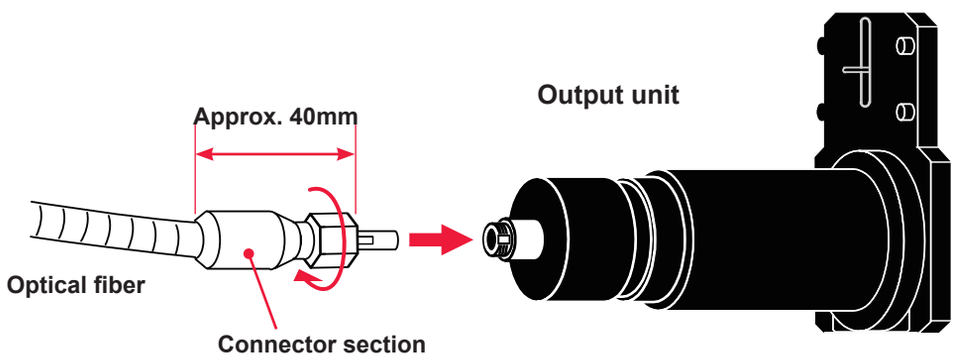
(1) Remove the cap at the end of the optical fiber and blow off dust by using the air blow.

(2) Insert the key provided on the optical fiber plug along the groove on the output unit side.

(3) Turn the outer-side ring of the plug in the direction of the arrow to fix the optical fiber.

⇒ Tighten the ring by hand without using a tool.

⇒ The connector section cannot be bent. Take care not to give excessive force to this section.



⇒ Keep the recover cap in a clean place in custody. If a dirty cap is mounted again, this will cause seizure.

5. Connecting the Laser Controller Circuit Cable

For separating the laser controller from the main unit for use, connect the circuit cable.

⚠ CAUTION

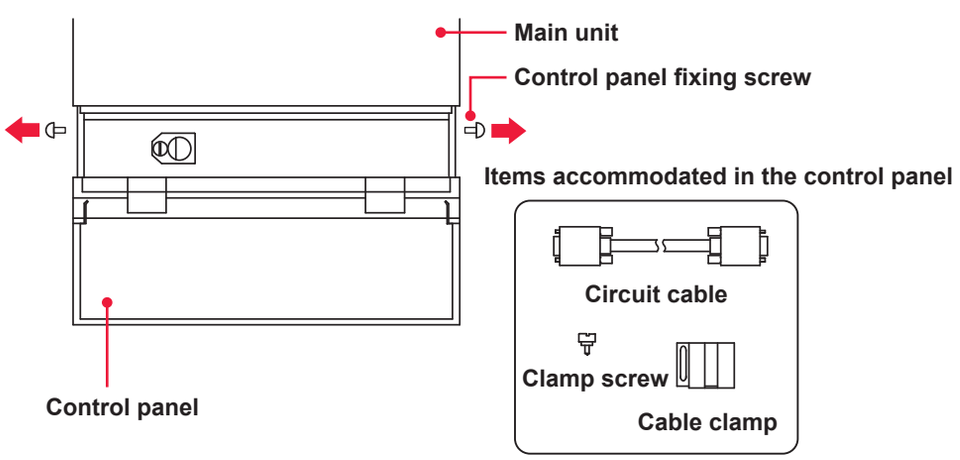
Be sure to turn OFF the power supply before starting a circuit cable connecting operation.

Item required

Circuit cable, cable clamp, set screws, and Phillips screwdriver

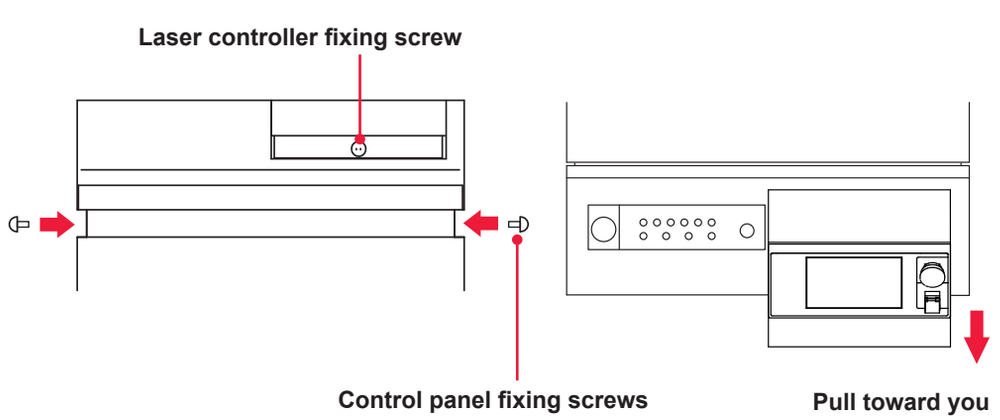
Operating Procedure

(1) Remove the set screws for control panel on both sides and open the control panel. Then, take out the circuit cable, cable clamp, and set screws that are accommodated in the control panel.

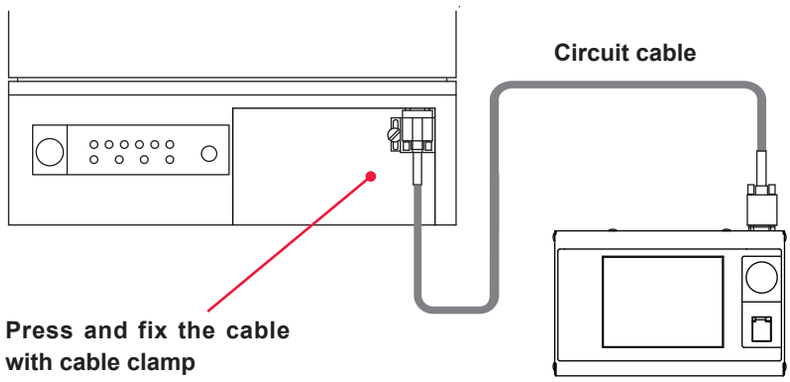


(2) Close the control panel and tighten the fix screws to fix the control panel as it was.

(3) Remove the set screws for laser controller and slide the laser controller forward to remove it.



(4) Connect the circuit cable to the laser controller and the Laser.
Clamp the cable at the Laser with the cable clamp and clamp screw.



6. Connecting the External Communication Conversion Adapter (Option)

To perform laser welding by external communication control (RS-485 CONTROL) by using a control unit mounting RS-232C such as personal computer, the optional conversion adapter for external communication "RS-232C/RS-485 conversion adopter" is required.

⇒ For making a connection to a PLC provided with RS-485, the conversion adapter for external communication is not required.

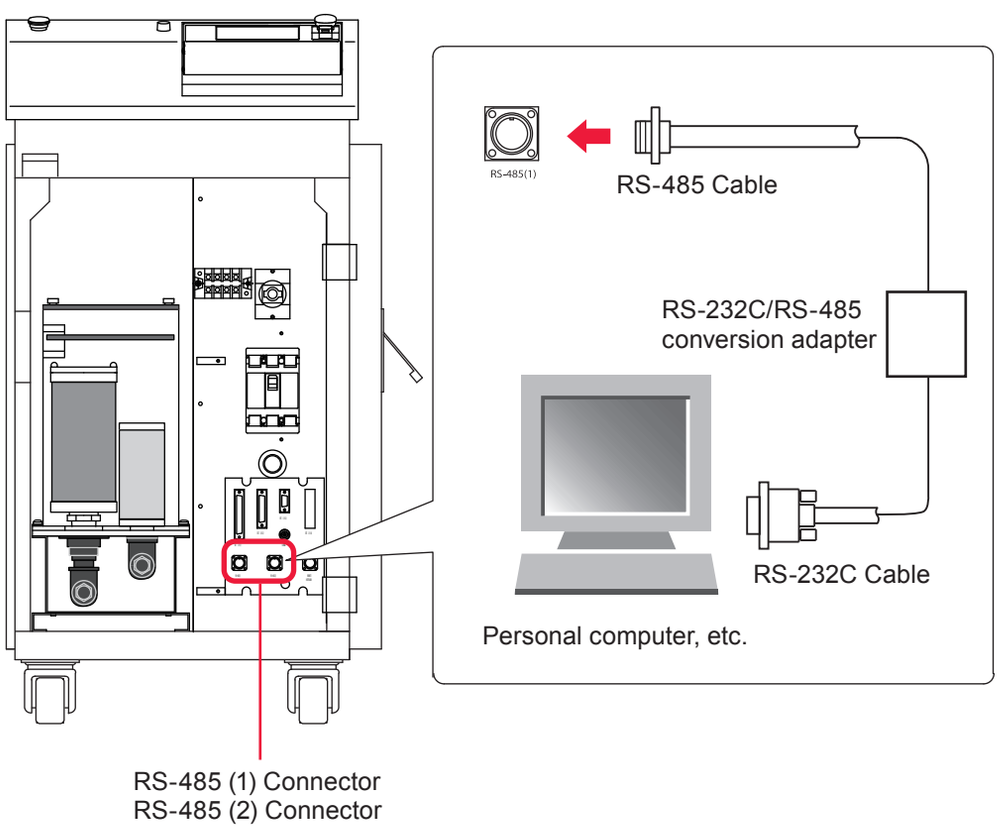
Item required

RS-232C/RS-485 conversion adapter, RS-485 cable, and RS-232C cable

Operating Procedure

(1) Connect the RS-485 cable to the RS-485 (1) or RS-485 (2) connector of the main unit.

(2) Connect the RS-232C cable to the RS-232C connector of the personal computer or the like through the "RS-232C/RS-485 conversion adapter."



Operating Part

Operating Part

Chapter 1

Control Method, and Start and Stop

1. Control Method

This section explains the control method for the laser.

The following 3 control methods are available, namely, control from the laser controller (PANEL CONTROL), control by external input/output signals connecting the PLC (*) to the laser (EXTERNAL CONTROL), and control by sending commands from the personal computer or the like (RS-485 CONTROL).

Select one of these 3 control methods according to the welding work. The selected control method is displayed on the STATUS screen.

*: PLC: Programmable Logic Controller which is a unit to perform sequence control by executing the programmed contents of control in sequence. This unit is often called sequencer (product name of Mitsubishi Electric Corporation).

Switching the Control Method

Control by Laser Controller (PANEL CONTROL)

When the laser is used independently or when the power supply of the PLC or personal computer connected to the laser is OFF, the laser is under control by laser controller.

⇒ To switch the control by external input/output signals over to the control by laser controller, turn OFF pin No.23 (control switching) of the EXT. I/O (1) connector.

⇒ To switch the control by external communication control over to the control by laser controller, send a command to set the control method from the personal computer.

⇒ If the CONTROL keyswitch of the main unit is turned OFF even if another control method is used, it is reset to the control by laser controller. When the CONTROL keyswitch is turned on again, the control method is switched to the control from the laser controller if the external communication control is used, or the control method is set to the control by external input/output signals if the control by external input/output signals is used and Pin No.23 (control switching) of the EXT. I/O (1) connector is ON (closed circuit).

Control by External Input/Output Signals (EXTERNAL CONTROL)

When the PLC or the like is connected to the main unit and pin No.23 (control switching) of the EXT.I/O (1) connector is turned ON (closed circuit), the control by external input/output signals (EXTERNAL CONTROL) is selected.

⇒ This control method cannot be selected by operating the laser controller or personal computer.

Control by External Communication Control (RS-485 CONTROL)

The control by external communication control is selected by sending a command to set the control method from the personal computer or the like connected to the main unit.

⇒ This control method cannot be selected by operating the laser controller or external input/output signals.

2. Start and Stop

This section explains the methods of starting and stopping the laser.

How to Start the Laser

Operating Procedure

(1) Turn ON the MAIN POWER switch.

(2) Turn ON the CONTROL keyswitch.

(3) Select a control method as required and perform laser welding.

⇒ For the control by laser controller, set the output schedules and sharing method by operating the buttons while watching the liquid crystal screen display, and press the LASER START/STOP button to output laser light.

⇒ For the control by external input/output signals, execute the program by PLC, switch the control method, select output schedules, set the sharing method, and exert laser start/stop to output laser light.

⇒ For the control by external communication control, execute the program, switch the control method, set output schedules, set the sharing method, and exert laser start/stop to output laser light.

How to Stop the Laser

Operating Procedure

(1) Turn OFF the high voltage.

(2) Turn OFF the CONTROL keyswitch and pull out the key.

(3) Turn OFF the MAIN POWER switch.

⇒ The laser safety supervisor takes charge of the key of the CONTROL keyswitch.

Operating Part

Chapter 2

Various Settings

1. Setting Welding Schedules

This section explains the method of setting various laser welding schedules by using the laser controller. The set schedules can be protected so that they cannot be changed.

Welding Schedule Setting Screen

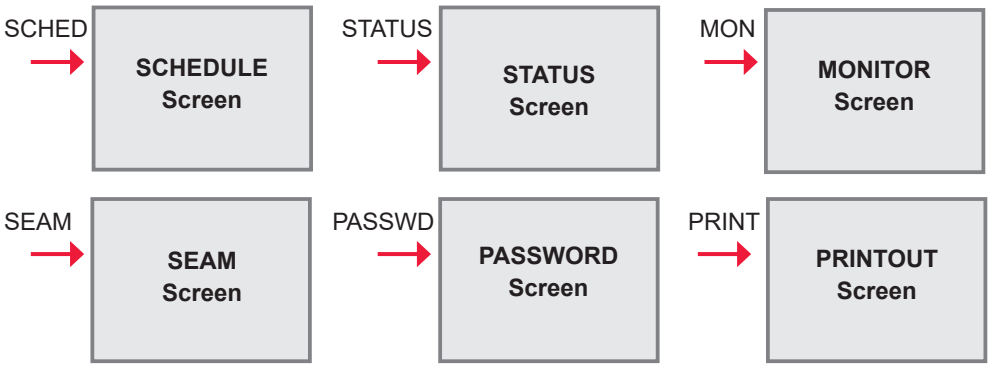
This section explains how to see the SCHEDULE, STATUS, MONITOR, SEAM, and PASSWORD screens to set a welding schedule, and also the PRINTOUT and INITIALIZE screens.

There are 6 types of basic screen as shown below which are displayed on the liquid crystal display of the laser controller. Each screen is selected to perform each setting by the button displayed on the screen.

Each time the screen selecting button arranged on the right side of each screen is pressed, each of the SCHEDULE screen, STATUS screen, MONITOR screen, SEAM screen, PASSWORD screen, and PRINTOUT screen appears in sequence from the top. When laser light is output, the MONITOR screen is automatically displayed so that the output energy can be checked.

To set the external communication function by using a PC or to switch each function, display the INITIALIZE screen.

When each of the screen selecting buttons is pressed:

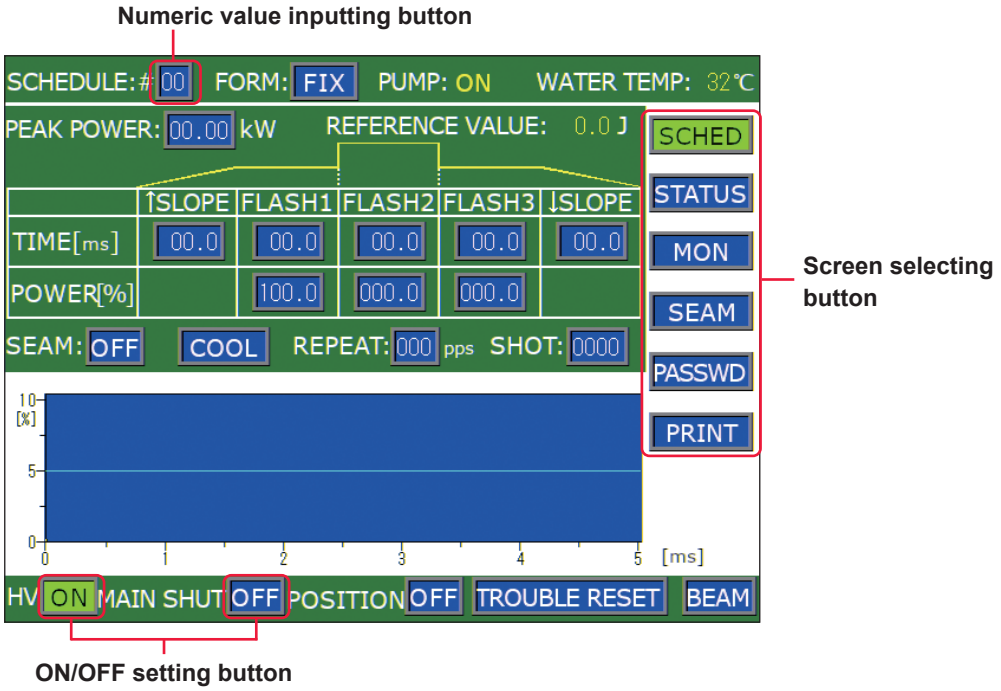


When the power supply is turned ON with the CONTROL keyswitch OFF:

How to Use the Touch Panel

The laser controller of this laser welder adopts a touch panel type that permits touching the screen directly for an operation. Press the displayed button portion on the screen with a finger to select a screen or perform each setting.

There are screen selecting buttons, ON/OFF setting buttons, numeric value inputting buttons and others.

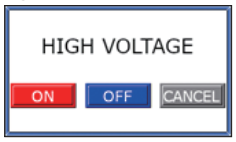


Screen selecting button

Regarding the screen selecting buttons, the selected screen button is displayed in green.

ON/OFF setting button

Regarding the ON and OFF setting buttons, OFF is displayed in blue and ON is displayed in blinking green. When the OFF blue button is pressed, a check window is displayed. If OFF is switched over to ON by pressing the ON or YES button, the ON setting is displayed in green.

Example: OFF → 

When pressing ON → ON

* There are some buttons displayed in green at ON.
* There are some buttons that change the setting without displaying a check window.
* While the ON/OFF setting windows is displayed, screens cannot be switched even if another button is pressed.

Numeric value inputting button

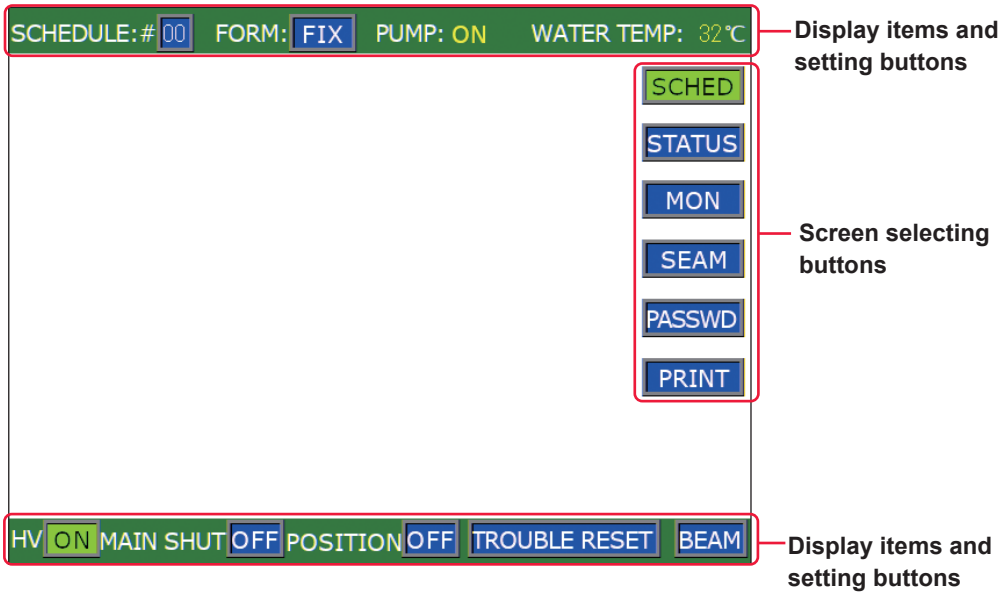
When this button is pressed, a numeric keypad is displayed and then a numeric value can be input. When there are multiple input items, change the item by using the ◄ ► key. The input value is definitively set by pressing the ENT key.

Example: 000.0 → 

Numbers of the numeric keypad are pressed and then the ENT key is pressed. → 100.0

Items and Buttons Common to Each Screen

The display items, setting buttons, and screen selecting buttons provided on the following screens are common to the 6 types of basic screen.



How to See the Display Items and How to Use the Setting Buttons

: Settable item

SCHEDULE	Sets the SCHEDULE No. of laser light. Output conditions can be registered by setting the 32 numbers of #00 to #31 or set schedule can be called. The set schedule number is displayed on the button.
FORM	Sets the waveform creating method. When this button is pressed, a window to select "FIX" (fixed waveform) or "FLEX" (flexible waveform) is displayed. Select a creating method by pressing an optional button. The set method (FIX or FLEX) is displayed at the button.
PUMP	Displays the ON/OFF status of the pump to circulate cooling water.
WATER TEMP	Displays the temperature of cooling water.
HV	Sets the high voltage (HIGH VOLTAGE) to ON/OFF. When this button is pressed, a window to select ON/OFF is displayed. At ON, a high voltage is turned ON and the HIGH VOLTAGE lamp comes on. At OFF, no high voltage is supplied and no laser light is output. The set value (ON or OFF) is displayed at the button.
MAIN SHUT	Sets the opening/closing status of the resonator shutter (MAIN SHUTTER). When this button is pressed, a window to select ON/OFF is displayed. At ON, the resonator shutter is opened and laser light can be output. At OFF, the resonator shutter is closed. With the resonator shutter closed, the flashlamp does not come on and no laser light is output. The set value (ON or OFF) is displayed at the button.

POSITION	Sets the guide light output to ON/OFF. When the button is pressed, a window to select ON/OFF is displayed. At ON, guide light is output. At OFF, no guide light is output. The selected result (ON or OFF) is displayed at the button. The time required for guide light to go out automatically can be set by "POSITION AUTO-OFF" on the INITIALIZE screen.
TROUBLE RESET	Resets the screen by clearing the error display after error processing is completed. When an error screen appears at occurrence of an error, remove the cause of the error and press this button. Then, the ordinary screen reappears.
BEAM	Sets the opening/closing of the branch shutter or beamsplitter to ON/OFF. With this button pressed, a window to set the opening/closing of the branch shutter or beamsplitter is displayed. (The window depends on the setting of the DIP switch.) At ON, the branch shutter is opened. At OFF, the branch shutter is closed. When there is even one branch shutter or beamsplitter set to ON, the button is displayed in blinking green.

How to Use the Screen Selecting Buttons

SCHED	When this button is pressed, the SCHEDULE screen appears. Select this button to set laser output conditions or call the set SCHEDULE.
STATUS	When this button is pressed, the STATUS screen appears. Select this button to check the laser welder control method or perform each setting such as the opening/closing of the branch shutter.
MON	When this button is pressed, the MONITOR screen appears. Select this button to check the measured value of laser light.
SEAM	When this button is selected, the SEAM screen appears. Select this button to set the output waveform of seam welding.
PASSWD	When this button is pressed, the PASSWORD screen appears. Select this button to set the password.
PRINT	When this button is pressed, the PRINTOUT screen appears. Select this button to print the set values of each SCHEDULE or the measured values of the MONITOR screen when an optional printer is connected.

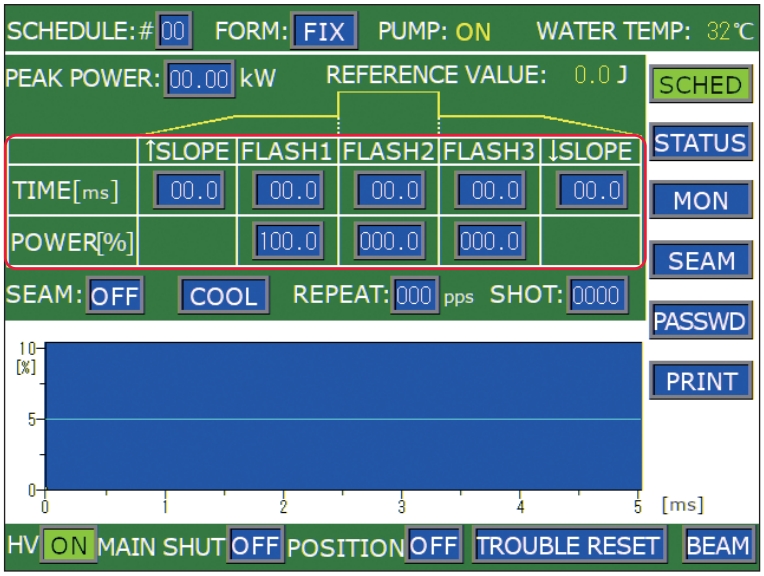
SCHEDULE Screen

On the SCHEDULE screen, the laser light output schedules are set and registered by giving SCHEDULE numbers.

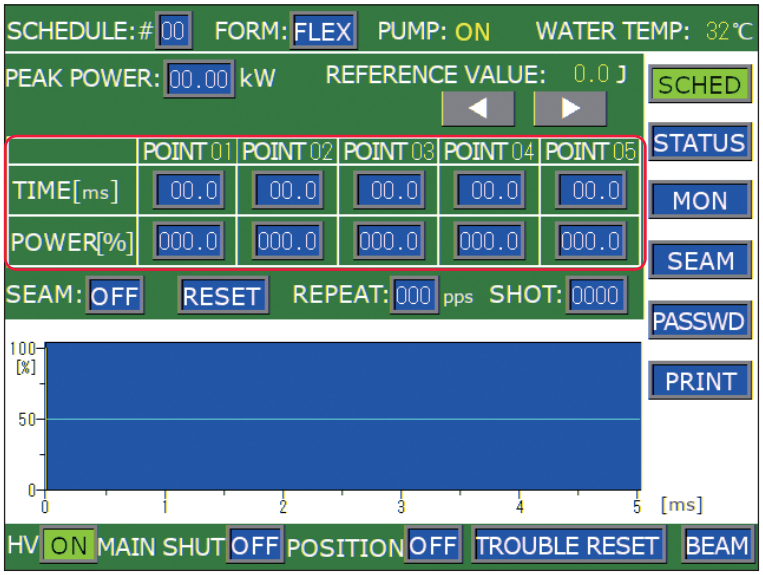
If a registered SCHEDULE number is entered, the corresponding output schedules can be called.

The setting items of laser output time and laser output value are different between fixed waveform (FIX) and flexible waveform (FLEX). For seam welding, the output conditions for seam welding can be set on the SEAM screen.

Fixed waveform (FIX) screen



Flexible waveform (FLEX) screen



How to see the displayed items

: Settable item

PEAK POWER	Sets the peak value of laser output (value when "FLASH1" to "FLASH3" are 100%). Regarding the actual laser output value ("FLASH1" to "FLASH3"), set the ratio (%) to the peak value supposing that the set peak value is the reference value (100%). ***<Note>*** The settable maximum peak value of laser output differs depending on the model. ML-2350A: 7.0 kW, ML-2351A: 5.0 kW

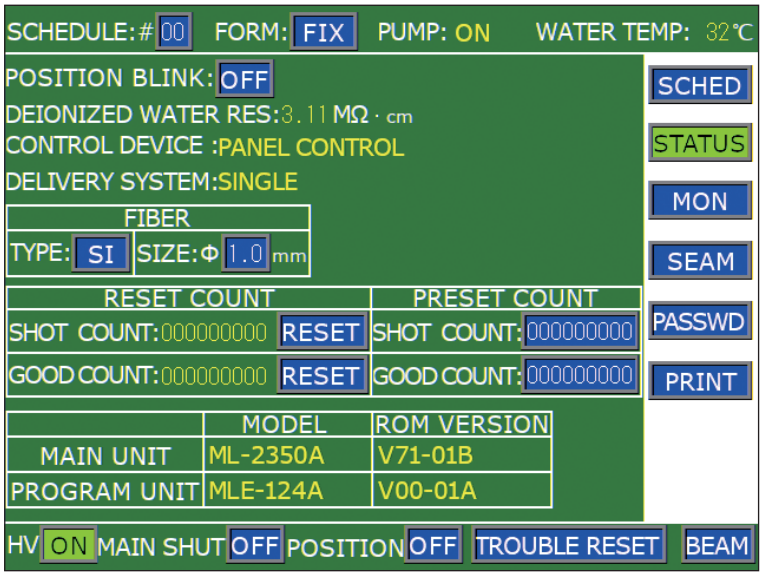
Fixed waveform (FIX)	**↑SLOPE**	Sets the up-sloping (the laser output becomes gradually stronger) time to "FLASH1." After setting "FLASH1", set this time in the range of ↑SLOPE ≤ FLASH1.
	FLASH1	Sets the laser output time TIME [ms] and laser output value POWER [%] of the first laser in the following range. Laser output time (TIME [ms]): 0.0 to 30.0 ms Laser output value (POWER [%]): 0 to 200% The time of ↑SLOPE is included in the output time of FLASH1.
	FLASH2	Sets the laser output time TIME [ms] and laser output value POWER [%] of the second laser in the same range as that for the first laser.
	FLASH3	Sets the laser output time TIME [ms] and laser output value POWER [%] of the third laser in the same range as that for the first laser. The time of ↓SLOPE is included in the output time of FLASH3.
	↓SLOPE	Sets the down-sloping (the laser output becomes gradually weaker) for the last FLASH. Sets this time in the range of ↓SLOPE ≤ FLASH1, FLASH2, FLASH3. ***<Notes>*** - The laser output value (%) setting range is 0 to 200%. However, the laser output value cannot be set exceeding the maximum value of "PEAK POWER" x 100%. If the laser output value is set to 100%, the value set in "PEAK POWER" is selected. ML-2350A: The threshold value of PEAK is 7.0 kW. (The laser output value of FLASH is up to 100% when PEAK is set to 7.0 kW.) ML-2351A: The threshold value of PEAK is 5.0 kW. (The laser output value of FLASH is up to 100% when PEAK is set to 5.0 kW.) - Set the laser output time so as to satisfy the expression of 0.25 ms ≤ FLASH1 + FLASH2 + FLASH3 ≤ 30.0 ms. - Set the total time of FLASH1 + COOL1 + FLASH2 + COOL2 + FLASH3 to a less value than 90.0 ms.
Flexible waveform (FLEX)		Scrolls the POINT display column of POINT 01 to POINT 20 to the right and left. When a POINT is not displayed, press this button to display it.
	POINT 01 . . . **POINT 20**	To set the flexible waveform "FLEX", set the laser output time (TIME [ms]) and laser output value (POWER [%]) at each point of "POINT 01" to "POINT 20" in the following range. Laser output time (ms): 0.1 to 30.0 ms Laser output value (%): 0 to 200% ***<Notes>*** - Set the laser output time so as to satisfy the expression of 0.25 ms ≤ Total of all POINT values ≤ 100.0 ms. - Set the total time of laser output time of all POINTs to a less value than 90.0 ms when the time of 0% is included in the output value.
	RESET	Clears all the set values of POINT 01 to POINT 20.
REFERENCE VALUE		The forecast value of laser output energy (J) based on the set laser output schedules is displayed. ***<Note>*** This laser calculates the laser light output energy by laser power feedback control. However, there is a little difference between the forecast value of laser output energy and the measured value (actually measured value) depending on the optical and electrical characteristics. Use the forecast value of laser output energy as reference.

SEAM	Sets the fade function (*) to ON or OFF. *: Laser output value adjusting function. The laser energy is increased decreased slowly to provide a continuous waveform suitable for seam welding. When this item is set to ON, the fade function for seam welding is enabled. When the item is set to OFF, this function is disabled. When this function is not used, set it to OFF.
COOL	Sets the COOL1/COOL2. COOL1: Sets a value other than 0.0 ms to insert the non-laser output time between FLASH1 and FLASH2. COOL2: Sets a value other than 0.0 ms to insert the non-laser output time between FLASH2 and FLASH3.
REPEAT	Sets the number of laser light outputs per second in the range of 000 to 200 pps (pulse per second). When 0 is set, the single output is set. Common to "REPEAT" on the SEAM screen.
SHOT	Sets the number of laser outputs in the range of 0000 to 9999. When the laser output count reaches the set value, the laser output is stopped. When 1 is set, a single-shot output is performed. When "REPEAT" is set to a value other than 0 and "SHOT" is set to 0, laser light is continuously output until a laser stop signal is input. Common to "SHOT" on the SEAM screen.

⇒ For the common items in the upper/lower part of the screen, refer to page 63.

STATUS Screen

On the STATUS screen, the laser control method is checked and it is set that the branch shutter to output laser light is opened. In addition, the total number of laser light outputs and the appropriate number of outputs are set.



How to see the displayed items : Settable item

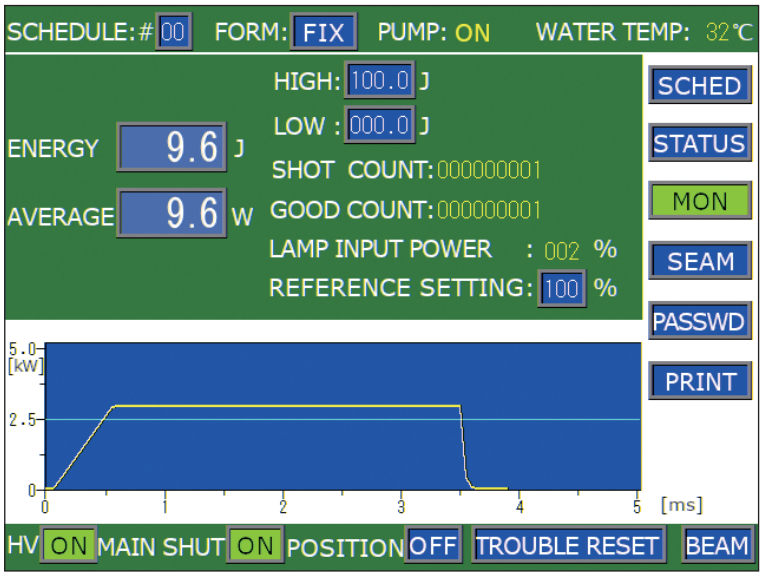
POSITION BLINK	Sets the guide light blinking status (POSITION) or continuous lighting to ON or OFF. When POSITION BLINK is set to ON with the guide light ON, the guide light blinks. If it is set to OFF, the guide light is put into a continuous ON status.

DEIONIZED WATER RES	Displays the insulation level of the secondary cooling water.
CONTROL DEVICE	Displays the used laser control method. EXTERNAL CONTROL (external control): Control is exerted by the PLC connected to the EXT.I/O connector. PANEL CONTROL (internal control): Control is exerted by laser controller. RS-485 CONTROL (external communication control): Control is exerted by the personal computer connected to the RS-485 (1) or RS-485 (2) connector.
DELIVERY SYSTEM	Displays the laser light sharing method such as single delivery, powersharing, and timesharing.
FIBER TYPE **SIZE**	Selects SI (Step Index) or GI (Graded Index) for the optical fiber type to be used. Usually, SI is selected. Sets the core diameter of the applied optical fiber to protect the optical fiber from excessive incident light to the optical fiber. The setting range is φ0.2 to 1.0 mm. The maximum value that can be input into the optical fiber is calculated from the set core diameter in order to restrict the lamp input power.
RESET COUNT **SHOT COUNT** **GOOD COUNT**	Resets the displayed total number of laser light outputs (SHOT COUNT). Resets the displayed appropriate number of laser light outputs (GOOD COUNT).
PRESET COUNT **SHOT COUNT** **GOOD COUNT**	Sets the count-notification function. When the total number of laser light outputs (SHOT COUNT) or the appropriate number of laser light outputs (GOOD COUNT) reaches the set number, a message is displayed.
MAIN UNIT	Displays the product model and the software version of the main unit.
PROGRAM UNIT	Displays the product model and the software version of the laser controller.

⇒ For the common items in the upper/lower part of the screen, refer to page 63.

MONITOR Screen

On the MONITOR screen, the measured value of monitored laser light is checked and the monitor value range and the upper limit value of flashlamp input power are set.



How to see the displayed items

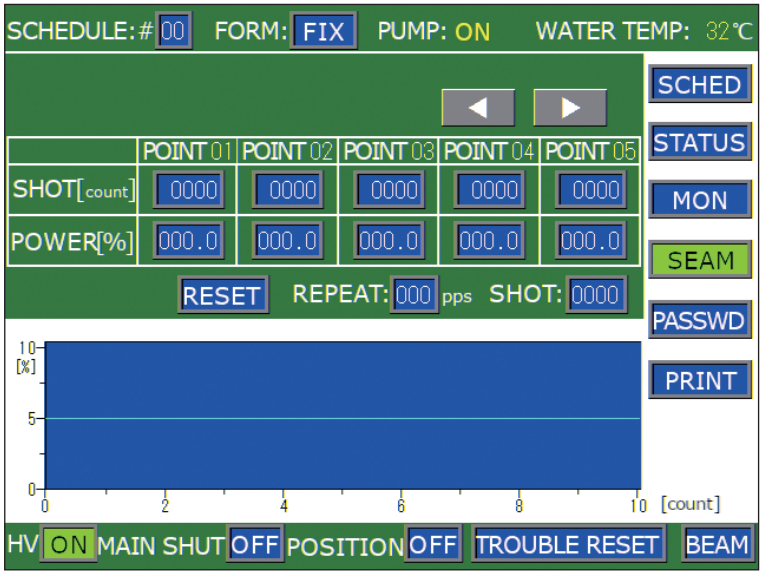
: Settable item

ENERGY	Displays the measured value (J) of laser energy. Each time laser light is output, the laser energy is measured and its value is displayed. In the case of a high-speed repeated output, however, the energy is displayed at certain intervals because the display timing is too quick.
AVERAGE	Displays the average power (W) of output laser light per second. An upper/lower limit judgment is not performed.
HIGH **LOW**	Sets the upper limit value "HIGH" and lower limit value "LOW" of the laser energy to be monitored. When the laser energy comes out of the set value range, a monitor trouble is output. Press the TROUBLE RESET button to clear the trouble.
SHOT COUNT	Displays the total number of laser light outputs. Refer to this number when replacing the flashlamp. To reset the display to 0, perform a reset operation on the STATUS screen.
GOOD COUNT	Displays the appropriate number of laser light outputs. The appropriate number of outputs means the laser light output within the allowable energy range set at "HIGH" and "LOW." To reset the display to 0, perform a reset operation on the STATUS screen.
LAMP INPUT POWER	Displays the flashlamp power. The power input to the lamp is displayed by the ratio (%) to the maximum input value native to the lamp. ***<Note>*** When the laser is used in the status where a value of 80% or more is displayed, the replacement cycle of the flashlamp may be shortened.
REFERENCE SETTING	Sets the upper limit value of lamp input power in the range of 0 to 100%. Usually, this value is set to 100%. The set value becomes the reference value for flashlamp deterioration notice. When the set value is exceeded, a screen to notify the approach of the flashlamp replacement time is displayed.

⇒ For the common items in the upper/lower part of the screen, refer to page 63.

SEAM Screen

On the SEAM screen, the fade-in/out function of seam welding is set. The fade-in/out function means a laser output value adjusting function. This function lowers and raises the later energy in a gentle slope form to provide a continuous waveform suitable for seam welding.



How to see the displayed items

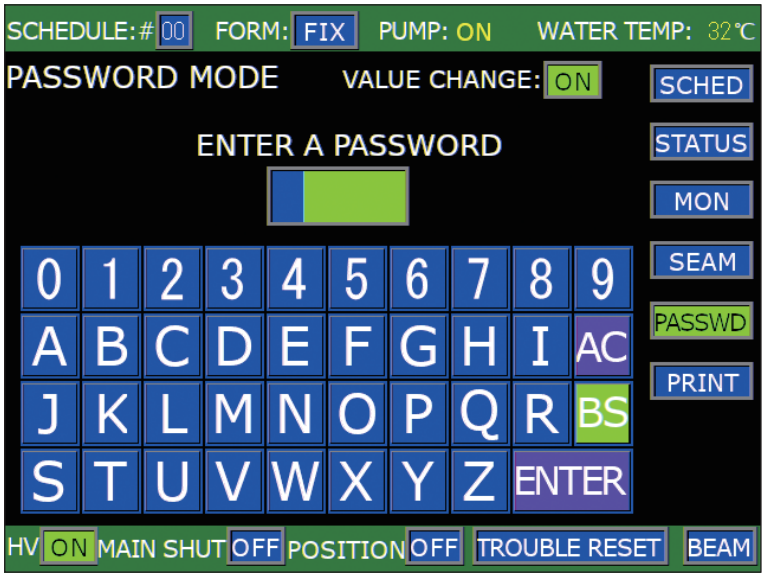
: Settable item

◀ ▶	Scrolls the POINT display column of POINT 01 to POINT 20 to the right and left. When a POINT is not displayed, press this button to display it.
SHOT [COUNT]	Sets the laser light output count of POINT 01 to POINT 20 in the range of 0000 to 9999.
POWER [%]	Sets the laser output value of each "SHOT" of POINT 01 to POINT 20 in the range of 0 to 150.0% being the ratio to "PEAK POWER" set on the SCHEDULE screen. The laser output value is shifted to the output value set for the next POINT in a gentle slope waveform by the fade-in/out function to adjust the laser output value.
RESET	Clears all the set values of POINT 01 to POINT 20.
REPEAT	Sets the number of laser light outputs per second in the range of 000 to 200 pps (pulse per second). When 0 is set, the single output is set. Common to "REPEAT" on the SCHEDULE screen.
SHOT	Sets the number of laser outputs in the range of 0000 to 9999. When the laser output count reaches the set value, the laser output is stopped. When 1 is set, a single-shot output is performed. When "REPEAT" is set to a value other than 0 and "SHOT" is set to 0, laser light is continuously output until a laser stop signal is input. Common to "SHOT" on the SCHEDULE screen.

⇒ For the common items in the upper/lower part of the screen, refer to page 63.

PASSWORD Screen

On the PASSWORD screen, a password is set to protect the set welding schedule.



How to see the displayed items

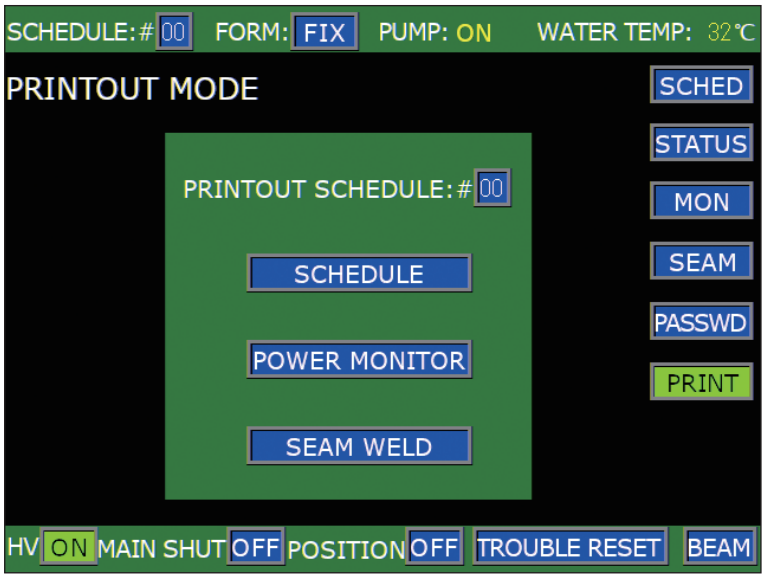
: Settable item

VALUE CHANGE	Sets the validity/invalidity of the set password to ON/OFF. At OFF, the password is validated and the set values are protected. At ON, the password is not validated and the set values are not protected.
ENTER A PASSWORD	Enter a password into the input box from the keyboard displayed on the screen. AC: Deletes all the entered characters. BS: Deletes a character in front of the cursor one by one. ENTER: Checks the entered password for correctness.

⇒ For the common items in the upper/lower part of the screen, refer to page 63.

PRINTOUT Screen

On the PRINTOUT screen, the set values are printed by connecting an optional printer.



How to see the displayed items

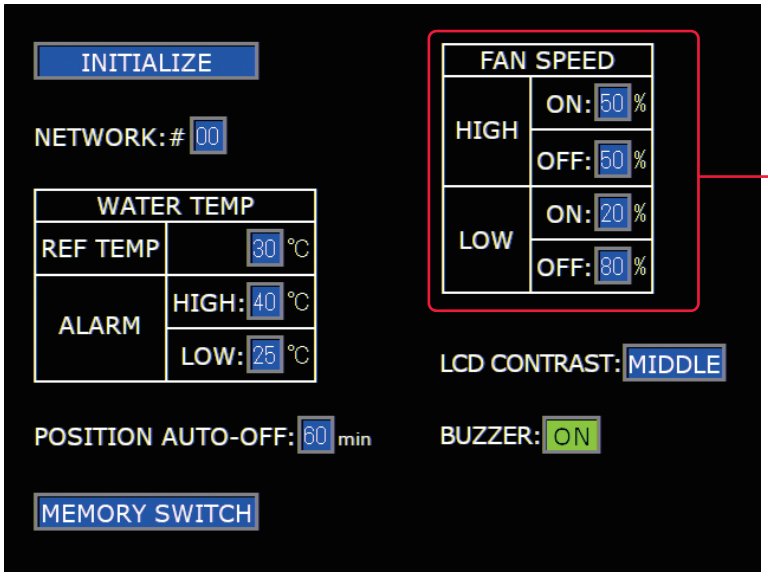
: Settable item

PRINTOUT SCHEDULE	Sets the SCHEDULE number to be printed.
SCHEDULE	Prints the set values and waveform on the SCHEDULE screen by using the schedule number set by PRINTOUT SCHEDULE.
POWER MONITOR	Prints the set values and measured result on the MONITOR screen by using the schedule number set by PRINTOUT SCHEDULE.
SEAM WELD	Prints the set values on the SEAM screen by using the schedule number set by PRINTOUT SCHEDULE.

⇒ For the common items in the upper/lower part of the screen, refer to page 63.

INITIALIZE Screen

On the INITIALIZE screen, the equipment No. and communication conditions for using the external communication function and the alarm range of secondary cooling water temperature are set. The MEMORY SWITCH screen is displayed from the INITIALIZE screen in order to switch a special function and set the alarm range of secondary cooling water temperature.



How to see the displayed items

: Settable item

INITIALIZE	Initializes the set values. After replacing the lithium battery, rewriting the program, or replacing the CPU board, the set values may change or be lost. Accordingly, perform initialization and set the values again. When this button is pressed, it takes about 15 seconds until initialization is completed. The POWER lamp blinks during that time. Turn off the power supply after blinking stops. When the power supply is turned off during initialization (lamp blinking), Error No.52 MEMORY TROUBLE occurs at the time of the next power-on. At that time, press the button again.
NETWORK	Sets the equipment No. in the range of #00 to #15 to perform remote operations by using the external communication function.
REF TEMP **ALARM** **HIGH** **LOW**	Sets the control temperature of secondary cooling water. When the temperature of secondary cooling water exceeds the set value, the solenoid valve for primary cooling water is opened. Sets the alarm temperature range by lower limit value (LOW) and upper limit value (HIGH). Usually, it is not necessary to change the set value. When you must change it for a compelling reason, contact us for information. ***<Note>*** When the temperature of secondary cooling water goes down below the value set in "LOW", Error No.11 LOW TEMPERATURE OF COOLANT occurs. When the above temperature exceeds the value set in "HIGH", Error No.10 HIGH TEMPERATURE OF COOLANT occurs. If the temperature of secondary cooling water does not reach "LOW + 2ºC or more" and "HIGH or less", Error No.10 or Error No.11 occurs.
POSITION AUTO-OFF	Sets the time required for the guide light to go out automatically in the range of 01 to 98 minutes. This can be set in units of minute. When 00 is set, no guide light is output. When 99 is set, the guide light does not go out automatically.

MEMORY SWITCH	Displays the MEMORY SWITCH screen. Then, the acceptance time for laser start signal and schedule signal can be changed.
LCD CONTRAST	Sets brightness of the liquid crystal display to HIGH, MIDDLE or LOW.
BUZZER	Sets the sound of buzzer during the touch panel operation to ON or OFF. At ON, the buzzer sounds. ***<Note>*** Even when the setting is OFF, the buzzer sounds if an error occurs.

MEMORY SWITCH Screen

When the MEMORY SWITCH button is pressed on the INITIALIZE screen, the MEMORY SWITCH screen appears. On this screen, the functions assigned to SWITCH 1 to SWITCH 6 are set.

How to see the displayed items

: Settable item

SWITCH 1	Sets the functions assigned to 1 to 8 of "SWITCH 1" to ON or OFF.
1	1: Sets the high voltage to ON or OFF. At ON, a high voltage is not output at AUTO START and the screen is displayed in the status of HV: OFF.
2	2: Switches the laser start/stop control by using the EXT.I/O connector. At ON, laser start/stop control can be exerted from the PLC connected to the EXT.I/O connector even in the status of PANEL CONTROL (internal control).
3	3: At ON, the laser output signal is output from pin No.7 of the EXT.I/O (1) connector. It is turned ON at the start of the first shot and turned OFF at the end of the last shot.
4	4: At ON, the noise filter function of the EXT. LASER START signal becomes invalid.
5	5: Unused.
6	6: Switches the measurement accuracy of the measured laser energy value (J). OFF: x 1 (000.0 J)/ON: x 10 (00.00 J) ***<Note>*** At ON, the maximum peak value of laser output "PEAK POWER" on the SCHEDULE screen becomes 1.0 kW regardless of the model.
7	7: Switches the setting range of pulse width (laser output time TIME [ms]). OFF: 00.0 ms/ON: 0.00 ms ***<Note>*** At ON, the maximum total value of laser output time "TIME [ms]" ("FLASH1" + "COOL1" + "FLASH2"+ "COOL2" + "FLASH3") on the SCHEDULE screen becomes 5.00 ms.
8	8: Sets to ON to change the setting of No.6 and No.7 of SWITCH 1. ***<Note>*** When the setting of No.6 or No.7 of SWITCH 1 is changed, the set values of SCHEDULE are initialized. To prevent misoperation, the setting cannot be changed unless No.8 of SWITCH 1 is set to ON. When the setting of No.6 or No.7 of SWITCH 1 is changed, the setting of No.8 of SWITCH 1 is returned to OFF. It takes about 15 seconds until initialization is completed. The POWER lamp blinks during that time. Turn off the power supply after blinking stops.

SWITCH 2

Switches the transfer speed of external communication data type assigned to 1 to 8 of "SWITCH 2" to ON or OFF.

1 1: Switches the data bit length. OFF: 8 bits/ ON: 7 bits
2 2: Sets whether a parity bit exists or not. OFF: Parity bit/ ON: No parity bit
3 3: Sets the parity mode. OFF: Even/ ON: Odd
4 4: Sets the stop bit. OFF: 2/ ON: 1
5・6 5 and 6: Set the communication speed.

The following speeds can be set by combining ON and OFF.

5	6	bps
OFF	OFF	9600
OFF	ON	19200
ON	OFF	38400
ON	ON	(9600)

7 7: At ON, the automatic laser power monitor value transmission of external communication becomes ON by default.
8 8: Unused.

SWITCH 3

Switches the functions assigned to 1 to 8 of "SWITCH 3" to ON/OFF.

1 1: Unused.
2 to 4 2, 3, and 4: Sets the acceptance time for laser start signal and schedule signal.

The following speeds can be set by combining ON and OFF.

2	3	4	Acceptance time
ON	ON	ON	0.1ms
OFF	ON	ON	
ON	OFF	ON	
OFF	OFF	ON	
ON	ON	OFF	1ms
OFF	ON	OFF	4ms
ON	OFF	OFF	8ms
OFF	OFF	OFF	16ms

5 5: At ON, pin No.4 (End output) of the EXT.I/O (1) connector is put in a closed circuit only once after the completion of the set shots. The end signal is also output when an error occurs during laser output or the laser stop signal is input.
6 to 8 6, 7, and 8: Unused.

SWITCH 4

Switches the functions assigned to 1 to 8 of "SWITCH 4" to ON/OFF.

1 to 6 1, 2, 3, 4, 5, and 6: (Enabled only when the branch shutter is put under independent control)

Press the setting buttons of "1" to "6" of "SWITCH 4" to set the branch shutter No. to be operated to ON. "1" to "6" of "SWITCH 4" are associated with branch shutters 1 to 6. Accordingly, set them to ON within the number of mounted branch shutters.

7・8 7 and 8: Unused.

SWITCH 5	Switches the functions assigned to 1 to 8 of "SWITCH 5" to ON/OFF.
1 to 5	1, 2, 3, 4, and 5: (Enabled only when the branch shutter is put under independent control) Press the setting buttons of "1" to "5" of "SWITCH 5" to set the timesharing unit numbers to be operated to ON. "1" to "5" of "SWITCH 5" are associated with the timesharing units 1 to 5. Accordingly, set them to ON within the number of mounted timesharing units.
6	6: At ON, the function automatically switching the screen from the SCHEDULE screen to the MONITOR screen becomes invalid.
7 • 8	7 and 8: Unused.
SWITCH 6	Switches the functions assigned to 1 to 8 of "SWITCH 6" to ON/OFF.
1	1: At ON, the contents of the other SCHEDULE No. can be referred even in the control mode other than PANEL CONTROL.
2	2: At ON, the limit of Error No.53 POWER FEEDBACK TROUBLE becomes 0.5%. At OFF (default), the limit is 1.0%.
3	3: At ON, when using the fade-in/out function, an upper/lower limit judgment of the laser energy monitor is performed even for shots other than the shot output at 100.0%.
4 to 8	4, 5, 6, 7, and 8: Unused.
BACK	Returns to the INITIALIZE screen.

⇒ When the setting of SWITCH 1 or SWITCH 6 has been changed, be sure to turn OFF the power to make the setting effective before use.

Setting Laser Light Output Schedules (SCHEDULE Screen)

This section explains the how to set the SCHEDULE screen. On this screen, the peak value, output time, and output value of laser light are set and they are registered after SCHEDULE number are given to them.

⇒ 32 types of output schedules can be set and registered with SCHEDULE numbers of #00 to #31. To perform laser welding, enter the registered SCHEDULE numbers and laser welding can be performed in the set output schedules.

⇒ It is convenient if you enter the set output schedules in the Appendix "Output Schedule Data Entry Table" in advance.

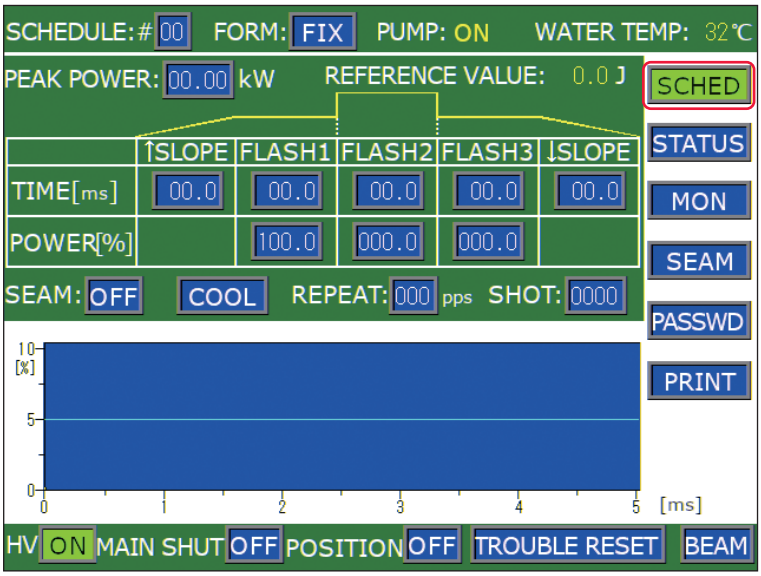
⇒ For the details of setting items, refer to "Welding Schedule Setting Screen" on page 65.

1 Setting Output Schedules by Fixed Waveform (FIX)

Set the output time and output value of laser light in "FLASH1" (first laser) to "FLASH3" (third laser) by "FIX." Set the laser light that becomes a fixed waveform by up to 3 divisions.

In the following example, SCHEDULE No.: #00, peak value: 7.0 kW, FLASH1: 1.0 ms/100%, COOL1: 0.0 ms, FLASH2: 1.5 ms/25%, COOL2: 0.0 ms, FLASH3: 3.0 ms/50%, up slope: 0.5 ms, and down slope: 1.0 ms are set as output schedules.

(1) Press the "SCHED" button to display the SCHEDULE screen.



(2) Press the "SCHEDULE" setting button.
Enter the SCHEDULE number.

(3) Press the "FORM" setting button to set "FIX."

(4) Press the "PEAK POWER" setting button.
Enter the laser output peak value.

<Note>

The settable maximum peak value of laser output differs depending on the model.

ML-2350A: 7.0 kW / ML-2351A: 5.0 kW

(5) Press the laser output time "TIME [ms]" and laser output value "POWER [%]" setting buttons of "FLASH1" to "FLASH3."
Enter each value.

⇒ The laser output time is set in the range of 0.0 to 30.0 ms. Regarding the laser output value, the ratio (%) based on the case where the set laser output peak value is 100% is set.

<Note>

Set the laser output time so as to result in the following value.

0.25 ms ≤ FLASH1 + FLASH2 + FLASH3 ≤ 30.0 ms

(6) To insert non-laser output time between "FLASH1" and "FLASH2", press the COOL button to set the output stop time (ms) in "COOL1."

(7) To insert non-laser output time between "FLASH2" and "FLASH3", press the COOL button to set the output stop time (ms) in "COOL2."

(8) Press the "↑SLOPE" setting button.
Enter the time "TIME [ms]" required for laser light to up-slope (get gradually stronger) in FLASH1.

<Note>

The output time of FLASH1 includes the time of "↑SLOPE."

Set "↑SLOPE" so as to result in the following value.

↑SLOPE ≤ FLASH1

(9) Press the "↓SLOPE" setting button.
Enter the time "TIME [ms]" required for laser light to down-slope (get gradually weaker) in the last FLASH.

<Note>

The output time of the last FLASH includes the time of "↓SLOPE."

Set "↓SLOPE" so as to result in the following value.

↓SLOPE ≤ FLASH1, FLASH2, FLASH3

(10) To output laser light several times for one second, press the "REPEAT" setting button and then set the laser light output count for one second in the range of 000 to 200 pps (pulse per second).

⇒ When 0 is set, a single output is performed.

(11) To output laser light repeatedly, press the "SHOT" setting button and set the laser light output count in the range of 0000 to 9999.

⇒ When "REPEAT" is not 0 and "SHOT" is set to 0, laser light is continuously output until a laser stop signal is input.

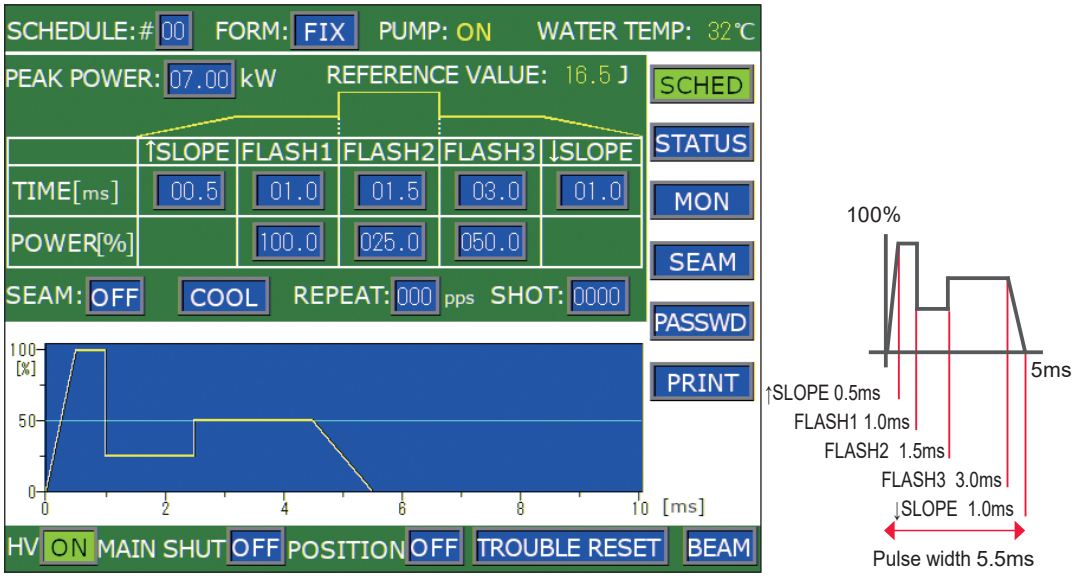
2 Setting ON/OFF for the Output Conditions for Seam Welding

(1) Press the "SEAM" setting button and set the seam welding output condition to ON/OFF.
At ON, the fade function for seam welding set on the SEAM screen is enabled. When this function is not used, set OFF.

⇒ When the "SEAM" button for screen switching is pressed, the SEAM screen appears and the output conditions for seam welding can be set. For the setting method, refer to "Setting the Output Conditions for Seam Welding" on page 83.

3 Checking Output Schedules

(1) Check the waveform displayed on the screen.
The set laser output time and laser output value are graphically displayed and the output laser light can be checked as a waveform.



⇒ At the leading edge of waveform, an overshoot (higher form than the set value) may occur. In this case, extend "↑SLOPE" by 0.1 to 1.0 ms.

(2) Check the output energy displayed in "REFERENCE VALUE."

⇒ In "REFERENCE VALUE", the forecast value of laser output energy based on the set output schedules is displayed. This value is a little different from the actually measured value (measured value displayed on the MONITOR screen) provided at laser welding. However, use it as reference.

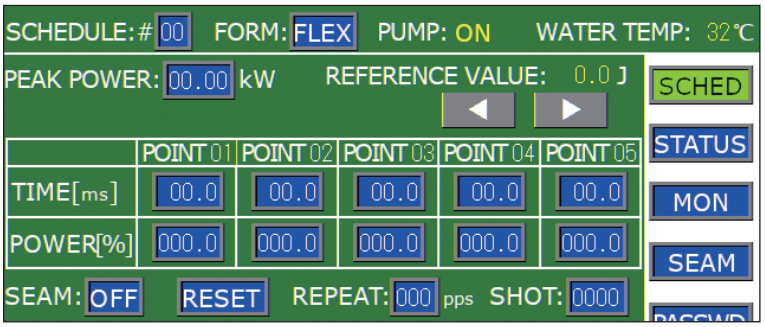
1 Setting Output Schedules by Flexible Waveform (FLEX)

Set the output time and output value of each POINT in the range of "POINT 01" to "POINT 20" by "FLEX" and set the laser light output that becomes a flexible waveform.

In this example, SCHEDULE No.: #01, peak value: 7.0 kW, POINT 01: 1.0 ms/90%, POINT 02: 1.0 ms/70%, POINT 03: 1.0 ms/88%, POINT 04: 1.0 ms/65%, and POINT 05: 1.0 ms/0% are set as output schedules.

(1) Press the "SCHED" button to display the SCHEDULE screen.

(2) Press the "SCHEDULE" setting button.
Enter the SCHEDULE number.



(3) Press the "FORM" button to set "FLEX."

(4) Press the "PEAK POWER" setting button.
Enter the laser output peak value.

<Note>

The settable maximum peak value of laser output differs depending on the model.

ML-2350A: 7.0 kW / ML-2351A: 5.0 kW

(5) Press the laser output time "TIME [ms]" and laser output value "POWER [%]" setting buttons of "POINT 01" to "POINT 05."
Enter the respective value.

⇒ When the ◀ ▶ button of POINT is pressed, the POINT display column is scrolled to the right and left so as to display a POINT that is not yet displayed.

⇒ Set the point in the range of "POINT 01" to "POINT 20" and the laser output time in the range of 0.1 to 30.0 ms. For the laser output value, set the ratio (%) supposing that the set laser output peak value is 100%.

<Note>

For setting the laser output time, enter the time from the previous POINT.
Set the laser output time so as to result in the following value.

0.25 ms ≤ Total of all POINT values ≤ 30.0 ms (90.0 ms when the time of 0% is included in the output value)

(6) To output laser light several times for one second, press the "REPEAT" setting button and set the laser light output count for one second in the range of 000 to 200 pps (pulse per second).

⇒ When 0 is set, a single output is performed.

(7) To output laser light repeatedly, press the "SHOT" button and set the laser light output count in the range of 0000 to 9999.

⇒ When "REPEAT" is not set to 0 and "SHOT" is set to 0, laser light is continuously output until a laser stop signal is input.

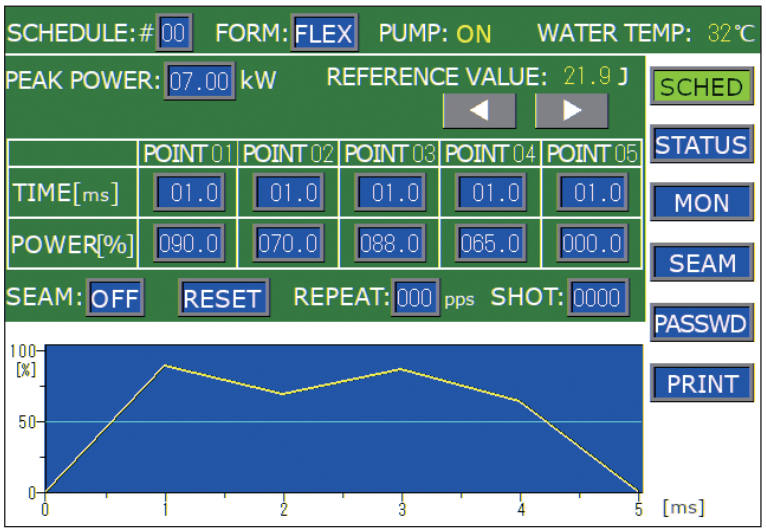
2 Setting ON/OFF for the Output Conditions for Seam Welding

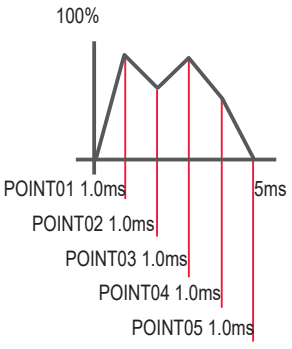
(1) Move the cursor to "SEAM" and press the ON or OFF key to set whether the output conditions for seam welding are valid or not.
At ON, the fade function for seam welding set on the SEAM screen is enabled. When this function is not used, set OFF.

⇒ When the "SEAM" button for screen switching is pressed, the SEAM screen appears and the output conditions for seam welding can be set. For the setting method, refer to "Setting the Output Conditions for Seam Welding" on page 83.

3 Checking Output Schedules

(1) Check the waveform displayed on the screen.
The set laser output time and laser output value are graphically displayed so that the output laser light can be checked as a waveform.





⇒ At the leading edge of waveform, an overshoot (higher form than the set value) may occur. In this case, extend "POINT 01" by 0.1 to 1.0 ms.

(2) Check the output energy displayed in "REFERENCE VALUE."

⇒ In "REFERENCE VALUE", the forecast value of laser output energy based on the set output schedules is displayed. This value is a little different from the actually measured value (measured value displayed on the MONITOR screen) provided at laser welding. However, use it as reference.

Setting the Output Conditions for Seam Welding (SEAM Screen)

The method of setting the output waveform for seam welding by using the fade-in/out function after displaying the SEAM screen is explained below. The fade function increases or decreases the laser energy in a gently-sloping form to obtain a continuous waveform suitable for seam welding. As a result, the finished status of seam welding is made beautiful.

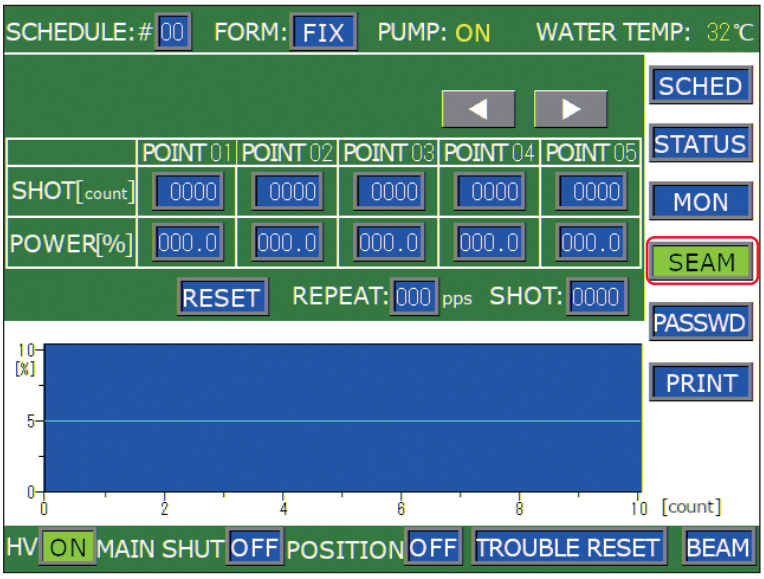
⇒ The fade function ON/OFF state set herein is set on the SCHEDULE screen.

1 Setting the Output Conditions

Taking seam welding in which laser light is continuously output 100 times, as an example, the output count of "POINT 01" to "POINT 06" and energy are set. The energy at the beginning/end of laser light output is made weaker by the fade function. This prevents an overlapped portion at circumferential seam welding against an excessive burn and makes the welding mark of the final shot inconspicuous.

⇒ The fade function can also be set for other processes than the beginning/end of welding.

(1) Press the "SEAM" button to display the SEAM screen.



2 Setting the Fade-in/out Function

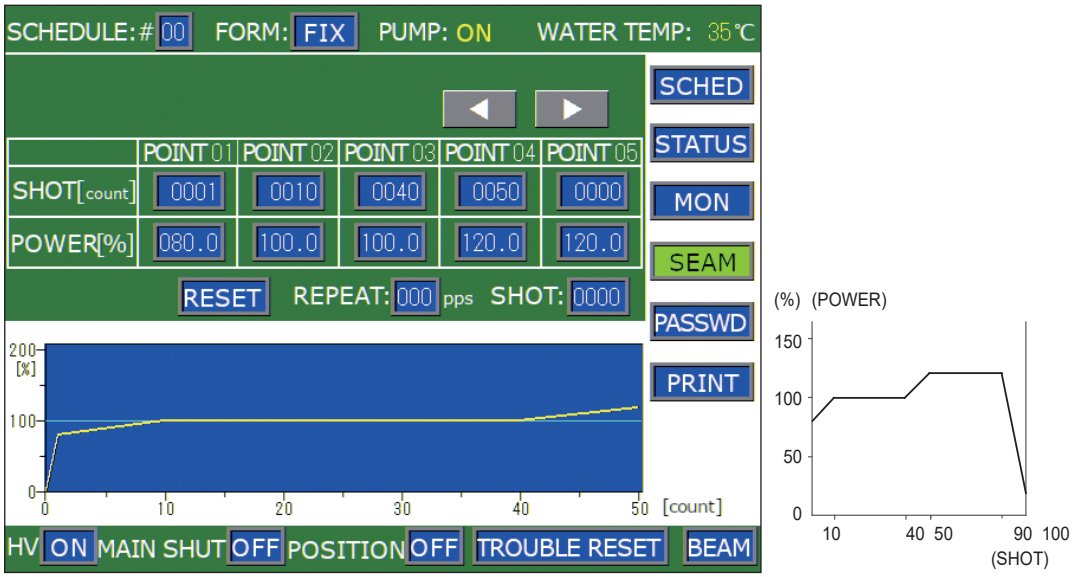
(1) Press the "SHOT [COUNT]" setting button of "POINT 01."
Enter the laser light output count.
Set 0001 because of the first output count.

⇒ For "SHOT [COUNT]" of "POINT 01", only 0001 can be set.

(2) Press the "POWER [%]" setting button of "POINT 01."
Enter the laser output value (%).
Set the ratio to "PEAK POWER" set on the SCHEDULE screen in the range of 0 to 150.0%.

(3) Likewise, set "SHOT [COUNT]" and "POWER [%]" of "POINT 02" to "POINT 06."

⇒ For "POINT 06", press the ▶ button to scroll the POINT display column to the right. Then, it is displayed.



<Note>

If the output count set in "SHOT" is smaller than that set in "SHOT [COUNT]", any larger output count set in "SHOT [COUNT]" is invalidated.

When the output count set in "SHOT" is larger than that set in "SHOT [COUNT]", the POWER of the final set value in "SHOT [COUNT]" is repeated until the output count reaches the output count set in "SHOT."

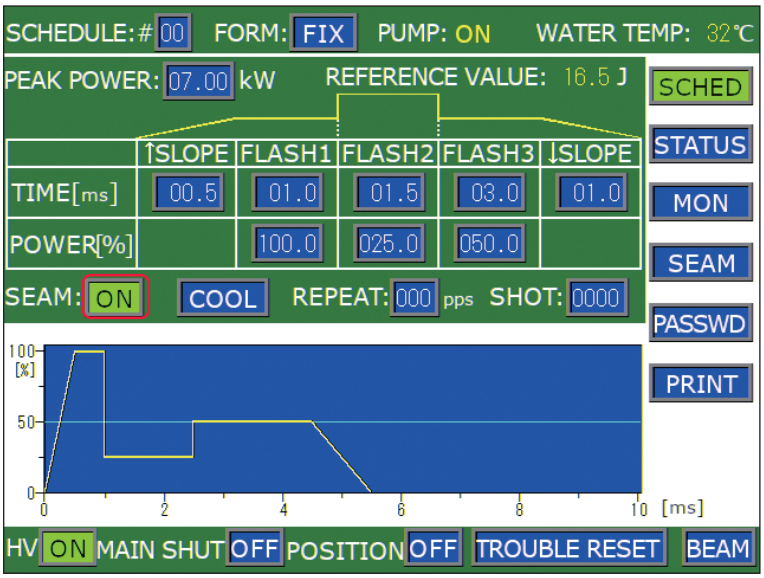
For example, supposing that "SHOT" is set to 40, up to 40 shots are also validated for "SHOT [COUNT]." (Up to 0040 of POINT 03 on the above screen) When "SHOT" is set to 200, the POWER of the final set value is repeated up to 101 to 200 shots for "SHOT [COUNT]." (In this case, the 20% energy of POINT 06 is repeated up to 101 to 200 shots.)

(4) Press the "SCHED" button to return to the SCHEDULE screen.

3 Enabling the Fade Function

(1) Press the "SEAM" setting button on the SCHEDULE screen to set it to ON.
The fade-in/out function for seam welding is enabled.

⇒ When the fade-in/out function is not used, keep the "SEAM" setting button OFF.



<Note>

When using the fade-in/out function, an upper/lower limit judgment of the laser energy monitor is performed only for the shot that is output by setting POWER to 100.0%.

For shots other than the shot output at 100.0%, no upper/lower limit judgment is performed and both Monitor Normal and Monitor Error are not output. Error No.56 OVERLIMIT OF LASER POWER and Error No.57 UNDERLIMIT OF LASER POWER are not displayed on the screen.

Setting the Output Status (STATUS Screen)

In the following, the method of setting the STATUS screen is explained. On this screen, check the displayed control method and the set the branch shutter at the output destination to OPEN. Set or reset the number of laser light outputs.

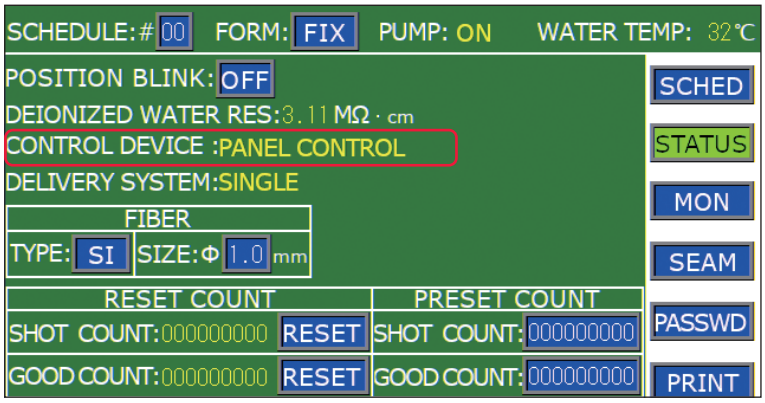
⇒ For details of setting items, refer to "Welding Schedule Setting Screen" on page 67.

Checking the Control Method

(1) Press the "STATUS" button to display the STATUS screen.

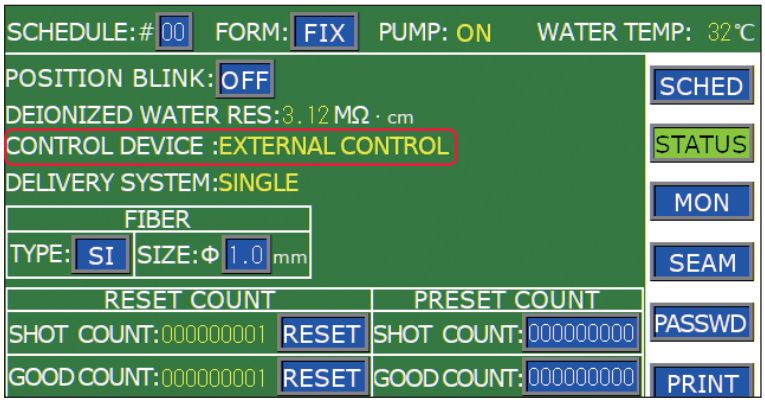
Control by Laser Controller (PANEL CONTROL)

When the laser is independently used or when the power supply of the PLC or personal computer connected to the laser is OFF, control is exerted from the laser controller and "PANEL CONTROL" is displayed in "CONTROL DEVICE."



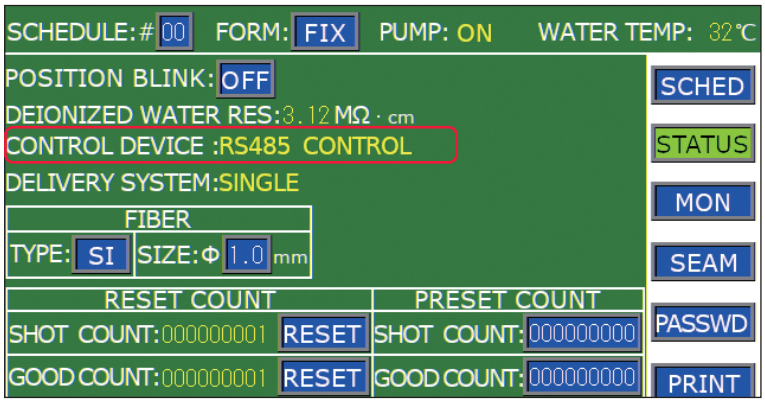
Control by External Input Signal (EXTERNAL CONTROL)

Connect the main unit to the PLC or the like and turn ON pin No.23 (control switching) of the EXT.I/O (1) connector. Then, the control method is switched over to the control by external input/output signals (EXTERNAL CONTROL) and "EXTERNAL CONTROL" is displayed in "CONTROL DEVICE."



Control by External Communication Control (RS-485 CONTROL)

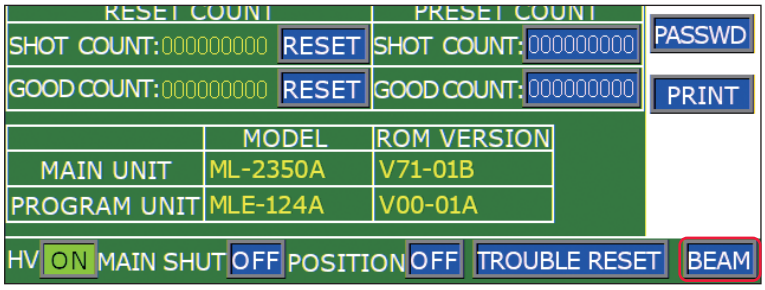
When a command to set a control method is sent from the personal computer connected to the main unit, external communication control is selected and "RS-485 CONTROL" is displayed in "CONTROL DEVICE" on the STATUS screen.



Setting the Opening/Closing Status of the Branch Shutter

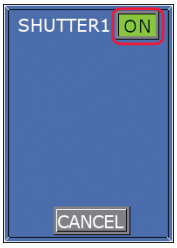
To control the laser welder from the laser controller, press the "BEAM" button on the STATUS screen to set the opening/closing the branch shutter. "SHUTTER 1" to "SHUTTER 6" are associated with branch shutters 1 to 6.

At ON, the corresponding branch shutter is opened and laser light is output.



(1) Press the "BEAM" button.
A window to set the opening/closing the branch shutter and beamsplitter is opened.
⇒ The displayed window depends on the specification.

(2) Press the setting buttons for "SHUTTER 1" to "SHUTTER 6" to set the opening/closing of the branch shutters to ON/OFF.



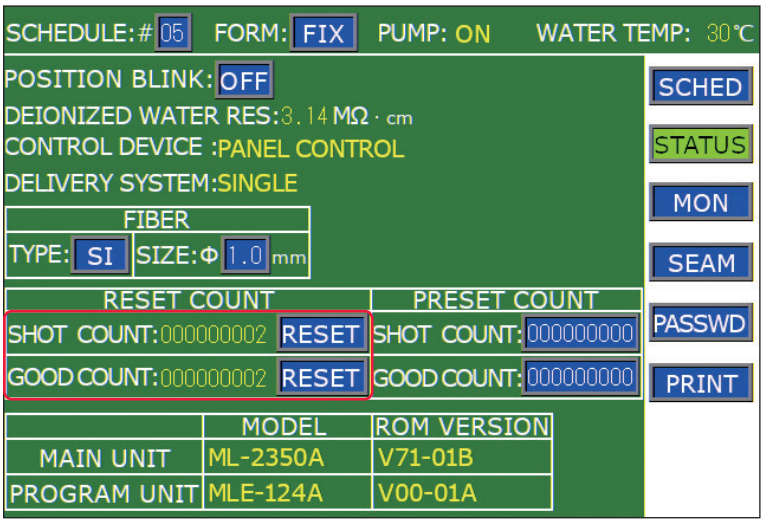
(For single delivery specification)

(3) Press the "CANCEL" button.
The opening/closing of the branch shutter is set and the window is closed.

Resetting the Number of Laser Light Outputs

Reset the numeric values of "SHOT COUNT" (total number of laser light outputs) or "GOOD COUNT" (appropriate number of laser light outputs) that are displayed on the MONITOR screen.

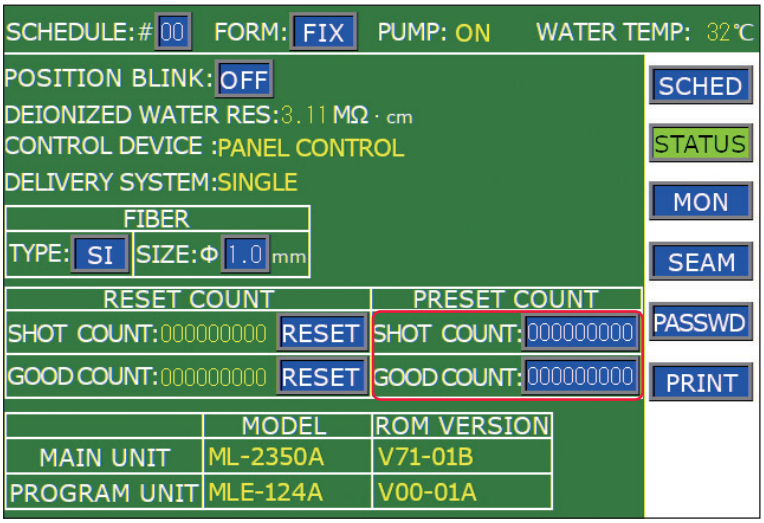
(1) Press the "RESET" button of "SHOT COUNT" or "GOOD COUNT" of RESET COUNT.
The numeric value is reset and "000000000" is displayed.



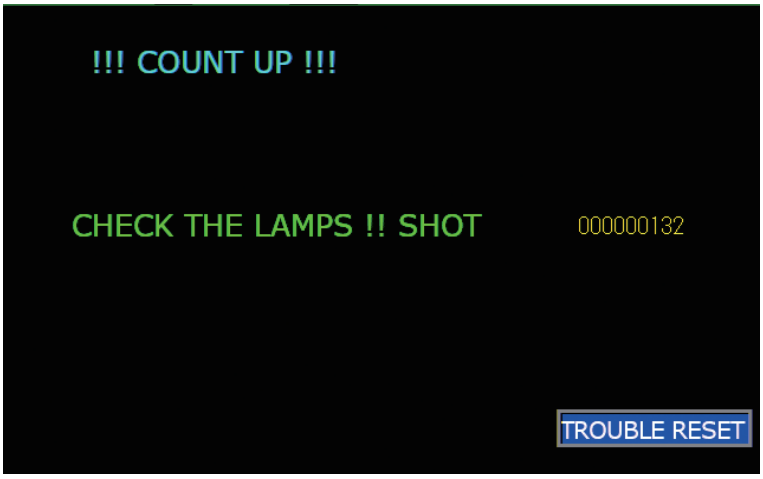
Setting the Count-notification Function

When "SHOT COUNT" (total number of laser light outputs) or "GOOD COUNT" (appropriate number of laser light outputs) that are displayed on the MONITOR screen reaches the set number, a message is displayed. This function will be of assistance for maintenance or manufacturing control.

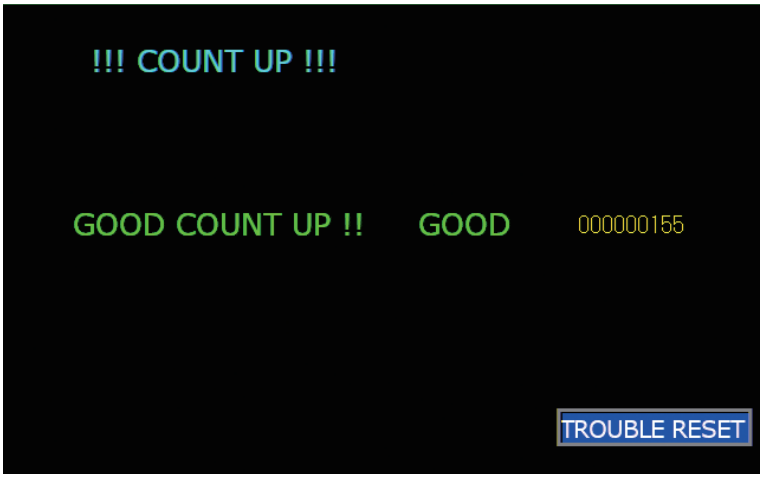
(1) Press the "SHOT COUNT" or "GOOD COUNT" setting button of PRESET COUNT.
Enter an optional output count.



When "SHOT COUNT" reaches the value set in PRESET COUNT, a screen to prompt the operator to check the flashlamp is displayed.



When "GOOD COUNT" reaches the value set in PRESET COUNT, a screen to notify the number of good products is displayed.



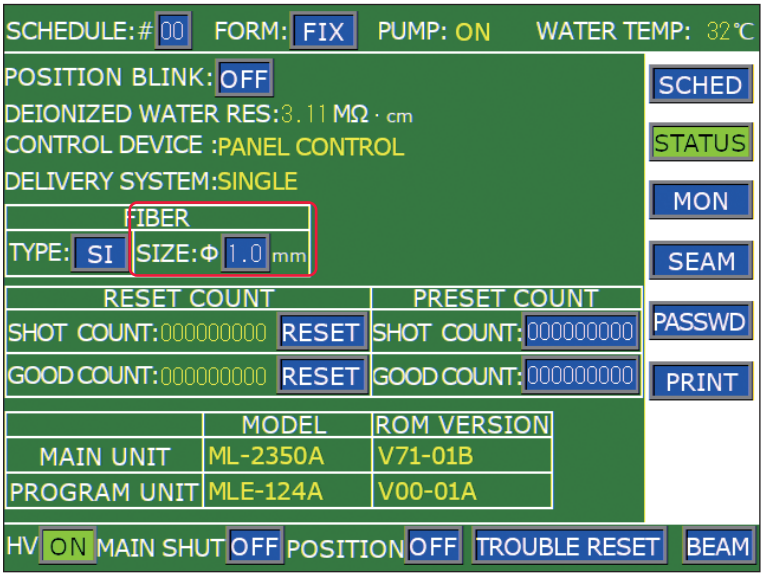
Press the "TROUBLE RESET" button to return the current screen to the initial screen.

Setting the Protection of Optical Fiber

The optical fiber is protected from overfill to the optical fiber. When the core diameter to be used is set, the maximum possible incident light to the optical fiber is calculated to limit the lamp input power.

(1) Press the "SIZE" setting button of "FIBER."
Enter the core diameter.
The set core diameter is displayed.

⇒ The factory-set value is TYPE: SI and SIZE: φ1.0 mm. The settable range is φ0.2 to 1.0 mm.



⇒ When a beam expander (option) or internal aperture (option) is installed in the oscillator, set a one-size larger core diameter.

⇒ If the laser output conditions (PEAK POWER, FLASH ms/%, REPEAT) are not matched with the set core diameter, Error No.51 FIBER SETTING ERROR or Error No.48 FIBER OVERRATE is displayed. At this time, change the core diameter setting. For the laser output conditions for the core diameter, refer to Chapter 2 "Standard Maximum Incident Energy and Power of Optical Fiber" on page 51, in the Installation and Preparation Part.

<Notes>

- **When the end face of the optical fiber is stained or dirty, the end face of the fiber may be damaged even if no error is displayed. When the optical fiber is not used, put the cover on it.**
- **If the GI fiber is used, the end face of the fiber may be damaged depending on the conditions (energy density to be received by the end face) even if no error is displayed.**
- **When the end face of the fiber is damaged, the lens of the connected input unit or output unit may be stained. Perform inspection and cleaning. When the input unit has been dismounted, a fiber incidence adjustment is required.**

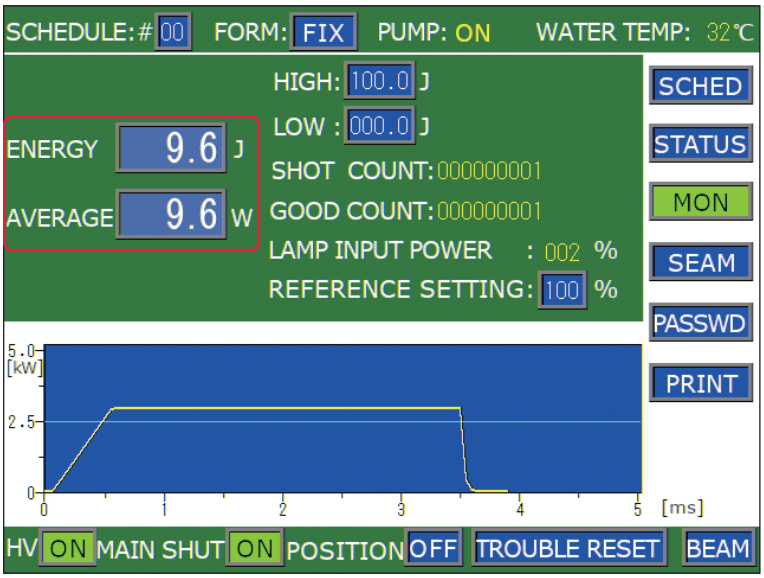
Setting the Output Status Check Screen (MONITOR Screen)

In the following, the method of setting the MONITOR screen is explained. On this screen, the measured energy value of output laser light is checked, the energy range to be monitored is set, and the upper limit value of flashlamp input power is set.

Checking the Measured Energy Value of Laser Light

When laser light is output, the MONITOR screen is automatically displayed and a measured energy value is displayed. The measured energy value of the last output laser light can also be checked by the corresponding SCHEDULE number if a registered SCHEDULE number is entered.

(1) Press the "SCHEDULE" setting button.
Enter the SCHEDULE number.
The measured energy value of the last output laser light and laser light waveform are displayed according to the set SCHEDULE.

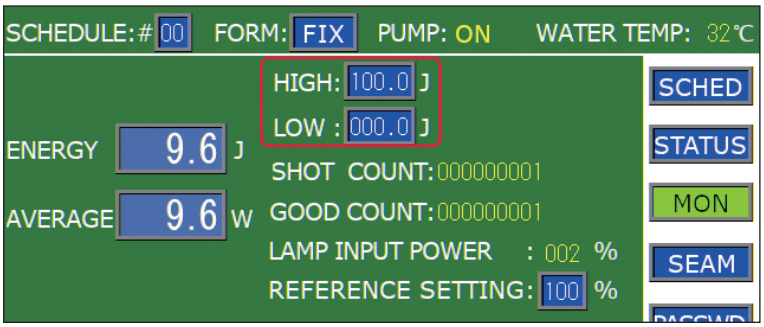


Setting the Laser Energy Range To Be Monitored

Set the upper limit value and lower limit value of energy to be monitored. This set range is used as the allowable energy range.

(1) Press the "HIGH" setting button.
Enter the upper limit value.
The upper limit value of allowable energy is registered.

(2) Press the "LOW" setting button.
Enter the lower limit value.
The lower limit value of allowable energy is registered.

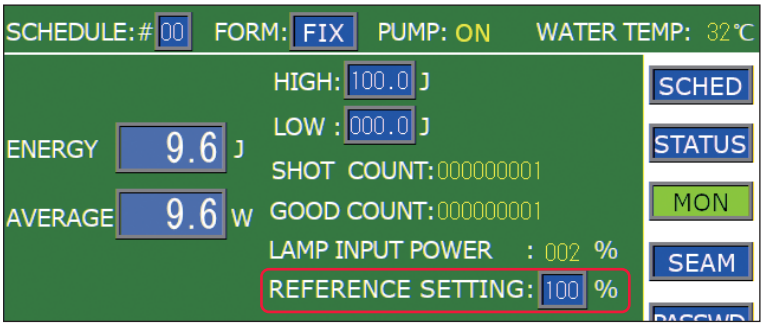


⇒ When laser light is out of the set allowable energy range, a monitor error is output.

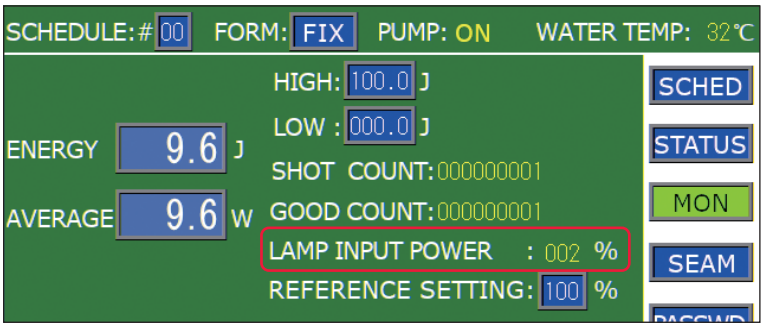
Setting the Upper Limit Value of Lamp Input Power

Set the maximum value of power to be input into the flashlamp. Since the performance of the flashlamp is gradually deteriorated, it is necessary to increase the supply power little by little. When the supply power exceeds the value set here, a screen to prompt you to replace the flashlamp is displayed.

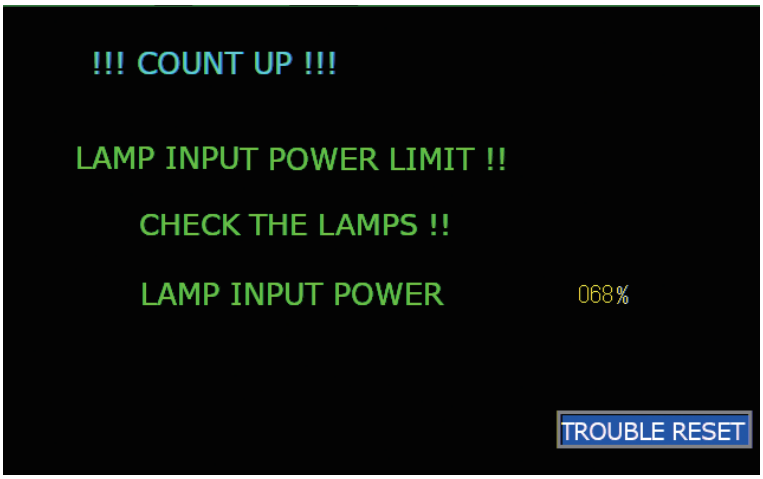
(1) Press the "REFERENCE SETTING" setting button. Enter the ratio (%) of the upper limit value of lamp input power.



⇒ If the laser welder is used in the status where 80% or more is displayed in "LAMP INPUT POWER", the flashlamp replacement cycle may be shortened.



The set ratio of the upper limit value is registered. When the upper limit value is exceeded, a screen to prompt the operator to replace the flashlamp is displayed.



When this screen appears, output pin No.9 (upper limit of lamp input) of the external output signal EXT.I/O (1) connector is open-circuited for output.

Press the "TROUBLE RESET" button to clear the screen display.

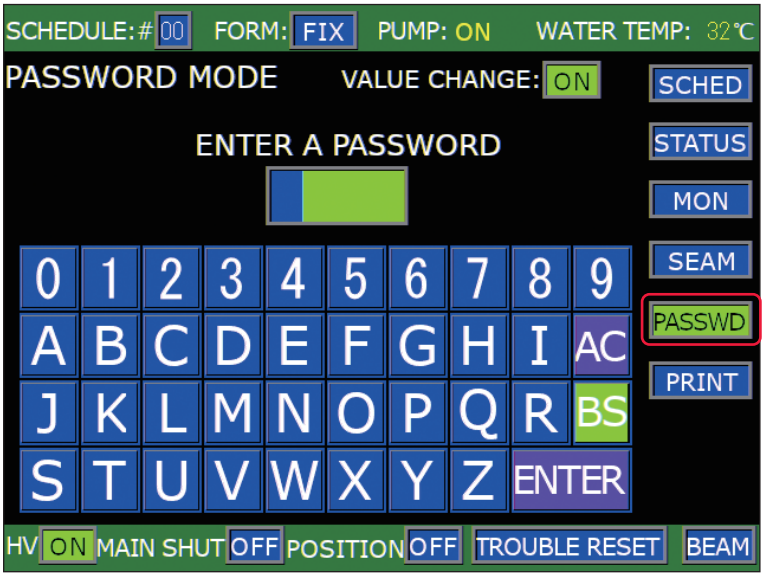
⇒ After the screen display is reset, pin No.9 of the EXT.I/O (1) connector output remains in an open circuit output state. If the power supply is less than the upper limit value of lamp input power when the flashlamp lights next time, the open circuit output state is returned to a closed circuit state. The open circuit output state is also reset by turning on the power supply again.

Protecting Set Values (PASSWORD Screen)

The method of protecting set values by setting the password is explained below. When the password is set and validated, set values are protected and cannot be changed by any person other than the supervisor.

1 Displaying the PASSWORD Screen

(1) Press the "PASSWD" button.
The PASSWORD screen appears.



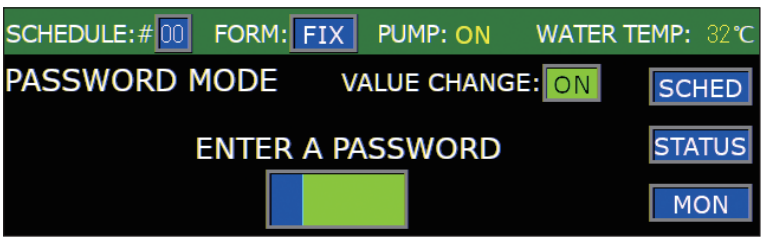
2 Entering the Present Password

(1) Enter the set password into the password input box.
Press the password by pressing keyboard keys on the screen. The AC key deletes all the entered characters. The BS key deletes a character in front of the cursor one by one. The ENTER key is used to check the entered password for correctness.

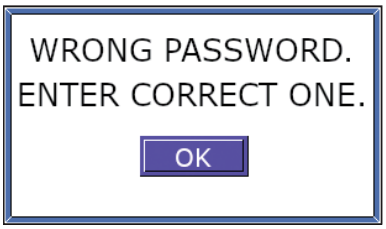
⇒ "REDS" is set as the initial value. To enter a new password after changing this password, enter "REDS."

⇒ The password to be entered must consist of 4 alphanumerical characters.

(2) Press the ENTER key on the keyboard.
When the entered password is correct, the new password setting screen is displayed.



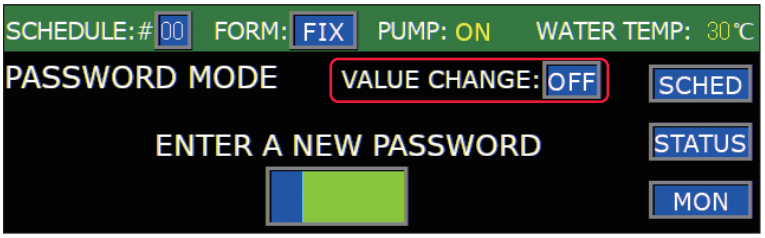
When the entered password is wrong, the WRONG PASSWORD screen is displayed.
Then, enter the set password once again.



3 Validating the Password

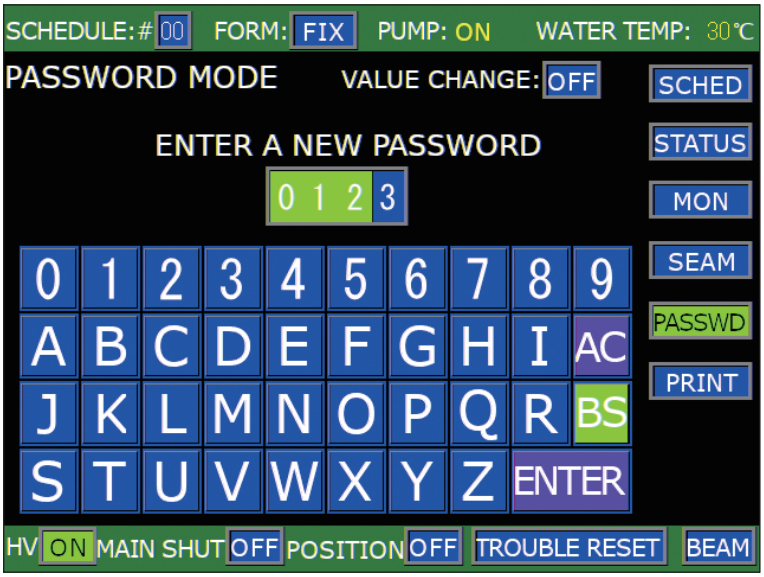
(1) Press the "VALUE CHANGE" setting button.
A window to select ON/OFF is opened. At ON, the set password can be changed.
At OFF, it is impossible to change the set password.
⇒ The "VALUE CHANGE" setting button cannot function unless a correct password is entered.

(2) Press the OFF button to set OFF.
The password is validated and a part of setting items is protected, disabling a change.
⇒ Unless "VALUE CHANGE" is set to OFF even if a password is set, the setting items are not protected, so that any person who does not know the password can change the setting values.

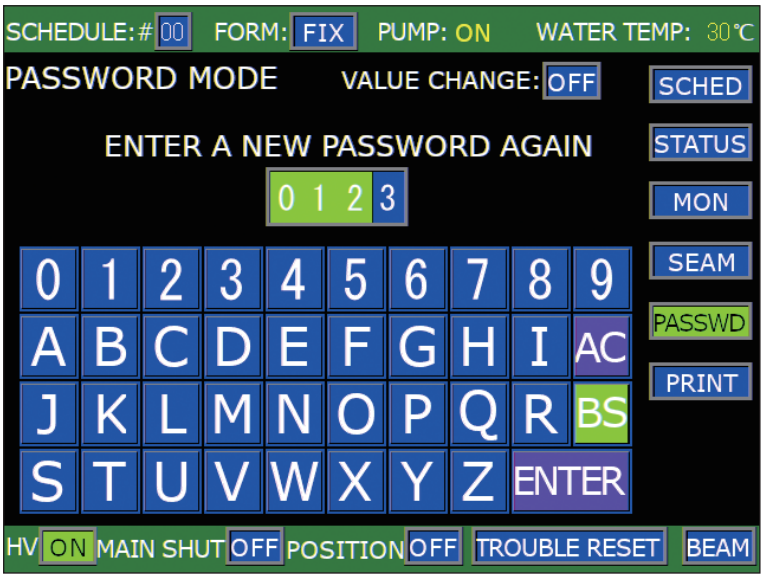


4 Setting a New Password

(1) Enter a new password into the password input box.
Enter 4 alphanumerical characters.



(2) Press the ENTER key on the keyboard.
A confirmation screen appears.



(3) Enter the same password and press the ENTER key.
The set password is registered and the PASSWORD screen reappears.
⇒ Unless the two passwords coincide, the WRONG PASSWORD screen appears.
Press the OK button and enter the same password.

The items that can be protected are as follows.

Display Screen	Item
SCHEDULE Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX waveform switching) PEAK POWER (Laser output peak value) SEAM (Fade function ON/OFF) REPEAT (Number of laser light outputs per second) SHOT (Total number of laser light outputs) ↑SLOPE (Time for up-sloping to FLASH1) FLASH1 (Output time ms and output value % of the first laser) COOL1 (Non-laser output time to be inserted between FLASH1 and FLASH2) FLASH2 (Output time ms and output value % of the second laser) COOL2 (Non-laser output time to be inserted between FLASH2 and FLASH3) FLASH3 (Output time ms and output value % of the third laser) ↓SLOPE (Time for down-sloping to the last FLASH) POINT 01 to 20 (Output time ms and output value % of each point for FLEX)
SEAM Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX waveform switching) SHOT (Laser light output count of each No. of POINT 01 to POINT 20) POWER (Laser output value % of each No. of POINT 01 to POINT 20)
STATUS Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX waveform switching) POSITION BLINK (Guide light blinking or lighting ON/OFF) FIBER TYPE (SI/GI) SIZE (Setting core diameter) RESET COUNT SHOT COUNT (Resetting the total number of laser light outputs, SHOT COUNT) GOOD COUNT (Resetting the appropriate number of laser light outputs, GOOD COUNT) PRESET COUNT SHOT COUNT (Count-notification setting of the total number of laser light outputs, SHOT COUNT) GOOD COUNT (Count-notification setting of the appropriate number of laser light outputs, GOOD COUNT)
MONITOR Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX waveform switching) HIGH (Upper limit value of laser energy to be monitored) LOW (Lower limit value of laser energy to be monitored) REFERENCE SETTING (Upper limit value of lamp input power)

The above setting items become unchangeable and the set values are protected.
⇒ To change any set value, enter the password to display the password setting screen and turn ON "VALUE CHANGE."

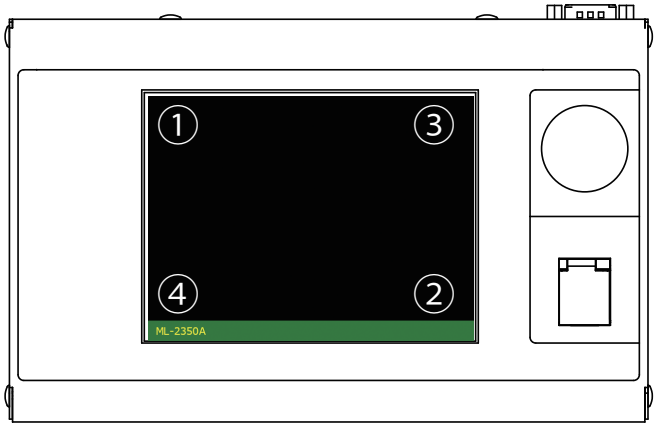
Switching the Accuracy of the Measured Laser Energy Value (J) (MEMORY SWITCH Screen)

In the following, the method of switching the measurement accuracy of the laser energy value (J) by displaying the MEMORY SWITCH screen from the INITIALIZE screen is explained.

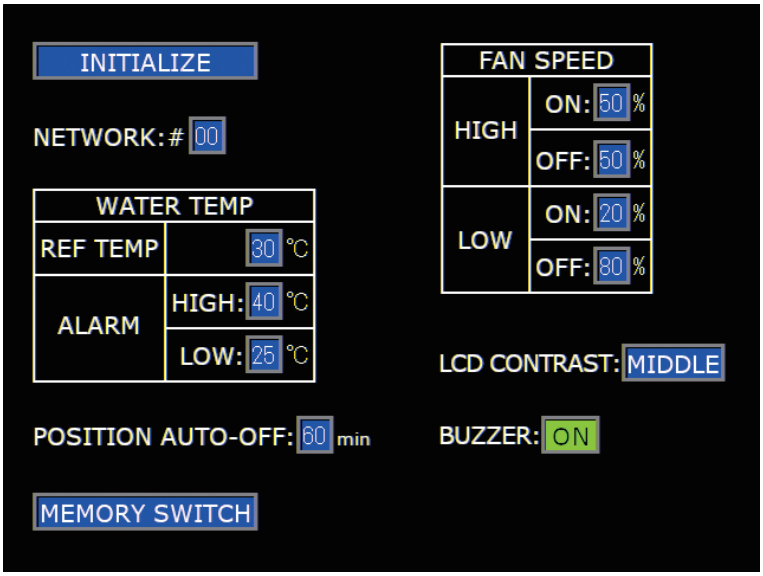
Usually, this setting permits switching the measured value of 0.1 J increments over to 0.01 J increments, so that more minute welding work can be performed.

1 Displaying the MEMORY SWITCH Screen

(1) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch. Power is supplied and the POWER lamp comes on. The screen of model name appears.



(2) While the model name screen is displayed (for about 3 seconds), press the corners of the touch panel display in the order shown in the figure above. The INITIALIZE screen appears.



⇒ Unless the CONTROL keyswitch is OFF, the INITIALIZE screen is not displayed.

(3) Press the MEMORY SWITCH button.
The MEMORY SWITCH screen appears.

2 Switching the Accuracy of the Measured Value (J)

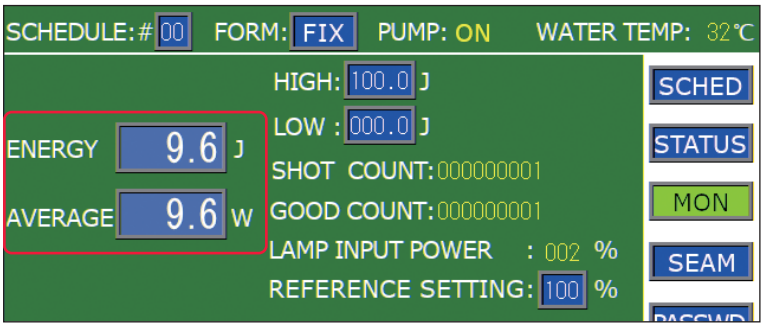
(1) Move the cursor to "6" of "SWITCH 1" and press the ON key.

<Note>

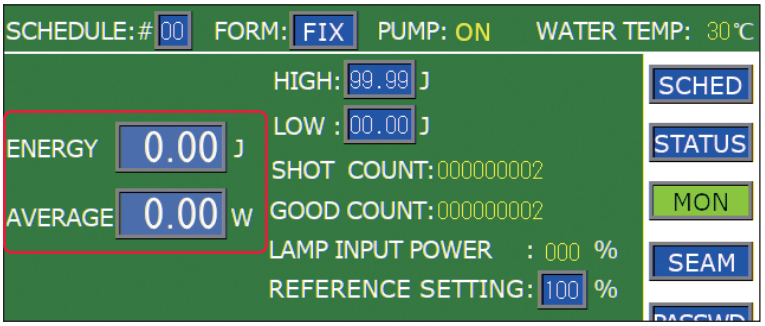
When the accuracy of the measured value is switched, the set values of SCHEDULE are initialized. To prevent misoperation, the setting cannot be changed unless No.8 of SWITCH 1 is set to ON. When the setting of No.6 of SWITCH 1 is changed and the ENTER key is pressed, the setting of No.8 of SWITCH 1 is returned to OFF. It takes about 15 seconds until initialization is completed. The POWER lamp blinks during that time. Turn off the power supply after blinking stops.

(2) Press the "BACK" button.
The INITIALIZE screen reappears and the accuracy of the measured value on the MONITOR screen is switched.

Setting example before switching ("6" of SWITCH 1: OFF)



Setting example after switching ("6" of SWITCH 1: ON)



<Note>

When No.6 of SWITCH 1 is set to ON, the settable maximum peak value of laser output "PEAK POWER" on the SCHEDULE screen becomes 1.0 kW regardless of the model.

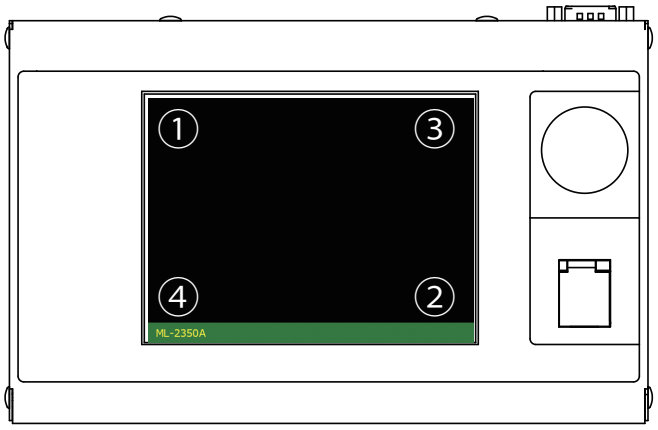
Switching the Pulse Width Setting Range (MEMORY SWITCH Screen)

In the following, the method of changing the pulse width setting range for laser light (laser output time ms) by displaying the MEMORY SWITCH screen from the INITIALIZE screen is explained.

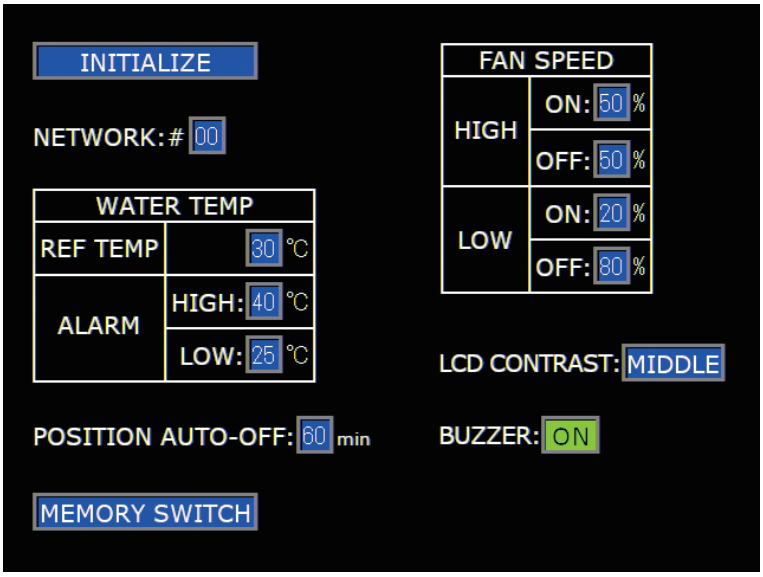
Usually, this setting permits switching the pulse width of 0.1 ms step over to 0.05 ms step, so that more minute welding work can be performed.

1 Displaying the MEMORY SWITCH Screen

(1) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch. Power is supplied and the POWER lamp comes on. The screen of model name appears.



(2) While the model name screen is displayed (for about 3 seconds), press the corners of the touch panel display in the order shown in the figure above. The INITIALIZE screen appears.



⇒ Unless the CONTROL keyswitch is OFF, the INITIALIZE screen is not displayed.

(3) Press the MEMORY SWITCH button.
The MEMORY SWITCH screen appears.

2 Switching the Pulse Width Setting Range

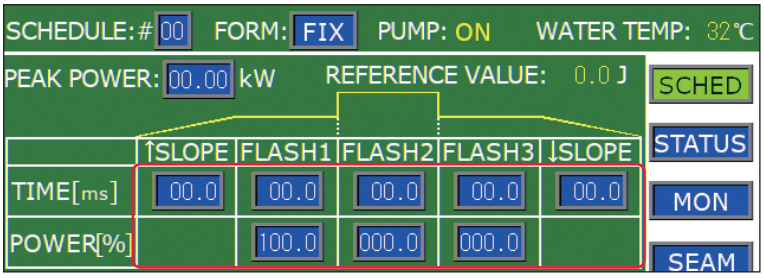
(1) Move the cursor to "7" of "SWITCH 1" and press the ON key.

<Note>

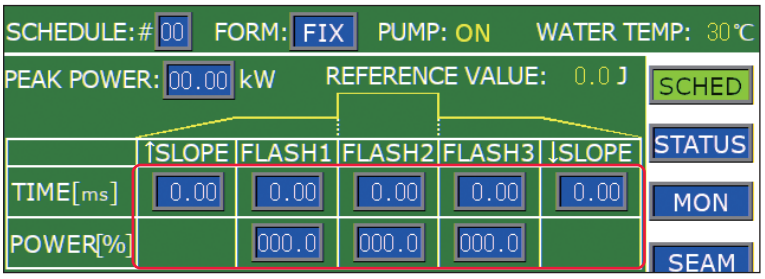
When the pulse width setting range is switched, the set values of SCHEDULE are initialized. To prevent misoperation, the setting cannot be changed unless No.8 of SWITCH 1 is set to ON. When the setting of No.7 of SWITCH 1 is changed and the ENTER key is pressed, the setting of No.8 of SWITCH 1 is returned to OFF. It takes about 15 seconds until initialization is completed. The POWER lamp blinks during that time. Turn off the power supply after blinking stops.

(2) Press the "BACK" button.
The INITIALIZE screen reappears and the setting range for pulse width on the SCHEDULE screen is switched.

Setting example before switching ("7" of SWITCH 1: OFF)



Setting example after switching ("7" of SWITCH 1: ON)



⇒ On the FLEX screen, the screen is switched and displayed in the same way.

<Note>

The value of "FLASH1" + "COOL1" + "FLASH2" + "COOL2" + "FLASH3" is as follows after the setting of "7" of SWITCH 1.

Setting	Maximum value (ms)	Minimum value (ms)	Step (ms)
ON	5.00	0.25	0.05
OFF	90.0	00.3	00.1

2. Setting the Laser Light Delivery

This laser can output single laser light to multiple optical fibers or to a single optical fiber by the functions of the built-in beamsplitter and timesharing unit. This section explains the sharing specifications of this laser.

Laser Light Sharing

The laser light sharing specification is divided into powersharing and timesharing.

At powersharing, laser light is split into multiple beams by beamsplitter and then transfer them to multiple optical fibers to perform welding at multiple points at the same time. Since laser light is split into multiple beams, the respective laser outputs become weak.

At timesharing, a single laser light reflected on the mirror of the timesharing unit is transferred to a single optical fiber to perform welding. A selected branch shutter is opened, so that laser light is output as 100% energy without being split.

The ML-2350A/2351A main unit is provided with a branch shutter with opening/closing sensor and a timesharing unit according to the sharing specification. At delivery, a sharing method is initially set by the DIP switch of the main unit.

For this laser, the following 12 types of sharing specification are available.

Sharing method	Corresponding model
Single: Output to single optical fiber	ML-235□A-010
2-powersharing: Output to 2 optical fibers at the same time	ML-235□A-020
3-powersharing: Output to 3 optical fibers at the same time	ML-235□A-030
4-powersharing: Output to 4 optical fibers at the same time	ML-235□A-040
2-timesharing: Output to one optionally selected out of 2 optical fibers	ML-235□A-002
3-timesharing: Output to one optionally selected out of 3 optical fibers	ML-235□A-003
4-timesharing: Output to one optionally selected out of 4 optical fibers	ML-235□A-004
5-timesharing: Output to one optionally selected out of 5 optical fibers	ML-235□A-005
6-timesharing: Output to one optionally selected out of 6 optical fibers	ML-235□A-006
2 timesharings of 2-powersharing deliveries: Output to 2 optical fibers of an optionally selected block after 4 fibers are divided into 2 blocks, namely, front 2-fiber block and rear 2-fiber block	ML-235□A-022
3 timesharings of 2-powersharing deliveries: Output to 2 optical fibers of an optionally selected block after 6 fibers are divided into 3 blocks, namely, front 2-fiber block, intermediate 2-fiber block, and rear 2-fiber block	ML-235□A-023
2 timesharings of 3-powersharing deliveries: Output to 3 optical fibers of an optionally selected block after 6 fibers are divided into 2 blocks, namely, front 3-fiber block and rear 3-fiber block	ML-235□A-032

At the above timesharing, as soon as the branch shutter is opened after "SHUTTER 1" to "SHUTTER 6" are set to ON, the timesharing unit is automatically operated to split laser light.

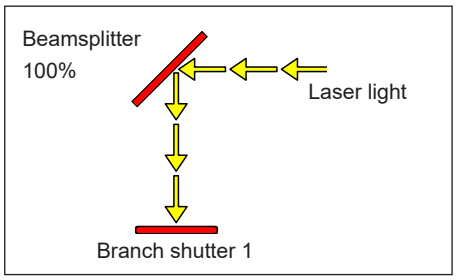
Laser light can also be output by a sharing method other than the above so that the timesharing unit may not be operated even when the branch shutter is opened.

For this setting, set the independent control of the branch shutter by using the DIP switch in the main unit and then set the branch shutter and timesharing unit to be operated on the MEMORY SWITCH screen.

⇒ For how to set the independent control of the branch shutter, refer to "Controlling Branch Shutters Independently" on page 110.

Single

A single branch shutter is opened to output laser light only to a single optical fiber.

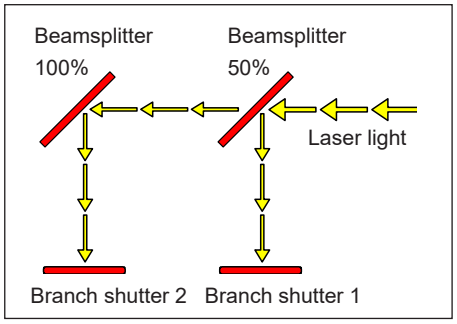


Laser light is reflected on the beamsplitter and transferred from opened branch shutter 1. The timesharing unit is not installed.

2-powersharing delivery to 4-powersharing delivery

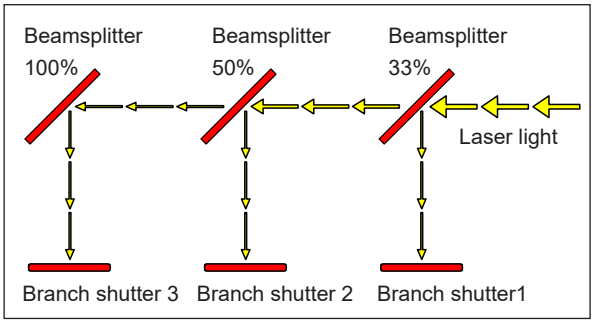
Laser light is split according to the number of built-in branch shutters and then simultaneously output. For example, in the 2-powersharing delivery, two branch shutters are opened to branch laser light into 2 beams, so that these beams are output simultaneously. At 3-powersharing, three branch shutters are opened and laser light is split into 3 beams, and then simultaneously output.

2-powersharing



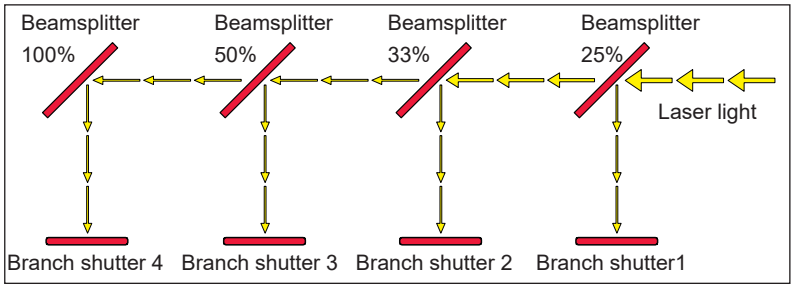
Laser light is reflected on the beamsplitter and split, and then simultaneously transferred from opened branch shutters 1 and 2.

3-powersharing



Laser light is reflected on the beamsplitter and split, and then simultaneously transferred from opened branch shutters 1, 2, and 3.

4-powersharing

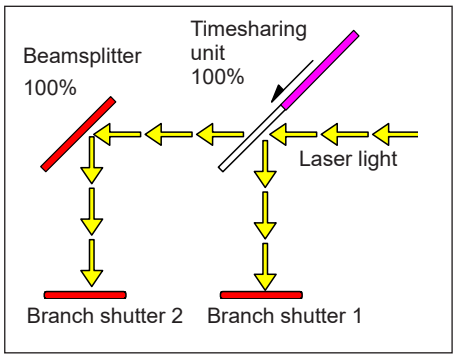


Laser light is reflected on the beamsplitter and split, and then simultaneously transferred from opened branch shutters 1, 2, 3, and 4.

2-timesharing delivery to 6-timesharing delivery

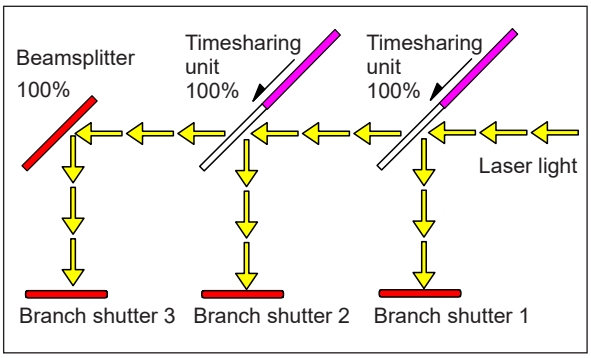
One optionally selected out of the built-in branch shutters is opened to output laser light. For example, when branch shutter 2 is opened, laser light is output to the optical fiber connected to input unit 2. If an operation is performed to open two branch shutters or more, the branch shutter with a smaller No. has priority because two or more branch shutters are not opened.

2-timesharing



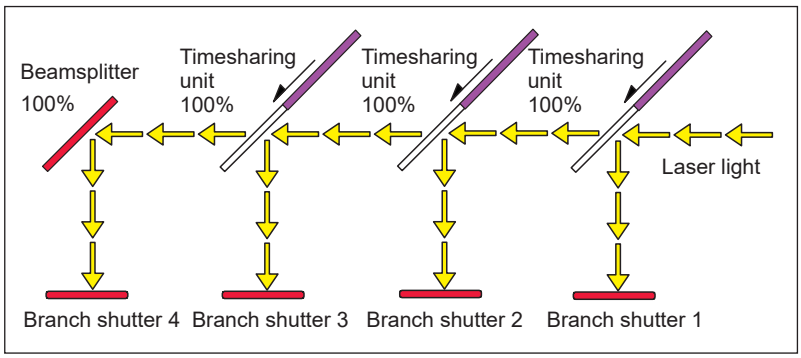
Laser light is reflected on the beamsplitter by operated timesharing unit and transferred from opened branch shutter 2.

3-timesharing



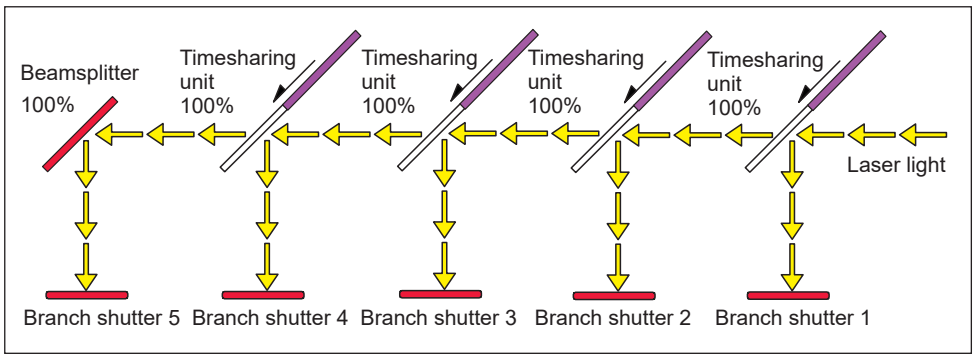
Laser light is reflected on the beamsplitter by operated timesharing unit and transferred from opened branch shutter 3.

4-timesharing



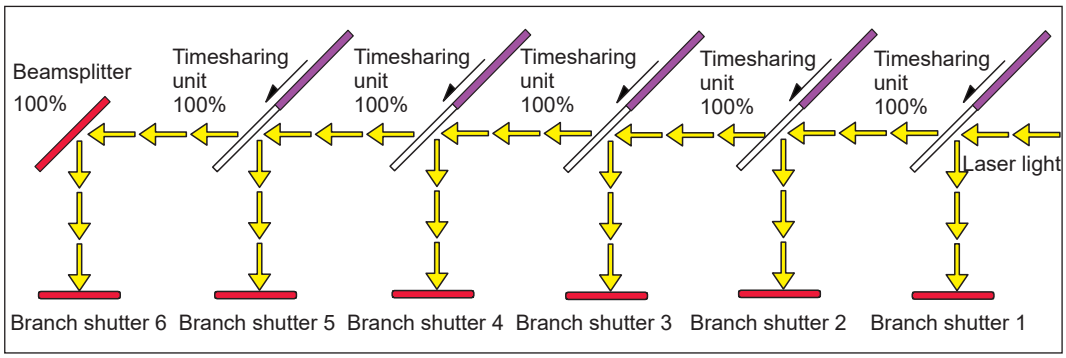
Laser light is reflected on the beamsplitter by operated timesharing unit and transferred from opened branch shutter 1 to 4.

5-timesharing



Laser light is reflected on the beamsplitter by operated timesharing unit and transferred from opened branch shutter 1 to 5.

6-timesharing

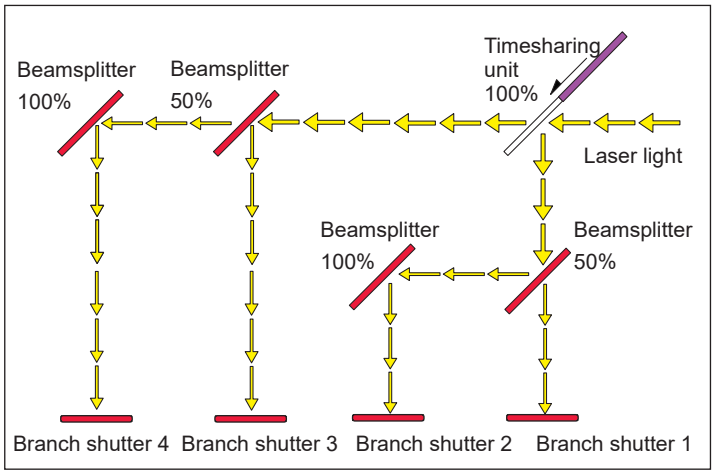


Laser light is reflected on the beamsplitter by operated timesharing unit and transferred from opened branch shutter 1 to 6.

2 or 3 timesharings of 2- or 3-powerhsring deliveries

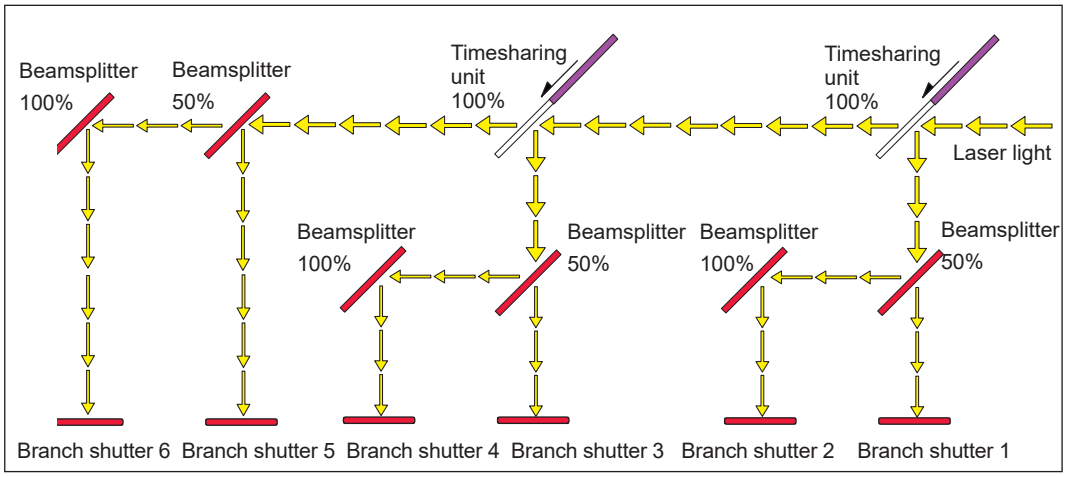
The incorporated branch shutters are divided into 2 or 3 blocks, namely, front 2-shutter block and rear 2-shutter block, or front 3-shutter block, intermediate 3-shutter block, and rear 3-shutter block. Then, laser light is branched into 2 to 3 beams by an optional block and these beams are simultaneously output.

2 timesharings of 2-powersharing deliveries



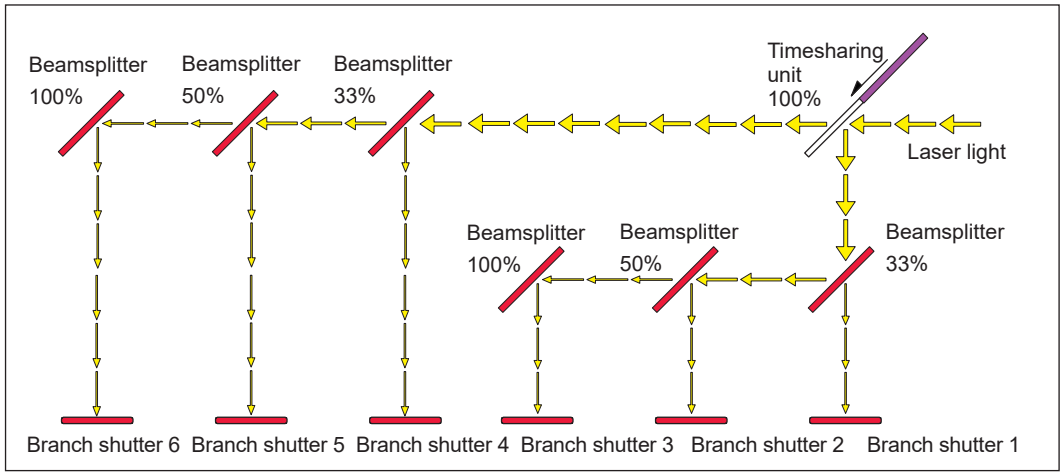
Laser light is reflected and branched on the front or rear beamsplitter by the operation of the timesharing unit. The beams are simultaneously transmitted when branch shutters 1 and 2 or 3 and 4 are opened.

3 timesharings of 2-powersharing deliveries



Laser light is reflected and branched on the front, intermediate, or rear beamsplitter by the operation of the timesharing unit. The beams are simultaneously transmitted when branch shutters 1 and 2, 3 and 4, or 5 and 6 are opened.

2 timesharings of 3-powersharing deliveries



Laser light is reflected and branched on the front or rear beamsplitter by the operation of the timesharing unit. The beams are simultaneously transmitted when branch shutters 1, 2, and 3 or 4, 5, and 6 are opened.

Operating Branch Shutters on the STATUS Screen

In the following, the method of performing open/close operations for branch shutters on the STATUS screen.

On the STATUS screen, perform open/close operations for branch shutters to transfer laser light.

For this laser, the following 12 types of sharing specification are available. The DIP switches in the main unit are initially set according to the specifications provided at delivery.

Sharing type	DIP switch (SW2) settings			
	5	6	7	8
Single	OFF	OFF	OFF	OFF
2-powersharing	OFF	OFF	OFF	ON
3-powersharing	OFF	OFF	ON	OFF
4-powersharing	OFF	OFF	ON	ON
2-timesharing	OFF	ON	OFF	OFF
3-timesharing	OFF	ON	OFF	ON
4-timesharing	OFF	ON	ON	OFF
5-timesharing	ON	ON	OFF	OFF
6-timesharing	ON	ON	OFF	ON
2 timesharings of 2-powersharing deliveries	OFF	ON	ON	ON
3 timesharings of 2-powersharing deliveries	ON	ON	ON	OFF
2 timesharings of 3-powersharing deliveries	ON	ON	ON	ON

Operating Procedure

(1) Press the "BEAM" button.
A window to set the opening/closing of the branch shutter is opened.

(2) Press the setting button for "SHUTTER 1" to "SHUTTER 6" corresponding to the connected optical fiber to set it to ON.
"SHUTTER 1" to "SHUTTER 6" are associated with branch shutters 1 to 6 and input units 1 to 6. The branch shutter that is set to ON is opened to allow laser light to be transmitted. The branch shutters that are set to OFF are not opened, so laser light is interrupted.

⇒ The displayed window depends on the delivery specification. "SHUTTER 1" is displayed for the single delivery specification. "SHUTTER 1" and "SHUTTER 2" are displayed for the 2 timesharing deliveries and 2-powersharing deliveries. "SHUTTER 1", "SHUTTER 2", and "SHUTTER 3" are displayed at 3-powersharing and 3-timesharing.

(3) Press the "CANCEL" button to close the window.

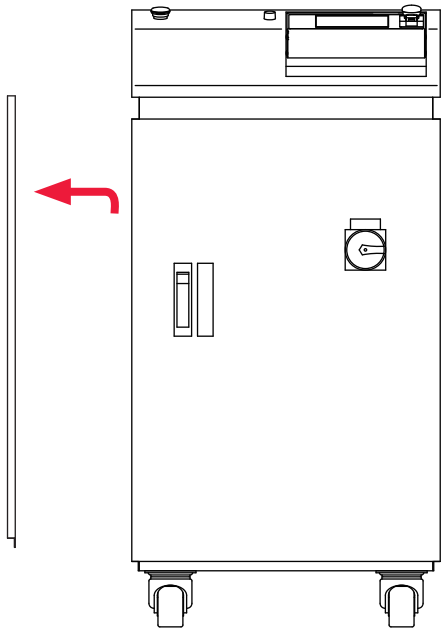
Controlling Branch Shutters Independently

In the following, the method of setting branch shutters to independent control by setting DIP switches.

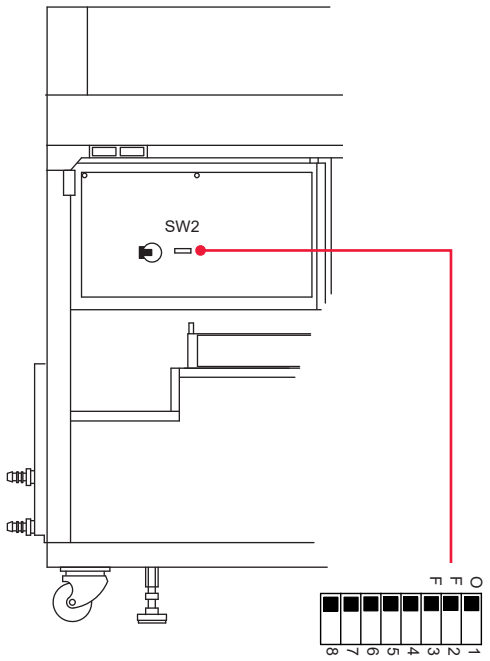
⇒ Usually, the sharing specification is changed by our engineer.

When "SHUTTER 1" to "SHUTTER 6" are set to ON and the branch shutter is opened, the branch shutter and the timesharing unit are automatically operated to transmit laser light. When branch shutters are put under independent control, the timesharing unit and the branch shutter are not operated in the interconnected form even if "SHUTTER" is set to ON. Accordingly, laser light can be transferred by a sharing method other than the prepared 12 types of sharing specification.

The DIP switches of SW2 is provided on the CPU board in the main unit. The branch shutter independent control function is assigned to No.5, 6, 7, and 8 of SW2. Accordingly, remove the side cover of the main unit and set SW2 to ON/OFF for this setting.



Remove the screws of the side cover, raise the cover, and pull it out forward.

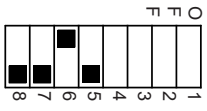


Set the branch shutter independent control by SW2.

Setting Independent Control

(1) Remove the side cover of the main unit and set No.5 of DIP switch SW2 to ON, No.6 to OFF, and No.7 and No.8 to ON.

SW2



Set No.5 to ON.
Set No.6 to ON.
Set No.7 to ON.
Set No.8 to ON.

Branch shutter independent control

The branch shutter independent control is set and the MEMORY SWITCH screen is displayed from the INITIALIZE screen. As a result, it is possible to set that only an optional branch shutter and timesharing unit can be operated.

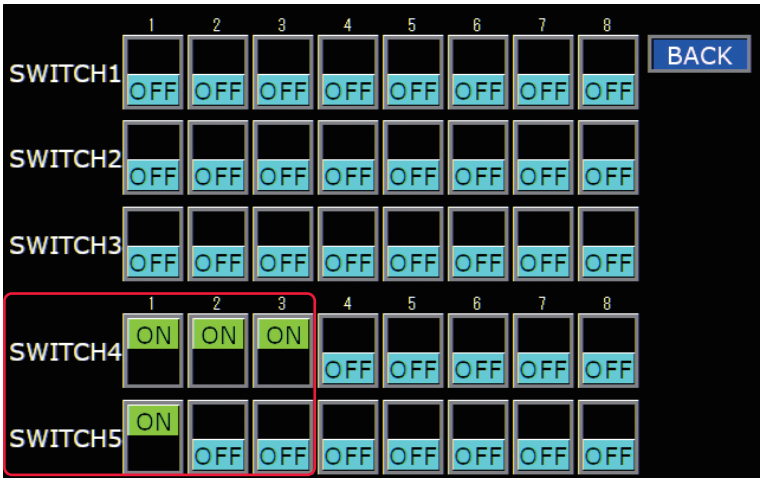
Operating an Optional Branch Shutter and Timesharing Unit

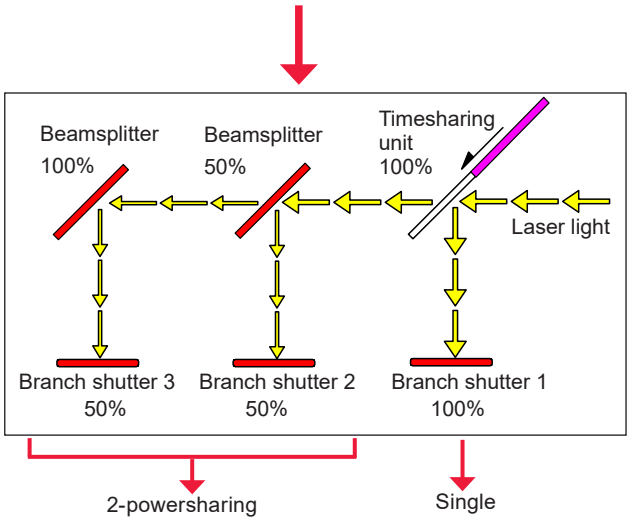
(1) After putting the branch shutter under independent control, press the MEMORY SWITCH button on the INITIALIZE screen.
The MEMORY SWITCH screen is displayed.

(2) Press the setting buttons of "1" to "6" of "SWITCH 4" to set the branch shutter No. to be operated to ON.
"1" to "6" of "SWITCH 4" are associated with branch shutters 1 to 6. Accordingly, set them to ON within the number of mounted branch shutters.

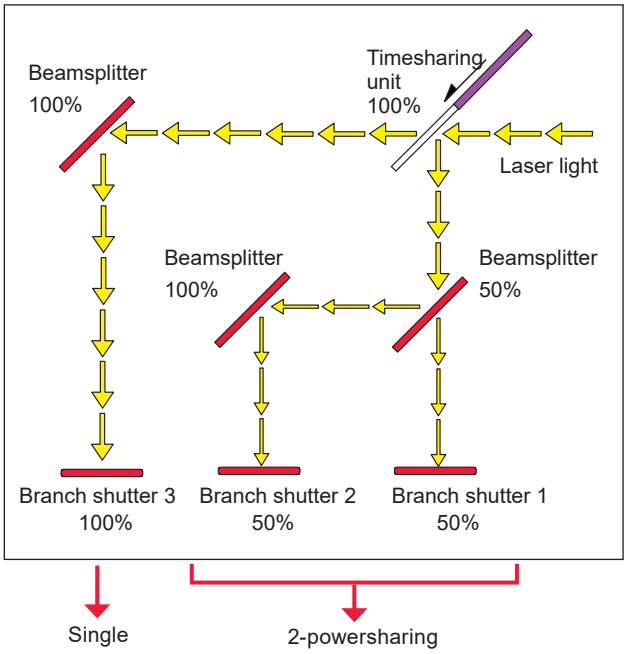
(3) Press the setting buttons of "1" to "5" of "SWITCH 5" to set the timesharing unit numbers to be operated to ON.
"1" to "5" of "SWITCH 5" are associated with the timesharing units 1 to 5. Accordingly, set them to ON within the number of mounted timesharing units.

For example, in the case of single delivery + 2-powersharing delivery, set ON by "SWITCH 4" and "SWITCH 5" as shown below. Then, laser light is output from branch shutter 1 as a single delivery and from branch shutter 2 and 3 as 2-powersharing delivery.





In the case of 2-powersharing delivery + single delivery, laser light is output from branch shutters 1 and 2 as 2-powersharing delivery and from branch shutter 3 as single delivery, depending on a difference in beamsplitter mounting condition.



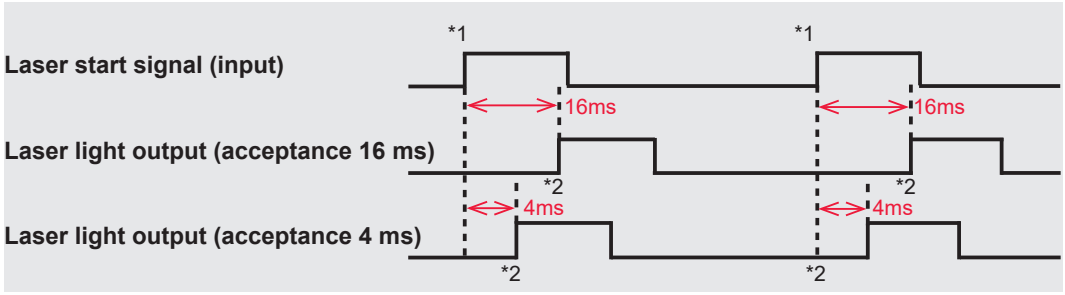
3. Changing Acceptance Time for the Laser Start Signal/ Schedule Signal (MEMORY SWITCH Screen)

This section explains how to change the acceptance time for the laser start signal and schedule signal to be input into the EXT.I/O (1) connector by setting the DIP switches provided in the side face of the main unit when EXTERNAL CONTROL is exerted by external input/output signals.

The laser signal acceptance time means the time required until laser light is actually output after the laser start signal is input. The schedule signal acceptance time means the time required until this laser establishes schedules after a schedule signal 1, 2, 4, 8, or 16 to select a SCHEDULE number is input.

The following timing chart shows the laser light output timing when the laser signal acceptance time is 16 ms and 4 ms.

*1: Laser start signal input *2: Laser light output



⇒ The laser start signal acceptance time and the schedule signal acceptance time are common. A different value cannot be set for the respective time.

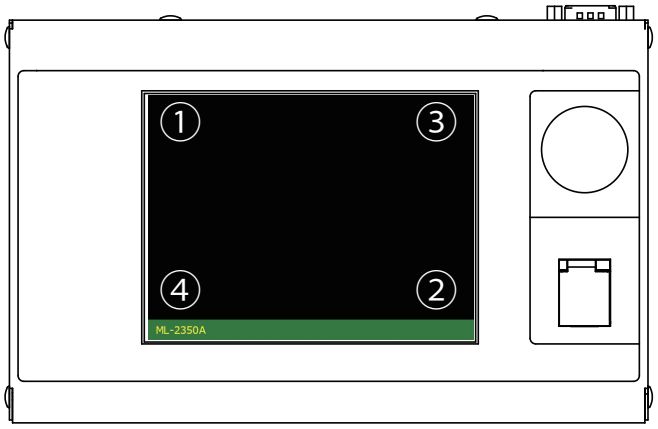
As the acceptance time for laser start signal, the 5 types of 0.1 ms, 1 ms, 4 ms, 8 ms, and 16 ms are available. At delivery, the acceptance time is set to 16 ms.

Usually, the acceptance time for laser start signal is 16 ms but can be shortened as required. To change this setting, switch the ON/OFF states of No.2, 3, and 4 of "SWITCH 3" on the MEMORY SWITCH screen as shown below.

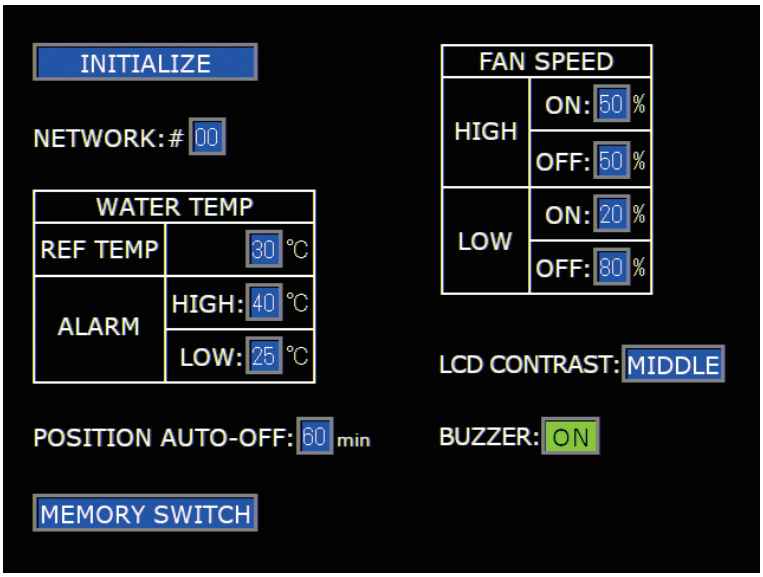
Acceptance time	No.2	No.3	No.4
0.1ms	ON	ON	ON
	OFF	ON	ON
	ON	OFF	ON
	OFF	OFF	ON
1ms	ON	ON	OFF
4ms	OFF	ON	OFF
8ms	ON	OFF	OFF
16ms	OFF	OFF	OFF

1 Displaying the MEMORY SWITCH Screen

(1) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch. Power is supplied and the POWER lamp comes on. The screen of model name appears.



(2) While the model name screen is displayed (for about 3 seconds), press the corners of the touch panel display in the order shown in the figure above.
The INITIALIZE screen appears.

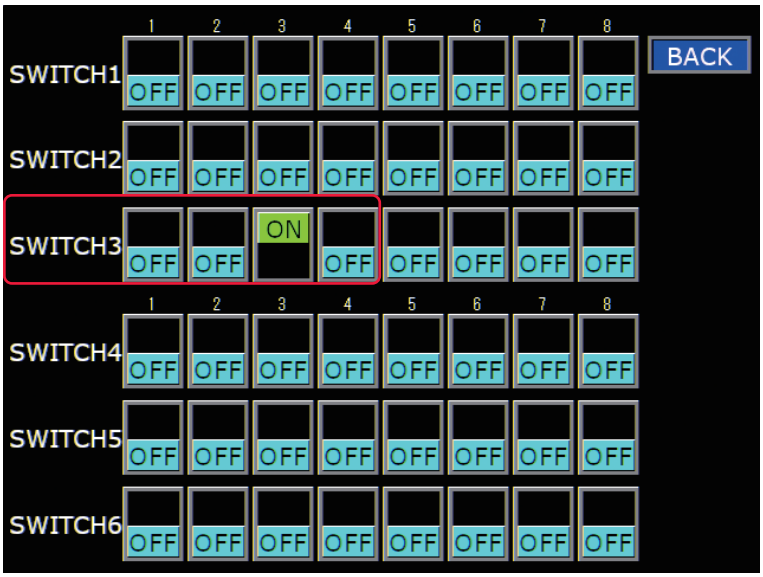


⇒ Unless the CONTROL keyswitch is OFF, the INITIALIZE screen does not appear.

(3) Press the "MEMORY SWITCH" button.
The MEMORY SWITCH screen appears.

2 Changing the Acceptance Time

(1) Press the setting buttons of "2", "3", and "4" of "SWITCH 3" to set them to ON.
For example, to set the acceptance time to 4 ms, set "2" to OFF, "3" to "ON, and "4" to OFF.



(2) Press the "BACK" button.
The INITIALIZE screen reappears and the acceptance time for laser start signal and schedule signal is changed.

4. Setting the Function of the Output Unit with Fiber Sensor (Option)

For using the output unit with fiber sensor (option), perform a setting to make the function effective by the DIP switches provided in the side face of the main unit.

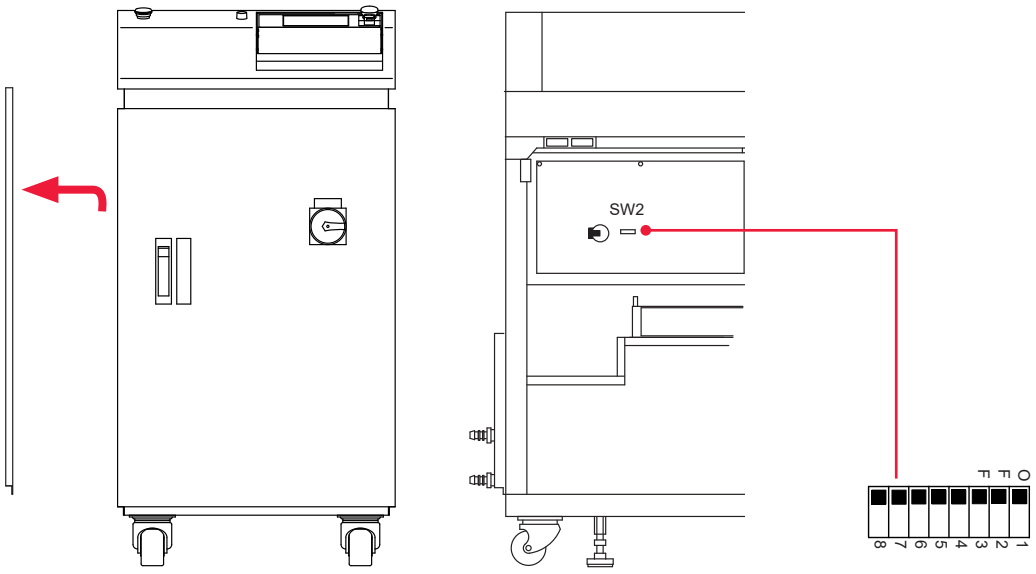
This section explains how to set the function of the output unit with fiber sensor.

The output unit with fiber sensor is provided with the following 3 functions.

Fiber breakage detection:	Detects that the fiber was broken during laser output.
Fiber mount check:	Check that the fiber is correctly mounted in the output unit.
LED ON check:	Check that the HV-ON lamp of the output unit lights when a high voltage is applied.

DIP switches are provided on the CPU board in the side surface and on the fiber breaking sensor board in the top surface of the main unit. First, remove the cover and set No.3 of SW2 provided on the CPU board to ON to enable the fiber breakage detecting function. Next, set the fiber mount checking function and the LED ON checking function by SW1 and SW2 provided on the fiber breaking sensor board in the top surface.

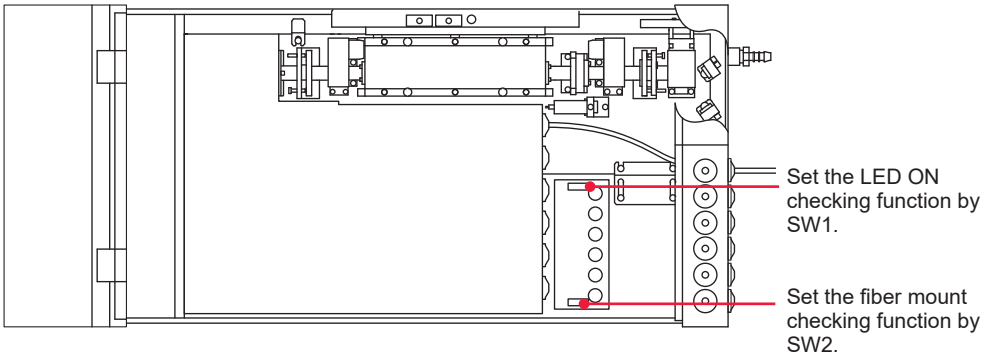
Inside of the side surface of the main unit



Remove the screws of the side cover, raise the cover, and pull it out forward.

Set the fiber breakage detecting function by SW2.

Inside of the top surface of the main unit



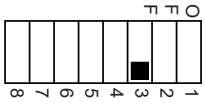
Set the LED ON checking function by SW1.

Set the fiber mount checking function by SW2.

Operating Procedure

(1) Set the fiber breakage detecting function.
Remove the side cover of the main unit and set No.3 of SW1 to ON.
The fiber breakage detecting function is set. When optical fiber breakage or end face damage is detected during laser light output, Error No.38 to 43 FIBER SENSOR 1 to 6 TROUBLE is displayed.

SW2



Set No.3 to ON.

(2) Set the fiber mount checking function.
Remove the top cover of the main unit and set all the output units to be used out of No.1 to No.6 of SW2 to OFF. Set the other switches to ON.
The fiber mount checking function is set. When the optical fiber or trouble detecting cable is not connected, Error No.32 FIBER SWITCH TROUBLE is displayed.

⇒ Set the fiber mount checking function after setting the fiber breakage detecting function in (1).

(3) Set the LED ON checking function.
Out of No.1 to No.6 of SW1, set all of the output unit numbers to be used to OFF and set the others to ON.
The LED ON checking function is set. When the LED (HV-ON lamp) ON status of the specified output unit is not checked, Error No.33 E.INDICATOR TROUBLE (OUTPUT UNIT) is displayed.

⇒ Set the LED ON checking function after setting the fiber breakage detecting function in (1).

As an example of (2) and (3) settings, set No.1 to No.3 of SW1 and SW2 to OFF to use output units No.1 to No.3.

SW2

1: Checking that the fiber 1 HV-ON LED is ON.
2: Checking that the fiber 2 HV-ON LED is ON.
3: Checking that the fiber 3 HV-ON LED is ON.

SW1

1: Checking that fiber 1 is mounted.
2: Checking that fiber 2 is mounted.
3: Checking that fiber 3 is mounted.

Operating Part

Chapter 3

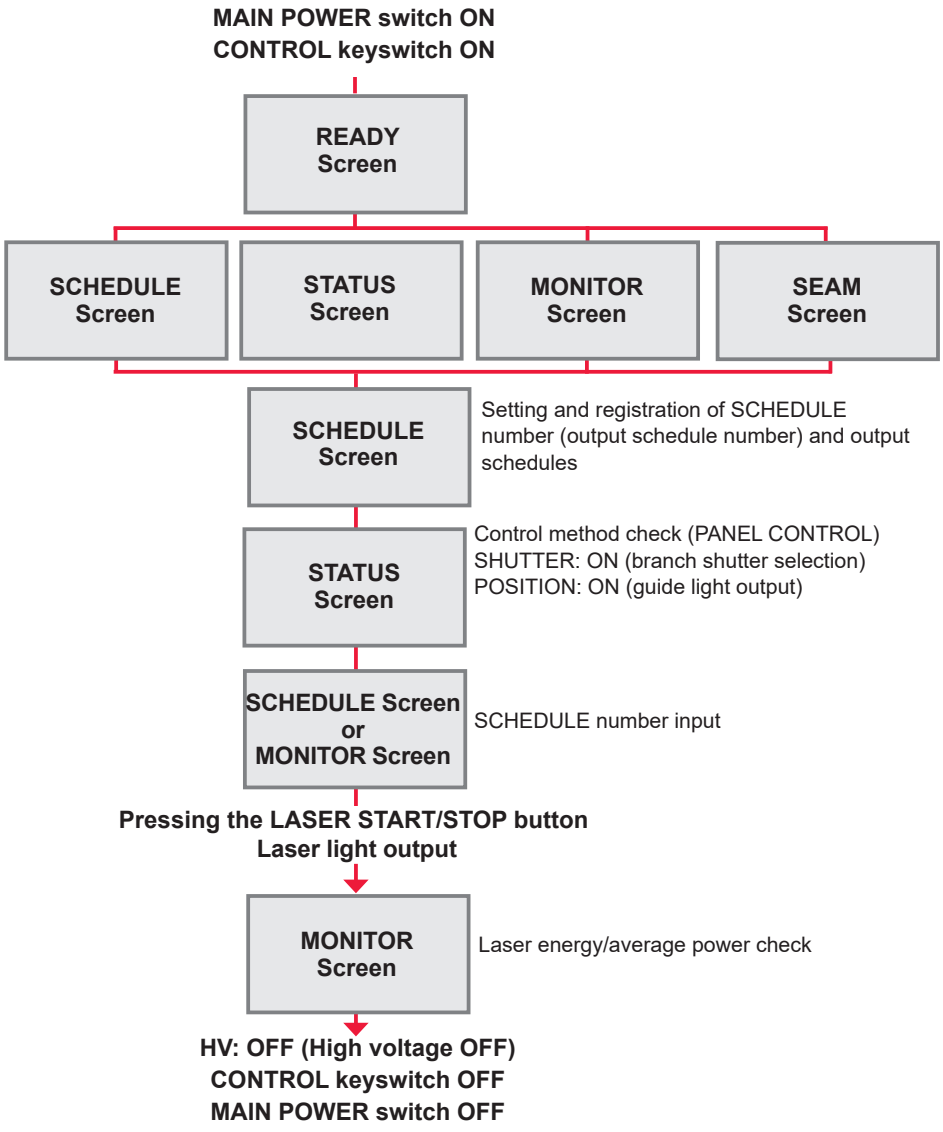
Laser Welding by Laser Controller (PANEL CONTROL)

1. Operation Flow

This section explains a laser welding operation flow by laser controller.

The following methods for laser welding operations are available: control from the laser controller (PANEL CONTROL), control by external input/output signals from the connected PLC (Programmable Logic Controller) (EXTERNAL CONTROL), and control by sending a command from the connected personal computer (RS-485 CONTROL).

At PANEL CONTROL, welding schedules are set by using the laser controller and laser light is output.

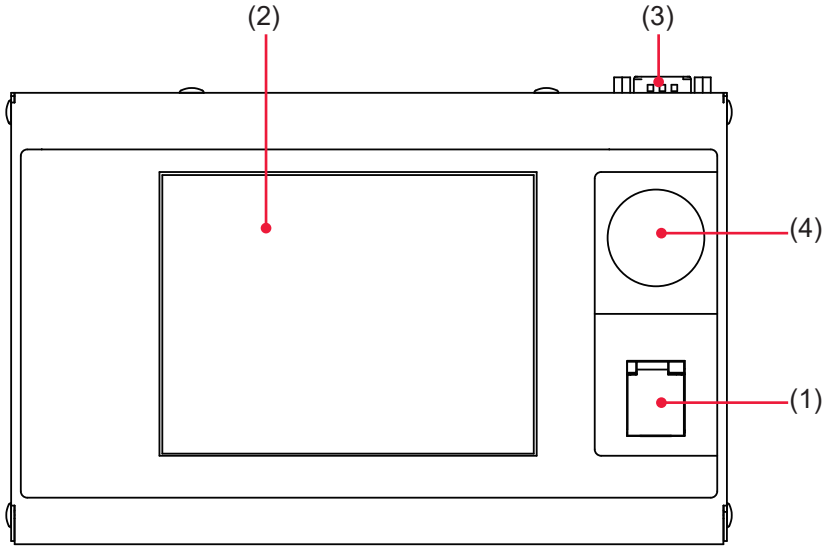


2. Laser Controller Functions

This section explains the functions of the laser controller.

At PANEL CONTROL, welding schedules are set by using the liquid crystal display of the laser controller and laser light is output by pressing the LASER START/STOP button. After the output, you can check the laser output energy on the MONITOR screen.

⇒ It is possible to perform laser welding operations in a remote place from the laser welder after removing the laser controller from the main unit.



Function of Each Section on the Laser Controller

(1) LASER START/STOP (Button)	If you press the button when a laser light output becomes ready (*), laser light is output. If the button is pressed again while laser light is repeatedly output, the repeated output is stopped. * Pin No.23 (control switching) of the EXT.I/O (1) connector is in a closed circuit, a high voltage is supplied, and the branch shutter is open.
EMISSION (Lamp)	When a high voltage is applied to the laser oscillator section, the EMISSION lamp comes on.
(2) Liquid Crystal Display	This is a touch panel type liquid crystal color display. This unit displays setting items, setting buttons, set values, monitor data, and windows and keyboard required for settings.
(3) Circuit Cable Connector	Connect the supplied circuit cable to this connector. Connect the other end of the cable to the Laser.
(4) EMERGENCY STOP (Button)	This is an emergency stop button. With this button pressed, the laser welder operation is stopped. When the pressed button is turned in the direction of RESET (clockwise), the button is reset to the initial state. This button functions in the same way as the EMERGENCY STOP button of the main unit.

3. Operating Procedure

This section explains the operating procedure for laser welding to be controlled from the laser controller.

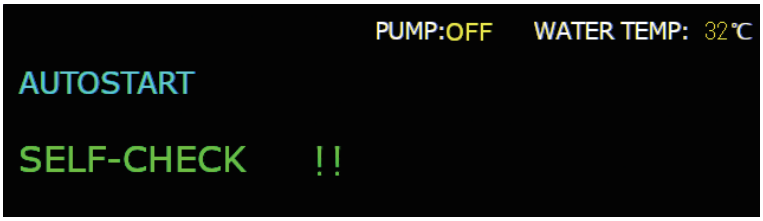
⇒ For the details of welding schedule settings, refer to Chapter 2, "1. Setting Welding Schedules" on page 59. For connector functions, refer to Chapter 4, "3. Connector Functions" on page 131.

⇒ Before turning on the power supply, put pin No.23 (control switching) of the EXT. I/O (1) connector to an open circuit to invalidate external input signals. As a result, the control by external input signals (EXTERNAL CONTROL) is invalidated and "PANEL CONTROL" is displayed in "CONTROL DEVICE" on the STATUS screen.

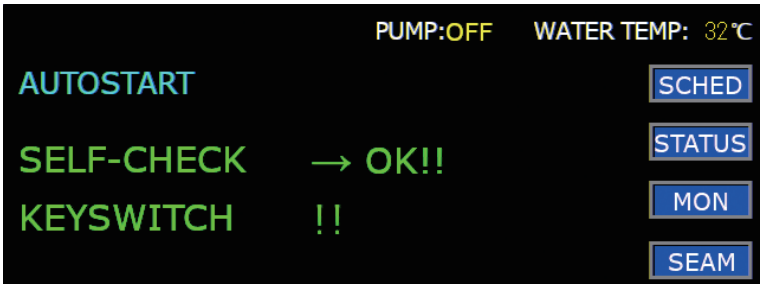
1 Starting the Laser

(1) Turn ON the MAIN POWER switch at the front of the main unit.

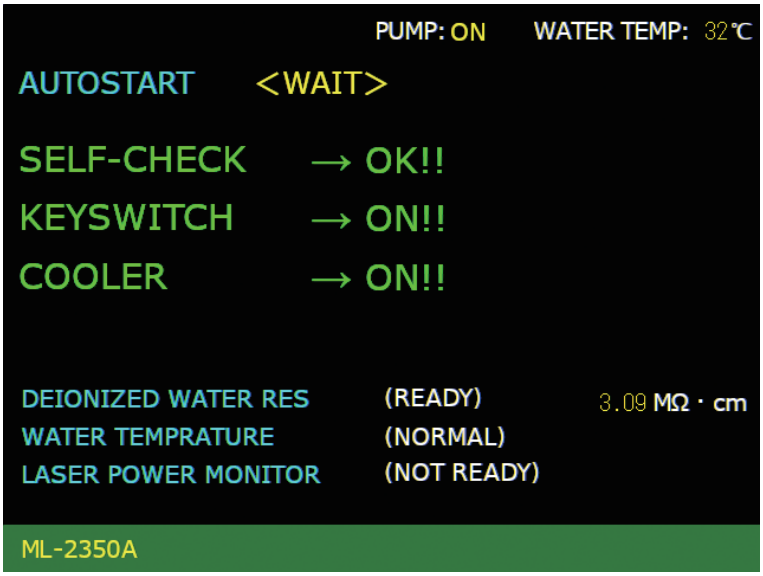
The power supply is turned ON and the POWER lamp comes on. Then, the SELF-CHECK !! screen appears.



The resonator shutter, timesharing unit, branch shutter, memory, and power supply unit are automatically checked. When no error is found, the KEYSWITCH !! screen is displayed.

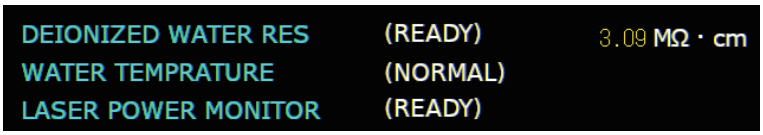


(2) Turn ON the CONTROL keyswitch.
The laser is put to an operable status and the COOLER → ON !! screen appears.

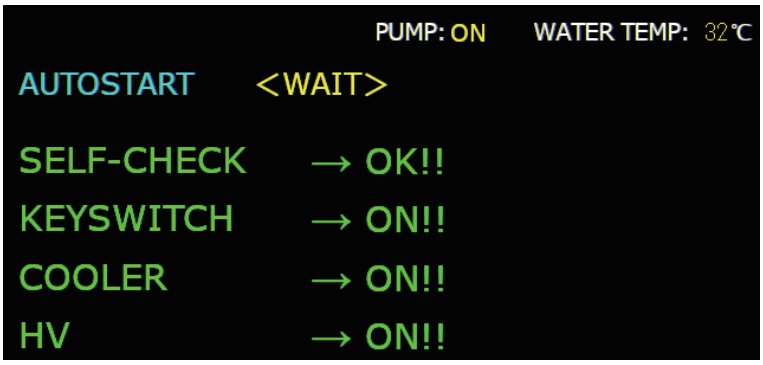


How to see the displayed items

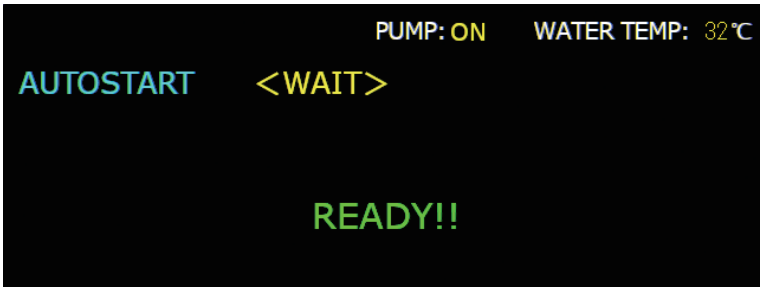
PUMP	Displays the ON/OFF status of the pump to circulate cooling water.
WATER TEMP	Indicates the secondary cooling water temperature. Upon completion of SELF CHECK, a temperature measurement is started and the measured value is indicated.
DEIONIZED WATER RES	Indicates the resistivity of secondary cooling water. NOT READY: Indicated when the resistivity is below 3.00 MΩ·cm. READY: Indicated when the resistivity is 3.00 MΩ·cm or more.
WATER TEMPERATURE	Indicates the secondary cooling water temperature status. LOW: Displayed at 24ºC or less. NORMAL: Displayed at 25ºC to 40ºC. After the power supply is turned on, the temperature of cooling water is not stable for a while. Immediately after the power supply is turned on, NORMAL is displayed when the temperature rises up to 27ºC. HIGH: Indicated at 41ºC or more.
LASER POWER MONITOR	Indicates the sensor status of the power monitor unit. NOT READY: Indicated during warming-up. READY: Indicated at completion of warming-up.



When "DEIONIZED WATER RES" is (READY), "WATER TEMPERATURE" is (NORMAL), and "LASER POWER MONITOR" is (READY), a high voltage is turned ON and charging is started. Then, the HV → ON !! screen appears.



After completion of charging, the READY !! screen appears for 0.5 sec.



After the READY !! screen appears, the screen (SCHEDULE screen, STATUS screen, or MONITOR screen) displayed at the previous completion appears.

2 Setting Output Schedules

As an example, the procedure for setting SCHEDULE No.05, laser output peak value 5.00 kW, FLASH1 laser output time 3.6 ms/output value 60%, and up-slope 0.6 ms is explained below.

⇒ For how to set the output conditions for seam welding, refer to "Setting the output conditions for seam welding" on page 83.

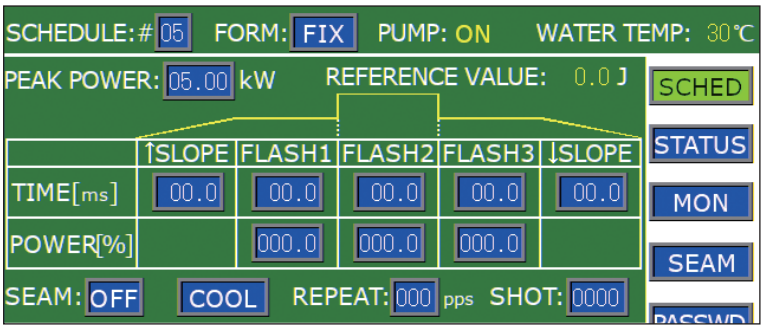
(1) Press the "SCHED" button to display the SCHEDULE screen.

(2) Press the "SCHEDULE" setting button.
Enter the SCHEDULE number by using the numeric keypad and then press the ENT key.
In this example, set #05.

⇒ As the SCHEDULE number, it is possible to set 32 schedules of #00 to #31. In "FORM", the fixed waveform "FIX" or flexible waveform "FLEX" can be specified.

⇒ When the registered SCHEDULE number is entered, the set output schedules are displayed.

(3) Press the "PEAK POWER" setting button.
Enter the laser output peak value by using the numeric keypad and then press the ENT key.
In this example, set 5.00 kW.



<Note>

The settable maximum peak value of laser output differs depending on the model. For the laser output value setting (% of FLASH), set a value not exceeding the maximum value of each model.

ML-2350A: 7.0 kW	**ML-2351A: 5.0 kW**

(4) Press the "TIME [ms]" setting button of "FLASH1."

Enter the laser output time (ms) by using the numeric keypad and then press the ENT key.

In this example, set 03.6 ms in "FLASH1."

<Note>

Set the laser output time so as to result in the following value.

0.25 ms ≤ "FLASH1" + "FLASH2" + "FLASH3" ≤ 30.0 ms

(5) Press the "↑SLOPE" setting button.

Enter the time "TIME [ms]" required for laser light to up-slope (get gradually stronger) in FLASH1 by using the numeric keypad, and then press the ENT key.

In this example, set 00.6 ms.

<Note>

Set "↑SLOPE" so as to result in the following value.

↑SLOPE ≤ FLASH1

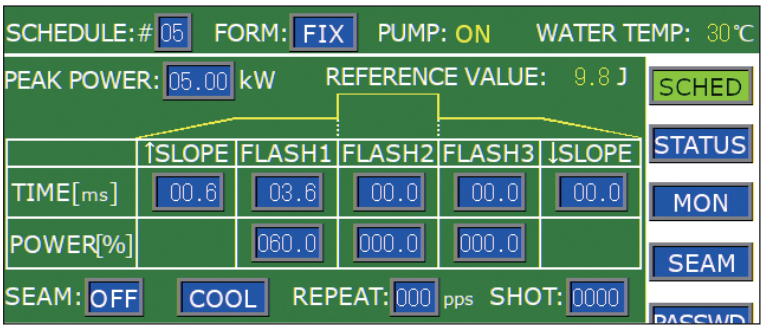
When setting "FLASH2" or "FLASH3", set the time required for laser light to down-slope (the laser output is gradually weaker) to FLASH. Set "↓SLOPE" so as to result in the following value.

↓SLOPE ≤ FLASH1, FLASH2, FLASH3

(6) Press the "POWER [%]" setting button of "FLASH1."

Enter the laser output value (%) by using the numeric keypad and then press the ENT key.

In this example, set 060.0% in "FLASH1."



⇒ For the laser output value, set the ratio (%) supposing that the set laser output peak value is 100%. In this example, this peak value is 60% of "PEAK POWER=5.00 kW", so that the actual laser output value is 3.0 kW. In this case, even if "PEAK POWER=3.00 kW" and "FLASH1 03.6 ms 100%" are set, the actual laser output value is the same.

⇒ For setting the number of continuous laser light outputs, set the number of outputs per second in "REPEAT" in the range of 000 to 200 pps (pulse per second). When 0 is set, a single output is performed.

⇒ For setting the number of laser light outputs, set it in "SHOT" in the range of 0000 to 9999. When "REPEAT" is not set to 0 and "SHOT" is 0, laser light is continuously output until the LASER START/STOP button is pressed.

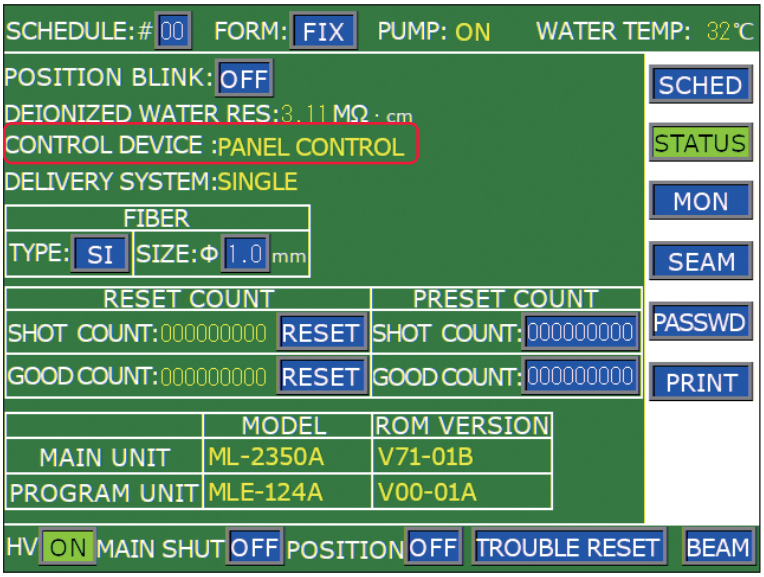
3 Outputting Laser Light

⚠ WARNING

Be sure to put on protective glasses for YAG Laser (1064 nm) during laser light output operation. If laser light enters the eyes directly, a loss of eyesight may be caused.

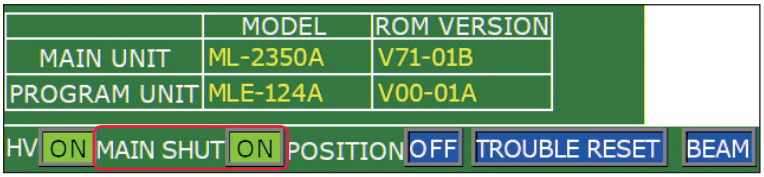
(1) Press the "STATUS" button to display the STATUS screen.

When Pin No.23 (control switching) of the EXT.I/O (1) connector remains in an open state, external input signals are disabled and "PANEL CONTROL" is displayed in "CONTROL DEVICE."



(2) Adjust the workpiece and output unit positions to set an appropriate work distance (distance between the workpiece and the output position).

(3) Press the "MAIN SHUT" setting button to set it to ON to open the resonator shutter.



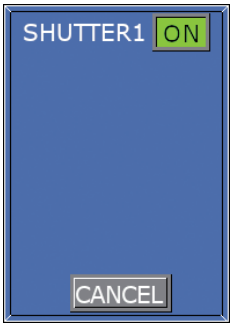
(4) Press the "BEAM" button.

A window to set the opening/closing of the branch shutter and beamsplitter is opened.

⇒ The displayed window depends on the specification.

(5) Press the setting buttons for "SHUTTER 1" to "SHUTTER 6" to set the opening/closing of the branch shutters.

In this example, set "SHUTTER 1" to ON. Branch shutter 1 is opened and the corresponding SHUTTER comes on.



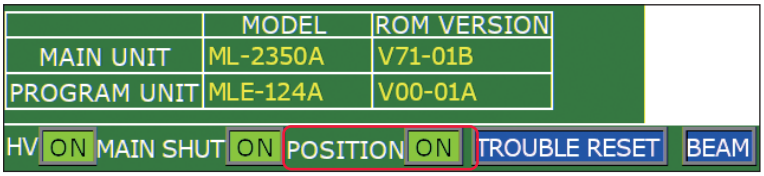
(6) Press the "CANCEL" button.

The opening/closing of the branch shutter is set and the window is closed.

⇒ For powersharing, set all the SHUTTERs to be used to ON to open all the branch shutters.

(7) Press the "POSITION" setting button to set it to ON to output guide light.

The "POSITION" setting button is set to ON and a red dot of guide light appears at the laser light injecting position. Laser light is injected to the red-dot position.



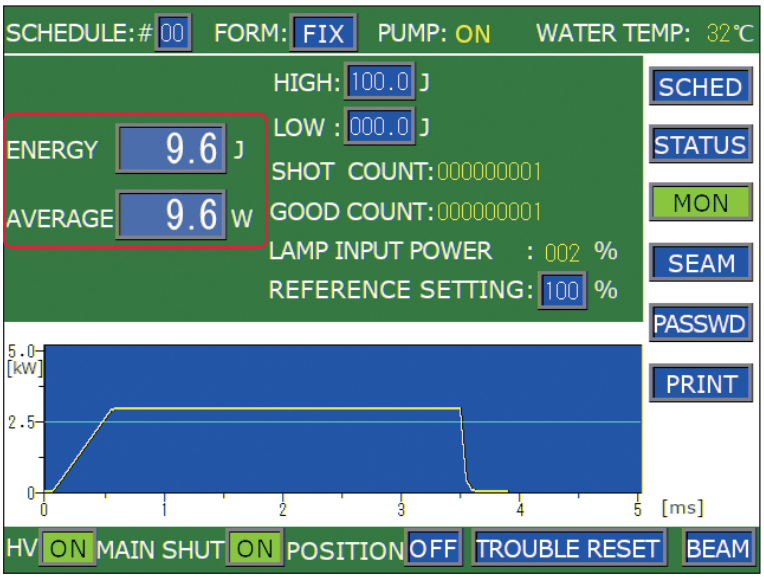
(8) Check the laser light irradiation position.

If the point to be worked deviates from the red point of guide light, adjust the position by moving the output unit or workpiece.

(9) Press the LASER START/STOP button.
Laser light is output.

⇒ Before pressing the LASER START/STOP button, display the SCHEDULE screen or MONITOR screen and input another registered SCHEDULE number. With this, laser light is output in the output conditions of this SCHEDULE.

(10) Press the MON button to display the MONITOR screen, and check the laser output energy (J) and average power (W) of the output laser light.



4 Stopping Laser Welding

⚠ CAUTION

During a laser light output or for 5 seconds immediately after a laser light output, do not turn OFF the MAIN POWER switch. Damage may be caused to the lamp and YAG rod by insufficient cooling.

(1) Press the "HV" setting button on each screen to set it to OFF.
The high voltage is cut off.

(2) Turn OFF the CONTROL keyswitch.
The key can be pulled out.

(3) Turn OFF the MAIN POWER switch.
The power supply is turned OFF and the POWER lamp goes out.

⇒ Return the key of the CONTROL keyswitch to the laser safety supervisor so that it can be kept in custody.

Operating Part

Chapter 4

Laser Welding by External Input/ Output Signals (EXTERNAL CONTROL)

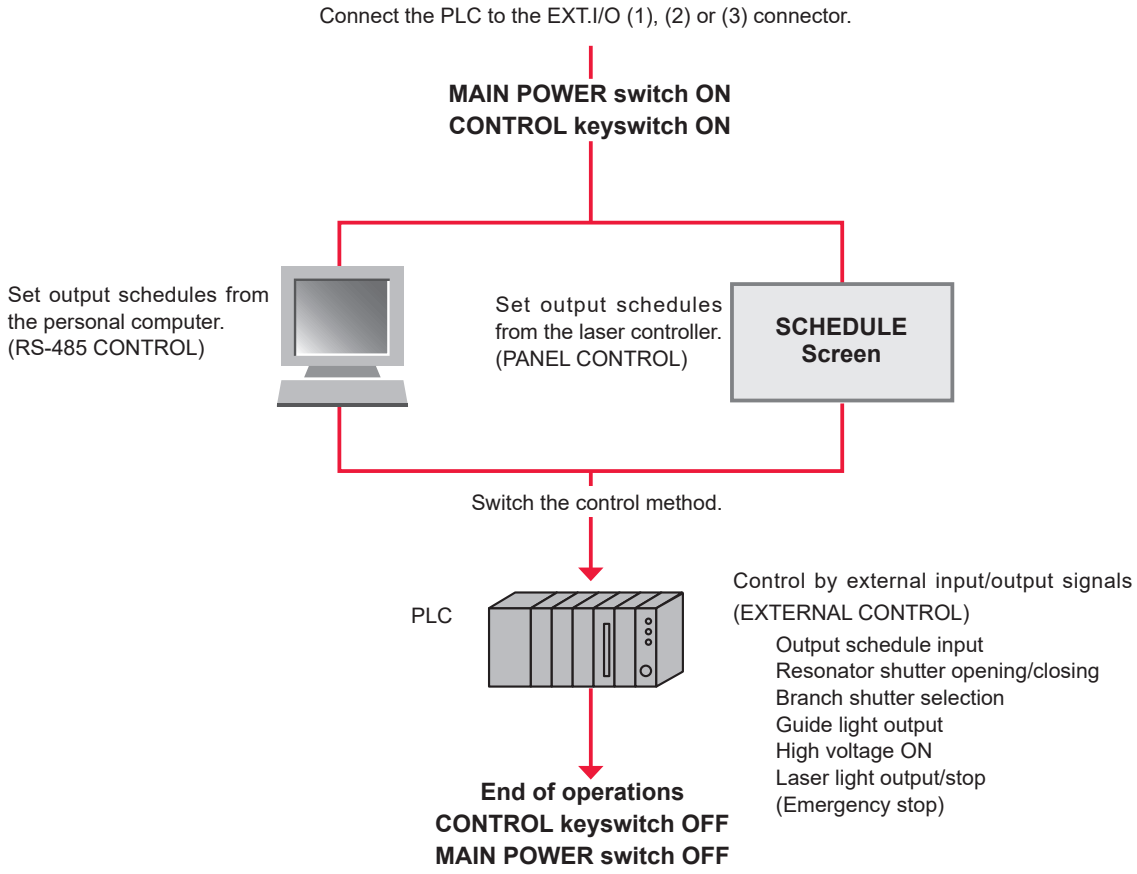
1. Operation Flow

This section explains an operation flow of laser welding by external input/ output signals (EXTERNAL CONTROL).

The following methods for laser welding operations are available: control from the laser controller (PANEL CONTROL), control by external input/output signals from the PLC (Programmable Logic Controller) connected to the connector (EXTERNAL CONTROL), and control by sending a command from the connected personal computer (RS-485 CONTROL).

At the control by external input/output signals (EXTERNAL CONTROL), output schedules are set by another method (PANEL CONTROL/RS-485 CONTROL) in advance. After that, such control as schedule selection, laser light output, and emergency stop is exerted.

* PLC: Programmable Logic Controller This unit exerts sequence control by executing the programmed contents of control in sequence. This is often called Sequencer (product name of Mitsubishi Electric Corporation).

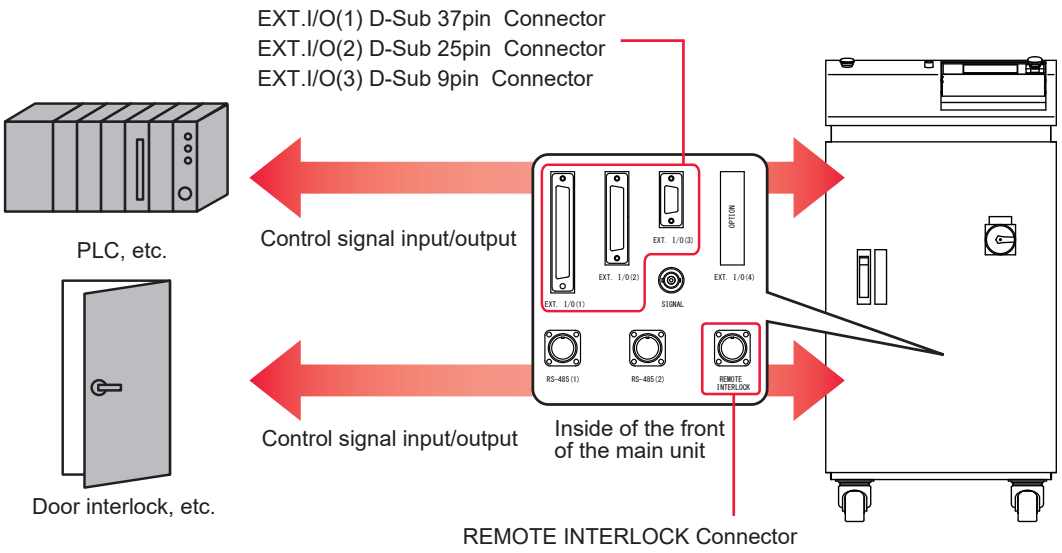


2. Preparations for Operations

This section explains the devices and connectors required for laser welding by external input/output signals (EXTERNAL CONTROL).

Connect the PLC to the EXT.I/O (1), (2) or (3) connectors provided in the front of the main unit to control the main unit by executing the program from the outside. The EXT.I/O (3) connector plays a role to stop the laser welder operation when an error occurs in another unit on the production line or an emergency stop signal is received from the PLC.

Also, for preventing hazards, a remote interlock must be connected as a matter of duty. The REMOTE INTERLOCK connector is connected to the interlock of the door of the chamber or room for laser welding. If the door is suddenly opened, the branch shutter is closed to cut off laser light.



The plug and case models of connectors are as follows.

Connector	Plug	Case	Manufacturer
EXT.I/O (1)	HDCB-37P(05)	HDC-CTH(10)	HIROSE ELECTRIC CO., LTD.
EXT.I/O (2)	HDBB-25P(05)	HDB-CTH(10)	
EXT.I/O (3)	HDEB-9P(05)	HDE-CTH(10)	
REMOTE INTERLOCK	116-12A10-2AF10.5		TAJIMI ELECTRONICS CO., LTD.

⇒ Prepare a program and its development environment for laser control on the customer side.

⇒ The model numbers of plug and case are subject to change without notice. Depending on the part to be changed, the mounting screw shape may change and a necessary tool may be different. For the latest parts information, contact a nearest sales office.

3. Connector Functions

Pin Arrangement and Functions

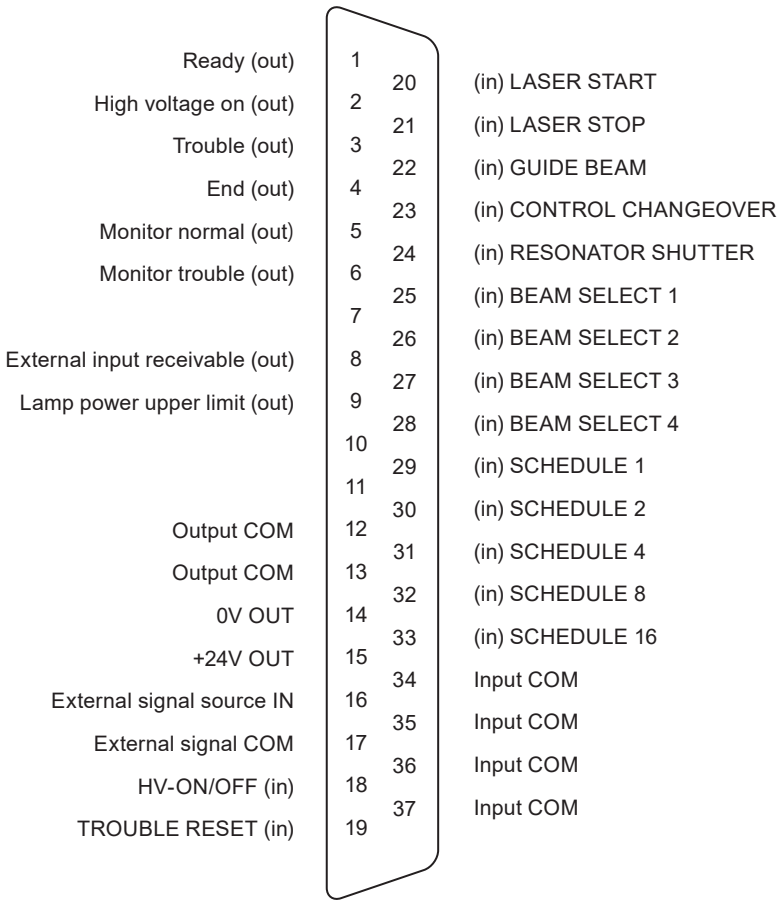
There are 4 connectors to be connected for the control by external input/output. This section explains the arrangement and functions of the respective pins.

EXT.I/O (1) Connector (D-Sub 37 pin)

The EXT.I/O (1) connector inputs welding schedules and inputs or outputs the start signal of guide light and laser light.

⇒ Use the following product out of the attached connectors.

Plug	Case	Manufacturer
HDCB-37P(05)	HDC-CTH(10)	HIROSE ELECTRIC CO., LTD.



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

⇒ Supply power to pin No.16 and pin No.17 and put the section between pin No.23 and COM in a closed circuit.

Pin No.	Description
14	0 V OUT Power supply for external input signals. This pin is exclusively used for the ML-2350A/2351A. Do not use it for any other purpose.
15	+24 V OUT Power supply for external input signals. This pin is exclusively used for the ML-2350A/2351A. Do not use it for any other purpose.
16	External signal source IN Input terminal for the external signal power supply. Connect it to Pin 14 or Pin 15, depending on the input signal circuit.
17	External signal COM Common input terminal for external signals. Connect it to Pin 15 or Pin 14, depending on the input signal circuit.
18	HV-ON/OFF When this Pin 18–COM circuit 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 19–COM circuit is closed, the alarm will be canceled.
20	LASER START When Pin 21–COM circuit is closed, the laser beam is output. Make sure that the circuit is left closed for at least the time set on the MEMORY SWITCH screen. When the signal is input repeatedly, make sure that the circuit is left open for at least 40 ms between each input and the repetition interval is within the maximum rated output.
21	LASER STOP When outputting the laser using Pin 20, close this Pin 21–COM circuit. For the repeated output for which the number of outputs is set in "REPEAT" on the SCHEDULE screen, the laser output is stopped by closing the section between the pin and COM during a laser output. The closed circuit time should be 1 ms or more.
22	GUIDE BEAM While this Pin 22–COM circuit is closed, the guide beam is output.
23	CONTROL CHANGEOVER While this Pin 23–COM circuit is closed, the external input signals are effective.
24	RESONATOR SHUTTER When the section between this pin and the COM is closed, the resonator shutter is opened to enable laser oscillation. When this section is opened, the resonator shutter is closed to disable laser oscillation.
25	BEAM SELECT 1 When this Pin 25–COM circuit is closed, laser beam input unit 1 is selected and the unit becomes ready to project a laser beam.
26	BEAM SELECT 2 When this Pin 26–COM circuit is closed, laser beam input unit 2 is selected and the unit becomes ready to project a laser beam.

Pin No.	Description	
27	BEAM SELECT 3 When this Pin 27–COM circuit is closed, laser beam input unit 3 is selected and the unit becomes ready to project a laser beam.	
28	BEAM SELECT 4 When this Pin 28–COM circuit is closed, laser beam input unit 4 is selected and the unit becomes ready to project a laser beam.	
29	SCHEDULE 1	Select a registered SCHEDULE number by combining schedule signal inputs 1, 2, 4, 8, and 16. For how to select a SCHEDULE number, refer to the following table.
30	SCHEDULE 2	
31	SCHEDULE 4	
32	SCHEDULE 8	
33	SCHEDULE 16	

SCHEDULE Number Selection

Set "SCH.#" by combining pin No.29 to pin No.33 (schedule signals 1, 2, 4, 8, and 16) inputs.

Input / SCH.#	SCH 16	SCH 8	SCH 4	SCH 2	SCH 1
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 opened.

Output Pins of EXT.I/O (1) Connector

Pin No.	Description
1	Ready When the high voltage is turned ON and the capacitor is fully charged, this Pin 1–COM circuit is closed internally.
2	High Voltage ON While the high voltage is supplied, this Pin 2–COM circuit is closed internally.
3	Trouble If trouble arises, this Pin 3–COM circuit is opened internally until it is reset.
4	End After the lamp has flashed, this Pin 4–COM circuit is closed internally for 40 ms.
5	Monitor normal When the monitor value of laser energy is in the range of "HIGH" and "LOW" set on the MONITOR screen, the circuit is closed for 40 ms.
6	Monitor trouble When the monitor value of laser energy is out of the range of "HIGH" and "LOW" set on the MONITOR screen, the circuit is closed for 40 ms.
7	Unused Do not connect anything.
8	External input receivable When an external input signal is acceptable (when the section between pin No.23 and COM is in a closed circuit), the circuit is closed. In the open circuit status, an external input signal is not acceptable if it is input.
9	Lamp power upper limit When the lamp input power exceeds the value set in "REFERENCE SETTING", the circuit is opened.
10	Unused Do not connect anything.
11	Unused Do not connect anything.

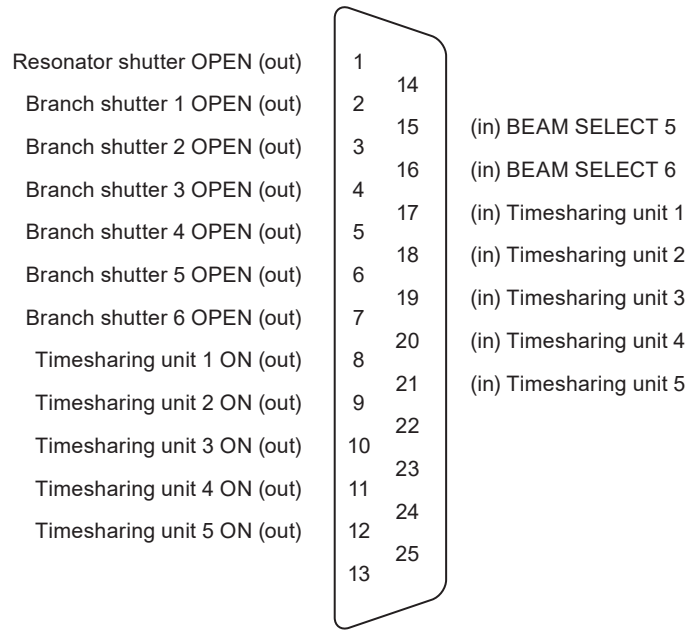
Type of output: Photo MOS relay output
Rating of output: 24 V DC, 20 mA max.

EXT.I/O (2) Connector (D-Sub 25 pin)

The EXT.I/O (2) connector inputs and outputs control signals for the timesharing unit and branch shutter.

⇒ Use the following product out of the attached connectors.

Plug	Case	Manufacturer
HDBB-25P(05)	HDB-CTH(10)	HIROSE ELECTRIC CO., LTD.



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

Pin No.	Description
15	BEAM SELECT 5 When this Pin 15–COM circuit is closed, laser beam input unit 5 is selected and the unit becomes ready to project a laser beam.
16	BEAM SELECT 6 When this Pin 16–COM circuit is closed, laser beam input unit 6 is selected and the unit becomes ready to project a laser beam.
17	Timesharing unit 1 (Enabled only when the branch shutter is put under independent control) When the section between this pin and COM is put in a closed circuit, timesharing unit 1 is operated so that laser light can be output from input unit 1.
18	Timesharing unit 2 (Enabled only when the branch shutter is put under independent control) When the section between this pin and COM is put in a closed circuit, timesharing unit 2 is operated so that laser light can be output from input unit 2.
19	Timesharing unit 3 (Enabled only when the branch shutter is put under independent control) When the section between this pin and COM is put in a closed circuit, timesharing unit 3 is operated so that laser light can be output from input unit 3.
20	Timesharing unit 4 (Enabled only when the branch shutter is put under independent control) When the section between this pin and COM is put in a closed circuit, timesharing unit 4 is operated so that laser light can be output from input unit 4.
21	Timesharing unit 5 (Enabled only when the branch shutter is put under independent control) When the section between this pin and COM is put in a closed circuit, timesharing unit 5 is operated so that laser light can be output from input unit 5.

Pin No.	Description
22	Unused Do not connect anything.
23	Unused Do not connect anything.
24	Unused Do not connect anything.
25	Unused Do not connect anything.

Output Pins of EXT.I/O (2) Connector

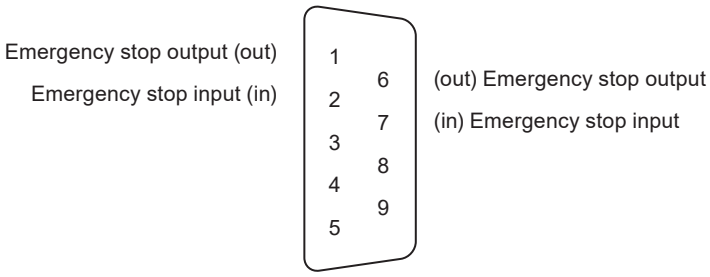
Pin No.	Description
1	Resonator shutter Open When the resonator shutter is open, this Pin 1–COM circuit closes internally.
2	Branch Shutter 1 Open While branch shutter 1 is open, this Pin 2–COM circuit closes internally.
3	Branch Shutter 2 Open While branch shutter 2 is open, this Pin 3–COM circuit closes internally.
4	Branch Shutter 3 Open While branch shutter 3 is open, this Pin 4–COM circuit closes internally.
5	Branch Shutter 4 Open While branch shutter 4 is open, this Pin 5–COM circuit closes internally.
6	Branch Shutter 5 Open While branch shutter 5 is open, this Pin 6–COM circuit closes internally.
7	Branch Shutter 6 Open While branch shutter 6 is open, this Pin 7–COM circuit closes internally.
8	Timesharing unit 1 ON While timesharing unit 1 is operated, this Pin 8–COM circuit closes internally.
9	Timesharing unit 2 ON While timesharing unit 2 is operated, this Pin 9–COM circuit closes internally.
10	Timesharing unit 3 ON While timesharing unit 3 is operated, this Pin 10–COM circuit closes internally.
11	Timesharing unit 4 ON While timesharing unit 4 is operated, this Pin 11–COM circuit closes internally.
12	Timesharing unit 5 ON While timesharing unit 5 is operated, this Pin 12–COM circuit closes internally.
13	Unused Do not connect anything.
14	Unused Do not connect anything.

EXT.I/O (3) Connector (D-Sub 9 pin)

The EXT.I/O (3) connector inputs and outputs an emergency stop signal for the laser.

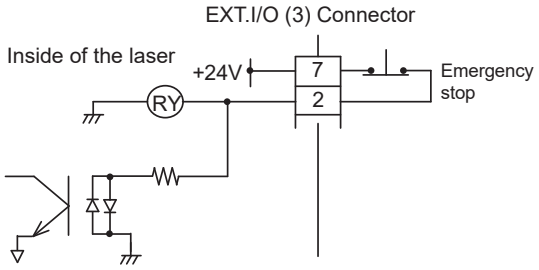
⇒ Use the following product out of the attached connectors.

Plug	Case	Manufacturer
HDEB-9P(05)	HDE-CTH(10)	HIROSE ELECTRIC CO., LTD.

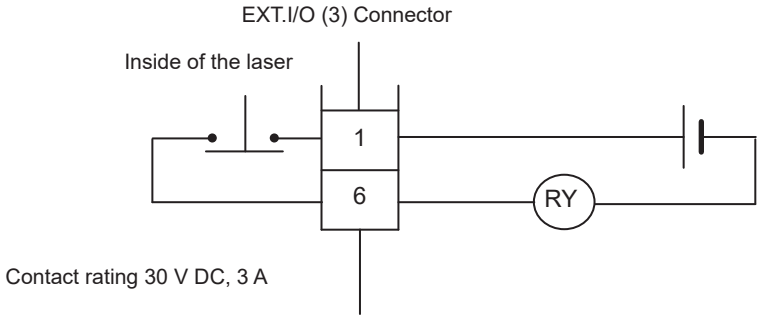


Pin No.	Description
1	When the laser is put in an emergency stop, the section between pin No.1 and pin No.6 is put in an open circuit.
2	When the section between Pin No.2 and Pin No.7 is put in an open circuit, the operation of the laser is stopped.
6	When the laser is put in an emergency stop, the section between pin No.1 and pin No.6 is put in an open circuit.
7	When the section between Pin No.2 and Pin No.7 is put in an open circuit, the operation of the laser is stopped.

⇒ When the section between Pin No.2 (emergency stop input) and Pin No.7 (emergency stop input) is opened, the laser welder is put to an emergency stop status and the laser welder is put to the same status as where the CONTROL keyswitch is OFF.



At occurrence of an emergency stop, the section between pin No.1 (emergency stop output) and pin No.6 (emergency stop output) is put in an open circuit and the emergency stop output status shown in the following figure is provided.



REMOTE INTERLOCK Connector

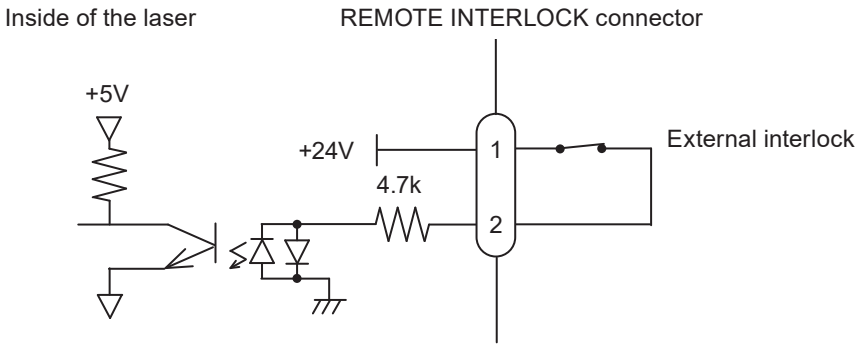
The REMOTE INTERLOCK connector closes the branch shutter and connects the interlock to cut off laser light in an emergency.

⇒ Use the following product out of the attached connectors.

Plug	Case	Manufacturer
116-12A10-2AF10.5		TAJIMI ELECTRONICS CO., LTD.

Pin No.	Description
1	When the section between pin No.1 and pin No.2 is put an open circuit, the branch shutter is closed.
2	

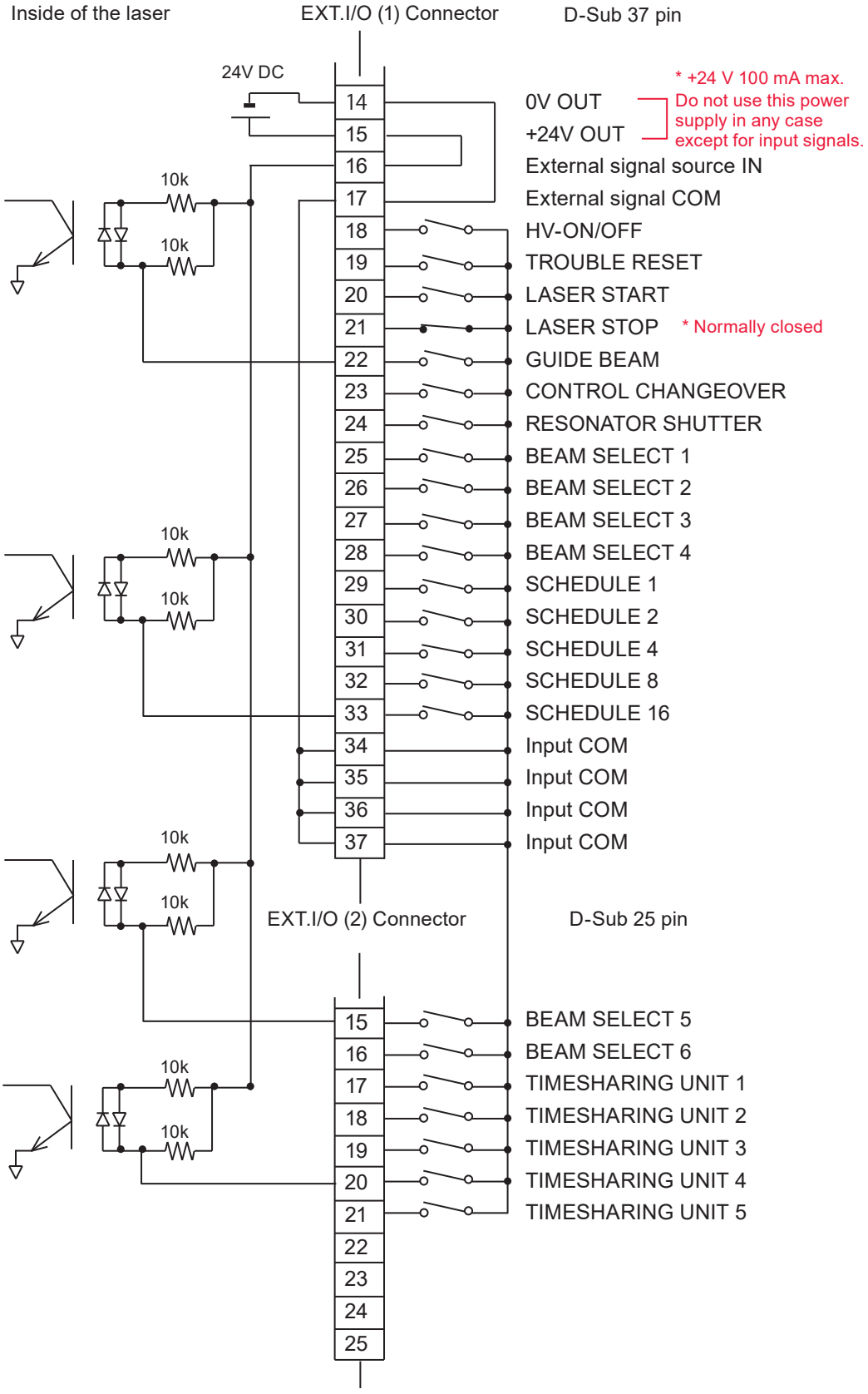
⇒ When the section between 2 pins of this connector is opened by operating the external interlock, the resonator shutter and the branch shutter are closed and both guide light and laser output are stopped. Connect this connector to the main interlock, chamber interlock, door interlock, or other interlock. A multiple number of these interlocks may be connected in series as required. At delivery, the connector for short circuit is installed.



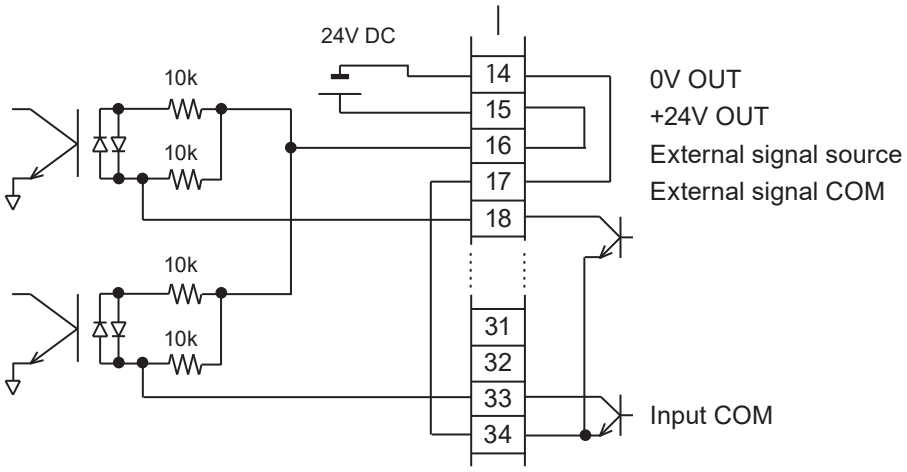
Example Connections of External Input Signals

An example of external input signal connections of the EXT.I/O connector is explained below.

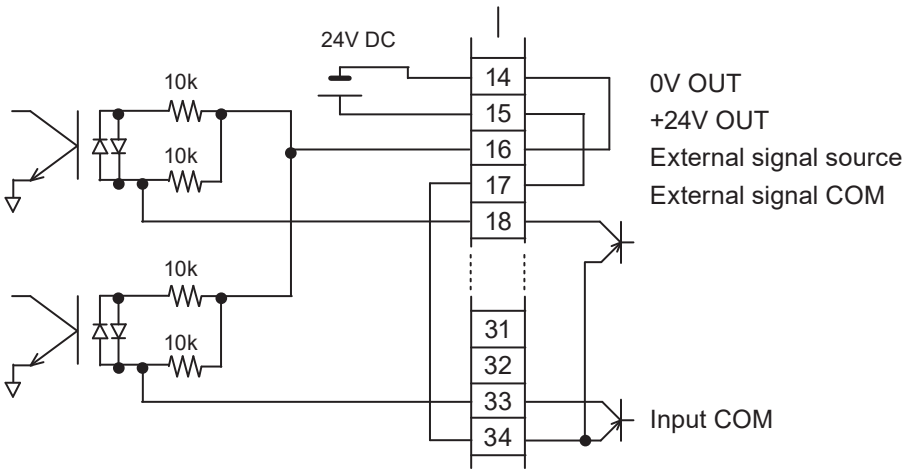
When External Inputs are Contacts



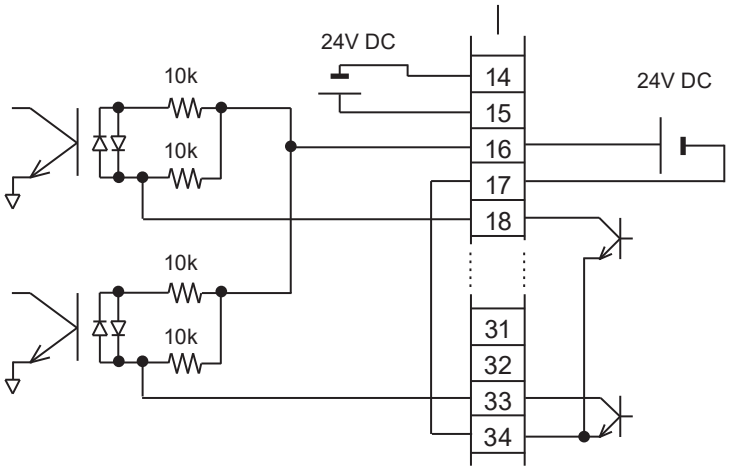
When External Inputs are NPN Transistors



When External Inputs are PNP Transistors

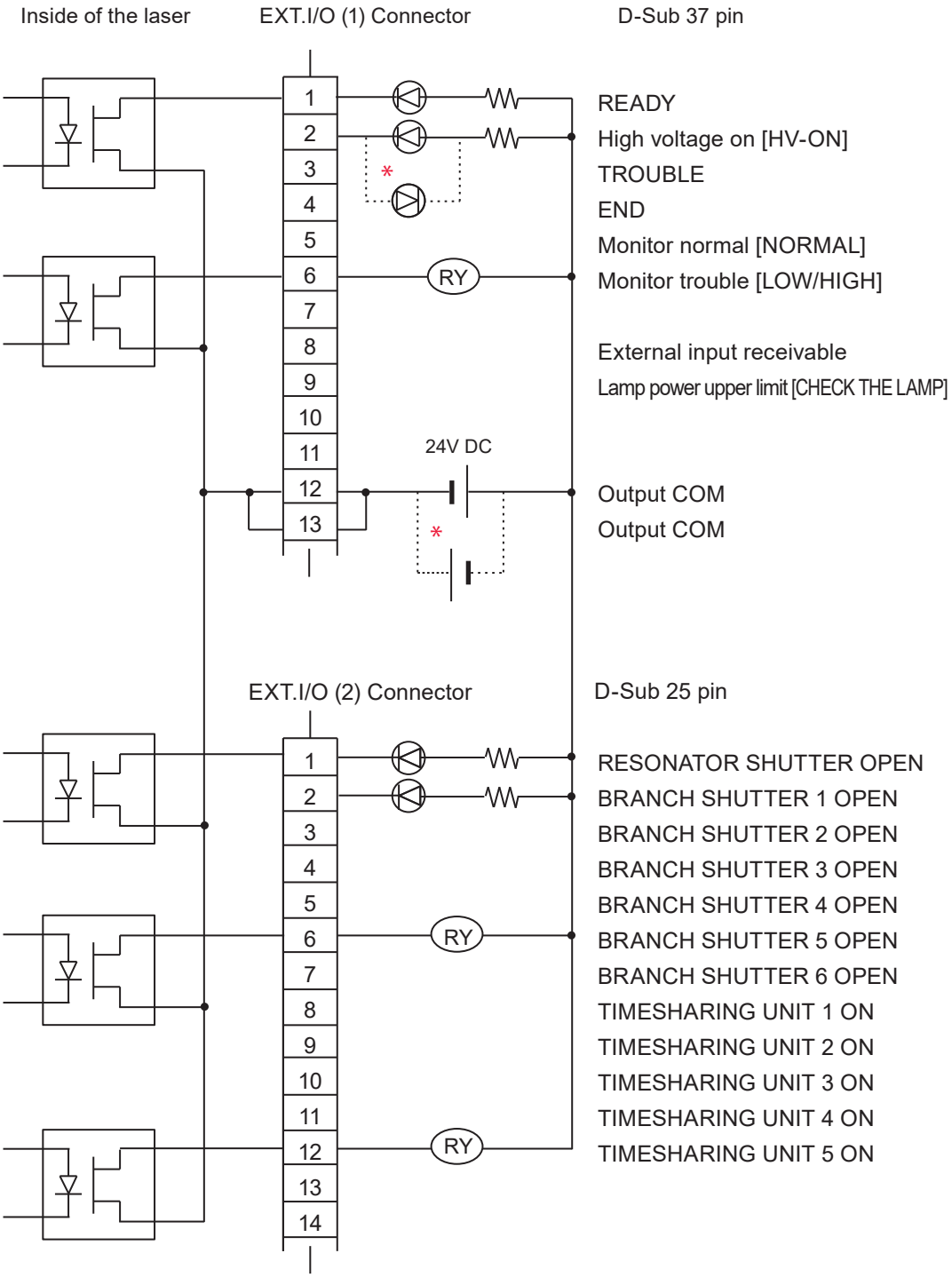


When External Power Source is Supplied



Example Connection of External Output Signals

An example of external output signal connections of the EXT.I/O connector is explained below.



Type of output: Photo MOS relay output

Rating of output: 24 V DC, 20 mA max.

* **The polarity may be positive or negative.**

4. Programming

This section explains the precautions for programming laser welding by external input/output signals (EXTERNAL CONTROL).

The timing chart of the appendix shows the input signal length and input waiting time required to correctly operate the laser. Perform actual programming referring to this timing chart.

In the following, a control flow is explained by taking the case where "Schedule 1" is first specified and then "Schedule 2" is specified to perform a single laser light output by 2-powersharing from BEAM1 and BEAM2, as an example.

1 Switching the Control Method

(1) Put pin No.23 (control switching) of the EXT.I/O (1) connector in a closed circuit.

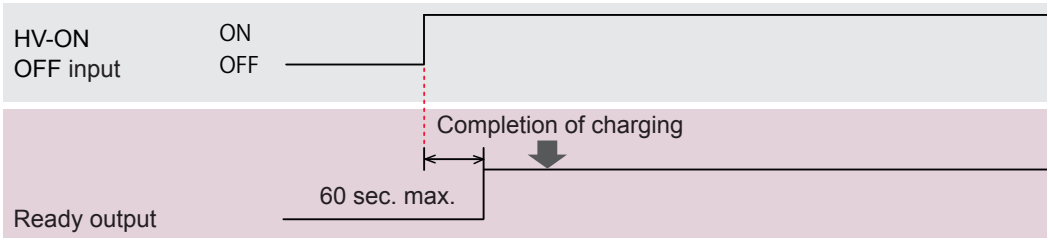
Pin No.8 of the EXT.I/O (1) connector is put in a closed circuit and the signal (external input acceptable) is returned from the laser.

⇒ Press the "STATUS" button on the laser controller to display the STATUS screen. Then, you can confirm that "EXTERNAL CONTROL" is selected as the control method.

2 Turning ON the High Voltage

(1) Put the section between pin No.18 of the EXT.I/O (1) connector and COM in a closed circuit to turn ON the high voltage.

The capacitor can be charged in 60 sec. max. At completion of charging, pin No.1 of the EXT.I/O (1) connector is put in a closed circuit and the signal (Ready) is returned from the laser.



3 Selecting a Beam (Setting the Branch Shutter)

(1) Put the section between the pin corresponding to the beam and COM in a closed circuit. In this example, the section between pin No.25 and pin No.26 of the EXT. I/O (1) connector is put in a closed circuit to select Beam 1 and Beam 2.

The branch shutter is opened and the corresponding SHUTTER lamp comes on.

4 Opening the Resonator Shutter

(1) Close pin No.24 of the EXT.I/O (1) connector.

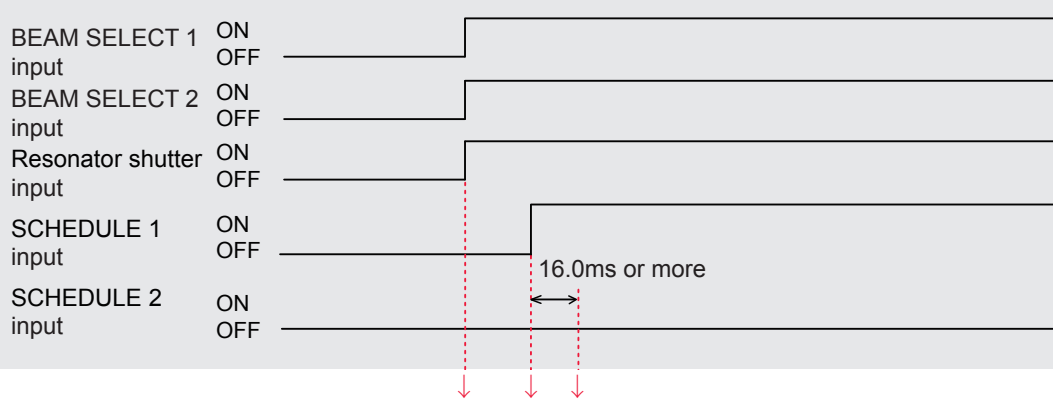
The resonator shutter is opened and the flashlamp comes on. Then, a laser light output is enabled.

5 Setting Output Schedules (SCH.#01)

(1) Set the SCHEDULE number by combining pin No.29 to pin No.33 of the EXT.I/O (1) connector. In this example, pin No.29 of the EXT.I/O (1) connector is put in a closed circuit for 16 ms or more to set SCH.#01.

⇒ Refer to "SCHEDULE Number Selection" on page 133.

⇒ At delivery, the signal acceptance time (time from a signal input till establishment of schedules) of welding schedules is set to 16 ms. Set the close circuit time referring to this value. As the signal acceptance time, 0.1 ms, 1.0 ms, 4.0 ms, 8.0 ms, or 16.0 ms can be selected by displaying the MEMORY SWITCH screen from the INITIALIZE screen. For details, refer to Chapter 2, "3. Changing the Acceptance Time for Laser Start Signal/Schedule Signal" on page 113.

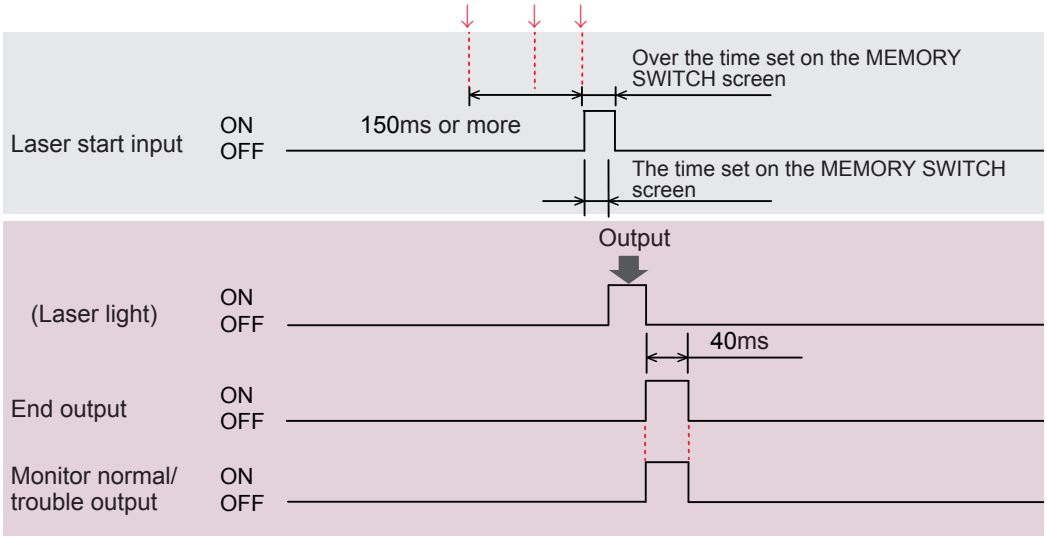


6 Outputting Laser Light

(1) Put pin No.20 (Laser Start) of the EXT.I/O (1) connector in a closed circuit.

Laser light is output simultaneously from Beam 1 and Beam 2.

Pin No.4 (End output) of the EXT.I/O (1) connector is put in a closed circuit for 40 ms and a signal is returned from the laser. Pin No.5 (Monitor normal output) or pin No.6 (Monitor trouble output) of the EXT.I/O (1) connector is put in a closed circuit for 40 ms and a signal is returned from the laser.



⇒ In more than 150 ms after a beam select signal input or in more than the time set on the MEMORY SWITCH screen after the setting of welding conditions, close the LASER START pin.

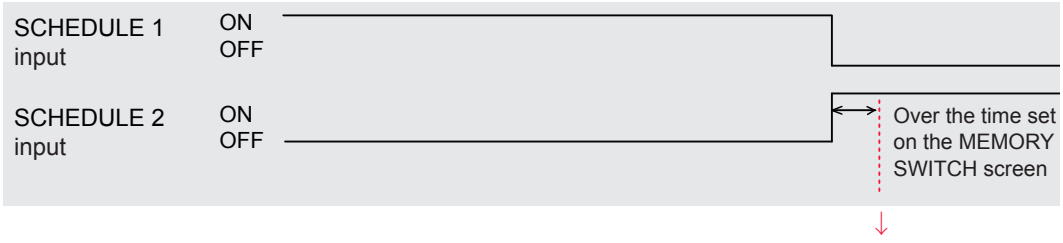
⇒ At delivery, the laser start acceptance time (time from a signal input till an actual output of laser light) is set to 16 ms. As the laser start acceptance time, 0.1 ms, 1.0 ms, 4.0 ms, 8.0 ms, or 16.0 ms can be selected by displaying the MEMORY SWITCH screen from the INITIALIZE screen. For details, refer to Chapter 2, "3. Changing the Acceptance Time for Laser Start Signal/Schedule Signal" on page 113.

⇒ Be sure to put the laser start pin in a closed circuit at least the time set on the MEMORY SWITCH screen.

7 Setting Output Schedules (SCH.#02)

(1) Set the SCHEDULE number by combining pin No.29 to pin No.33 of the EXT.I/O (1) connector. In this example, put pin No.29 of the EXT.I/O (1) connector to an open circuit to turn OFF SCH.#01, and put pin No.30 in a closed circuit to turn on SCH.#02.

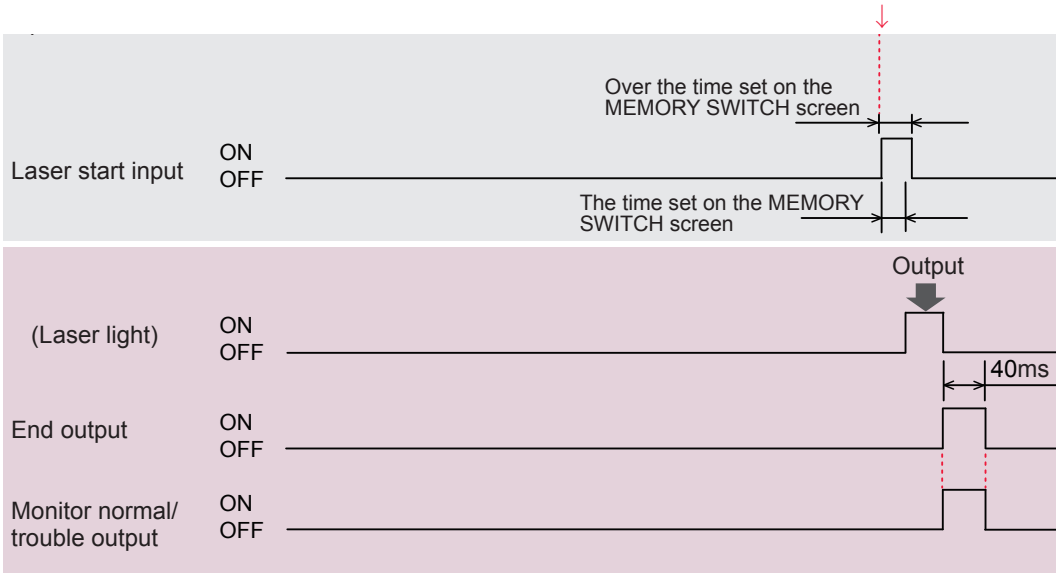
⇒ Refer to "SCHEDULE Number Selection" on page 133.



8 Outputting Laser Light

(1) Put pin No.20 (Laser start) of the EXT.I/O (1) connector in a closed circuit.
Laser light is output simultaneously from BEAM1 and BEAM2.

⇒ The details are the same as Step **6**.



9 Stopping the Operation

(1) Put the section between pin No.18 of the EXT.I/O (1) connector and COM in an open circuit to cut off the high voltage.

(2) Put pin No.23 (control switching) of the EXT.I/O (1) connector in an open circuit to invalidate external input signals

Making a Position Adjustment by Guide Light

Make a position adjustment by guide light before welding according to the following procedure.

(1) Adjust the workpiece and output unit positions to set an appropriate work distance (distance between the workpiece and the output position).

(2) Put the section between pin No.22 of the EXT.I/O (1) connector and COM in a closed circuit.

Guide light can be seen as a red point. Laser light is irradiated to this red point position.

(3) Check the laser light irradiation position.

If the welding point deviates from the red point of guide light, move the output unit or workpiece to adjust the position.

Operating Part

Chapter 5

Laser Welding by External Communication Control (RS-485 CONTROL)

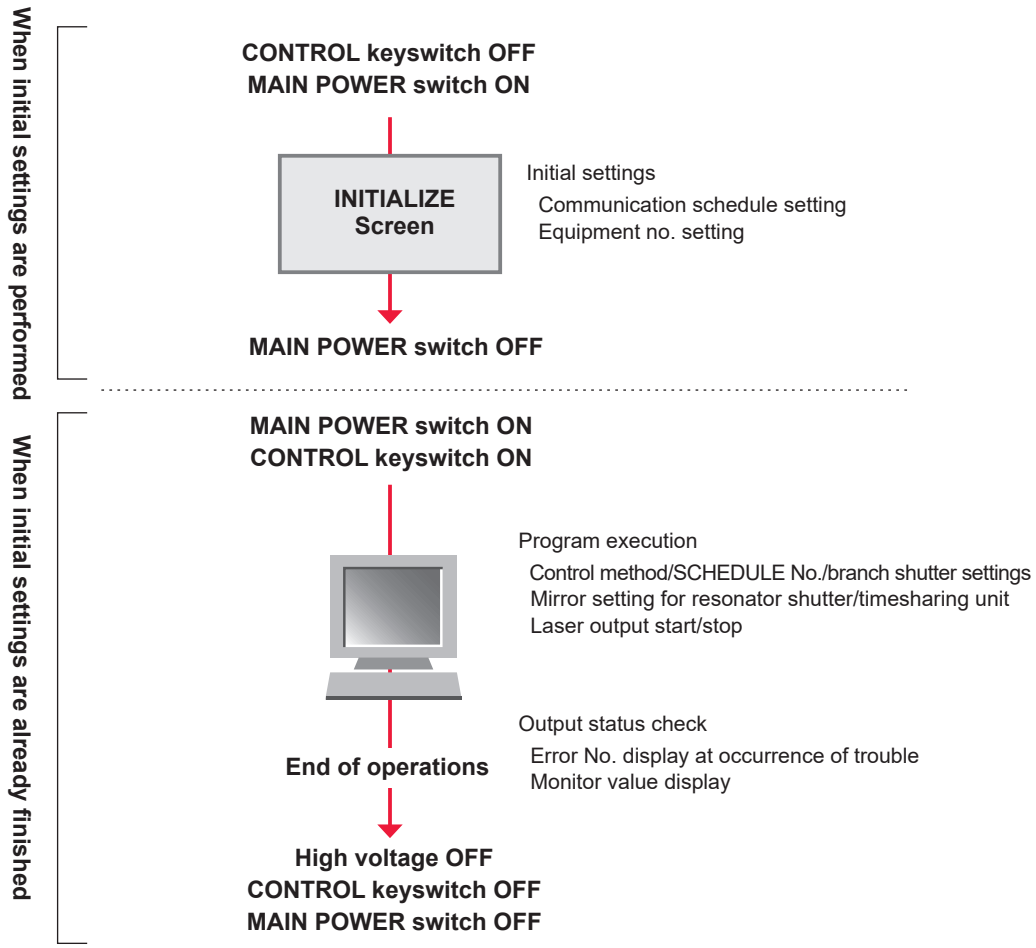
1. Operation Flow

This section explains an operation flow of a laser welding by external communication control (RS-485 CONTROL).

The following methods for laser welding operations are available: control from the laser controller (PANEL CONTROL), control by external input/output signals from the PLC (Programmable Logic Controller) connected to the connector (EXTERNAL CONTROL), and control by sending a command from the connected personal computer (RS-485 CONTROL).

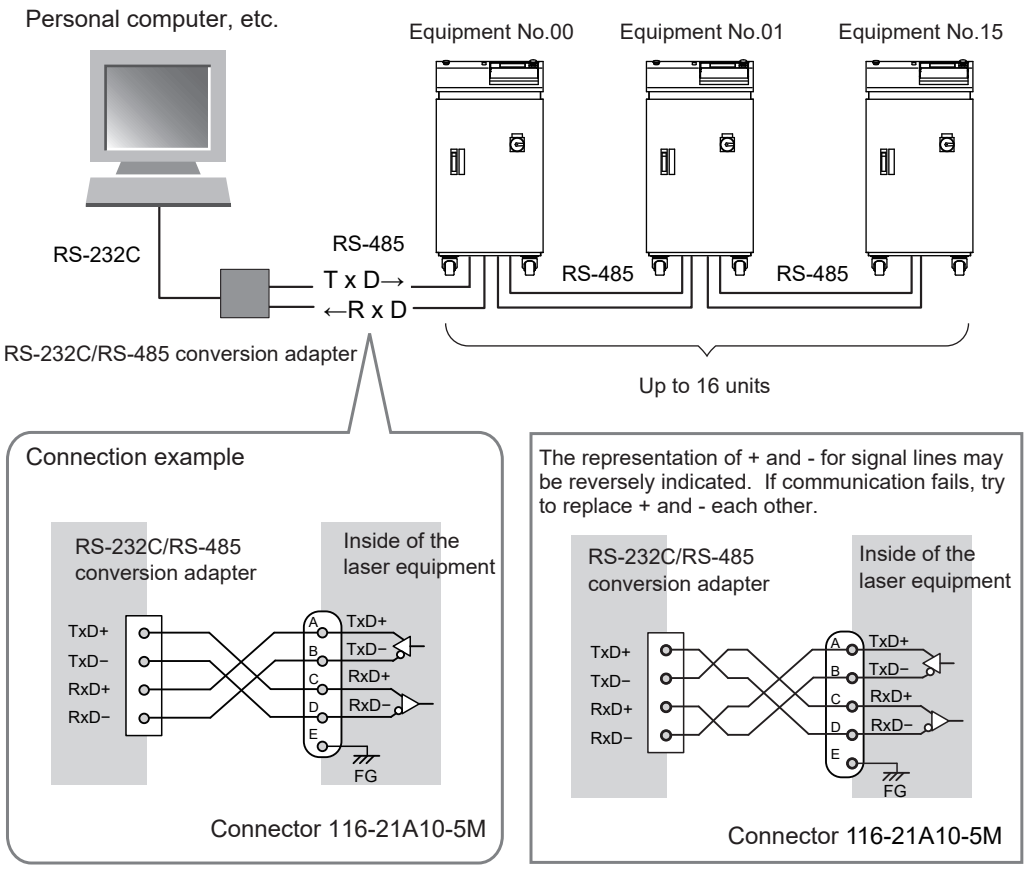
At the control by external communication (RS-485 CONTROL), the original customer-developed program is executed on the personal computer to set laser output schedules and read monitor data and various types of status.

* PLC: Programmable Logic Controller This unit exerts sequence control by executing the programmed contents of control in sequence. This is often called Sequencer (product name of Mitsubishi Electric Corporation).



2. Preparations for Operations

Up to 16 laser units can be controlled from a single personal computer. The equipment configuration and connector connections are shown in the following figure.



⇒ For controlling multiple lasers by single personal computer, it is necessary to register equipment No. (NETWORK #) for each equipment. Set equipment No. without duplication. If duplication of equipment No. exists, a data collision will occur on the communication line and the laser cannot be correctly operated.

⇒ The RS-232C/RS-485 conversion adapter is an option separately sold. Purchase it as required. For details, refer to the Introduction Part, Chapter 1 "Options" on page 27.

⇒ Prepare the program and its development environment for laser control on the customer side.

⇒ Connect the shielded portion to FG (frame ground) inside the laser equipment only when using the shielded cable. Do not use as SG (signal ground).

3. Initial Settings

Perform initial settings to control laser welding by external communication (RS-485 CONTROL). Set communication schedules and equipment No. on the laser controller of the laser.

The communication schedules for data transfer are as follows.

Data transfer system	Conforming to RS-485, asynchronous, full duplex	
Transfer rate	9600, 19200, 38400bps	
Data type	Start bit	1
	Data bit	8 or 7
	Stop bit	2 or 1
	Parity bit	Even/odd/none
Character code	ASCII	

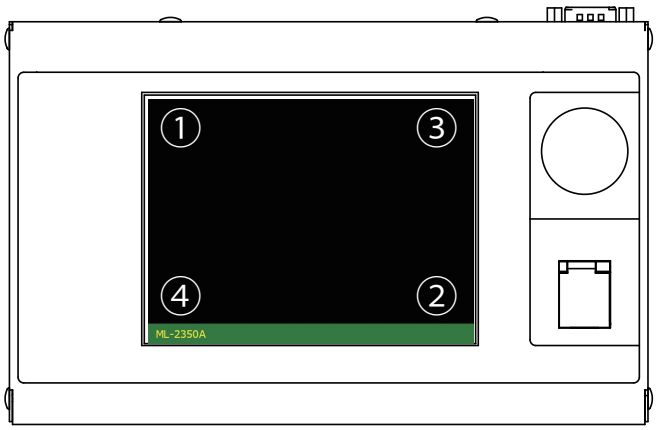
⇒ Set the transfer rate, data type, and equipment No. by displaying the MEMORY SWITCH screen from the INITIALIZE screen by the laser controller of each equipment that is connected to the personal computer, etc.

Setting Communication Schedules

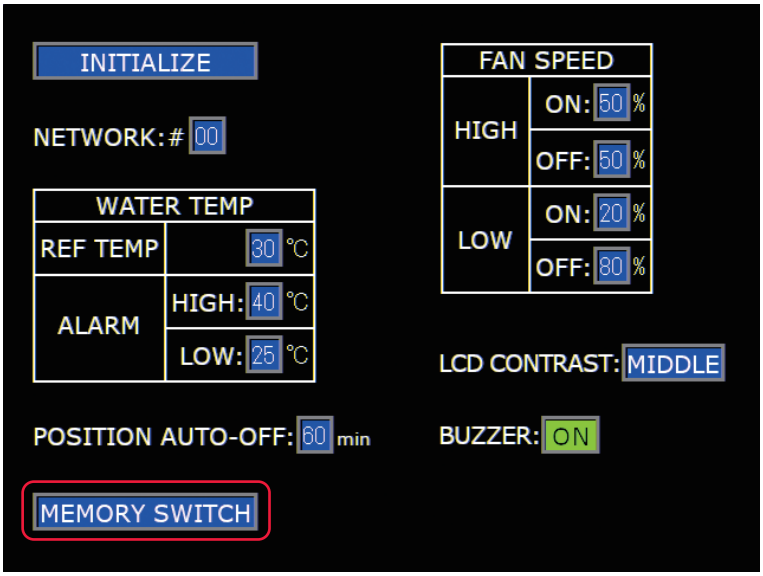
Set the communication conditions by displaying the MEMORY SWITCH screen from the INITIALIZE screen by the laser controller of the equipment.

1 Displaying the MEMORY SWITCH Screen

(1) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch.
Power is supplied and the POWER lamp comes on. The screen of model name appears.

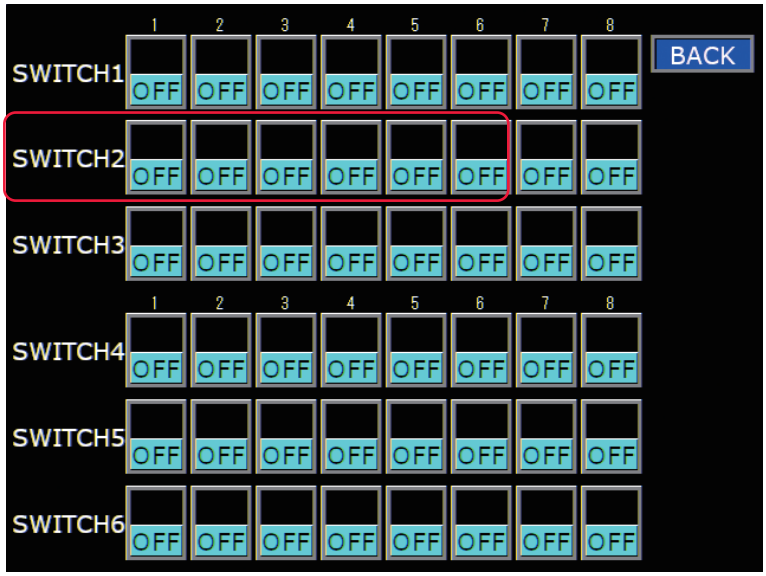


(2) While the model name screen is displayed (for about 3 seconds), press the corners of the touch panel display in the order shown in the figure above.
The INITIALIZE screen appears.



⇒ Unless the CONTROL keyswitch is OFF, the INITIALIZE screen does not appear.

(3) Press the "MEMORY SWITCH" button.
The MEMORY SWITCH screen is displayed.



2 Specifying Communication Schedules

(1) Set communication schedules by setting 1 to 6 of "SWITCH 2" to ON or OFF. Move the cursor to the switch to be changed and press the ON key or OFF key for this setting.

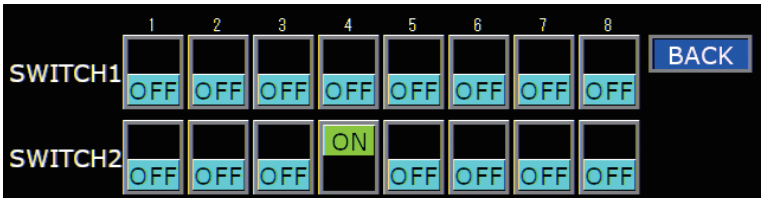
1: Data bit length (OFF: 8 bits, ON: 7 bits)
2: Parity bit (OFF: Parity bit, ON: No parity bit)
3: Parity mode (OFF: Even, ON: Odd)
4: Stop bit (OFF: 2, ON: 1)
5/6: Communication speed (as shown in the following table depending on the combination of ON and OFF)

SW2-5	SW2-6	bps
OFF	OFF	9600
OFF	ON	19200
ON	OFF	38400
ON	ON	(9600)

7/8: Unused

In this example, each item is set as shown below.

Switch No.	Setting	Setting example
1 (Data bit)	ON	7bit
2 (Parity bit)	ON	None
3 (Parity mode)	OFF	Even
4 (Stop bit)	ON	1bit
5/6 (Communication speed)	5: ON 6: OFF	38400bps



(2) Press the "BACK" button.
Returns to the INITIALIZE screen.

<Note>

When any SWITCH 2 setting has been changed, turn OFF the power supply before a laser output, and then turn it ON again.

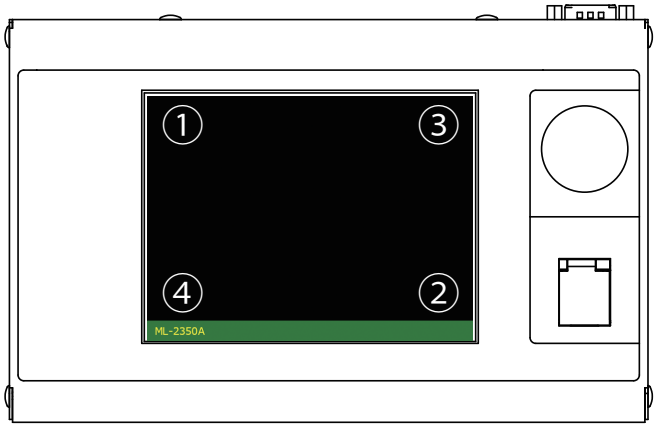
Setting Equipment No.

Display the INITIALIZE screen on the laser controller of the laser and set equipment No. (NETWORK #).

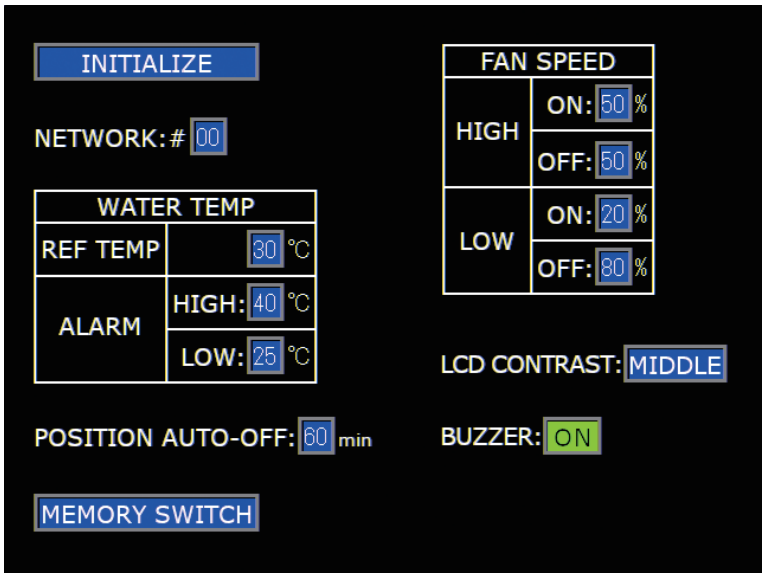
⇒ For controlling multiple lasers by single personal computer, it is necessary to register equipment No. (NETWORK #) for each equipment. Set equipment No. without duplication. If duplication of equipment No. exists, a data collision will occur on the communication line and the laser cannot be correctly operated.

1 Displaying the INITIALIZE Screen

(1) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch.
Power is supplied and the POWER lamp comes on. The screen of model name appears.



(2) While the model name screen is displayed (for about 3 seconds), press the corners of the touch panel display in the order shown in the figure above.
The INITIALIZE screen appears.



⇒ Unless the CONTROL keyswitch is OFF, the INITIALIZE screen does not appear.

2 Specifying Equipment No.

(1) Press the "NETWORK#" setting button.
Enter the laser welder No. in the range of 00 to 15.

⇒ For details of each item on the INITIALIZE screen, refer to Chapter 2 "1. Setting Welding Schedules" on page 73.

4. Commands

This section explains the commands that are used to control laser welding by external communication.

Code Table

The codes for external communication with a personal computer and the text structure are as follows. For details, refer to "Setting Data" on page 155 to "Reading Error No. at Occurrence of Trouble" on page 168.

Control Codes (Hexadecimal Codes)

ACK: 06H NAK: 15H STX: 02H ETX: 03H

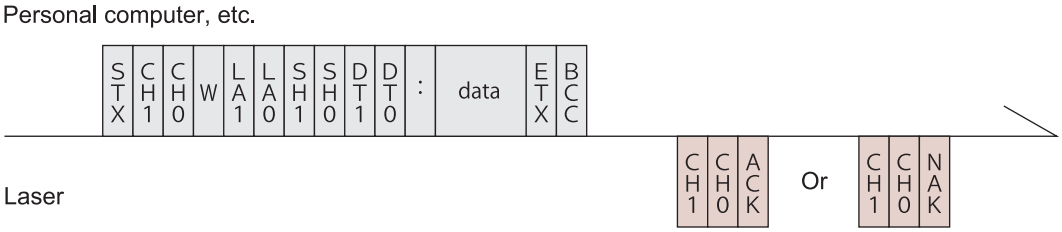
BCC (block check code) ... 1-byte horizontal even parity up to ETX excluding STX

Code	Contents	Text structure																		
W	Setting data	PC to laser	STX	CH1	CH0	W	LA1	LA0	SH1	SH0	DT1	DT0	:	data	ETX	BCC				
		Laser to PC	CH1	CH0	ACK	Or			CH1	CH0	NAK	Write data is out of the setting range or external communication control is not performed.								
R	Reading data	PC to laser	STX	CH1	CH0	R	LA1	LA0	SH1	SH0	DT1	DT0	ETX	BCC						
		Laser to PC	STX	data			ETX	BCC	Or			CH1	CH0	NAK	The schedule No. or data No. is out of the range.					
WS	Setting the control method, SCHEDULE No., branch shutter, etc.	PC to laser	STX	CH1	CH0	W	S	SH1	SH0	cnt	s1	s2	s3	...	s9	mon	ETX	BCC		
		Laser to PC	CH1	CH0	ACK	Or			CH1	CH0	NAK	The specified status cannot be provided or external communication control is not performed.								
WM	Setting the timesharing unit	PC to laser	STX	CH1	CH0	W	M	m1	m2	m3	m4	m5	ETX	BCC						
		Laser to PC	CH1	CH0	ACK	Or			CH1	CH0	NAK	The specified status cannot be provided or external communication control is not performed.								
RS	Reading the control method, SCHEDULE No., branch shutter, etc.	PC to laser	STX	CH1	CH0	R	S	ETX	BCC											
		Laser to PC	STX	SH1	SH0	cnt	s1	s2	s3	s4	s5	s6	s7	s8	s9	mon	rdy	ETX	BCC	
RM	Reading the timesharing unit status	PC to laser	STX	CH1	CH0	R	M	ETX	BCC											
		Laser to PC	STX	SH1	SH0	cnt	m1	m2	m3	m4	m5	ETX	BCC							
$0	Laser start command	PC to laser	STX	CH1	CH0	$	0	ETX	BCC											
		Laser to PC	CH1	CH0	ACK	Or			CH1	CH0	NAK	The HV is OFF, the voltage does not reach the specified value, trouble occurs, or external communication control is not performed.								

Code	Contents	Text structure										
$9	Laser stop command	PC to laser	STX	CH1	CH0	$	9	ETX	BCC			
		Laser to PC	CH1	CH0	ACK	Or			CH1	CH0	NAK	External communication control is not performed.
C0	Trouble reset command	PC to laser	STX	CH1	CH0	C	0	ETX	BCC			
		Laser to PC	CH1	CH0	ACK	Or			CH1	CH0	NAK	External communication control is not performed.
C1	SHOT COUNT reset command	PC to laser	STX	CH1	CH0	C	1	ETX	BCC			
		Laser to PC	CH1	CH0	ACK	Or			CH1	CH0	NAK	External communication control is not performed.
C2	GOOD COUNT reset command	PC to laser	STX	CH1	CH0	C	2	ETX	BCC			
		Laser to PC	CH1	CH0	ACK	Or			CH1	CH0	NAK	External communication control is not performed.
RT	Reading trouble	PC to laser	STX	CH1	CH0	R	T	ETX	BCC			
		Laser to PC	STX	E1	E0	,	E1	E0	,	.....	E1	E0	ETX	BCC

Setting Data

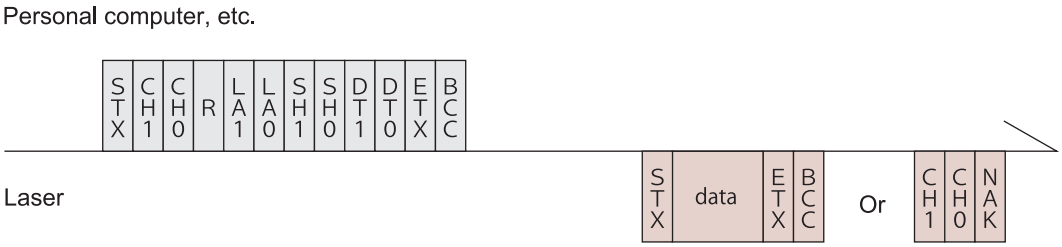
The command (code: W) to set welding schedules by specifying equipment No. and schedule No. is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
LA1/LA0	Classification No. of the setting (LA1 = tens digit, LA0 = units digit) 99 Settings for the cooler (Set the schedule No. [SH1/SH0] to 00.) 84 Schedule settings for both FIX and FLEX 85 Schedule settings for FIX 86 Schedule settings for FLEX, TIME 01 to 10 87 Schedule settings for FLEX, TIME 11 to 20 88 Schedule settings for FLEX, POWER 01 to 10 89 Schedule settings for FLEX, POWER 11 to 20 75 SEAM setting value SEAM ON/OFF 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	Schedule No. (SH1 = tens digit, SH0 = units digit) Enter the No. of the schedule you want to change within the data range of 00 to 31. If □□ (spaces) are entered, the currently selected schedule is used.
DT1/DT0	Data No. (DT1 = tens digit, DT0 = units digit) • For detailed information on the data No., see "Set Value/Monitor Value Table" on page 157. • If “99” is entered, data is written in a batch. data: (Data No.1), (Data No.2), (Data No.3), ... (the last Data No.) Insert [,] between individual data. The monitor data (WATER, SHOT COUNT, GOOD COUNT, ENERGY) will not be written.
ACK or NAK	When the setting data is within the setting range, [ACK] is returned. When this data is out of the setting range, [NAK] is returned. This command is effective only for external communication control. For the other control methods, [NAK] is returned.

Reading Data

The command (code: R) to read the set values and monitor values of welding schedules by specifying equipment No. and schedule No. is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
LA1/LA0	Classification No. of the setting (LA1 = tens digit, LA0 = units digit) 99 Settings for the cooler (Set the schedule No. [SH1/SH0] to 00.) 84 Schedule settings for both FIX and FLEX 85 Schedule settings for FIX 86 Schedule settings for FLEX, TIME 01 to 10 87 Schedule settings for FLEX, TIME 11 to 20 88 Schedule settings for FLEX, POWER 01 to 10 89 Schedule settings for FLEX, POWER 11 to 20 75 SEAM setting value SEAM ON/OFF 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	Schedule No. (SH1 = tens digit, SH0 = units digit) Enter the No. of the schedule you want to read within the data range of 00 to 31. If □□ (spaces) are entered, the currently selected schedule is used.
DT1/DT0	Data No. (DT1 = tens digit, DT0 = units digit) • For detailed information on the data No., see "Set Value/Monitor Value Table" on page 157. • If “99” is entered, data is read in a batch. data: (Data No.1), (Data No.2), (Data No.3), ... (the last Data No.) Insert [,] between individual data.
ACK or NAK	The Laser returns a [NAK] if the classification No., schedule No., or data No. falls outside the specified range.

Set Value/Monitor Value Table

⇉ The items marked * are monitor values. These values can be read out but cannot be set.

⇉ The value in ( ) indicates the unit.

⇉ The unit of time setting depends on the setting of "7" of SWITCH 1 on the MEMORY SWITCH screen. When setting to ON, set the values in increment of 5.

99 Settings for the Cooler (Set the schedule No. [SH1/SH0] to 00.)

Data No.	Item	Data Range
01*	Coolant temperature	000 – 999 (×1°C)
02	[REF TEMP] on the [INITIALIZE] screen Control temperature	00 – 99 (×1°C)
03	[HIGH] of ALARM on the [INITIALIZE] screen Coolant temperature high alarm	00 – 99 (×1°C)
04	[LOW] of ALARM on the [INITIALIZE] screen Coolant temperature low alarm	00 – 99 (×1°C)
05*	Coolant resistivity	000 – 999 (×0.01MΩ)

84 Schedule Settings for both FIX and FLEX

Data No.	Item	Data Range
01	[FORM] on the [SCHEDULE] screen Selection of waveform setting method 0: FIX 1: FLEX	0 – 1
02	Set waveform display on the [SCHEDULE] screen 0: OFF 1: ON	0 – 1
03	[PEAK POWER] on the [SCHEDULE] screen Laser output peak value	ML-2350A: 0000 – 0700 (×0.01kW) ML-2351A: 0000 – 0500 (×0.01kW)
04	[REPEAT] on the [SCHEDULE] screen Pulse repetition rate	000 – 200
05	[SHOT] on the [SCHEDULE] screen Number of consecutive shots	0000 – 9999
06	[HIGH] on the [MONITOR] screen Energy monitor upper limit setting	0000 – 9999 (×0.1J)
07	[LOW] on the [MONITOR] screen Energy monitor lower limit setting	0000 – 9999 (×0.1J)
08	Power monitor waveform display on the [MONITOR] screen 0: OFF 1: ON	0 – 1
09	[REFERENCE SETTING] on the [MONITOR] screen Lamp input power upper limit setting	000 – 100 (×1%)

85 Schedule Settings for FIX

Data No.	Item	Data Range
01	[↑SLOPE] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)

Data No.	Item	Data Range
02	[FLASH 1] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
03	[FLASH 2] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
04	[FLASH 3] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
05	[↓SLOPE] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
06	Unused	Fixed to 0000
07	[FLASH 1] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
08	[FLASH 2] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
09	[FLASH 3] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
10	Unused	Fixed to 0000
11*	[REFERENCE VALUE] on the [SCHEDULE] screen Approximate laser output energy of the set waveform	0000 – 9999 (×0.1J)
12	[COOL 1] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
13	[COOL 2] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)

86 Schedule Settings for FLEX — TIME 01 to 10

Data No.	Item	Data Range
01	[POINT 01] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
02	[POINT 02] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
03	[POINT 03] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
04	[POINT 04] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
05	[POINT 05] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
06	[POINT 06] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
07	[POINT 07] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
08	[POINT 08] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
09	[POINT 09] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
10	[POINT 10] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
11*	[REFERENCE VALUE] on the [SCHEDULE] screen Approximate laser output energy of the set waveform	0000 – 9999 (×0.1J)

87 Schedule Settings for FLEX — TIME 11 to 20

Data No.	Item	Data Range
01	[POINT 11] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
02	[POINT 12] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
03	[POINT 13] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
04	[POINT 14] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
05	[POINT 15] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
06	[POINT 16] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
07	[POINT 17] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
08	[POINT 18] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
09	[POINT 19] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)

Data No.	Item	Data Range
10	[POINT 20] TIME on the [SCHEDULE] screen	000 – 300 (×0.1ms/x0.01ms)
11*	[REFERENCE VALUE] on the [SCHEDULE] screen Approximate laser output energy of the set waveform	0000 – 9999 (×0.1J)

88 Schedule Settings for FLEX — POWER 01 to 10

Data No.	Item	Data Range
01	[POINT 01] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
02	[POINT 02] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
03	[POINT 03] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
04	[POINT 04] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
05	[POINT 05] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
06	[POINT 06] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
07	[POINT 07] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
08	[POINT 08] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
09	[POINT 09] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
10	[POINT 10] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
11*	[REFERENCE VALUE] on the [SCHEDULE] screen Approximate laser output energy of the set waveform	0000 – 9999 (×0.1J)

89 Schedule Settings for FLEX — POWER 11 to 20

Data No.	Item	Data Range
01	[POINT 11] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
02	[POINT 12] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
03	[POINT 13] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
04	[POINT 14] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
05	[POINT 15] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
06	[POINT 16] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
07	[POINT 17] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
08	[POINT 18] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
09	[POINT 19] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
10	[POINT 20] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
11*	[REFERENCE VALUE] on the [SCHEDULE] screen Approximate laser output energy of the set waveform	0000 – 9999 (×0.1J)

⇒ Data No.11 is set to the same value for 86, 87, 88, and 89.

75 SEAM setting value SEAM ON/OFF

Data No.	Item	Data Range
01	[SEAM] on the [SCHEDULE] screen Fade function ON/OFF 0: OFF 1: ON	0 − 1

76 SEAM setting value SHOT 01 to 10

Data No.	Item	Data Range
01	[POINT 01] SHOT on the [SEAM] screen	0000 − 9999
02	[POINT 02] SHOT on the [SEAM] screen	0000 − 9999
03	[POINT 03] SHOT on the [SEAM] screen	0000 − 9999
04	[POINT 04] SHOT on the [SEAM] screen	0000 − 9999
05	[POINT 05] SHOT on the [SEAM] screen	0000 − 9999
06	[POINT 06] SHOT on the [SEAM] screen	0000 − 9999
07	[POINT 07] SHOT on the [SEAM] screen	0000 − 9999
08	[POINT 08] SHOT on the [SEAM] screen	0000 − 9999
09	[POINT 09] SHOT on the [SEAM] screen	0000 − 9999
10	[POINT 10] SHOT on the [SEAM] screen	0000 − 9999

77 SEAM setting value SHOT 11 to 20

Data No.	Item	Data Range
01	[POINT 11] SHOT on the [SEAM] screen	0000 − 9999
02	[POINT 12] SHOT on the [SEAM] screen	0000 − 9999
03	[POINT 13] SHOT on the [SEAM] screen	0000 − 9999
04	[POINT 14] SHOT on the [SEAM] screen	0000 − 9999
05	[POINT 15] SHOT on the [SEAM] screen	0000 − 9999
06	[POINT 16] SHOT on the [SEAM] screen	0000 − 9999
07	[POINT 17] SHOT on the [SEAM] screen	0000 − 9999
08	[POINT 18] SHOT on the [SEAM] screen	0000 − 9999
09	[POINT 19] SHOT on the [SEAM] screen	0000 − 9999
10	[POINT 20] SHOT on the [SEAM] screen	0000 − 9999

78 SEAM setting value POWER 01 to 10

Data No.	Item	Data Range
01	[POINT 01] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
02	[POINT 02] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
03	[POINT 03] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
04	[POINT 04] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
05	[POINT 05] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
06	[POINT 06] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
07	[POINT 07] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
08	[POINT 08] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
09	[POINT 09] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
10	[POINT 10] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)

79 SEAM setting value POWER 11 to 20

Data No.	Item	Data Range
01	[POINT 11] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
02	[POINT 12] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
03	[POINT 13] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
04	[POINT 14] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
05	[POINT 15] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
06	[POINT 16] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
07	[POINT 17] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
08	[POINT 18] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
09	[POINT 19] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)
10	[POINT 20] POWER on the [SEAM] screen	0000 − 1500 (×0.1%)

95 Laser Power Monitor — SHOT COUNT, GOOD COUNT, AVERAGE

Data No.	Item	Data Range
01*	[SHOT COUNT] on the [MONITOR] screen Total number of outputs until the present	000000000 – 999999999
02*	[GOOD COUNT] on the [MONITOR] screen Number of outputs of appropriate energy	000000000 – 999999999
03*	[AVERAGE] on the [MONITOR] screen Average power of output laser light	0000 – 9999 (×0.1W)

00 Laser Power Monitor — Energy, number of waveform data, etc.

Data No.	Item	Data Range
01*	Schedule No. of laser power monitor data	00 – 31
02*	[LAMP INPUT POWER] on the [MONITOR] screen Lamp input power	000 – 999 (×1%)
03*	[ENERGY] on the [MONITOR] screen Laser energy	0000 – 9999 (×0.1J)
04*	Number of laser power monitor waveforms Total number of transmitted data with classification No. between 00 and 22.	000 – 108
05*	Flash pulse width	000 – 1000 (×0.1ms)

01 Laser Power Monitor — Waveform data 000 to 004

: :

22 Laser Power Monitor — Waveform data 105 to 109

Data No.	Item	Data Range
01*	Schedule No. of laser power monitor data	00 – 31
02*	Laser power monitor waveform data 1/5	0000 – 9999 (×0.1kW)
03*	Laser power monitor waveform data 2/5	0000 – 9999 (×0.1kW)
04*	Laser power monitor waveform data 3/5	0000 – 9999 (×0.1kW)
05*	Laser power monitor waveform data 4/5	0000 – 9999 (×0.1kW)
06*	Laser power monitor waveform data 5/5	0000 – 9999 (×0.1kW)

⇒ If the pulse width becomes long, the total number of waveform data can be controlled to 108 or less by extending the measurement interval.

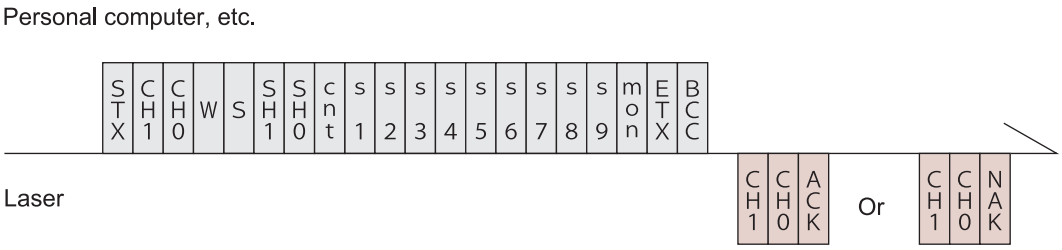
(Example)

* When the pulse width is 00.5 to 05.0 ms, a measured value is sent at intervals of 0.05 ms.
* When the pulse width is 05.1 to 10.0 ms, a measured value is sent at intervals of 0.10 ms.
* When the pulse width is 10.1 to 20.0 ms, a measured value is sent at intervals of 0.20 ms.
* When the pulse width is 20.1 to 30.0 ms, a measured value is sent at intervals of 0.30 ms.

⇒ Since the number of data to be sent each time is limited to 5, it is necessary to change the classification No. according to the "number of waveform data of the laser power monitor" sent by "R00 nn 04" to perform repeated reading.

Setting the Control Method, SCHEDULE No., Branch Shutter, etc.

The command (code: WS) to set the control method, SCHEDULE No., branch shutter, high voltage ON/OFF status, guide light ON/OFF status, automatic laser power value transmission ON/OFF status, etc. by specifying equipment No. is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
SH1/SH0	Schedule No. (SH1 = tens digit, SH0 = units digit) The data range is 00 to 31, and the schedule No. to be changed is entered. For □□ (spaces), the current schedule No. in use is entered.
cnt	Control method 0: Control by control panel 1: Control by external input/output signals (Output schedules are set on the laser controller.) 2: Control by external communication control 3: Maintenance mode 4: (Missing number) 5: Control by external input/output signals (Output schedules are set on the personal computer.) * The cnt value that can be set from the personal computer is "0" and "2." If another value or □ (space) is set, the control method cannot be changed. It is impossible to set "Control by external input/output signals" or "Maintenance mode." * The maintenance mode is used for our engineer to perform maintenance. Usually, this mode is not used by customer. In the maintenance mode, the control method cannot be changed. * When the CONTROL keyswitch is turned OFF, the control method is returned to "0: Control by laser controller" (when the control by external input/output signals is OFF). * To change the control method, blank all the other items. **When the control by external input/output signals (EXTERNAL CONTROL) is ON** The control by external input/output signals has priority over the other control methods. When "0" or "2" is entered from the personal computer, the control method is as shown in the following table. The order of setting does not matter.

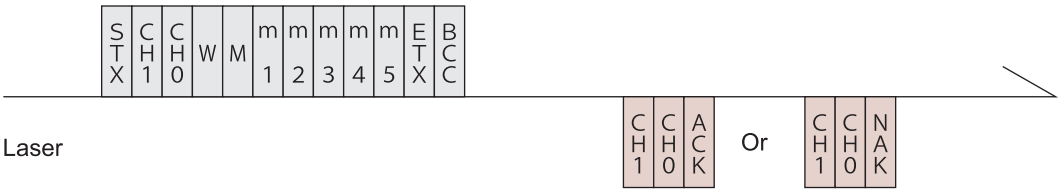
Control by external input/output signals	Set value	Control method to be set
At OFF	0	0: Control by laser controller
	2	2: Control by external communication control
At ON	0	1: Control by external input/output signals (Output schedules are set on the laser controller.)
	2	5: Control by external input/output signals (Output schedules are set on the personal computer.)

	* When the external input/output control is turned OFF at "1: Control by external input/output signals (Output schedules are set on the laser controller)", the control method is changed to "0: Control by laser controller." * When the external input/output control is turned OFF at "5: Control by external input/output signals (Output schedules are set on the personal computer)", the control method is changed to "2: Control by external communication control."
s1	HV (high voltage) (0: OFF 1: ON □: Current status kept)
s2	LD (guide light) (0: OFF 1: ON □: Current status kept)
s3	Resonator shutter (0: OFF 1: ON □: Current status kept)
s4	Branch shutter 1 (0: OFF 1: ON □: Current status kept)
s5	Branch shutter 2 (0: OFF 1: ON □: Current status kept)
s6	Branch shutter 3 (0: OFF 1: ON □: Current status kept)
s7	Branch shutter 4 (0: OFF 1: ON □: Current status kept)
s8	Branch shutter 5 (0: OFF 1: ON □: Current status kept)
s9	Branch shutter 6 (0: OFF 1: ON □: Current status kept)
mon	Automatic laser power monitor value transmission (0: OFF 1: ON □: Current status kept) Each time the flashlamp comes on, "00 Laser Power Monitor-Energy, number of waveform data, etc." on page 161 is sent. In the case of a high-speed repeated output, however, the data is sent at certain intervals because the communication is too quick. Even if the control method is changed in "cnt", the data is sent automatically until the power supply is turned OFF.
ACK or NAK	Valid only at external communication control. If there is any setting that cannot be changed, all are invalidated and [NAK] is returned.

Setting the Mirror of the Timesharing Unit

The command (code: WM) to set the mirror of the timesharing unit is explained below.

Personal computer, etc.

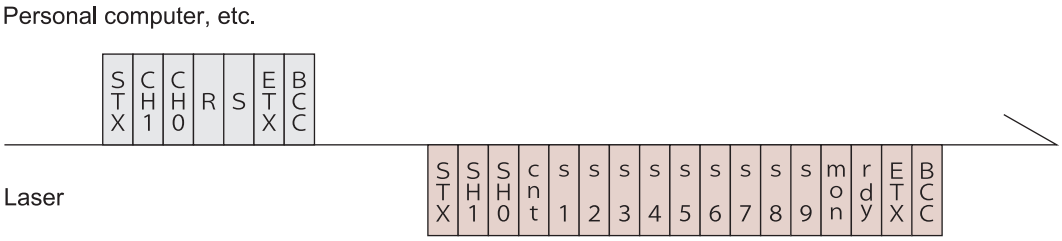


CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
m1	Timesharing unit 1 (0: OFF 1: ON □: Current status kept)
m2	Timesharing unit 2 (0: OFF 1: ON □: Current status kept)
m3	Timesharing unit 3 (0: OFF 1: ON □: Current status kept)
m4	Timesharing unit 4 (0: OFF 1: ON □: Current status kept)
m5	Timesharing unit 5 (0: OFF 1: ON □: Current status kept)

ACK or NAK	Valid only at external communication control. If there is any setting that cannot be changed, all are invalidated and [NAK] is returned.

Reading the Control Method, SCHEDULE No., Branch Shutter, etc.

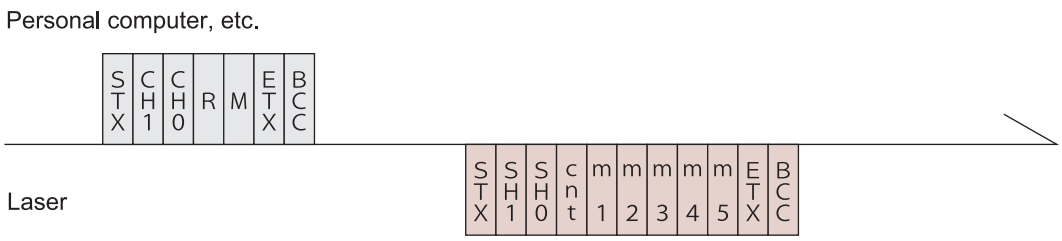
The command (code: RS) to read the control method, SCHEDULE No., branch shutter, high voltage ON/OFF status, guide light ON/OFF status, automatic laser power value transmission ON/OFF status, etc. is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
SH1/SH0	Schedule No. (SH1 = tens digit, SH0 = units digit)
cnt	Control method 0: Control by control panel 1: Control by external input/output signals (Output schedules are set on the laser controller.) 2: Control by external communication control 3: Maintenance mode 4: (Missing number) 5: Control by external input/output signals (Output schedules are set on the personal computer.)
s1	HV (0: OFF 1: ON)
s2	LD (0: OFF 1: ON)
s3	Resonator shutter (0: OFF 1: ON)
s4	Branch shutter 1 (0: OFF 1: ON)
s5	Branch shutter 2 (0: OFF 1: ON)
s6	Branch shutter 3 (0: OFF 1: ON)
s7	Branch shutter 4 (0: OFF 1: ON)
s8	Branch shutter 5 (0: OFF 1: ON)
s9	Branch shutter 6 (0: OFF 1: ON)
mon	Automatic laser power monitor value transmission (0: OFF 1: ON) Each time the flashlamp comes on, "00 Laser Power Monitor-Energy, number of waveform data, etc." on page 161 is sent.
rdy	READY status (0: Laser start disabled 1: Laser start enabled)

Reading the Timesharing Unit Status

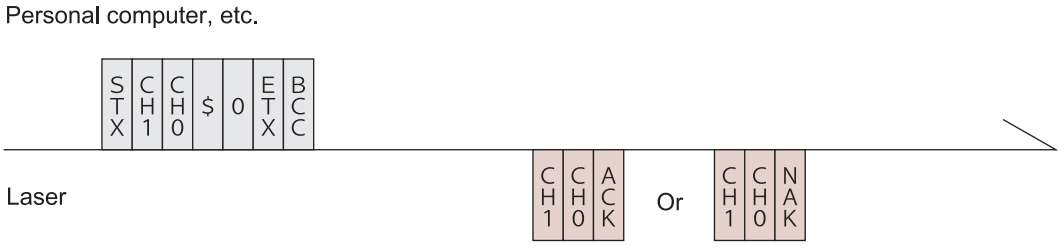
The command (code: RM) to read the timesharing unit status is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
SH1/SH0	Schedule No. (SH1 = tens digit, SH0 = units digit)
cnt	Control method 0: Control by control panel 1: Control by external input/output signals (Output schedules are set on the laser controller.) 2: Control by external communication control 3: Maintenance mode 4: (Missing number) 5: Control by external input/output signals (Output schedules are set on the personal computer.)
m1	Timesharing unit 1 (0: OFF 1: ON)
m2	Timesharing unit 2 (0: OFF 1: ON)
m3	Timesharing unit 3 (0: OFF 1: ON)
m4	Timesharing unit 4 (0: OFF 1: ON)
m5	Timesharing unit 5 (0: OFF 1: ON)

Starting a Laser Light Output

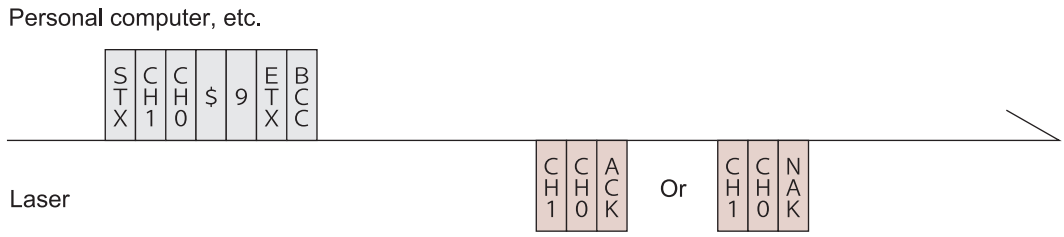
The command (code: $0) to start a laser light output is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
ACK or NAK	If the Laser is ready for use, it returns an [ACK]. If not, the Laser returns a [NAK]. The Laser is not ready for use when: • An alarm is activated. • HV is OFF. • The Laser is not charged to the set voltage. • The Laser is not in external communication control mode.

Stopping a Laser Light Output

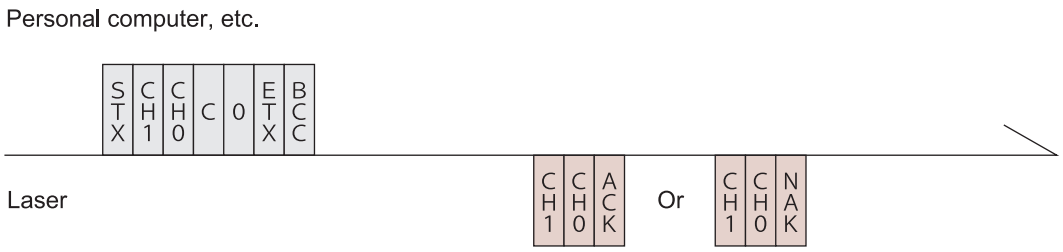
The command (code: $9) to stop a laser light output is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
ACK or NAK	The Laser accepts the command only when in external communication control (RS-485 CONTROL) mode. It returns a [NAK] when in any other control method.

Stopping an Error Signal Output

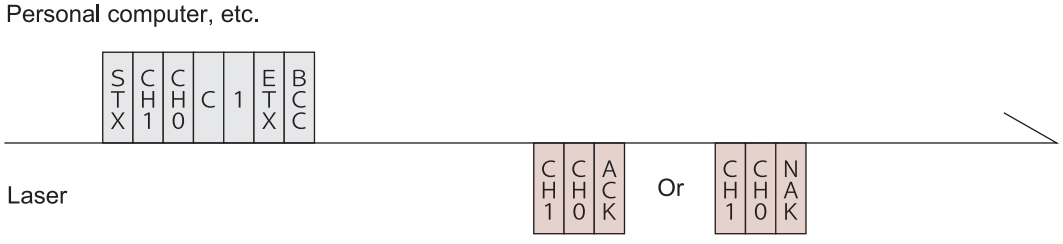
The command (code: C0) to stop an error signal output is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
ACK or NAK	The Laser accepts the command only when in external communication control (RS-485 CONTROL) mode. It returns a [NAK] when in any other control method.

Resetting the Total Number of Outputs

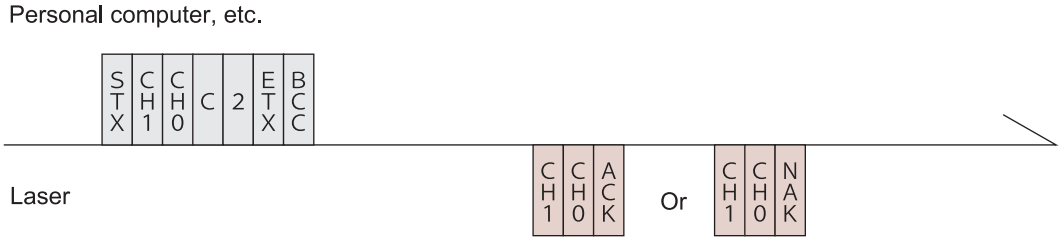
The command (code: C1) to reset the total number of outputs (SHOT COUNT) is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
ACK or NAK	The Laser accepts the command only when in external communication control (RS-485 CONTROL) mode. It returns a [NAK] when in any other control method.

Resetting the Appropriate Number of Outputs

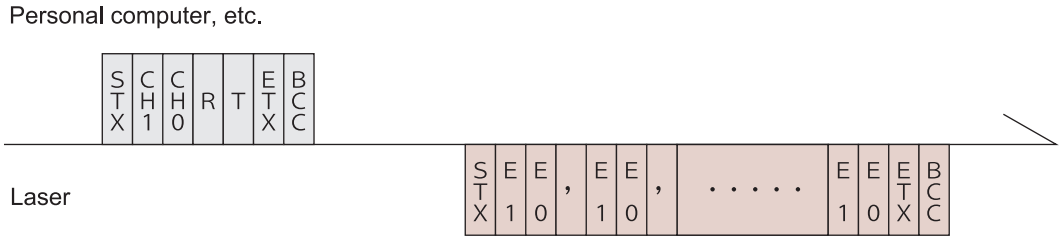
The command (code: C2) to reset the appropriate number of outputs (GOOD COUNT) is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
ACK or NAK	The Laser accepts the command only when in external communication control (RS-485 CONTROL) mode. It returns a [NAK] when in any other control method.

Reading Error No. at Occurrence of Trouble

The command (code: RT) to read error No. at occurrence of trouble is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
E1/E0	Error No. (E1 = tens digit, E0 = units digit) All error numbers are transmitted. If no error has occurred, the error No. is to be [00]. For the contents corresponding to error No., refer to "Table of Error Contents" on page 169.

Table of Error Contents

No.	Contents	No.	Contents
00	Normal	32	Optical fiber not connected
01	Side cover, rear cover opened	33	Emission indicator fault (output unit)
02	Head cover, lamp replacing cover opened	34	Emission indicator fault (laser controller)
03	Emergency stop	35	Low backup battery voltage
04	Low level of coolant	36	
05		37	
06	Pump fault	38	Optical fiber 1 broken
07		39	Optical fiber 2 broken
08	Discharge resistor overheat	40	Optical fiber 3 broken
09		41	Optical fiber 4 broken
10	High temperature of coolant	42	Optical fiber 5 broken
11	Low temperature of coolant	43	Optical fiber 6 broken
12	Low flow rate of coolant	44	External interlock activated
13	Low resistivity of coolant	45	Not charged
14	Simmer trouble	46	Power monitor unit overheating
15	Charge trouble	47	Over-duty-cycle
16	Condenser bank fault	48	Fiber overrated
17		49	Out-of-range setting
18	Resonator shutter fault	50	Out-of-range setting (lamp input power)
19	Branch shutter 1 fault	51	Out-of-range input power to fiber
20	Branch shutter 2 fault	52	Memory error
21	Branch shutter 3 fault	53	Power feedback system fault
22	Branch shutter 4 fault	54	Caution - coolant resistivity
23	Branch shutter 5 fault	55	
24	Branch shutter 6 fault	56	Laser power above upper limit
25		57	Laser power below lower limit
26		58	
27		59	Timesharing unit 1 fault
28	Discharge unit overcurrent	60	Timesharing unit 2 fault
29	Discharge unit temperature error	61	Timesharing unit 3 fault
30	Discharge unit overpower error	62	Timesharing unit 4 fault
31	Branch cover open	63	Timesharing unit 5 fault

Operating Part

Chapter 6

Printing Set Values and Measured Values _ Option

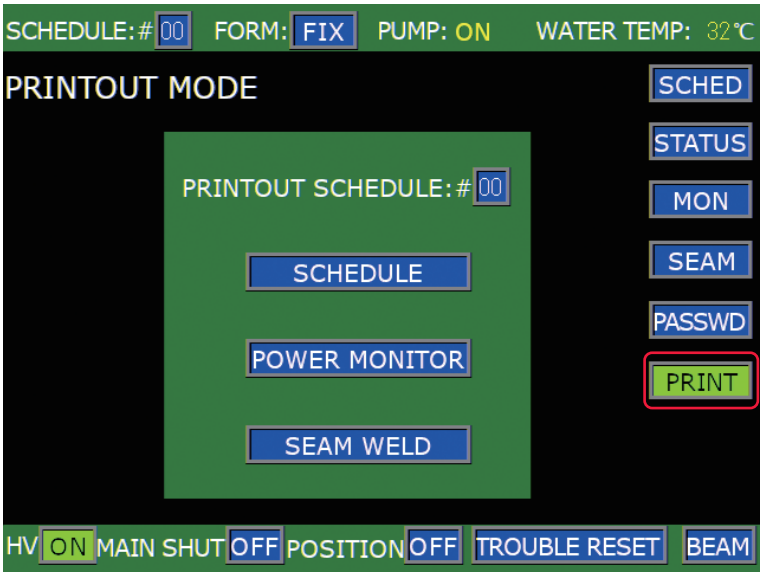
When the Printer Model BL2-58SNWJC (option) manufactured by SANEI ELECTRIC INC. is connected to the laser by using an RS-485 cable, the output schedules of each SCHEDULE and the measured values of the MONITOR screen can be printed.

1. Printing Set Values

⇒ If the power supply is OFF, turn ON the MAIN POWER switch and then turn ON the CONTROL keyswitch. When one of the SCHEDULE screen, STATUS screen, and MONITOR screen is displayed on the laser controller, perform the following operations.

1 Displaying the PRINTOUT Screen

(1) Press the "PRINT" button.
The PRINTOUT screen appears.



2 Specifying SCHEDULE

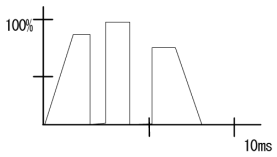
(1) Press the "PRINTOUT SCHEDULE" setting button.
Enter the SCHEDULE number of the output conditions to be printed by using the numeric keypad and then press the ENT key.

3 Executing Printing

(1) Press the "SCHEDULE" button.
The output schedules of the specified SCHEDULE are printed.

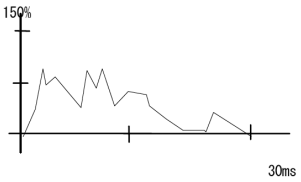
Example
FORM:FIX (fixed waveform setting)

```
[SCHEDULE]
-SCH.#06 [FORM:FIX]

PEAK POWER = 01.80kW

U-SLOPE = 01.0ms
FLASH 1 = 02.1ms 080.0%
FLASH 2 = 01.2ms 100.0%
FLASH 3 = 02.3ms 070.0%
D-SLOPE = 00.9ms

COOL1   = 01.0ms
COOL2   = 01.0ms

REPEAT  =  007pps
SHOT    = 0000

ESTIMATED VALUE =  6.7J

SEAM WELD MODE : OFF
```



Example
FORM:FLEX (flexible waveform setting)

```
[SCHEDULE]
-SCH.#01 [FORM:FLEX]

PEAK POWER = 02.00kW

Point1  = 01.1ms 032.2%
Point2  = 02.4ms 107.0%
Point3  = 03.3ms 084.1%
Point4  = 04.2ms 094.2%
Point5  = 05.5ms 072.3%
Point6  = 06.2ms 060.4%
Point7  = 07.4ms 036.0%
Point8  = 08.6ms 100.5%
Point9  = 10.2ms 060.0%
Point10 = 11.0ms 102.0%
Point11 = 12.1ms 042.1%
Point12 = 13.4ms 070.3%
Point13 = 14.5ms 062.0%
Point14 = 15.2ms 050.4%
Point15 = 18.3ms 013.0%
Point16 = 20.2ms 011.2%
Point17 = 20.5ms 008.7%
Point18 = 21.7ms 040.0%
Point19 = 26.3ms 012.1%
Point20 = 30.0ms 000.0%

REPEAT  =  002pps
SHOT    = 1120

ESTIMATED VALUE =  26.3J

SEAM WELD MODE : OFF
```



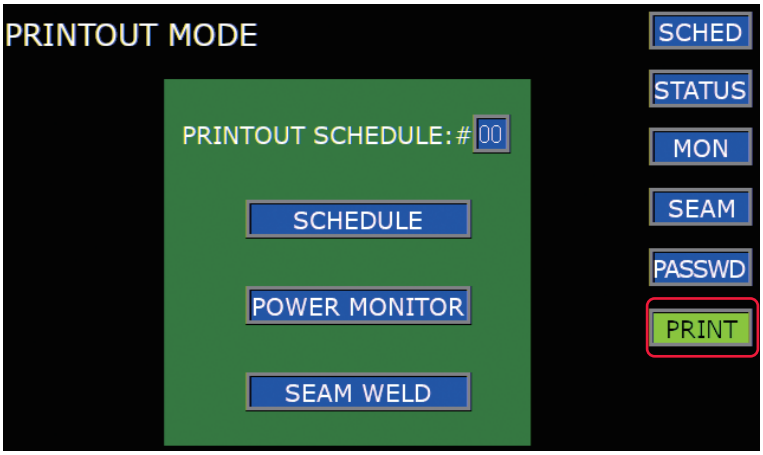
2. Printing Measured Values

⇒ If the power supply is OFF, turn ON the MAIN POWER switch and then turn ON the CONTROL keyswitch.

⇒ To print measured values, set welding schedules and output laser light actually. After making sure that the measured waveform is displayed, perform the following operations.

1 Displaying the PRINTOUT Screen

(1) Press the "PRINT" button.
The PRINTOUT screen appears.

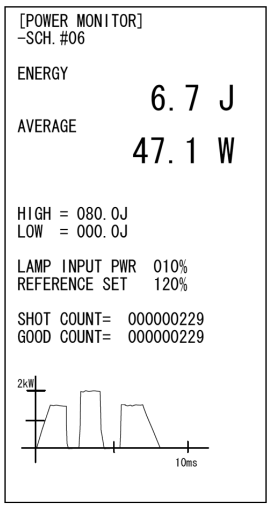


2 Executing Printing

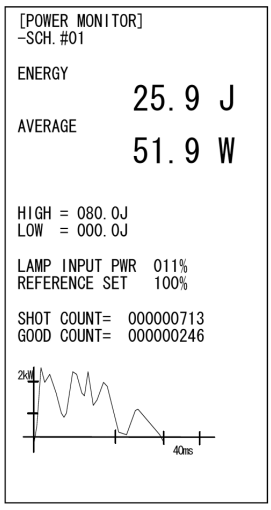
(1) Press the "POWER MONITOR" button.
The previously output measured values are printed.

⇒ The measured values and output waveform that can be printed are only the previous laser output data. Measured values under other schedules cannot be printed in succession by specifying SCHEDULE No.

Example
FORM:FIX (fixed waveform setting)



Example
FORM:FLEX (flexible waveform setting)

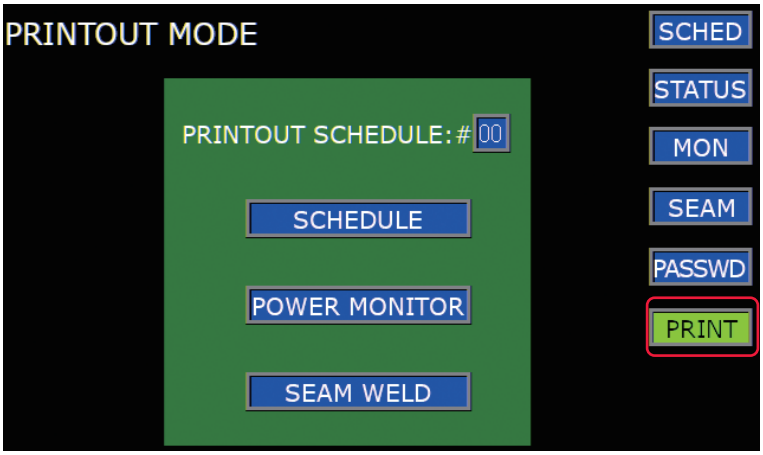


3. Printing Set Values for Seam Welding

⇒ If the power supply is OFF, turn ON the MAIN POWER switch and then turn ON the CONTROL keyswitch. When one of the SCHEDULE screen, STATUS screen, and MONITOR screen is displayed on the laser controller, perform the following operations.

1 Displaying the PRINTOUT Screen

(1) Press the "PRINT" button.
The PRINTOUT screen appears.



2 Specifying SCHEDULE

(1) Press the "PRINTOUT SCHEDULE" setting button.
Enter the SCHEDULE number of the output conditions to be printed by using the numeric keypad and then press the ENT key.

3 Executing Printing

(1) Press the "SEAM WELD" button.
The setting values for seam welding are printed in the specified SCHEDULE number.

Example of SEAM WELD (output conditions for seam welding)

```
[SEAM WELD]
-SCH. #00

NO SHOT ENERGY
 1 0001 050.2%
 2 0032 010.0%
 3 0100 070.4%
 4 0120 110.4%
 5 0300 060.0%
 6 0320 023.3%
 7 0350 015.0%
 8 0353 123.0%
 9 0400 052.0%
10 0420 016.3%
11 0500 150.0%
12 0520 025.0%
13 0553 160.0%
14 0563 022.2%
15 0720 036.0%
16 0890 045.3%
17 1234 125.5%
18 1352 025.6%
19 1455 133.0%
20 2001 041.6%
```

Maintenance Part

Maintenance Part

Chapter 1

How to Perform Maintenance

NOTE

Before starting maintenance, read the following items and take extreme care.

⚠ WARNING

- **Before starting maintenance operations, be sure to turn OFF the power supply. If a high voltage is already applied, turn OFF the power supply and then start these operations at least in 5 minutes.**
- **Turning ON the power supply for an operation check during maintenance puts the YAG Laser in oscillation. Take extreme care about it.**
- **The operator and those who may receive YAG laser light during maintenance must put on protective glasses.**

⚠ CAUTION

- **Use our genuine maintenance parts.**
- **For defect caused by non-genuine maintenance parts or use of non-genuine maintenance parts, the repair is charged even if it is still within the maintenance contract period or the warranty period.**

1. Maintenance Parts and Standard Intervals of Inspection/Replacement

The performance of maintenance parts will be gradually deteriorated while they are used, and they may have to be repaired or replaced. Perform inspection periodically referring to the following table.

⇒ The model numbers of maintenance parts are subject to change without notice. For the latest parts information, contact a nearest sales office.

Part name	Model No.	Operation interval (standard) (*1)	Contents of operation (*2)
Flashlamp	A-02914-001	1 million shots (*3)	Replace
Flowtube for lamp	PC1204453	Every two replacements of lamp	Replace
Ion-exchange resin refill	MLF-0021	6 months	Replace

Part name		Model No.	Operation interval (standard) (*1)	Contents of operation (*2)
Cartridge (Ion-exchanger) (With one bag of ion-exchange resin)		MLF-0025-00	3 years	Replace
Water filter		CW-5PM-H	6 months	Replace
Floating panel		Z-00869-001	1 year	Replace
Secondary cooling water (Purified water, 20L)		MLU-0604-00	6 months	Replace
Lithium battery (*4)		CR 2450	3 years	Replace
Air filter		MF-13 15t × 170 × 270	Every week	Clean
			1 year	Replace
Protective glass		Specified glass for output unit	Everyday	Clean
			—	Replace (*5)
Flowtube for rod		PC1205081	3 years	Replace
O-ring for chamber cover		WG42	3 years	Replace
O-ring for rod holder		P11.2	3 years	Replace
O-ring for rod	ML-2350A	S-8	3 years	Replace
	ML-2351A	S-7		
O-ring for electrode		P5	3 years	Replace
O-ring for electrode 2		S-8	3 years	Replace
Branch shutter (*6)		A-06090-001	5 million times	Replace
Timesharing unit (*7)		MLU-0704-00	1 million times	Replace
Pump		MD-70RZ	5 years	Replace
Cooling fan motor		109S025	4.5 years	Replace
Output unit lens		Supplied lens with output unit	1 year	Clean
			—	Replace
Aluminum electrolytic capacitor		ECST351LGC303QGNOM	5 years (*8)	Replace
Solenoid valve		RSV-15A-210W-2G211-AC200V	1 year	Clean
			100,000 times	Replace
Optical fiber		Specified fiber	If gets dirty	Clean
			If damaged (*9)	Repair, Replace

For the hatched portion, our engineer takes charge of maintenance work.

*1: The operation interval means the maintenance time or expected life of the part, and is different from the guarantee period.

*2: Part replacement is performed when any damage or defect is found or the

usable period ends.

*3: The number of flashes as an indication of the life of the lamp (lowering of light quantity, cracks in the lamp, and a lighting failure) differs greatly depending on the laser output conditions and the laser irradiation interval. When the flashlamp is used in a single shot or with a long standby time as compared with continuous flash in repetition of several shots to several tens of shots per second, the number of flashes may become one-tenth or less. This is why the normal pulse laser lamp flows a low current after turned on and be ready to flash immediately, but when the time of ready state where this low current flows is long, the tip of the lamp electrode tends to be deteriorated earlier. Also, the lamp electrode is deteriorated earlier when the lamp is used with nearly maximum output energy. Therefore, the number of flashes may become one-tenth or less as compared with continuous irradiation.

*4: When the laser is stopped for a long time (for about one month), the usable period of the lithium battery is shortened.

*5: We do not specify a degree of parallelism of our standard protective glass. Therefore, the condensing position may be shifted before and after replacing the protective glass due to individual differences. The protective glass having a very small positional deviation is also available. Contact us as needed.

*6: An expected life of the branch shutter is 5 million times. Switching ON and OFF of the branch shutter according to the ON/OFF state of the laser can lead to shortening the operation interval. The branch shutter can be used for a longer time by setting it to ON at startup of the equipment and keeping it ON during the laser operation in principle.

*7: An expected life of the timesharing unit is 1 million times. When the timesharing unit is operated over the operation interval, the optical fiber may be damaged by the optical axis deviation due to degradation in stop accuracy of the timesharing unit. We recommend a periodic inspection.

*8: This operation interval provides guidelines based on 8 hours of operation per day.

*9: The optical fiber may be damaged if it is used when dust or oil mist is attached on its end face.

2. Maintenance of the Cooler Unit Section

This section explains the maintenance of the coolant unit, including cleaning of the solenoid valve strainer, water drain of the primary cooling water and secondary cooling water tanks, maintenance of the ion-exchanger, and water drain for the case where the laser welder is not used for a long time.

Cleaning the Solenoid Valve Strainer

The solenoid valve has a function to adjust the quantity of primary cooling water. If the solenoid valve is clogged with dust, the primary cooling water is hard to flow, thereby causing overheating. Perform cleaning for the solenoid valve once every year as standard.

Item required

Brush, 10-mm and 17-mm spanners, screwdriver, and bucket (container to receive water)

Operating Procedure

(1) Remove the solenoid valve cover on the rear surface of the main unit and pull out the solenoid valve.

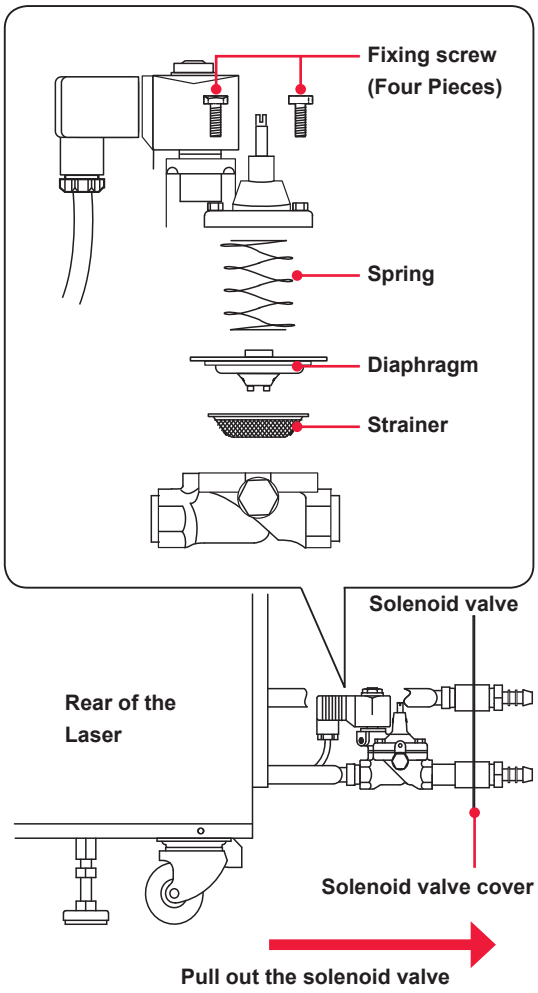
(2) Turn off the primary cooling water and disconnect the hose from the cooling water inlet, and drain the water.

⇒ Take care not to splash over the Laser as water may spurt. If water has splashed, wipe it off completely.

(3) Remove the 4 fixing screws of the solenoid valve and then remove the upper part of the solenoid valve. Then, pull out the spring and diaphragm.

(4) Take out the strainer and wash out the dust with which the mesh is clogged.

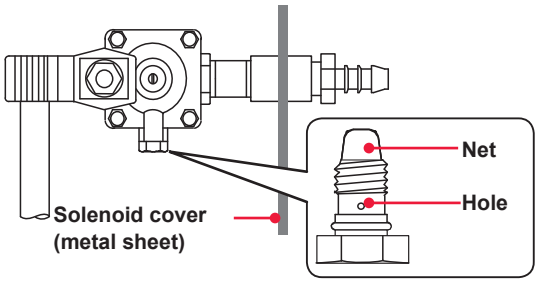
(5) Return the strainer into the initial status and install the diaphragm, spring, and upper part of the solenoid valve. Tighten the solenoid valve with the fixing screws (4 screws).



(6) Check whether the net and hole at the end of solenoid valve bolt are clogged with dust. Remove the dust.

⇒ If the net and hole at the end of solenoid valve volt are clogged with dust, the valve cannot be closed, so that the primary cooling water continues to flow. Check the bolt portion at the same time and perform cleaning for it.

Solenoid valve (Top view)



(7) Install the solenoid valve cover.

(8) Return the disconnected hose and secure it with the hose band.

Draining Water from the Primary Cooling Water

When the laser welder must be moved or transferred or its operation is stopped over one month, drain the primary cooling water.

⇒ For changing the ion-exchange resin for repacking, changing the ion-exchanger, changing the water filter, and changing the secondary cooling water, the primary cooling water does not need to be drained.

⇒ For the primary cooling water, use tap water or clean industrial water.

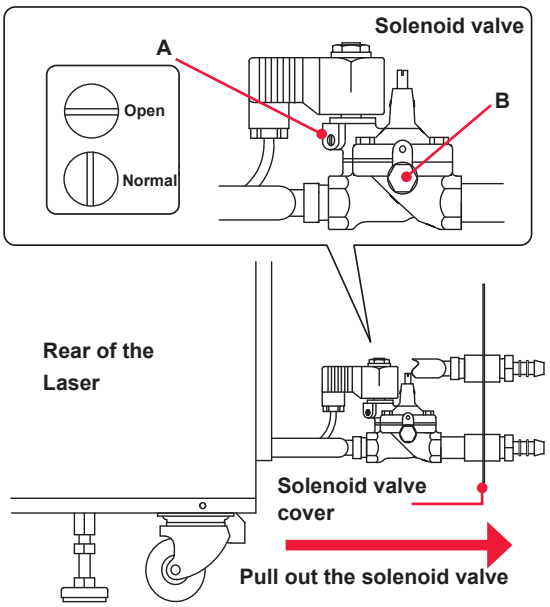
Item required

Screwdriver, water feed pump, and bucket (container to receive water)

Operating Procedure

(1) Open the solenoid valve cover on the back of the Laser and draw out the solenoid valve.

(2) Open the solenoid valve.
Push and turn the A portion shown at right to “Open” position with a blade-tip screwdriver.



(3) Remove the 2 hoses connected from the outside and drain water.

⇒ Sometimes, water may spout out hard. Take care not to splash water on the laser welder. If the laser welder is splashed with water, wipe it off completely with a cloth.

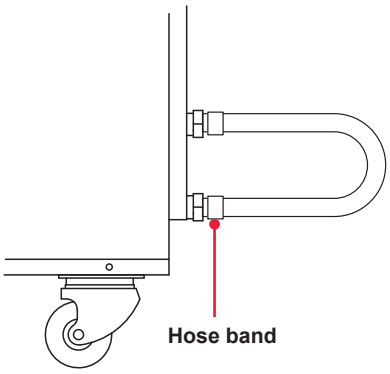
(4) Remove the solenoid valve plug (B portion in the previous figure) and apply clean compressed air at 0.3 MPa (approx. 3 kgf/cm^2) or less into the pipe to expel the remaining water in the pipe forcedly.

(5) Return the valve plug. Return the A portion to Normal position.

Put the A portion shown in the previous figure to the "Normal" status by turning it while pushing it with the screwdriver.

(6) Return the solenoid valve cover.

(7) Connect both of the cooling water inlet and outlet with a hose as shown.



Draining Water from the Secondary Cooling Water Tank

For changing the ion-exchange resin for repacking, changing the ion-exchanger, and changing the secondary cooling water (once every 6 months), drain water from the cooling water tank to make the tank empty. For moving or transporting the laser welder and stopping it over one month, make the cooling water tank empty.

Item required

Water feed pump and bucket

Operating Procedure

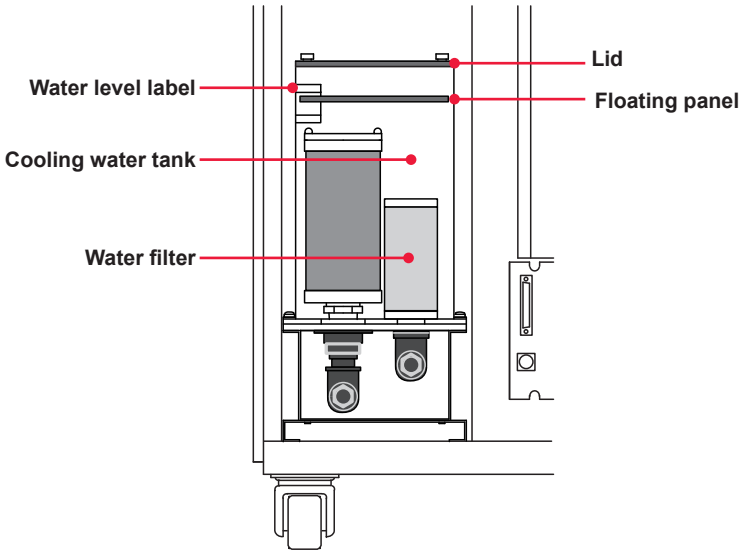
(1) Open the front door.

(2) Open the lid of the cooling water tank and take out the floating panel.
⇒ Keep the panel clean during the exchanging work.

(3) Pump out the tank.

(4) Return the floating panel into the tank and install the tank lid as it was.

The Laser front (With front door opened)



Changing the Ion-Exchange Resin and Replacing the Ion-Exchanger

The ion-exchange resin in the ion-exchanger has a function to keep high purity by removing the ion generated by deteriorated secondary cooling water. Change the ion-exchange resin with a new one within 6 months after use.

For the ion-exchanger of this laser, the cartridge type is adopted. This type can be repeatedly used if the content (ion-exchange resin) is changed.

Replace the ion-exchanger every 3 years.

⇒ Keep the ion-exchange resin for change in a cool place without being exposed to direct sunlight if possible. Do not freeze the ion-exchange resin to avoid lowering its performance.

Item required

Ion-exchanger mounting/removing tool, ion-exchange resin for change (or cartridge), secondary cooling water (12 liters), Phillips screwdriver, water feed pump, and gloves (vinyl)

1 Removing the Ion-Exchanger

(1) Open the lid of the cooling water tank and take out the floating panel.

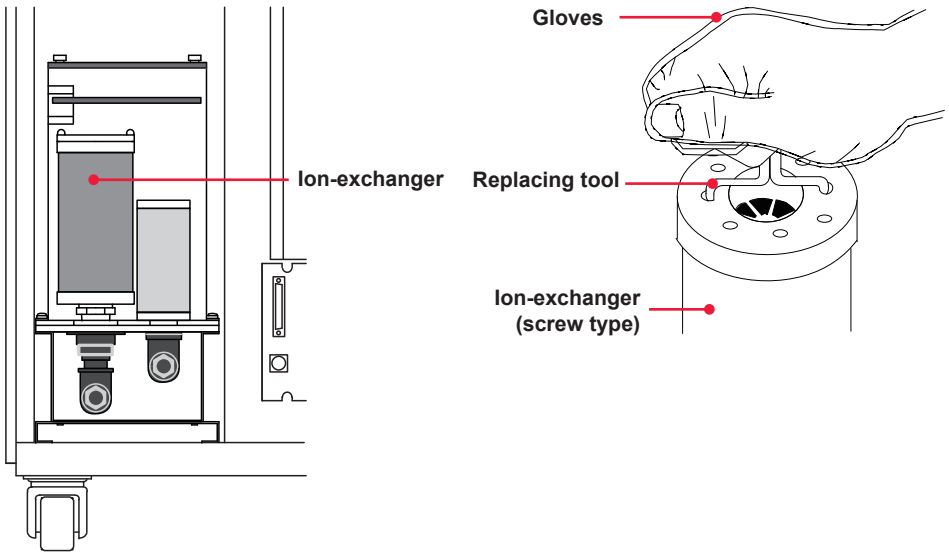
⇒ Keep the panel clean during the exchanging work.

(2) Pump out water in the tank.

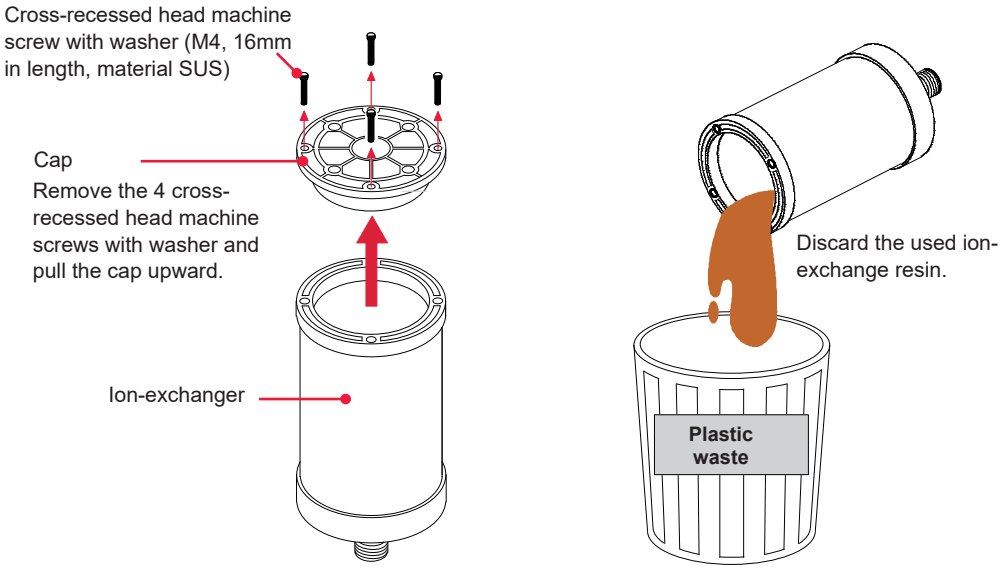
(3) Turn the ion-exchanger in the tank to the left with the replacing tool to remove it.

⇒ For changing with a new ion-exchange cartridge (with resin for change), proceed to Step **3**.

The Laser front (With front door opened)



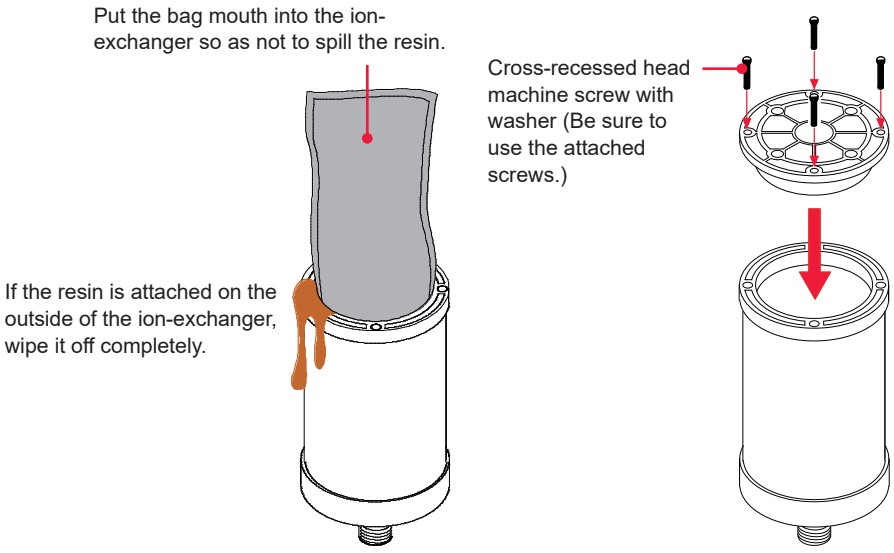
(4) Remove the cap of the ion-exchanger and discard the used ion-exchange resin.



⇒ Dispose of the used ion-exchange resin together as plastic waste.

2 Mounting a New Ion-Exchange Resin

(1) Put a new ion-exchange resin into the ion-exchanger and set the cap as it was.



<Notes>

- **If the ion-exchange resin is left in the air, it will be deteriorated. Immediately after the package is opened, put the ion-exchange resin into the ion-exchanger and return (dip) it into the cooling water tank.**
- **Take care not to spill the ion-exchange resin. Wipe off the ion-exchange resin attached on the mouth of the ion-exchanger.**

3 Installing the Ion-Exchanger

(1) Insert the ion-exchanger and turn it clockwise with the mounting/removing tool.

<Note>

Use the mounting/removing tool for installing the ion-exchanger. If the mounting/removing tool is too tightened, the thread portion may be broken.

(2) Put cooling water up to the line under HIGH of the water level label with the attached water feed pump.

(3) Float the floating panel on the water surface in the tank as it was and install the lid of the cooling water tank.

⇒ The floating panel can be repeatedly used. Because its material is polyethylene foam, dispose of the floating panel properly.

⇒ If the ion-exchanger is used without the floating panel in the tank, the ion-exchange resin will be deteriorated more quickly. Be sure to put the floating panel into the tank.

Changing the Water Filter and Secondary Cooling Water

The water filter has a function to filter the secondary cooling water to keep its purity. Change the water filter and the secondary cooling water every 6 months.

⇒ For the secondary cooling water, use deionized water or purified water. If tap water, industrial water, ground water, or ultra pure water (resistivity: 16 MΩ•cm or more) is used, corrosion and clogging will occur, resulting in a failure.

Item required

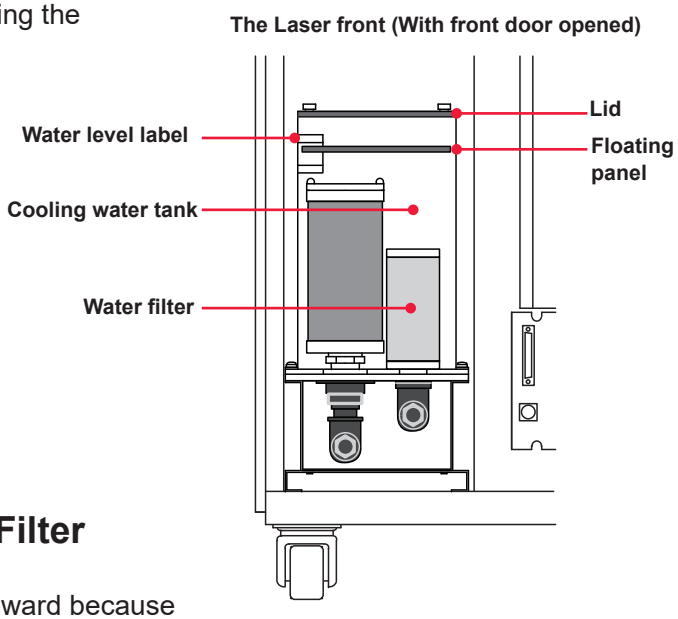
Secondary cooling water (12 liters), water feed pump, and water filter (new product)

1 Draining the Secondary Cooling Water

(1) Open the lid of the cooling water tank and take out the floating panel.
⇒ Keep the panel clean during the exchanging work.

(2) Pump out the tank.

The Laser front (With front door opened)



2 Changing the Water Filter

(1) Pull out the water filter upward because this water filter is an insertion type.

(2) Insert a new water filter.

3 Supplying the Secondary Cooling Water

(1) Supply the cooling water, with the attached hand pump, till it reaches HIGH-line on the water level label.

(2) Return the floating panel in the tank.
Return the lid of the cooling water tank and secure it.

Water Drain When the Laser Welder Is Not Used Over One Month or the Room Temperature at the Installation Place Goes Down Below 0ºC

When the laser welder is not used over one month or the room temperature at the installation place goes down below 0ºC, drain the primary cooling water and secondary cooling water, and also completely expel the remaining water in the laser chamber and piping.

Item required

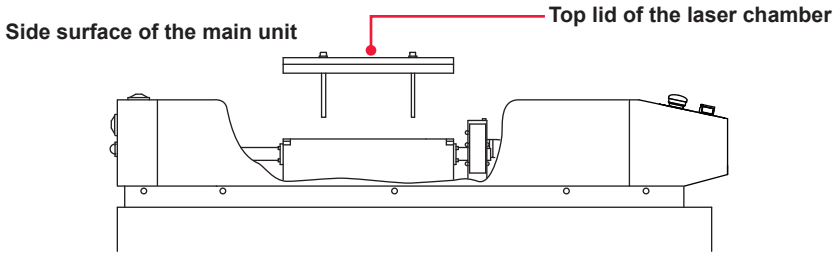
Gloves (vinyl), water feed pump, and clean cloth

1 Draining the Primary Cooling Water and the Secondary Cooling Water

For the drain method, refer to page 181 to page 183.

2 Draining Water from the Laser Chamber

(1) Open the lamp-replacing cover and remove the top lid of the laser chamber to drop the water in the chamber into the cooling water tank.



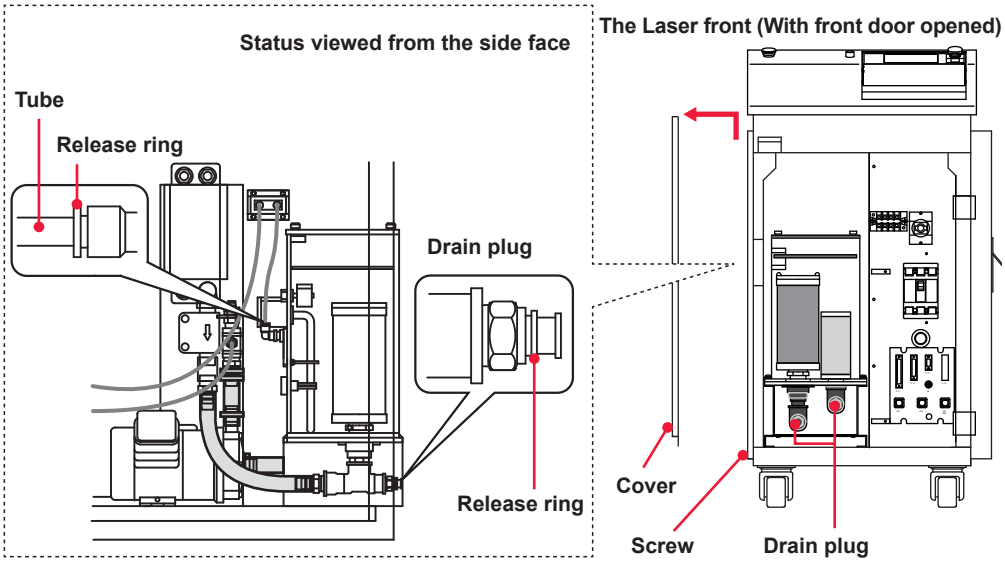
(2) Return and secure the top lid of the laser chamber and the lamp-replacing cover in the reversed order.

⇒ Tighten the bolts with 500 cN•m (50 kgf•cm) of standard tightening torque. If any water leaks, tighten them with up to 550 cN•m (55 kgf•cm) of tightening torque, and then check that no water leaks.

3 Draining Water from the Piping

(1) Remove two drain plugs to drain remaining water in piping.

⇒ When removing the plug, press the release ring evenly and pull the plug straight toward you. If the ring is not pressed enough, the plug may not come out or the adapter and plug may be damaged, causing water leak.



(2) Remove the left side cover of the main unit.
After removing the screws, raise the cover and then pull it out forward.

(3) Remove the tube on the side surface and feed clean compressed air at 0.3 MPa (approx. 3 kgf/cm^2) or less from the hole of the removed tube to drain the remaining water from the tube.
⇒ For installing and removing the tube, refer to the next item.

(4) After draining all the water, return the drain plugs and tubes.

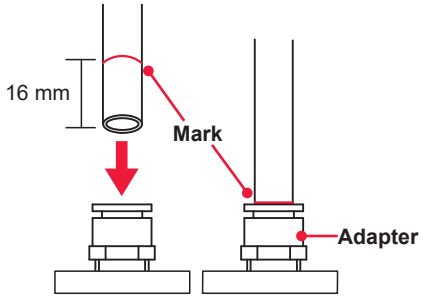
(5) Return and secure the left side cover.

How to Install/Remove/Cut the Tube

⇒ For installing or removing the tube, be sure to turn off the power supply of the laser welder. Do not apply air pressure.
⇒ To prevent water leakage, wipe out the dirt on the tube surface. Do not use any flawed or dented tube.

How to connect the tube

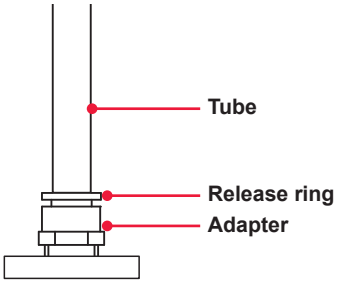
Mark the tube at 16 mm from its end. Insert the tube straight into the adapter until the mark reaches the release ring.
⇒ Pull the tube lightly to make sure it will not come out.



How to remove the tube

Push the tube to the bottom of the adapter. Pull out the tube straight without twisting it while pressing the release ring evenly with your fingers.

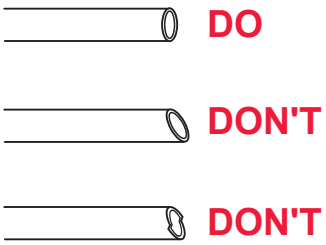
⇒ When connecting and disconnecting the tube several times, its section will be broken or transformed. Cut the tube to make its section new.



How to cut the tube

Cut the tube laterally with a sharp cutter.

⇒ A broken or slant cross section of tube will hurt sealing, causing water leak.



3. Maintenance of the Laser Oscillator Section

Replacing the Flashlamp

The flashlamp is provided in the laser chamber and used for excitation at laser oscillation. We recommend replacing the flashlamp when the number of laser outputs reaches about 1,000,000 shots, as standard.

⚠ CAUTION

When replacing the flashlamp, turn OFF the power to the Laser and wait for at least 5 minutes.

Item required

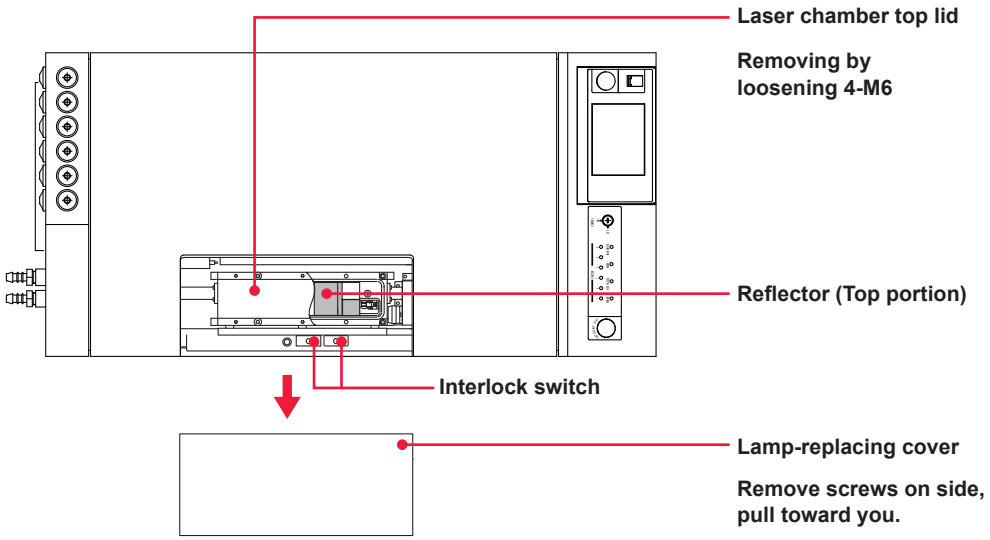
Gloves (vinyl), clean cloth, alcohol, Phillips screwdriver, ball-point screwdrivers 2.5 mm and 5 mm, and flashlamp (new product)

1 Removing the Laser Chamber

(1) Turn OFF the power supply of the laser welder and remove the lamp-replacing cover on the top surface of the main unit.

⇒ In 5 minutes or more after the turning OFF the power supply, remove the cover.

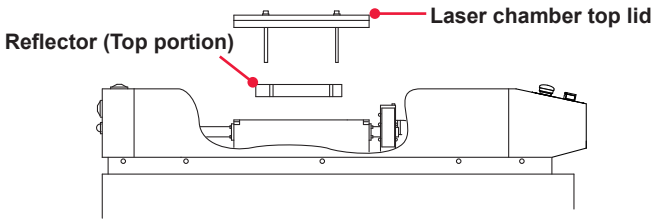
(2) Loosen the bolts of the laser chamber and remove the top lid.



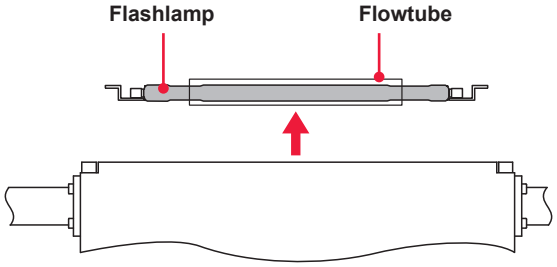
(3) Pull up the top part of the reflector to take it out.

⇒ Take care not to damage the internal surface of the reflector.

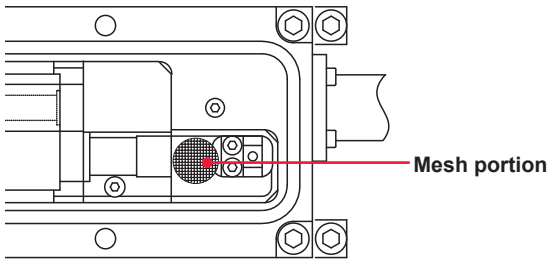
Status viewed from the side face of the main unit



(4) Loosen the bolts of both ends of the flashlamp. Hold both ends of the flowtube (glass tube) with both hands and lift it up together with the flashlamp.



⇒ When removing the flashlamp, you can see the net in the laser chamber. Check this mesh portion and remove dust or glass fragments with tweezers if any.



(5) Put the flashlamp on a clean cloth and remove the bolts on both ends. Then, pull out the flashlamp slowly from the flowtube.

⇒ Put the removed top lid, reflector, and other parts of the laser chamber on a clean cloth without allowing oil and dust to sticking on them.

<Notes>

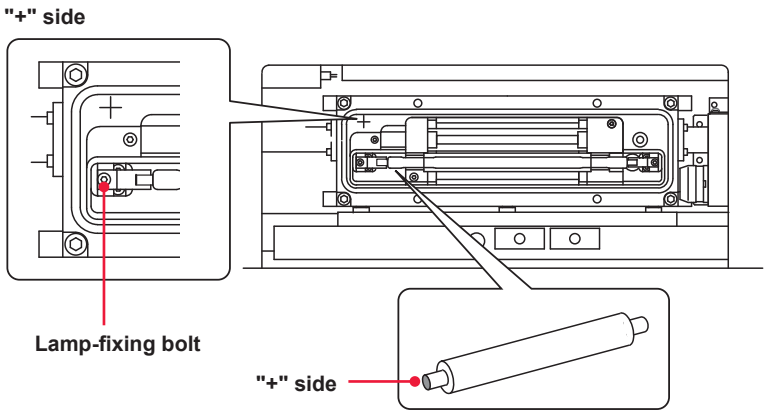
- **Handle the laser chamber with extreme care to void attaching a flaw or dust onto the mirror face inside the reflector. Such a flaw or dust will reduce the laser output.**
- **Do not touch the glass portion of the flashlamp and glass portion of the flowtube directly with a hand or do not blemish it. The flashlamp will be damaged. Before installing the flashlamp, clean the glass portion of the lamp by using alcohol.**

2 Installing a New Flashlamp

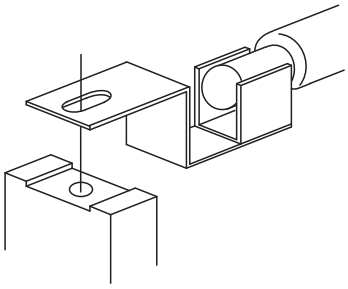
(1) Wipe a new flashlamp with alcohol and pass it through the flowtube.

(2) Adjusting the polarity of the flashlamp to the + sign printed on the laser chamber, return the flashlamp slowly into the laser chamber.

⇒ Check the polarity of the flashlamp. The red painted electrode is the positive side.



⇒ When returning the flashlamp into the laser chamber, set the lamp-side fixture correctly in the chamber-side fixture.



(3) Tighten the bolts on both ends of the flashlamp to fix the flashlamp.

⇒ Tighten the positive side and the negative side little by little alternately with a tightening torque of 60 cN•m (6 kgf•cm).

(4) Put the top part of the reflector slowly.

(5) Wipe off the waterdrops attached on the rear side of the top lid of the laser chamber, and then install the top lid of the laser chamber.

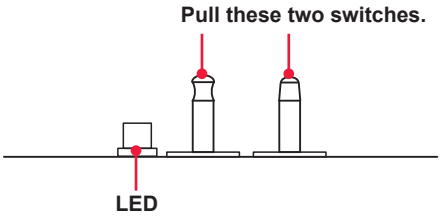
⇒ Tighten the 4 bolts with the standard tightening torque of 500 cN•m (50 kgf•cm).

⇒ If water leakage occurs during an operation check, tighten the 4 bolts within the maximum tightening torque of 550 cN•m (55 kgf•cm) and the make sure that no leakage occurs. At this time, the packings between the top lid and the chamber are equally pressurized.

3 Making an Operation Check

(1) Pull the end of the lamp-replacing cover interlock switch to release interlock.

Interlock switch (Actually, you can see only the ends of interlock switches with the cover closed.)



(2) Turn ON the MAIN POWER switch.
Check that the LED lights up.

(3) Turn ON the CONTROL keyswitch to run the cooler to check for water leakage.

⇒ If water leakage occurs, turn OFF the CONTROL keyswitch and the MAIN POWER switch immediately. In 5 minutes or more, wipe out leaked water and remove the cause for water leakage. Then, operate the cooler again to make sure that no water leakage occurs.

⇒ When the CONTROL keyswitch is turned ON, a bit of water may ooze out from the clearance between the laser chamber and the top lid. This is due to pushed waterdrops around the packing groove and is not abnormal. Wipe them out with a clean cloth.

(4) Make sure that the laser welder can be normally operated and then turn OFF the power supply of the laser welder.

(5) Install the lamp-replacing cover.

Making an Incident Beam Adjustment of the Optical Fiber

Since this laser adopts a high-precision optical fiber, no adjustment is required when the fiber is mounted or dismounted once an incident beam adjustment is finished. For the optical fiber models SIH-□□/GIH-□□, no readjustment is required at replacement. However, after a laser oscillation adjustment and optical axis adjustment, after removal of the beamsplitter, input unit, beam expander, YAG rod or laser chamber, after replacement of the Ø 0.2 mm optical fiber, and after shift of the YAG laser optical axis, incident adjustment is required.

⇒ For the incident beam adjusting method, contact us for information.

<Note>

Use an optical fiber specially intended for incident beam adjustment. If any other type of optical fiber is used, the optical axis of incident beam may be dislocated in installing, detaching or replacing the fiber, which will result in damage to the end of the fiber.

Cleaning the Optical Fiber

When the optical fiber is dirty, perform cleaning.

⚠ WARNING

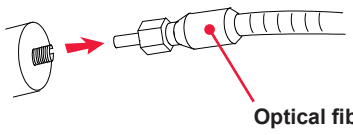
- **Be sure to receive education for this work from our engineer.**
- **Before starting work, be sure to turn OFF the power supply.**

Item required

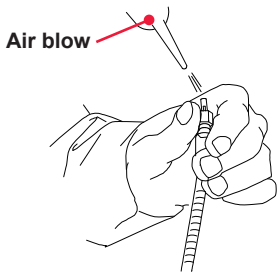
Air blow, lens cleaning paper, and end face checker

Operating Procedure

(1) Remove the optical fiber from the input unit or output unit.



(2) Blow off foreign particles by using the air blow.
If the foreign particles on the end face cannot be eliminated, wipe it lightly with the cleaning paper.



(3) Make sure with the end face checker that any flaw or foreign particle is not attached on the end face.

⇒ If the end face of the optical fiber is rubbed hard, this will result in a flaw. Be careful about it.

Cleaning the Optical Parts

The optical parts such as mirror and lens are delivered in a completely adjusted condition. If these parts are wiped with force or disassembled, the position may be shifted and the laser welder may not be normally operated. Do not touch them.

⇒ For cleaning the optical parts, contact us for further information.

4. Maintenance of the Power Supply Section

Replacing the Lithium Battery for Backup

Replace the lithium battery for backup provided on the CPU board in the main unit. The service life of the battery is about 3 years. Replace it within 3 years.

ATTENTION

Follow your local environmental regulations for battery disposal because Lithium Battery contains dangerous materials.

Item required

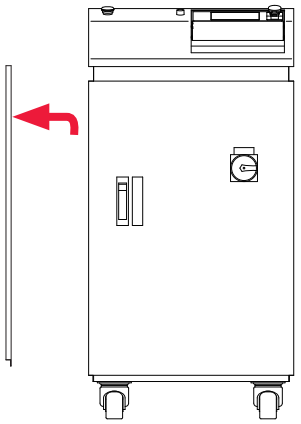
Phillips screwdriver and lithium battery CR2450

⇒ At battery replacement, the registered output schedule data may be lost. We recommend recording the data into the attached output schedule data entry table before replacement.

Operating Procedure

(1) Turn OFF the MAIN POWER switch and wait for 5 minutes or more.

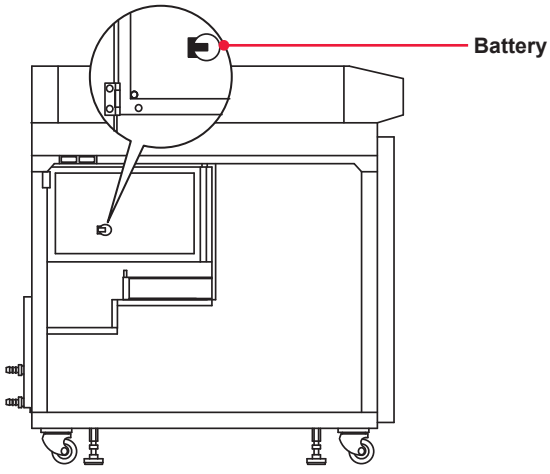
(2) Remove the left side cover as viewed from the front side.



Remove the screws of the side cover, raise the cover, and then pull it out forward.

(3) Remove the battery on the CPU board and install a new battery instead.

⇒ Set the battery minding the polarity.



(4) Install the side cover.

Cleaning the Air Filter

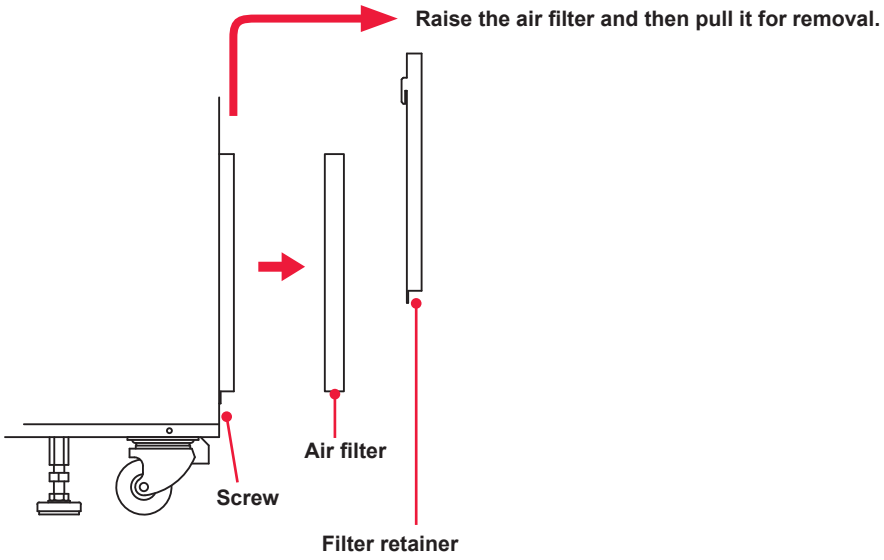
The air filter at the rear of the main unit is provided at the air inlet of the power supply section. Perform cleaning for this air filter at this portion every week.

Item required

Phillips screwdriver

Operating Procedure

(1) Remove the filter retainer from the rear.



(2) Take out the filter and wash it in tap water.
Then, dry the air filter completely.
When the air filter is very dirty, use a neutral cleaner.

(3) Install the air filter by using the filter retainer.

Maintenance Part

Chapter 2

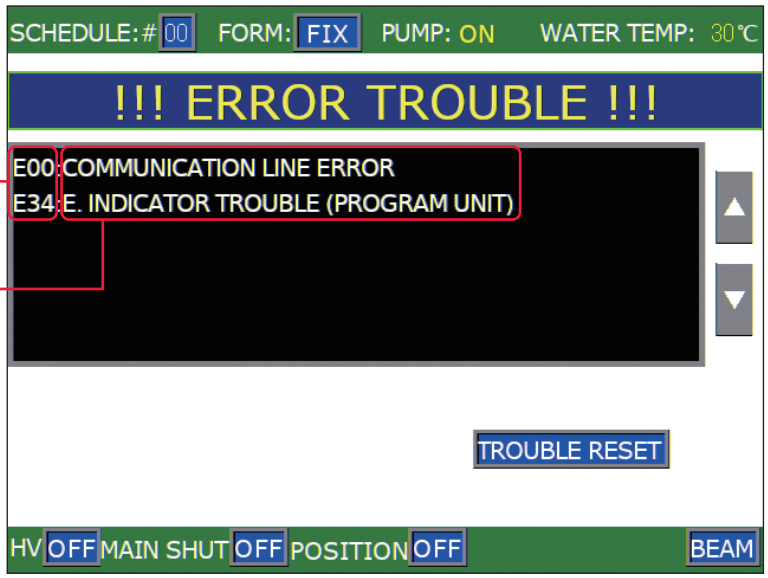
Inspection and Measure To Be Taken at Occurrence of an Error

1. Error Display and How to Take a Measure

When an error occurs in the laser, the contents of the error are displayed on the screen of the laser controller as shown below. In the following, how to take a measure is explained in the order of Error No. At occurrence of an error, read this chapter carefully and perform inspection of the laser and take a proper measure.

* If you have any unclear point, contact the distributor or us for information.

⇒ When there is any related page in this Operation Manual, the reference page is shown.



Error No.

Contents of the error (Troubles are displayed up to six occurrences.)

High voltage "-": State of high voltage doesn't change even if an error/fault occurs.
High voltage "OFF": High voltage is turned off automatically if an error/fault occurs.
Error/Fault signal "-": Error/Fault signal is not output if an error/fault occurs.
Error/Fault signal "ON": Error/Fault signal is output if an error/fault occurs.

No.	Contents of error	High voltage	Alarm output	Measures
00	COMMUNICATION LINE ERROR	-	-	The communication line between the laser power supply and the laser controller is abnormal. If there is any noise generation source nearby, separate it as far as possible or take a preventive measure for occurrence of noise.

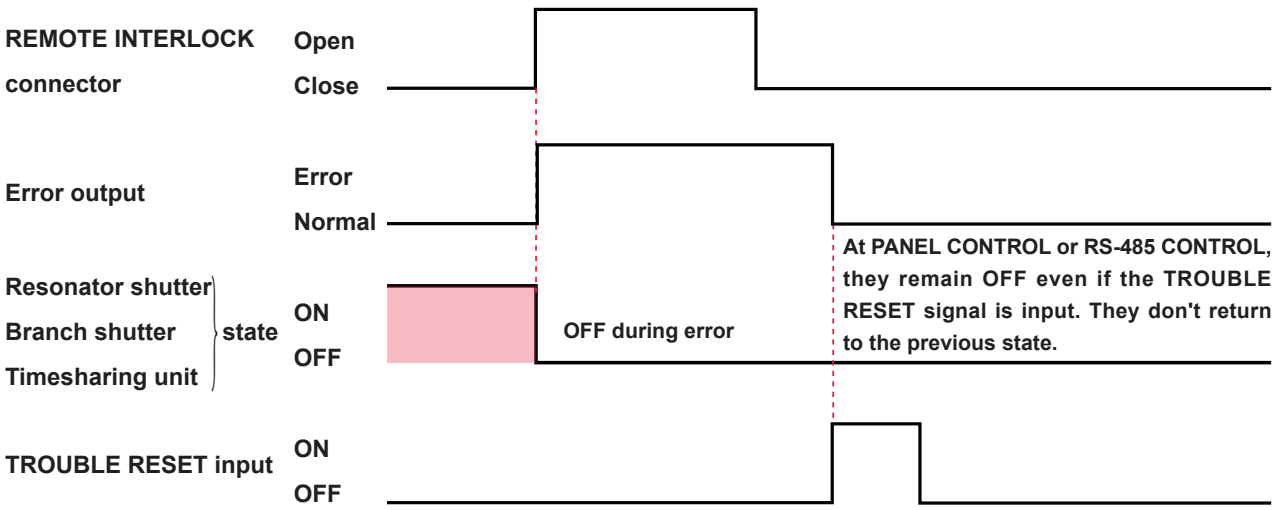
No.	Contents of error	High voltage	Alarm output	Measures
01	POWER SUPPLY COVER OPENED	OFF	ON	The side cover or rear cover is removed or their mounting screws are loosened. Secure the covers with the screws.
02	HEAD COVER OPENED	OFF	ON	The head cover or lamp replacing cover is removed. Mount them.
03	EMERGENCY STOP	OFF	ON	An emergency stop signal is input. Close the Pin No.2 and Pin No.7 of the EXT.I/O (3) connector. Reset the EMERGENCY STOP buttons provided at the front surface of the main unit and of the laser controller.
04	COOLANT LOW LEVEL	OFF	ON	Secondary cooling water volume is insufficient. Add cooling water. If the equipment is swayed, the coolant level may change. Stabilize the equipment.
06	OVERHEAT OF PUMP	OFF	ON	The cooler pump is overloaded. Check whether the cooling water route is abnormal.
08	DISCHARGE RESISTOR TEMP	OFF	ON	Frequent repetitions of HV-ON/OFF may cause this trouble. Wait for a while till the discharge resistor cools; press [TROUBLE RESET]. When this alarm is not reset even after the above measures, consult us.
10	HIGH TEMPERATURE OF COOLANT	OFF	ON	Primary cooling water flow rate is low or the cooling water temperature is too high. → P.73 Increase the primary cooling water flow rate. Check if the cooling water circulates normally.
11	LOW TEMPERATURE OF COOLANT	OFF	ON	The temperature of the secondary cooling water is too low. → P.73 If the ambient temperature is low, it takes time to raise the secondary cooling water temperature. Wait until the secondary cooling water temperature rises after the power is turned on.
12	LOW FLOW RATE OF COOLANT	OFF	ON	The secondary cooling water flow rate is low. The wire net in the oscillator or the water filter is clogged. Dust off the wire net or the water filter, or replace the water filter.
13	DEIONIZE TROUBLE (****MΩ•cm)	OFF	ON	Purity of the secondary cooling water is low. Allow the cooler to operate for 50–60 minutes. If this trouble still occurs, replace the ion-exchange resin.

No.	Contents of error	High voltage	Alarm output	Measures
14	SIMMER TROUBLE	OFF	ON	Flashlamp is not turned on. Check the flashlamp for malfunction. If faulty, replace it. Resistivity of the secondary cooling water may below. Referring to 13, take measures for the secondary cooling water.
15	CHARGE TROUBLE	OFF	ON	Too much time is required to charge the capacitor in the laser power supply or the charged voltage is too high. Check if the capacity of the power supply or power cable is insufficient.
				Check the fuse in the power supply. If it is blown, replace it.
16	BANK ALARM	OFF	ON	This signal is output when a trouble of undercharge, over-charge, no-voltage or over-voltage of capacitor in the power supply of the Laser occurs. In this case, consult us.
18	MAIN SHUTTER TROUBLE	OFF	ON	A laser start signal is input while the resonator shutter is moving. Extend the time from input of resonator shutter operating signal to input of laser start signal. If the trouble will continue even after the above measures, consult us.
19 20 21 22 23 24	BRANCH SHUTTER 1 TROUBLE BRANCH SHUTTER 2 TROUBLE BRANCH SHUTTER 3 TROUBLE BRANCH SHUTTER 4 TROUBLE BRANCH SHUTTER 5 TROUBLE BRANCH SHUTTER 6 TROUBLE	OFF	ON	A laser start signal is input while the branch shutter is operating. Extend the time from input of beam select signal to input of laser start signal. If the trouble will continue even after the above measures, consult us.
28	DISCHARGE UNIT OVERCURRENT	OFF	ON	Lamp or discharge unit (power transistor component, CT) fault. If trouble will continue even after the lamp has been replaced, consult us.
29	DISCHARGE UNIT TEMP	OFF	ON	Check discharge unit for absence of the secondary cooling water; and fan motor on the rear for not running.
30	DISCHARGE UNIT OVERPOWER	OFF	ON	Laser oscillation efficiency lowered. This may be due to the expired service life of the lamp, deviation of oscillation, contaminated YAG rod or mirror, or failure of the sensor unit. If the trouble will continue even after lamp has been replaced, consult us.
31	BRANCH UNIT COVER OPENED	OFF	ON	The branch unit cover plate is removed, or its mounting screws are loosened. Secure the cover plate with the screws.

No.	Contents of error	High voltage	Alarm output	Measures
32	FIBER SWITCH TROUBLE	OFF	ON	An optical fiber or a trouble detecting cable is disconnected. → P.117 Connect them securely.
33	E.INDICATOR TROUBLE (OUTPUT UNIT)	OFF	ON	Emission lamp fault on output unit. → P.117 Consult us.
34	E.INDICATOR TROUBLE (PROGRAM UNIT)	OFF	ON	Emission lamp fault on laser controller. Consult us.
35	MEMORY BATTERY LOW	-	ON	The voltage of the memory backup lithium battery is low. Replace it.
38 39 40 41 42 43	FIBER SENSOR 1 TROUBLE FIBER SENSOR 2 TROUBLE FIBER SENSOR 3 TROUBLE FIBER SENSOR 4 TROUBLE FIBER SENSOR 5 TROUBLE FIBER SENSOR 6 TROUBLE	OFF	ON	An optical fiber may be broken; or end face, damaged. → P.117 Check all the optical fibers for breakage. If the end face is broken, consult us.
44	EXTERNAL INTERLOCK OPENED	-	ON	The REMOTE INTERLOCK connector circuit is opened. Close it and turn on the [TROUBLE RESET] input to turn off the [TROUBLE] output and fault code indication. Refer to "Operation for Closing Interlock" on page 204.
45	LASER START IS NOT READY	-	ON	A start signal is input before charging is finished. Extend the inputting interval of the start signal, extend the time from the change of the schedule to the inputting of the start signal, or input the start signal after confirming READY signal.
46	POWER MONITOR TEMP	-	ON	The power monitor unit may be broken. Consult us.
47	OVERRATE	-	ON	The flashlamp power is too high. Lower the set value of PEAK POWER, output time or REPEAT.
48	FIBER OVERRATE	-	ON	Incident beam exceeds the limit. → P.90 Lower the set value of PEAK POWER, output time or REPEAT.
49	SET ERROR (TOO SHORT DURATION)	-	ON	Output time setting is below 0.25 ms; set it to 0.25 ms and above.
50	SET ERROR (OVERLIMIT OF MAX PWR)	-	ON	A set value of laser energy (PEAK POWER, output time, REPEAT) exceeds the capacity. The error message is displayed when inputting the set value. The set value is reset to the value before the change.

No.	Contents of error	High voltage	Alarm output	Measures
51	FIBER SETTING ERROR	-	ON	Input power setting (PEAK POWER, pulse width, REPEAT) to fiber exceeds the capacity. → P.90 The error message is displayed when inputting the set value. The set value is reset to the value before the change.
52	MEMORY ERROR	-	ON	The voltage of the memory backup lithium battery is low. Replace it.
53	POWER FEEDBACK TROUBLE	-	ON	Trouble with laser power feedback system. Consult us.
54	DEIONIZE CAUTION (****MΩ•cm)	-	-	Purity of the secondary cooling water is low. Allow the cooler to operate for 50–60 minutes. If this trouble still occurs, replace the ion-exchanger.
56	OVERLIMIT OF LASER POWER	-	-	Monitored value exceeds ENERGY HIGH. → P.85 Check the ENERGY HIGH setting. If monitored value is abnormal, consult us.
57	UNDERLIMIT OF LASER POWER	-	-	Monitored value is below ENERGY LOW. → P.85 Check the ENERGY LOW setting. If monitored value is abnormal, consult us.
59 60 61 62 63	BRANCH MIRROR 1 TROUBLE BRANCH MIRROR 2 TROUBLE BRANCH MIRROR 3 TROUBLE BRANCH MIRROR 4 TROUBLE BRANCH MIRROR 5 TROUBLE	OFF	ON	A start signal is input while timesharing unit is operating. Extend the time from input of beam select signal to input of laser start signal. If the trouble will continue even after the above measures, consult us.

Operation for Closing Interlock



2. Troubles not Displaying Fault Code

States of Laser	Measures
Laser output increases though monitor displays normal value. (When welding spot is not clean or spatter increases.)	Adjust PEAK POWER and output time. If the laser does not improve though the setting is adjusted, optical axis of resonator may have been dislocated. For adjusting the axis, consult us.
Laser output decreases though monitor displays normal value. (When welding is not performed or weld strength is not enough.)	

Appendixes

Specifications

		ML-2350A	ML-2351A
Oscillator	Maximum rated output	70 W	50 W
	Max. output energy	70 J/P (Pulse width 10 ms)	50 J/P (Pulse width 10 ms)
	Max. peak power	7 kW	5 kW
	Pulse width	Standard: 0.3 to 30.0 ms (0.1 ms steps) Fine setting: 0.25 to 5.00 ms (0.05 ms steps)	
	Pulse repetition rate	1 to 200 pps	
	Oscillation wavelength	1.064 µm	
	Resonator shutter	With open/close sensor	
	Positioning guide beam	Built-in visible laser (Red)	
	Output stability *1	±3%	
Power Supply	Power supply	3-phase, 220 V AC+10% -15%, 60 Hz 3-phase, 380 V AC±10%, 50/60 Hz (Tap switching)	
	Max. input current	10 A (at 220 V AC), 7A (at 380 V AC)	
	Max. apparent power	3.5 kVA (at 220 V AC), 4.2kVA (at 380 V AC)	
	Power consumption	Maximum: 3.3 kW / Stand-by: 0.45 kW (at 220 V AC) Maximum: 3.3 kW / Stand-by: 0.49 kW (at 380 V AC)	
	Breaker rated current (to be supplied by customers)	For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 20 A or more (for 220 V) or 10 A or more (for 380 V), which is applicable to harmonics and surges.	
	Ground	Class D (ground resistance: 100 Ω max.) (for 220 V) Class C (ground resistance: 10 Ω max.) (for 380 V)	
Cooler	Heat exchange method	Water – Water	
	Required city water	Pressure: 0.3 MPa (approx. 3 kgf/cm^2) maximum Water temperature: 5° to 32°C Flow rate: 4 liters/min at 25°C 18 liters/min at 32°C Differential pressure: 0.1 to 0.3 MPa (approx. 1 to 3 kgf/cm^2)	
	Inner diameter of hose	φ 15 mm	
	<Note> When chiller is employed, cooling capability of 2.5 kW (2150 kcal/h) is required for the chiller cooler maximum rating.		
Laser Controller MLE-124A	Schedule setting	Up to 32 schedules can be set by combining - Laser output waveform - Laser energy for upper/lower limit judgment - Number of outputs per second - Number of repeated outputs	
	Measurement function	Laser energy (J), Average power (W)	
	Counter	Displays total number of outputs (9 digits) Displays the number of acceptable outputs (9 digits)	
	Length of cable	Standard 3 m cable	

Operating Environment	Ambient temperature	5° to 35°C
	Ambient humidity	85%RH or less (non-condensing) ***<Note>*** For the upper limit of ambient humidity, refer to page 40.
Others	Mass	Approx. 210 kg (at 220 V AC) Approx. 240 kg (at 380 V AC)
	Dimensions	990 (H) x 495 (W) x 995 (D) mm

*1 Under the condition that laser output energy is at least 5 J per pulse and peak power is at least 1 kW.

Minimum bending radius of the optical fiber

Core diameter	Minimum bending radius
φ 0.2, 0.3, 0.4mm	100mm
φ 0.6mm	150mm
φ 0.8mm	200mm
φ 1.0mm	250mm

Standard Values of Maximum Incident Laser Energy and Power of the Optical Fiber

The following table shows the standard values of maximum laser energy and power that can be input into the optical fiber. Take care not to exceed these values when using the optical fiber.

For single-delivery or timesharing

The value becomes 1/2 at 2-powersharing, 1/3 at 3-powersharing, and 1/4 at 4-powersharing.
The value when the beam expander (option) is installed is shown in ( ).

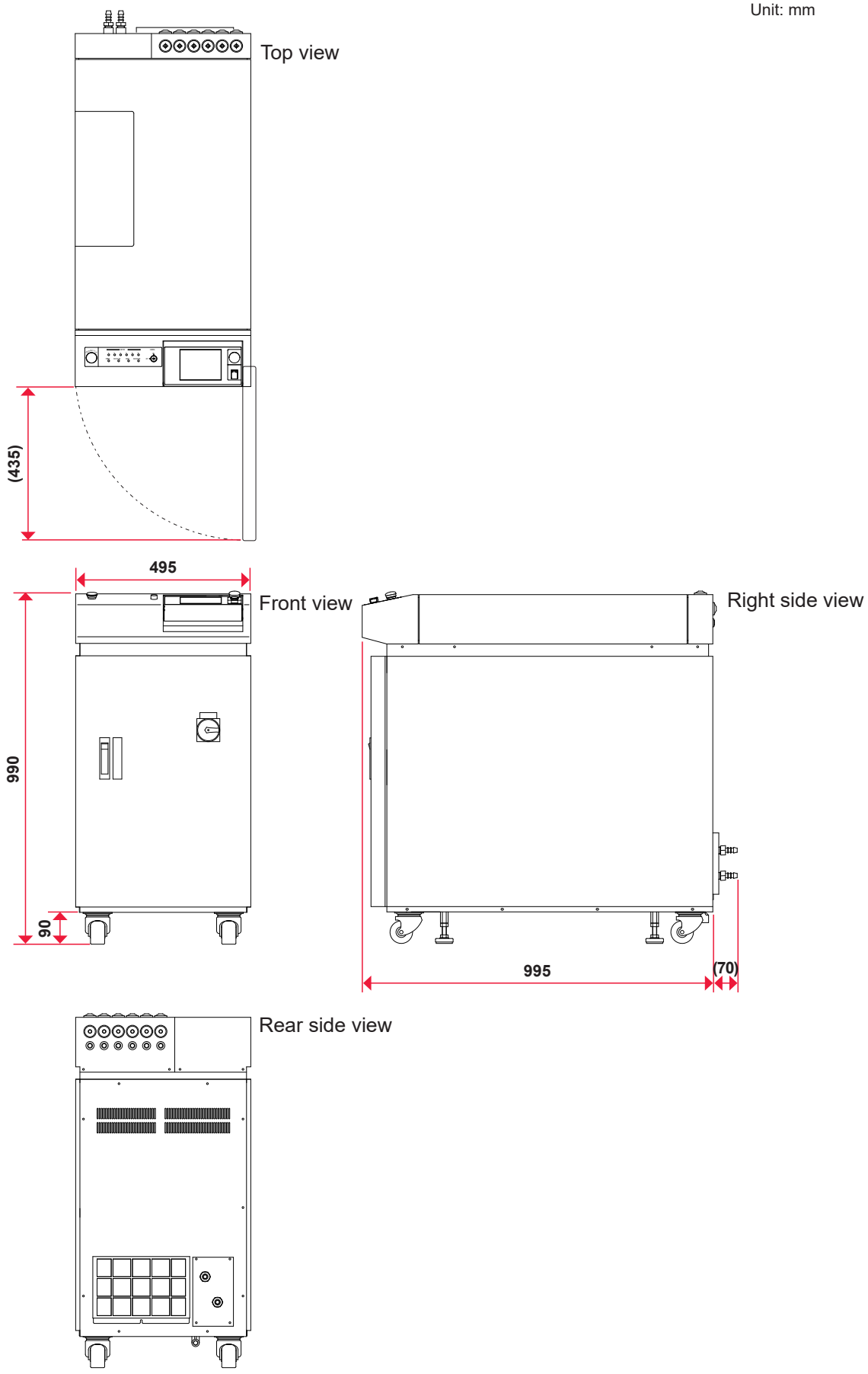
Core dia. / Model	ML-2350A	ML-2351A
SI φ 0.2mm	- (30J, 30W)	- (50J, 50W)
SI φ 0.3mm	50J, 30W (70W)	50J, 50W
SI φ 0.4mm	70J, 50W (70W)	
SI φ 0.6, 0.8, 1.0mm	70J, 70W	

⇒ Fiber of less than φ 0.4 mm is suitable for ML-2351A.

⇒ Use the SI optical fiber. The GI optical fiber cannot be used.

Dimensional Outline Drawings

Unit: mm



Available Output

The available upper-limit output depends on the setting of peak power and pulse width (laser output time ms). It is graphically shown for each model.

To obtain the maximum rated output with a short pulse width setting, it is necessary to increase the peak power or repetition. Set conditions such as the pulse width and repetition not to exceed the upper-limit output.

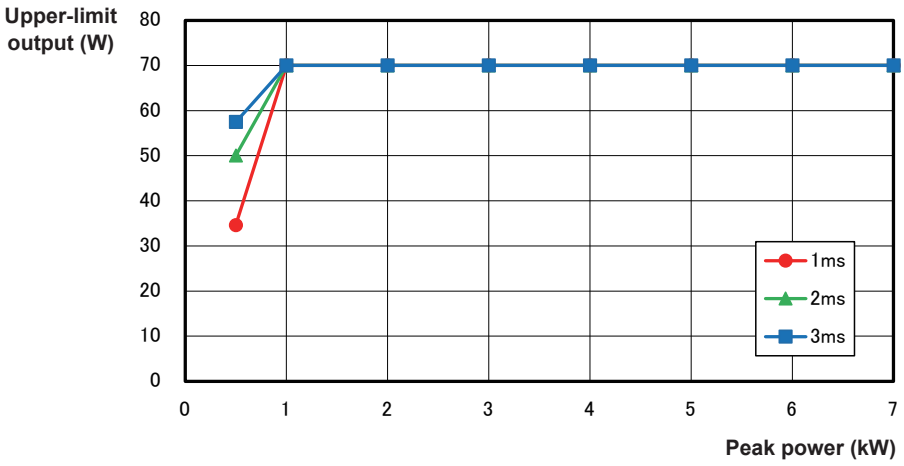
The specification for each model is as follows.

Model	ML-2350A	ML-2351A
Maximum rated output	70 W	50 W
Maximum output energy	70 J/P (Pulse width 10 ms)	50 J/P (Pulse width 10 ms)
Maximum peak power	7 kW	5 kW
Pulse width	Standard: 0.3 to 30.0 ms (0.1 ms steps) Fine setting: 0.25 to 5.00 ms (0.05 ms steps)	

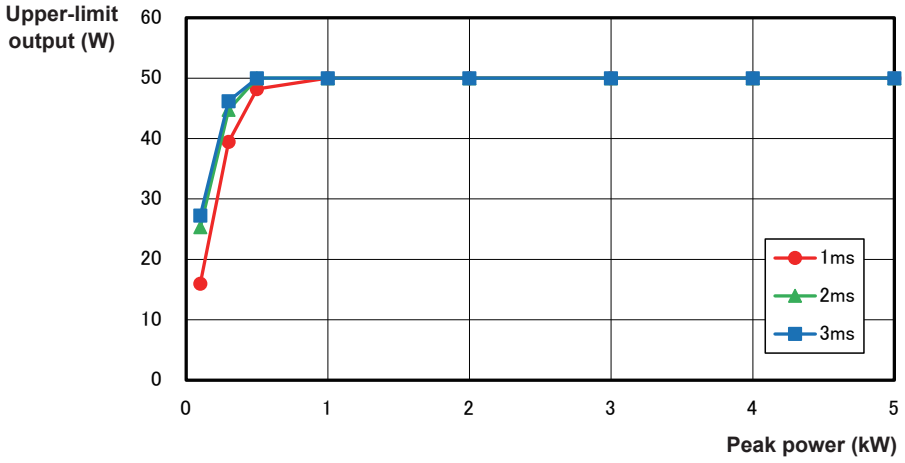
⇒ The graphical numeric value is for reference. The value changes according to each flashlamp, equipment, or set waveform.

⇒ To use the flashlamp for a longer time, we recommend the setting of 80% or less of the value shown in the graph below. The setting can be 100% of the value, but the lamp life and the replacement interval of the O-ring for YAG rod may become shorter.

ML-2350A



ML-2351A


Upper-limit output (W)
60
50
40
30
20
10
0
0
1
2
3
4
5
Peak power (kW)
1ms
2ms
3ms

Timing Chart

An example of timing chart for the case where a high voltage is supplied to this laser and laser light is output up to a monitor output is shown below. In each timing chart, the equipment operation is represented on the axis of ordinates and the lapse of time is represented on the axis of abscissas to show the change status based on changes with the lapse of time at each operation and the time required for a certain operation.

The following 5 types of timing chart are mentioned for your reference.

2-powersharing

Operation by laser controller (PANEL CONTROL)

Operation by external input signals (EXTERNAL CONTROL)

2 timesharings of 2-powersharing deliveries

Operation by external input signals (EXTERNAL CONTROL)

Repeated operation (EXTERNAL CONTROL)

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

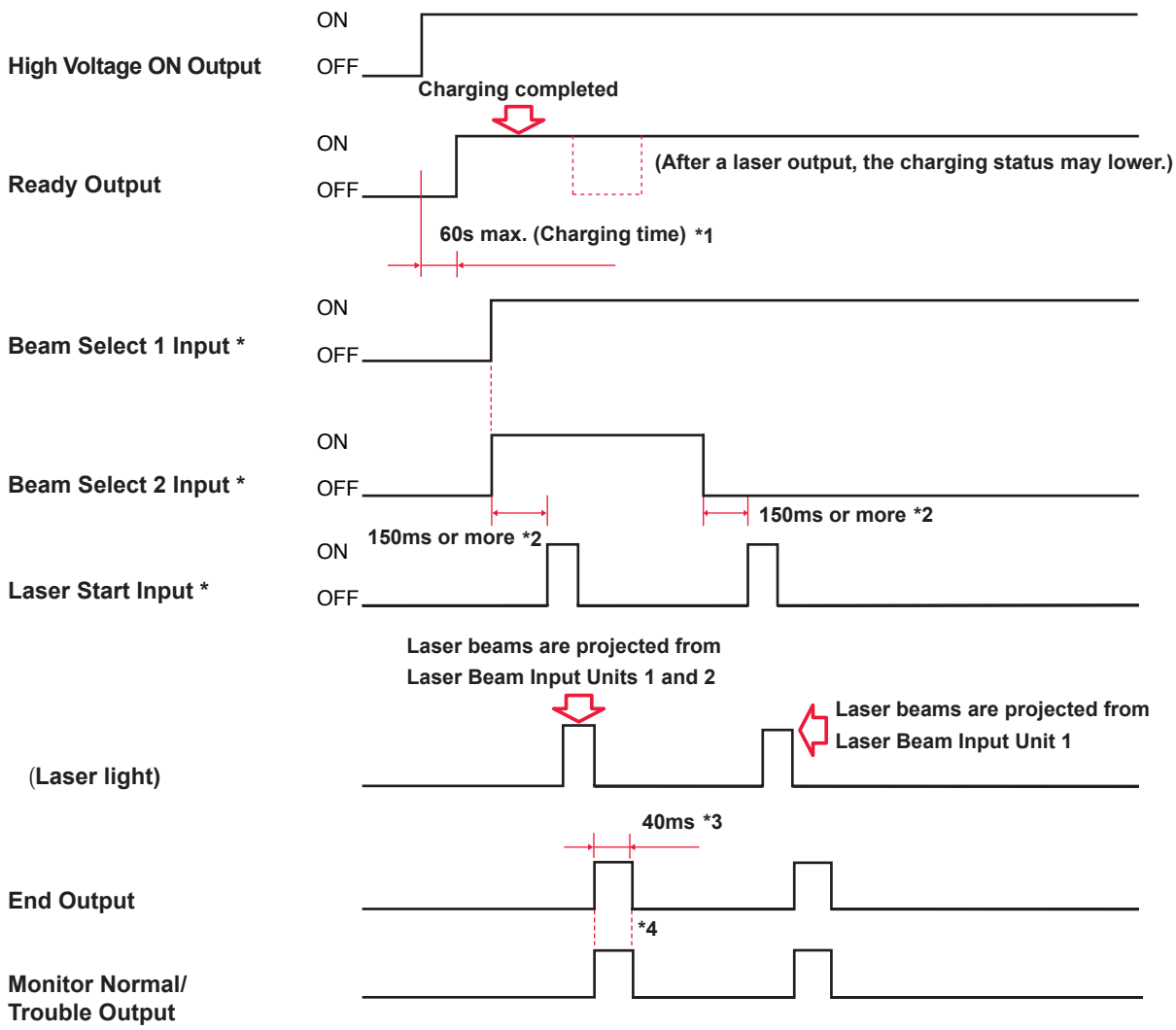
⇒ The control method is switched by putting pin No.23 of the EXT.I/O (1) connector in an open circuit or a closed circuit.
For PANEL CONTROL in which control is exerted by control panel, put this pin in an open circuit. For EXTERNAL CONTROL in which control is exerted by external input/output signals, put this pin in a closed circuit.

⇒ For the laser controller, laser light is output by pressing the LASER START/STOP button and stopped by pressing this button once again.
For external input/output signals, laser light is output by putting pin No.21 of the EXT.I/O (1) connector in a closed circuit and stopped by putting this pin in an open circuit.

2-powersharing ... Operation by laser controller (PANEL CONTROL)

The following diagram shows the lapse of time in the case where BEAM1 and BEAM2 to are set to ON on the laser controller and laser light is simultaneously output from input unit 1 and input unit 2 after the branch shutter is opened.

(*: Operation on the user side)

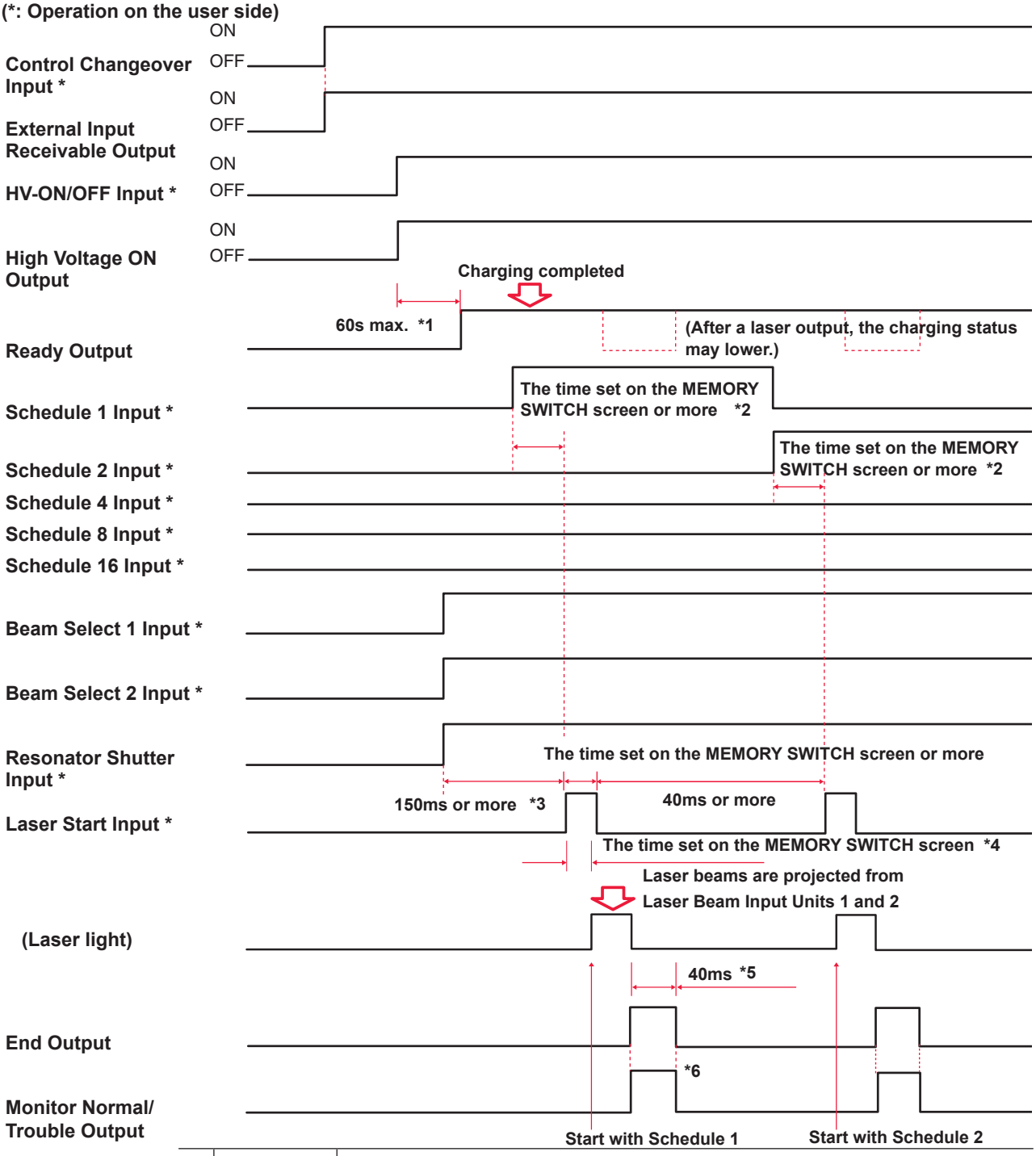


*1	60s max.	Charging time. When a high voltage is turned ON and charging is completed, the READY status is provided.
*2	150ms or more	Shutter operation time. After beam selection, a laser start input signal is input after the lapse of certain time for shutter operation.
*3	40ms	Time required for the end signal to be output after a laser output.
*4	40ms	Time required for outputting a signal to indicate whether the laser energy is within the set upper limit value (HIGH) and lower limit value (LOW) of monitor output.

2-powersharing ... Operation by external input signals (EXTERNAL CONTROL)

The following diagram shows the lapse of time in the case where a signal is sent from the PLC and schedule signal input, BEAM1 and BEAM2 are selected, and then laser light is simultaneously output from input unit 1 and input unit 2 by opening the resonator shutter.

(*: Operation on the user side)



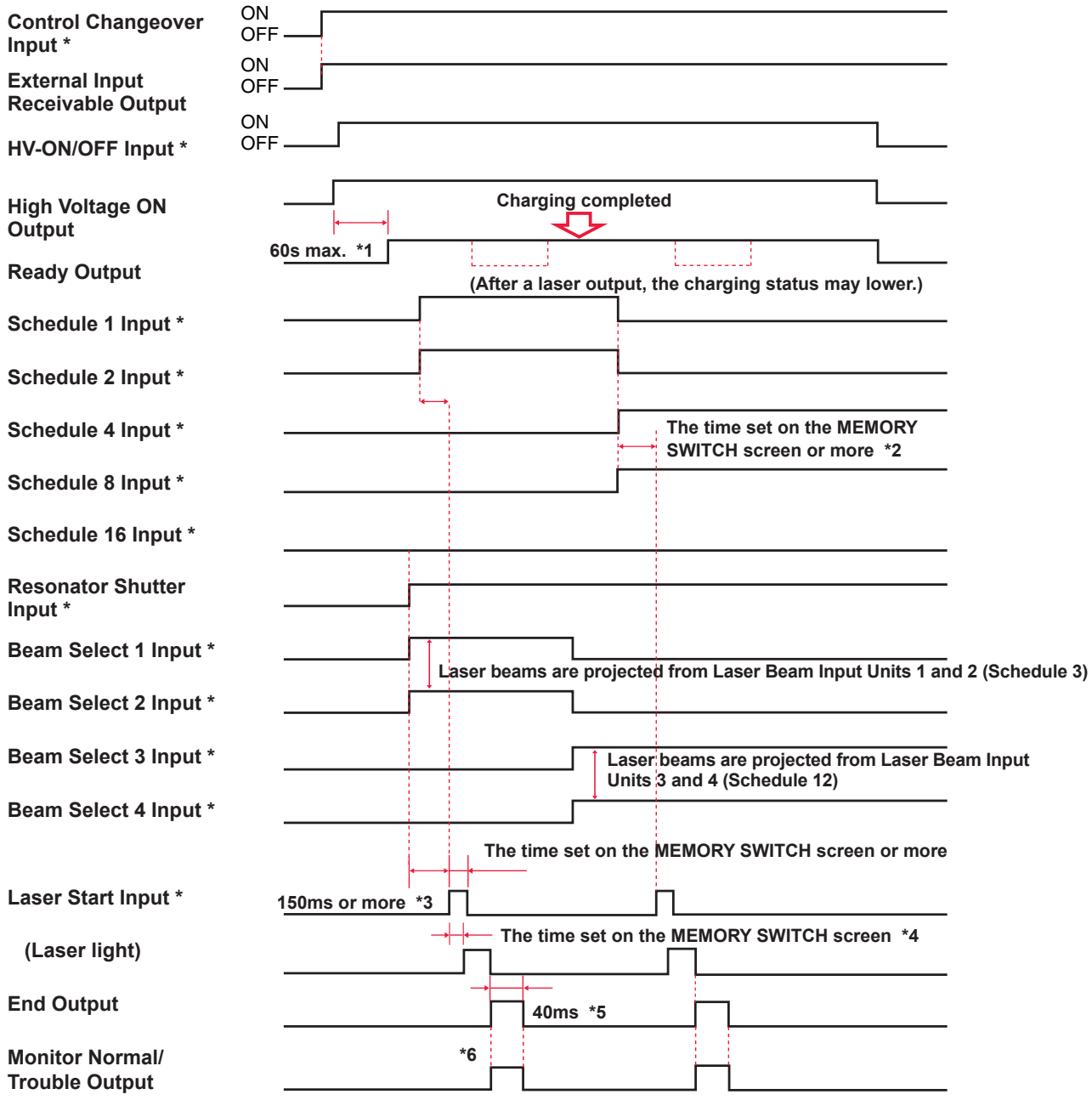
*1	60s max.	Charging time. When a high voltage is turned ON and charging is completed, the READY status is provided.
*2		Schedule signal acceptance time (time from a schedule signal input till establishment of schedules)
*3	150ms or more	Shutter operation time
*4		Laser start signal acceptance time (time from a signal input till an output)
*5	40ms	Time required for the end signal to be output after a laser output.
*6	40ms	Time required for outputting a signal to indicate whether the laser energy is within the set upper limit value (HIGH) and lower limit value (LOW) of monitor output.

In *2 and *4, the acceptance time is 16 ms but can be changed to 0.1, 4.0 or 8.0 ms on the MEMORY SWITCH screen.

2 timesharings of 2-powersharing deliveries ... Operation by external input signals (EXTERNAL CONTROL)

The following diagram shows the lapse of time in the case where a schedule signal input, BEAM1 to 4 are selected and laser light is output from input unit 1 to 4 respectively with a time difference by opening the resonator shutter.

(*: Operation on the user side)

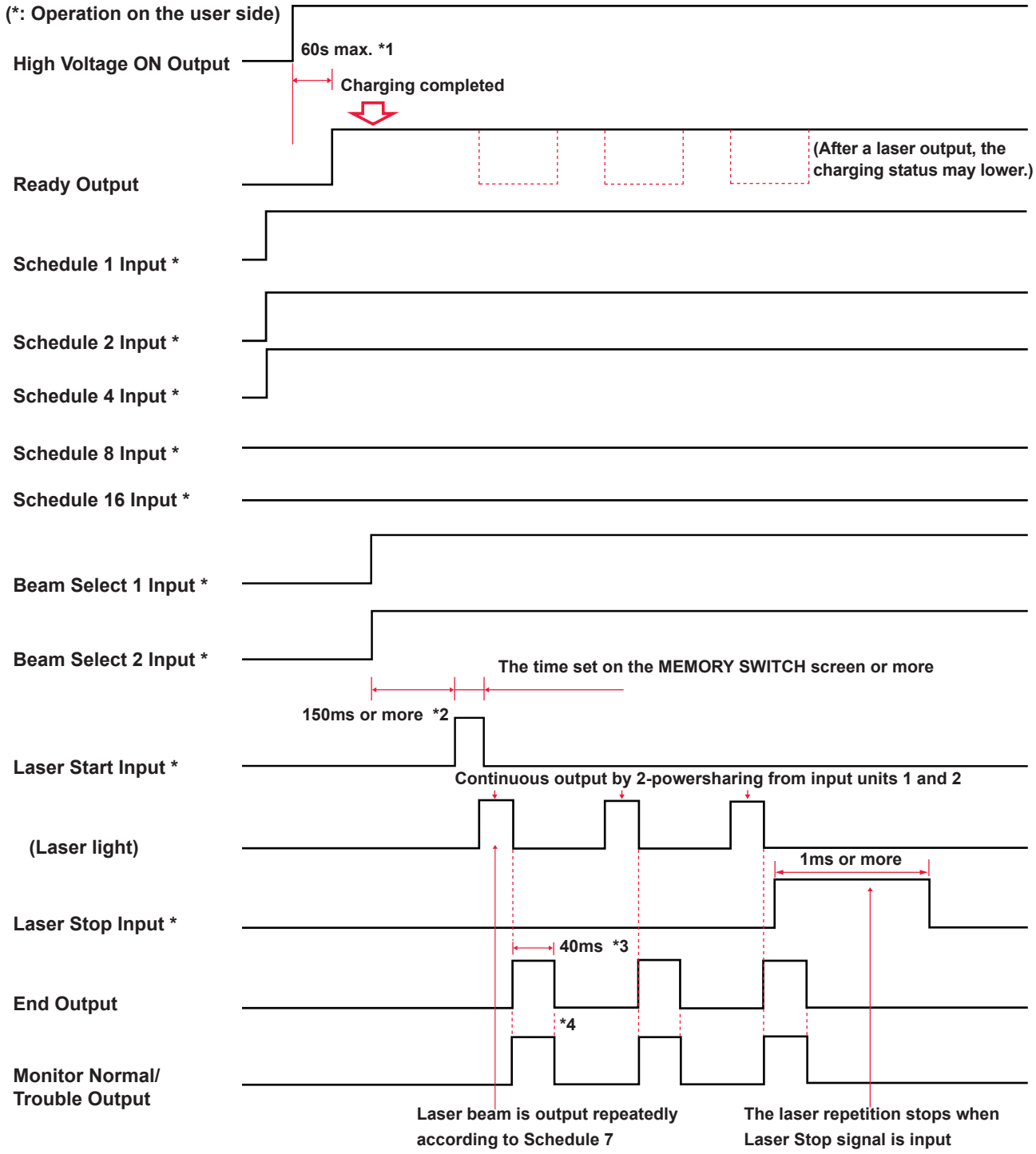


*1	60s max.	Charging time. When a high voltage is turned ON and charging is completed, the READY status is provided.
*2		Schedule signal acceptance time (time from a schedule signal input till establishment of schedules)
*3	150ms or more	Shutter operation time
*4		Laser start signal acceptance time (time from a signal input till an output)
*5	40ms	Time required for the end signal to be output after a laser output.
*6	40ms	Time required for outputting a signal to indicate whether the laser energy is within the set upper limit value (HIGH) and lower limit value (LOW) of monitor output.

In *2 and *4, the acceptance time is 16 ms but can be changed to 0.1, 4.0 or 8.0 ms on the MEMORY SWITCH screen.

Repeated operation (EXTERNAL CONTROL)

The following diagram shows the lapse of time in the case where a signal is sent from the PLC and schedule signal input, BEAM1 and BEAM2 are selected, and then laser light is simultaneously output from input unit 1 and input unit 2 by opening the resonator shutter.

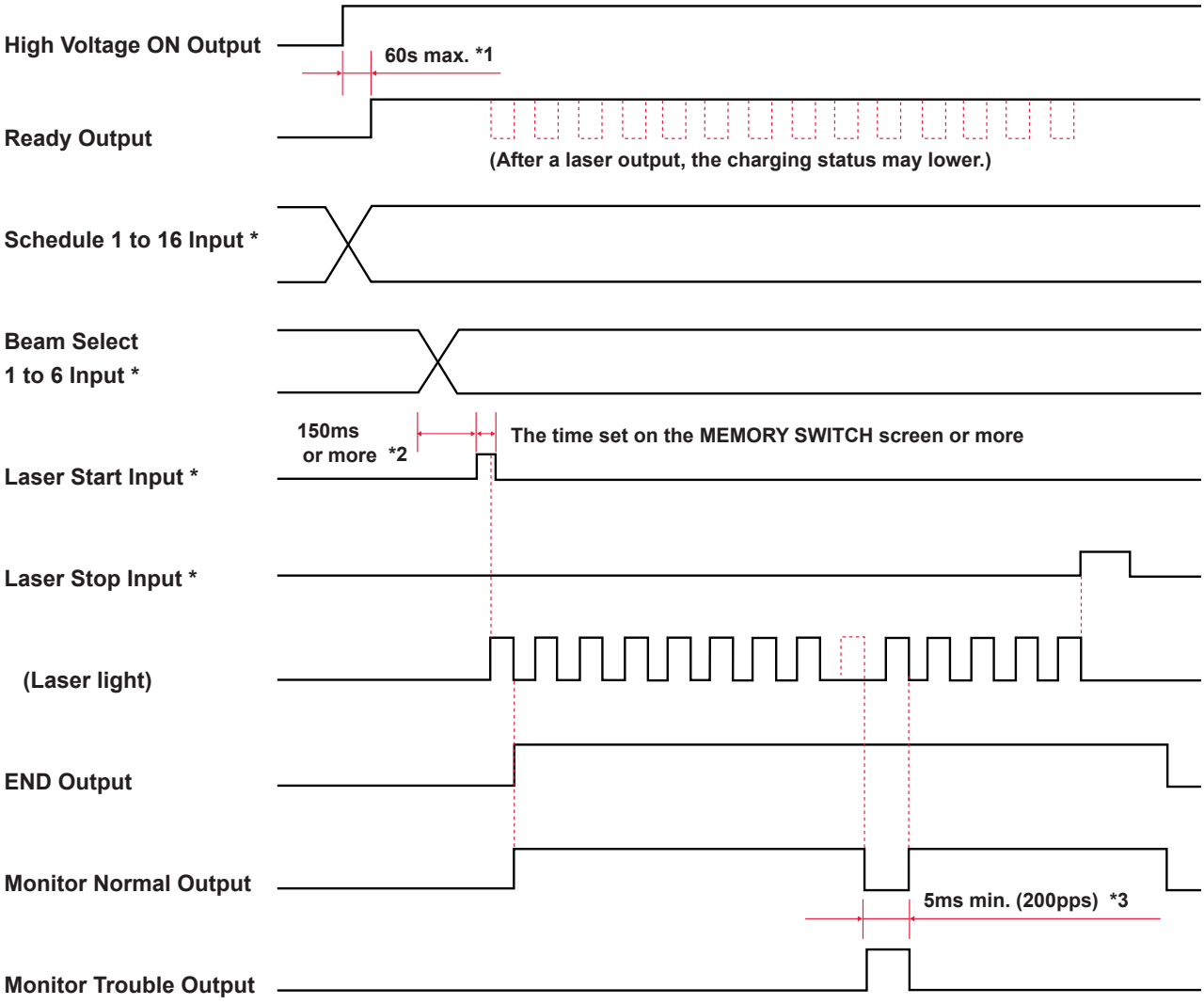


*1	60s max.	Charging time. When a high voltage is turned ON and charging is completed, the READY status is provided.
*2	150ms or more	Shutter operation time
*3	40ms	Time required for the end signal to be output after a laser output.
*4	40ms	Time required for outputting a signal to indicate whether the laser energy is within the set upper limit value (HIGH) and lower limit value (LOW) of monitor output.

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

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

(*: Operation on the user side)



*1	60s max.	Charging time. When a high voltage is turned ON and charging is completed, the READY status is provided.
*2	150ms or more	Shutter operation time
*3	5ms min.	Monitor error output time. Minimum error output time for 200 pps.

Explanation of Terminology

The following table explains the terminology related to laser welding. General terms and the terms peculiar to this laser are included. When there is any related page in this Operation Manual, the reference page is shown.

A	
ACK	Control code that is used for communication between computers. Affirmative response that is sent from the computer of transmission destination to the transmission source. Abbreviation of acknowledgement (affirmative response). → P.153
Asynchronous system	Communication system in which the transmitting timing is not matched with the receiving timing. In the synchronous system, timing information is transmitted at data transmission and the receiving side receive the data by using this timing information. In the asynchronous system, the receiving side receives only data.
B	
BCC	Control code that is used for communication between computers. Error check character that is added to check a transmission error for each block of the communication text. Abbreviation of Block Check Character. → P.153
Beamsplitter	Mirror to reflect laser light, which is incorporated in the laser oscillator section. → P.35 and P.104
Branch shutter	Shutter to cut off laser light, which is incorporated in the laser oscillator section. When the shutter is set to Open, laser light is output. → P.35 and P.88
C	
COM (Common)	Common line. This means a connecting point where the multiple points are connected to the same common point. The electric circuit includes an A contact, B contact, and Common. The common contact is connected to the A contact and B contact commonly. Abbreviation of Common.
Common	Common line. This means a connecting point where multiple points are commonly connected to the same point in the circuit or wiring. The electric circuit includes an A contact, B contact, and Common. The common contact is connected to the A contact and B contact commonly. This is abbreviated as COM.
Core diameter	External diameter of the core that is provided in the center of the optical fiber to transmit light. Its value can be determined from laser light transmission and equipment characteristics. → P.51 and P.92
CPU board	Wiring board that mounts the CPU (Central Processing Unit) to control the equipment.
D	
Data bit	Bit to indicate one-character data that is used for asynchronous communication. → P.149
Deionized water	Water in which an ion ingredient has been removed through the ion-exchange resin. For cooling water of this laser, deionized water or purified water is used. → P.44
DIP switch	Setting switch of an electronic device mounted on an electronic circuit board. The device operation is controlled by turning this switch ON or OFF. In this laser, DIP switches are mounted on the CPU board and the fiber breaking sensor board. DIP switch is an abbreviation of Dual In-line Package switch. → P.107
E	
ETX	Control code that is used for communication between computers. → P.153

Excitation	Phenomenon in which the electrons around an atom proceed from the ground status to a one-upper status. In the case of laser, excitation means that the atoms or molecules in the laser medium proceed from a low energy status to a high energy status when energy is given from the outside.
F	
FIX	Fixed waveform that is a laser light output means to be used by this laser. Laser light with a fixed waveform by up to 3 divisions in the case where output time and the output value are set in the range of the first laser and the third laser. → P.78
Fixed waveform	Laser output method by this laser. This is called FIX. Laser light with a fixed waveform by up to 3 divisions in the case where output time and the output value of each point are set in the range of the first laser and the third laser. → P.78
Flashlamp	Exciting lamp provided in the laser oscillator. When the flashlamp comes on, laser is generated by exciting the YAG rod. → P.191
FLEX	Flexible waveform that is a laser light output means to be used by this laser. Laser light with a flexible waveform in the case where output time and the output value of each point are set in the range of POINT 01 and POINT 20. → P.81
Flexible waveform	Laser light output method of this laser. This is called FLEX. Laser light with a flexible waveform in the case where output time and the output value of each point are set in the range of POINT 01 and POINT 20. → P.81
Full duplex	Communication system in which data can be sent and received simultaneously from both sides in two-way communication. The data transfer system of this laser is an asynchronous full duplex system. → P.149
G	
GI	Optical fiber type. Abbreviation of Graded Index. The GI type means one of multi-mode optical fibers (MMF: Multi Mode Optical Fiber) in which the refractive index distribution in the core changes moderately. Index means the refractive index. Usually, the model for this laser is the SI (Step Index) type. → P.68
Grounding	Electrical connection between an electric device and the ground. This is also called earth or ground.
Grounding work	Specified in Article 18 "Interpretation of Technical Standard of Electric Equipment." The grounding work for device connected to a low-voltage circuit of 300 V or less is performed in compliance with class D, and that of more than 300 V is performed in compliance with class C. → P.39
Guide light	Auxiliary light to check the laser light irradiating position and make a positional adjustment. Light with a wavelength of 380 nm to 780 nm that can be seen by man. This is also called visible laser. In this laser, guide light is output by guide light oscillator. → P.35
H	
Harmonic	Waveform having 3 to 40 times of frequency of the basic frequency (50/60 Hz). → P.47
I	
Input unit	Unit to transmit laser light to the optical fiber. → P.22 and P.51
Interlock	Circuit to prevent hazards, which stops the machine operation when a material comes close to a place where a hazardous unit or equipment is provided.
Ion-exchange resin	Synthetic resin to exchange ions in media (mainly water) in contact. In this laser, this resin removes the ions that are generated as cooling water is deteriorated, in order to keep the cleanliness. → P.184

L	
L	Line terminal. This is a terminal to be connected to a line conductor of the external circuit. Abbreviation of Live. → P.47
Laser	LASER is an abbreviation of Light Amplification by Stimulated Emission of Radiation, which is light artificially generated by laser oscillator. Laser is classified into solid laser, liquid laser, and gas laser by medium. YAG Laser is typical solid laser.
Laser chamber	This is a laser oscillation vessel. It includes a flashlamp and a YAG rod. The laser chamber is a part of the laser oscillator. → P.35
Laser light	Light artificially generated by laser oscillator. This laser light is widely used for electronic devices, optical communication, medial treatment, metal working, and other fields. As a matter of feature, laser light goes straight, its wavelength is fixed and the phase (wave peak and hollow) is the same, so high energy can be obtained by concentrating light to one point.
Laser power feedback	Control function that is adopted for this laser. The measured value and average power of output laser energy is returned to the input side so that they can be checked immediately after a laser output.
Laser safety supervisor	Person who is responsible for laser safety management, having an enough knowledge to execute laser hazard assessment and safety management. Regarding the facilities or place in which the laser product exceeding class 3B of JIS C 6802 "Safety Standard for Laser Products" is operated, it is necessary to appoint the laser safety supervisor and prepare a management area. Since most laser welder comes under class 4 of the highest hazard, the laser safety supervisor must be appointed. → P.10
Leakage breaker	Safety device to shut off the circuit at detection of a leakage current that flows from the power supply to the ground.
N	
NAK	Control code that is used for communication between computers. Negative response that is sent from computer of the transmission destination to the transmission source. Abbreviation of Negative Acknowledgement. → P.153
Nd: YAG laser	Name of laser that is generated by adding neodymium (Nd) to Yttrium-Aluminum-Garnet crystals. Laser light with a wavelength of 1064 nm that is generally called YAG laser is oscillated. YAG is an abbreviation of Yttrium-Aluminum-Garnet.
O	
Optical fiber	Cable to transmit light that is made of quarts glass or thin plastic fiber. This cable consists of a core of the center and a clad covering the surroundings, and light is propagated in the core. The mode is classified into 2 types, namely, multi mode and single mode by the number of light propagation modes, and the multi-mode optical fiber is divided into step index (SI) and graded index (GI) by refractive index distribution of the core.
Oscillator	In the laser welder, the oscillator means a unit to amplify and oscillate laser light. This unit consists of a laser medium, excitation source, amplifier, etc. Laser is amplified and oscillated when the laser medium is excited by excitation source.
Output unit	Unit to output the laser light transmitted by optical fiber to the workpiece. The optical fiber connected to the input unit is connected. → P.22 and P.53
P	
Parity	Method to check whether data is correctly transmitted or received in data communication. A data error is detected by using bit information or parity bit that is added to the data. Parity means Odd and Even.
Parity bit	Data that is added to the source data to detect an error in data communication. The receiving side collates with the parity bit by checking whether the number of 0s or 1s in the obtained bit train is odd or even. When an error is found, data is retransmitted or processing is interrupted. → P.149

PE	Protective earthing terminal. This is a terminal that is provided to ground a device. Abbreviation of Protective Earth. → P.47
Peak power	At laser welding, the peak power means the energy amount per time (value resulting from dividing the pulse energy by pulse width) and its unit is watt (W).
Peak value	Laser output peak value. "PEAK POWER" value that is set on the SCHEDULE screen in this laser. → P.65
Photo MOS relay	Full solid relay that adopts a light emitting diode on the driving side and MOS (Metal-Oxide Semiconductor) FET (Field-Effect Transistor) for the contact. → P.134
PLC	Device that exerts sequence control by executing the programmed contents of control in sequence. This is often called Sequencer (product name of Mitsubishi Electric Corporation). Abbreviation of Programmable Logic Controller.
Powersharing	Laser light delivery specification. Single laser light is split into multiple beams by beamsplitter so that laser light is output simultaneously to multiple optical fibers. → P.104
pps	Number of pulses per second. Abbreviation of pulse per second.
Protective glasses	Protective glasses that the operator puts on to protect the eyes from laser light. The protective glasses are divided into some types by wavelength of laser light.
Pulse width	Time during which laser light is irradiated.
Purified water	Water that has been purified by distillation, filtration, or deionization. Water whose electric resistivity is 1 to 3 MΩ-cm. For cooling water of this laser, deionized or purified water is used.
R	
Rated current	Maximum effective current value when a current can be continuously output. This value indicates that it is prohibited to cause a current to continuously flow exceeding this level.
Remote interlock	Interlock function to shut off the laser output in an emergency as a means for using the laser device safely. In this laser, the REMOTE INTERLOCK connector is connected to the door of the room so that laser light may be shut off when the door is opened. → P.126
Resistivity	Electric resistance generally used as a scale to indicate the hardness of current flow for a material. Its unit is ohm (Ω). The value that indicates this resistance by unit volume (1 cm x 1 cm x 1 cm) is volume resistivity and its unit is ohm centimeter (Ωcm).
Resonator mirror	Mirror composing resonators in the laser oscillator section. The light that has been excited by laser chamber is amplified between 2 resonator mirrors into a laser beam. → P.35
Resonator shutter	Resonator provided in the laser oscillator section. When this shutter is closed, no laser light is output though the flashlamp comes on. → P.35
RS-232C	Serial communication standard that is standardized by Electric Industries Alliance (EIA) of the United States. This is used for a connection between a data line terminator such as MODEM and a data terminal unit such as PC. Many different devices are based on this standard, so that this standard is used for various fields. Abbreviation of Recommended Standard-232C. → P.148
RS-485	Serial communication standard that is standardized by Electric Industries Alliance (EIA) of the United States. RS-485 meets the requirement for multi-connection for multiple units of up to 32 units by bus type multi-point connection. Abbreviation of Recommended Standard-485. → P.148
RxD	Pin for received data out of signal lines of the communication connector. → P.148
S	
SCHEDULE	This word means a laser light output schedule in this laser. Thirty-two types of SCHEDULE can be set and each schedule can be registered with a SCHEDULE number. → P.78

Sequencer	A type of PLC (Programmable Logic Controller) that exerts sequence control by executing the programmed contents of control, being a product name of Mitsubishi Electric Corporation.
SI	Optical fiber type that is used in this laser. Abbreviation of Step Index. The SI type is one of multi-mode optical fibers (MMF: Multi Mode optical Fiber) in which the refractive index distribution in the core is uniform. The index means the refractive index. → P.68
Single phase	Electric current whose magnitude and direction change periodically, having the same phase. This single phase is used as a 100 V power supply for electric lamps and plug sockets.
sq (square)	Unit that represents a sectional area of cable. Square millimeter. → P.47
Start bit	Bit to indicate the beginning of data in the asynchronous communication mode in which synchronization is performed for each data such as control character and symbol. The bit to indicate a separation between characters is called stop bit. → P.149
STX	Control code that is used for communication between computers. → P.153
Surge	Abnormal overvoltage or overcurrent applied momentarily to the electric circuit. → P.47
T	
3-phase	Current composed of a set of 3 alternating currents with a phase difference of 120º. This current is mainly used for a power of business use.
Timesharing	Laser light delivery specification. When the incorporated timesharing unit is operated, laser light is output to a single optical fiber. This function is provided in the timesharing specification of this laser. → P.104
Timesharing unit	Unit that mounts mirrors to reflect laser light. Laser light is output to the selected optical fiber when the mirror is operated. This unit is incorporated in the laser oscillator section according to the timesharing specification of this laser. → P.35
TxD	Pin for send data out of signal lines of communication connector. → P.148
U	
Ultra pure water	Water whose purity is unlimitedly close to the ideal water H_2O with a purity of 100%. This water is treated by a combination of strictly quality-controlled ion-exchange resin, active carbon, membrane filter, UF, UV, etc. As standard, when the resistivity is 16 to 17 Ω-cm or more, the water is called pure water.
Y	
YAG rod	This means a laser medium that is excited by flashlamp, which is composed of a transparent crystal which is made by adding Neodymium (Nd3+) to Yttrium-Aluminum-Garnet. This rod is inserted in the laser chamber in this laser. → P.22 and P.35
W	
Work distance	Distance from the laser light output position to the target workpiece for laser welding.

Output Schedule Data Entry Table [FORM:FIX] - 1

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE															
				00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
↑SLOPE	TIME	00.0 - 30.0	ms																
FLASH1	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
COOL1	TIME	00.0 - 30.0	ms																
FLASH2	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
COOL2	TIME	00.0 - 30.0	ms																
FLASH3	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
↓SLOPE	TIME	00.0 - 30.0	ms																
PEAK POWER **ML-2350A:** **ML-2351A:**		 00.00 - 07.00 00.00 - 05.00	kW																
REPEAT		000 - 200	pps																
SHOT		0000 - 9999																	
ENERGY	HIGH	000.0 - 999.9	J																
	LOW	000.0 - 999.9	J																

NETWORK # _____

Output Schedule Data Entry Table [FORM:FIX] - 2

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE															
				16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
↑SLOPE	TIME	00.0 - 30.0	ms																
FLASH1	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
COOL1	TIME	00.0 - 30.0	ms																
FLASH2	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
COOL2	TIME	00.0 - 30.0	ms																
FLASH3	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
↓SLOPE	TIME	00.0 - 30.0	ms																
PEAK POWER **ML-2350A:** **ML-2351A:**		 00.00 - 07.00 00.00 - 05.00	kW																
REPEAT		000 - 200	pps																
SHOT		0000 - 9999																	
ENERGY	HIGH	000.0 - 999.9	J																
	LOW	000.0 - 999.9	J																

NETWORK # _____

Output Schedule Data Entry Table [FORM:FLEX] - 1

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE (Enter No. optionally.)															
POINT 01	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 02	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 03	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 04	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 05	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 06	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 07	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 08	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 09	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 10	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 11	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 12	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 13	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 14	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 15	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																

Output Schedule Data Entry Table [FORM:FLEX] - 2

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE (Enter No. optionally.)															
POINT 16	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 17	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 18	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 19	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
POINT 20	TIME	00.0 - 30.0	ms																
	POWER	000.0 - 200.0	%																
PEAK POWER **ML-2350A:** **ML-2351A:**		 00.00 - 07.00 00.00 - 05.00	kW																
REPEAT		000 - 200	pps																
SHOT		0000 - 9999																	
ENERGY	HIGH	000.0 - 999.9	J																
	LOW	000.0 - 999.9	J																

NETWORK # _____

Output Schedule Data Entry Table [SEAM] - 1

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

Output Schedule Data Entry Table [SEAM] - 2

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE															
				16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
POINT 11	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																
POINT 12	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																
POINT 13	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																
POINT 14	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																
POINT 15	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																
POINT 16	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																
POINT 17	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																
POINT 18	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																
POINT 19	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																
POINT 20	SHOT	0000 - 9999																	
	POWER	000.0 - 150.0	%																

NETWORK # _____

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