Fiber Laser Welder

LF1000A

OPERATION MANUAL

990-557

MIYACHI
ML-6810A

Thank you for purchasing the Miyachi Unitek Fiber Laser Welder LF1000A.
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.

EC Declaration of Conformity

CE

MIYACHI CORPORATION

EC Declaration of Conformity

The company/manufacturer:	***MIYACHI CORPORATION*** ***95-3, Futatsuka, Noda-City, 278-0016 JAPAN***

Herewith declares in his own sole responsibility conformity of the product

Designation:	***Fiber Laser Welder***
Types/Serial Number, etc.:	***ML-6810A / LF1000A***

With applicable regulations below

EC Directive:	***Machinery Directive 2006/42/EC*** ***EMC Directive 2004/108/EC*** ***Low Voltage Directive 2006/95/EC***

Harmonized European/International Standards applied:

ISO12100-1:2003 ;ISO12100-2:2003 ;ISO14121:1999 ;
EN55011Group2 ClassA:1998 +A1:1999 +A2:2002;
EN 50178:1997 ;EN 60204-1:2006 ;EN 60825-1:2007 ;
EN 61000-6-2:2001 ;

Importer Distributor in EU: (please place distributor/importer stamp here)	***MIYACHI EUROPE CORPORATION*** Linbergstrasse 1, D-82178 Puchheim, GERMANY Tel: + 49 8983 940323

Division:	***MIYACHI CORPORATION***
Noda-City/Japan 2009-11-26 Place and Date	Shinichi Orikasa/Director Production Name/Signature/Position

Note: This Declaration certifies conformity with the above mentioned Directive(s), but gives no assurances of properties within the meaning of the Law concerning product liability and GPSG. It becomes invalid if any technical or other modification are carried out without manufacturers consent.

How to Use This Document

This document describes precautions for operating and using Miyachi Unitek Fiber Laser Welder LF1000A.

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

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

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.

Revision History

Revision	Date	Prepared	Checked	Approved	ECO
A	2/2/2010	M.Green	S. Loveland	D. Cielinski	38642

Organization of This Document and Its Contents

Introduction:	Explains the outline and functions of the laser. Regarding the Fiber Laser, this part explains the basic configuration and functional outline of this product including options so that the user knows the laser configuration and equipment composition, and also the name and function of each component section.
Installation and Preparation:	Explains the installation of the laser and preparatory operations such as connections of its respective sections.
Operation:	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:	Explains how to perform maintenance and how to handle trouble.
Appendices:	For reference materials, specifications, dimensional outline drawing, timing chart, definition of memory switch, and list of terminology are available. In the output schedule data entry table, the user can enter registered laser output schedule data for use.

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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 item, since all of precautions are important for safety.

Warning Symbol Meanings

⚠ **DANGER**	Denotes operations and practices that may imminently result in serious injury or loss of life if not correctly performed.
⚠ **WARNING**	Denotes operations and practices that may result in serious injury or loss of life if not correctly performed.
⚠ **CAUTION**	Denotes operations and practices that may result in personal injury or damage to the equipment if not correctly performed.
⊘ ⊘ ⊘ ⊘	Denotes "prohibition." These 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 the source voltage of 3-phase 200 V to 400 V AC is applied to the Laser high voltages are present 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 operations 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. This laser is a class IV device as defined by the CDRH.

⚠ WARNING

Wear protective glasses.
Be sure to wear protective glasses while using the Laser. Even if you wear them, you may lose your sight if the laser beam enters your eyes directly.

Do not look into or reach into the light path while the LD is turned on.
Fluorescence Emission can cause burns or blindness.

Do not expose your skin to the laser beam.

Your skin may be severely burned.

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 and/or 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 causing electric shock and fire. If any part needs to be repaired, consult Miyachi Unitek Corp. or your distributor.

Stop the operation if any trouble occurs.

Continuous operation after occurrence of trouble such as a burning smell, abnormal sound, abnormal heat, smoke, etc. can cause electric shock and/or fire. If such a trouble occurs, immediately consult Miyachi Unitek Corp. 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 beam block.

The laser beam is dangerous to human bodies. Prevent emission through the air by using a beam block (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. Fire or electric shock may 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 which 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 heated 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.

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, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection/Replacement" on page 171.
- 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 break.
- Operate the switches and buttons one at a time. If two or more of them are operated at a time, the Laser may not work correctly 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 (R100 mm) or apply any forms of shock to it.

* For details, refer to the following standards.

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

In compliance with IEC Standards IEC60825-1:2007 “Safety of laser products Part1: Equipment Classifications, requirements and use’s guide when integrated with appropriate safety enclosure.” The user is responsible for ensuring that the overall system conforms to IEC60825-1:2007

For Transportation

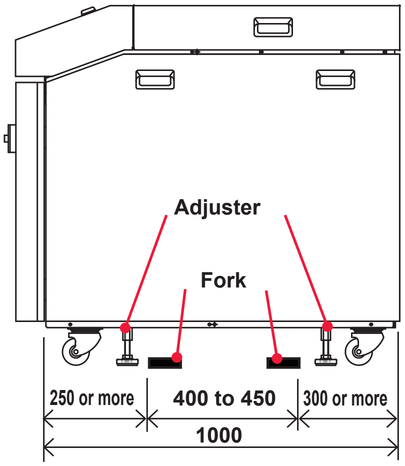
When transporting the laser, observe the following precautions to avoid hazards.

- 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 500 kg allowable load.
- Retract the level adjuster fully when transporting the Laser.

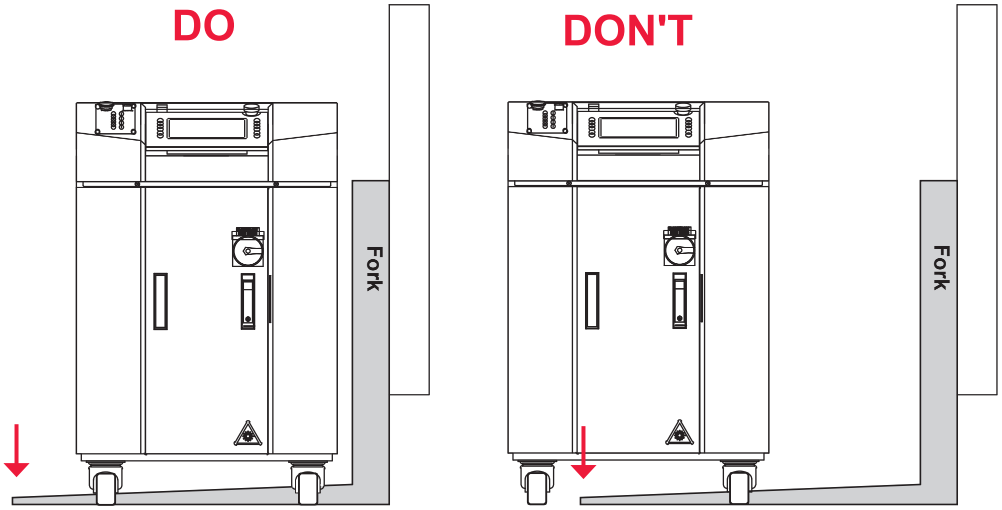
Precautions for using a fork lift

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 secure it horizontallyl.

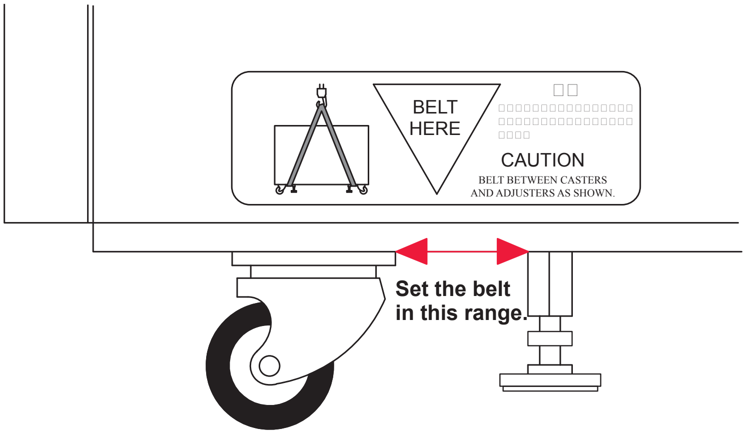


Figures below show an example; insert the forks fully until the points appear from under the Laser.

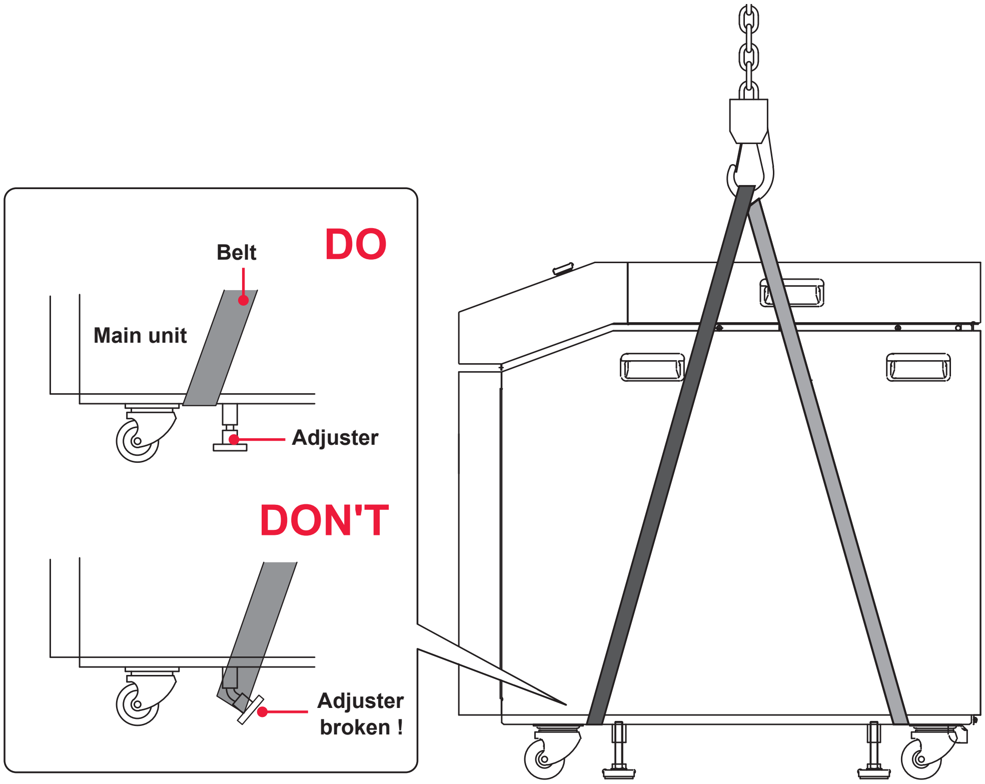


Precautions for using a crane

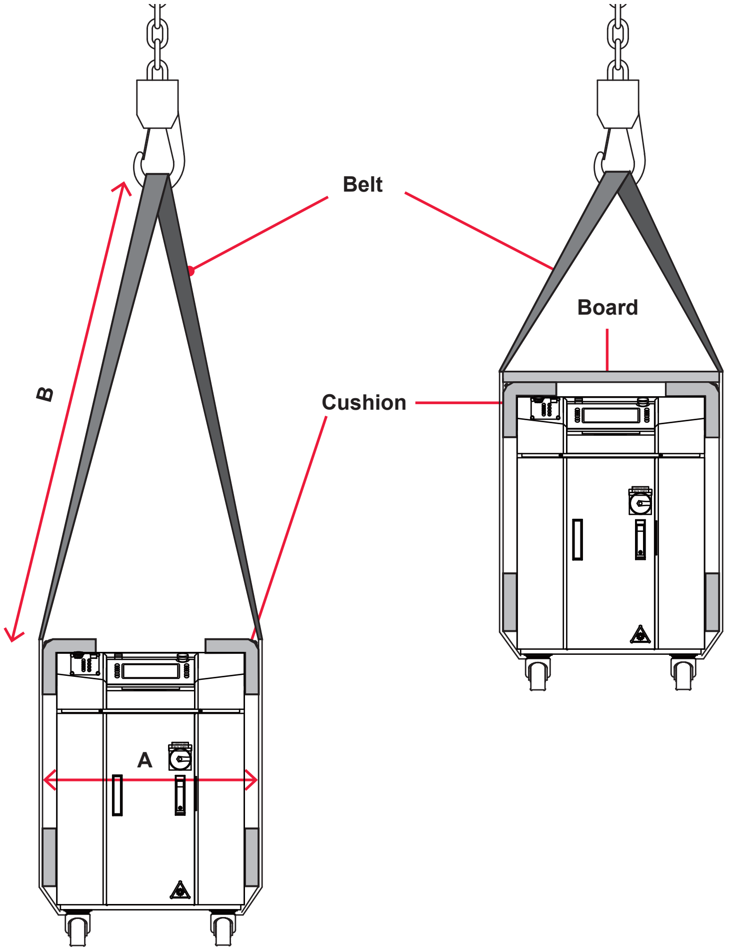
- When lifting the Laser, belt it between the caster and level adjuster observing a “BELT HERE” label.


BELT
HERE
CAUTION
BELT BETWEEN CASTERS
AND ADJUSTERS AS SHOWN.
Set the belt
in this range.

- Use two belts together.
- During transportation, keep the Laser horizontal.
- Make sure that the adjuster is not belted.

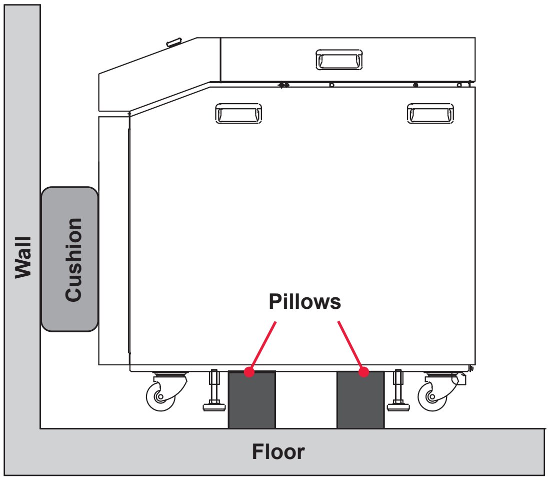

Belt
DO
Main unit
Adjuster
DON'T
Adjuster
broken !

- For transportation using a crane, insert a buffer material such as blanket, sponge, or 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.

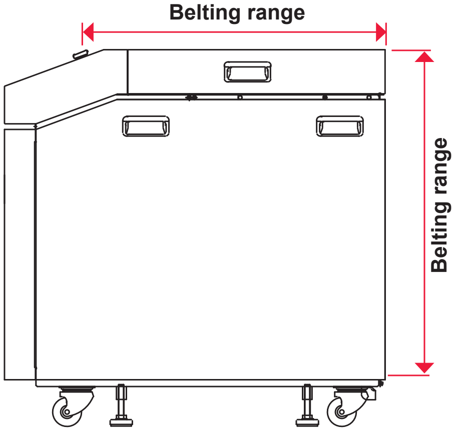


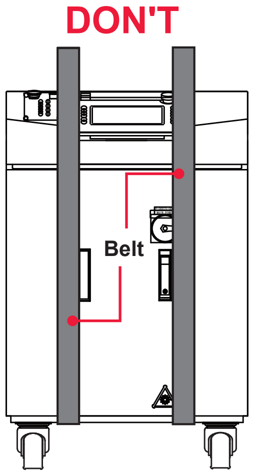
Precautions for transportation

- Fix it firmly using belts, cushions, etc., to prevent a fall, or 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 cushions such as timber between the bottom of the Laser and floor to balance the Laser. Position these cushions with respect to the forks of lift truck.



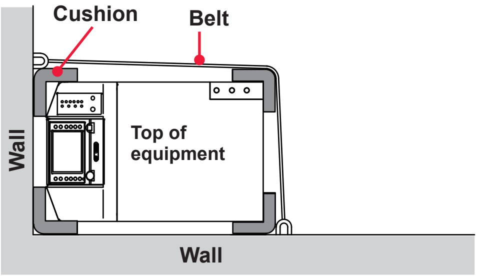
- Set the belt for fixing the laser welder within the effective range of belt setting shown in the following figure. If the belt is set from the lower part of the front side, the front door may be out of position or deformed. Avoid setting the belt in this way.

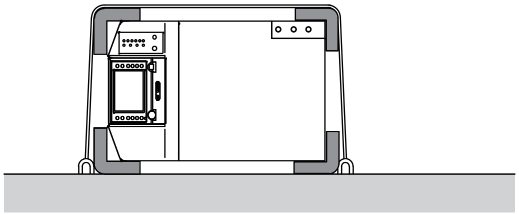

Belting range
Belting range

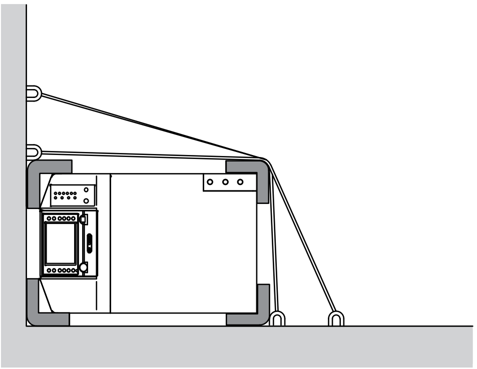


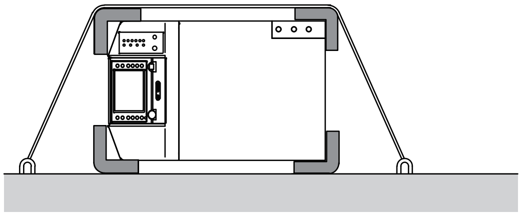
- Put the laser welder in close contact with the two surfaces of floor and wall and fix it securely with a belt. Be sure to use cushion between the Laser and belt not to hurt the Laser.

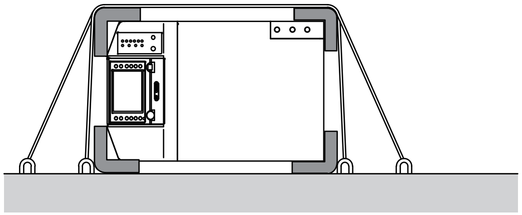
Example belting (Top view)


Cushion
Belt
Wall
Top of equipment
Wall







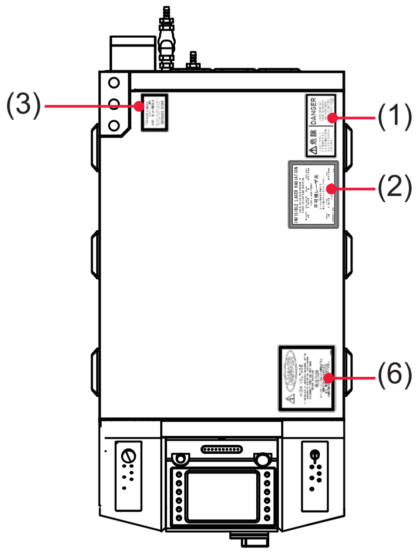


* The wall in the above Figures may be replaced with a plank or rod as far as it can support the Laser.

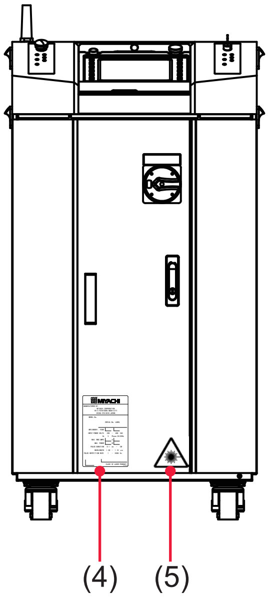
- When it is expected that the Laser may bounce during transportation, belt the Laser longitudinally.

Sticking Warning/Danger Labels

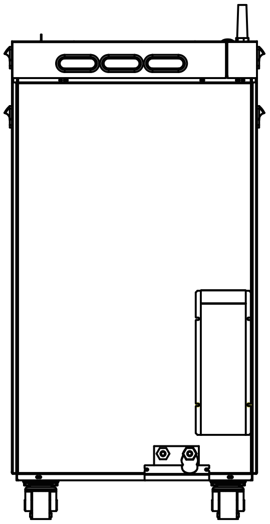
Warning/Danger labels are stuck on the laser. Read the precautions provided on each label for correct use. The numbers correspond to the label figure numbers on the next page.



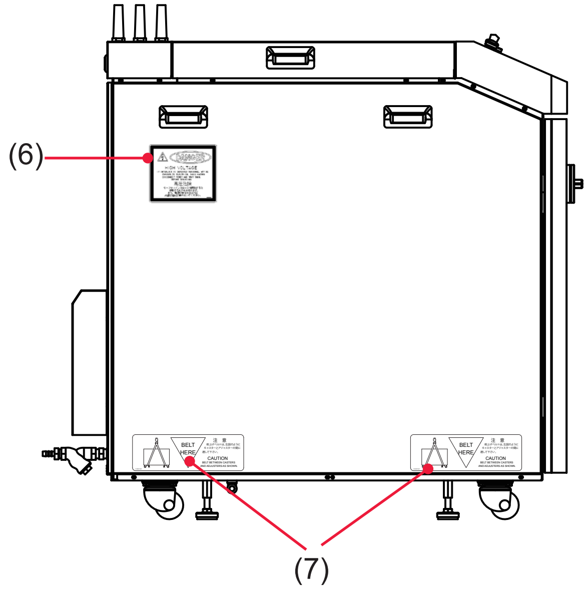
Top view



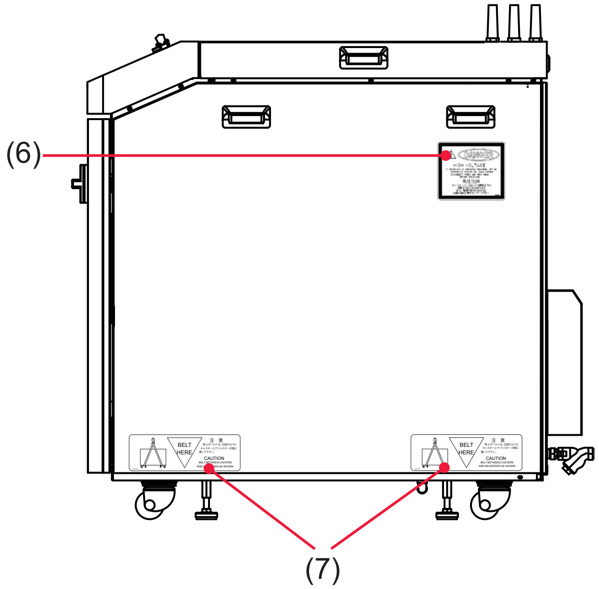
Front view



Rear view

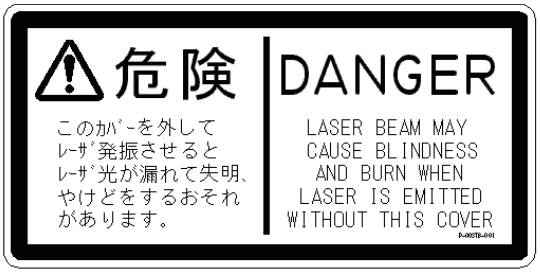


Left side view



Right side view

(1)



危険

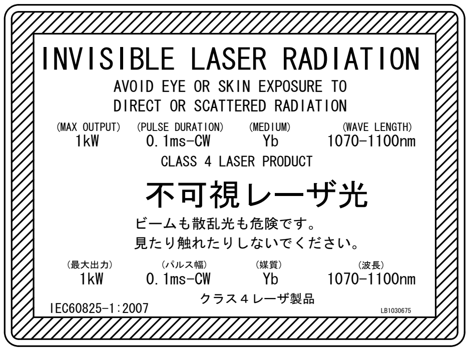
このカバーを外して
レーザ発振させると
レーザ光が漏れて失明、
やけどをするおそれ
があります。

DANGER

LASER BEAM MAY
CAUSE BLINDNESS
AND BURN WHEN
LASER IS EMITTED
WITHOUT THIS COVER

P-00378-001

(2)



INVISIBLE LASER RADIATION

AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION

(MAX OUTPUT)	(PULSE DURATION)	(MEDIUM)	(WAVE LENGTH)
1kW	0.1ms-CW	Yb	1070-1100nm

CLASS 4 LASER PRODUCT

不可視レーザ光

ビームも散乱光も危険です。
見たり触れたりしないでください。

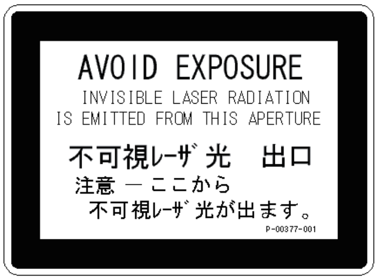
(最大出力)	(パルス幅)	(媒質)	(波長)
1kW	0.1ms-CW	Yb	1070-1100nm

クラス４レーザ製品

IEC60825-1:2007

LB1030675

(3)



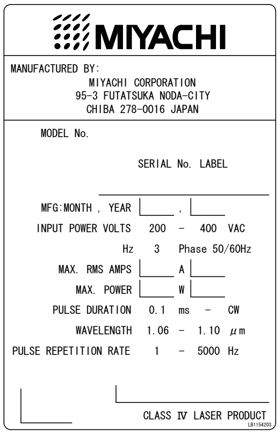
AVOID EXPOSURE

INVISIBLE LASER RADIATION
IS EMITTED FROM THIS APERTURE

不可視レーザ光　出口
注意 ― ここから
不可視レーザ光が出ます。

P-00377-001

(4)



MIYACHI

MANUFACTURED BY:
MIYACHI CORPORATION
95-3 FUTATSUKA NODA-CITY
CHIBA 278-0016 JAPAN

MODEL No.

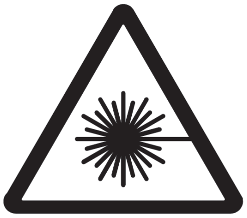
SERIAL No. LABEL

MFG:MONTH , YEAR ____ , ____
INPUT POWER VOLTS 200 - 400 VAC
Hz 3 Phase 50/60Hz
MAX. RMS AMPS ____ A ____
MAX. POWER ____ W ____
PULSE DURATION 0.1 ms - CW
WAVELENGTH 1.06 - 1.10 μm
PULSE REPETITION RATE 1 - 5000 Hz

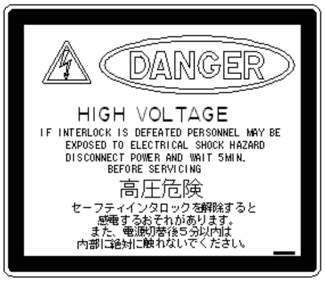
CLASS Ⅳ LASER PRODUCT

LB1154203

(5)



(6)



DANGER

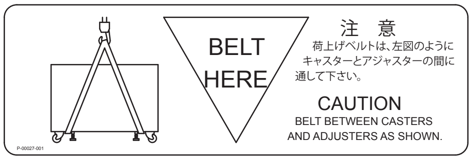
HIGH VOLTAGE

IF INTERLOCK IS DEFEATED PERSONNEL MAY BE
EXPOSED TO ELECTRICAL SHOCK HAZARD
DISCONNECT POWER AND WAIT 5MIN.
BEFORE SERVICING

高圧危険

セーフティインタロックを解除すると
感電するおそれがあります。
また、電源切替後5分以内は
内部に絶対に触れないでください。

(7)



注　意

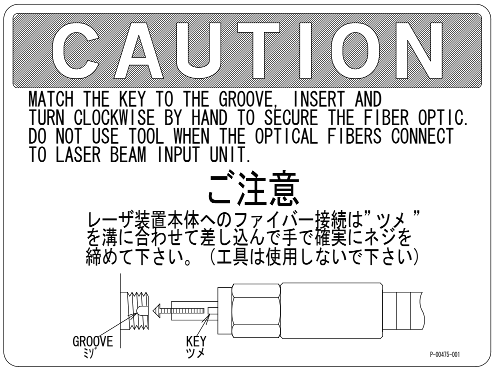
荷上げベルトは、左図のように
キャスターとアジャスターの間に
通して下さい。

CAUTION

BELT BETWEEN CASTERS
AND ADJUSTERS AS SHOWN.

P-00027-001

The following labels are stuck inside of the laser.



CAUTION

MATCH THE KEY TO THE GROOVE, INSERT AND
TURN CLOCKWISE BY HAND TO SECURE THE FIBER OPTIC.
DO NOT USE TOOL WHEN THE OPTICAL FIBERS CONNECT
TO LASER BEAM INPUT UNIT.

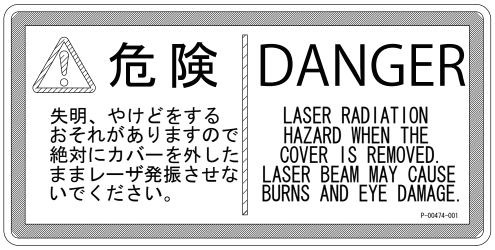
ご注意

レーザ装置本体へのファイバー接続は”ツメ ”
を溝に合わせて差し込んで手で確実にネジを
締めて下さい。（工具は使用しないで下さい）

GROOVE
ミゾ
KEY
ツメ

P-00475-001

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



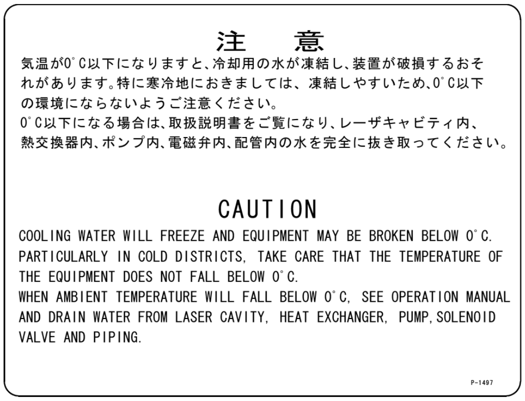
危険 DANGER

失明、やけどをする
おそれがありますので
絶対にカバーを外した
ままレーザ発振させな
いでください。

LASER RADIATION
HAZARD WHEN THE
COVER IS REMOVED.
LASER BEAM MAY CAUSE
BURNS AND EYE DAMAGE.

P-00474-001

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



注　意

気温が0°C以下になりますと、冷却用の水が凍結し、装置が破損するおそ
れがあります。特に寒冷地におきましては、凍結しやすいため、0°C以下
の環境にならないようご注意ください。
0°C以下になる場合は、取扱説明書をご覧になり、レーザキャビティ内、
熱交換器内、ポンプ内、電磁弁内、配管内の水を完全に抜き取ってください。

CAUTION

COOLING WATER WILL FREEZE AND EQUIPMENT MAY BE BROKEN BELOW 0°C.
PARTICULARLY IN COLD DISTRICTS, TAKE CARE THAT THE TEMPERATURE OF
THE EQUIPMENT DOES NOT FALL BELOW 0°C.
WHEN AMBIENT TEMPERATURE WILL FALL BELOW 0°C, SEE OPERATION MANUAL
AND DRAIN WATER FROM LASER CAVITY, HEAT EXCHANGER, PUMP, SOLENOID
VALVE AND PIPING.

P-1497

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

I. Introduction

Chapter 1

● Overview of the Fiber Laser Welder

1. Fiber Laser

LASER is an acronym for Light Amplification by the Stimulated Emission of Radiation. Laser light has a narrow low-divergence beam, common wavelength, and is spatially coherent. The word laser can refer to the laser beam itself, or refer to a piece of equipment which generates the laser beam. Lasers can be classified into various types based on the medium which creates the laser and the resultant wavelength. Fiber lasers are commonly used in industry for welding and cutting purposes due to their high reliability, excellent beam quality, and long life. This LF1000A is a fiber laser welder using a fiber doped with Ytterbium (Yb).

The Yb fiber laser wavelength generated in this laser welder occurs over a band spanning from 1070 to 1110 nm in the near infrared spectrum. These rays are invisible to the human eye. Most laser equipment used for laser welding is classified as Class 4 by the JIS, and US CDRH. This is the most hazardous category in the classification of laser products and has the potential to cause eye damage via direct and indirect (scattered) radiation. When laser light of this wavelength enters the eye it is focused by the lens and reaches the retina, where it damages the rods and cones used to percieve light. The result is a permanent loss of eyesight. Do not look at the laser light in any situation without adequate protection. Because both beams and scattered light are hazardous it is important to wear protection around the laser even if you are not directly observing the beam.

To check where the invisible laser beam encounters the workpiece a red guide light is generally mounted in the laser equipment. When the output unit is provided with a CCD camera a crosshair is usually shown on the monitor. The crosshair indicates where the laser beam will hit the workpiece. In this laser a red beam spot appears on the workpiece when the guide laser is turned on.

2. Mechanism of the Fiber Laser

The Fiber 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

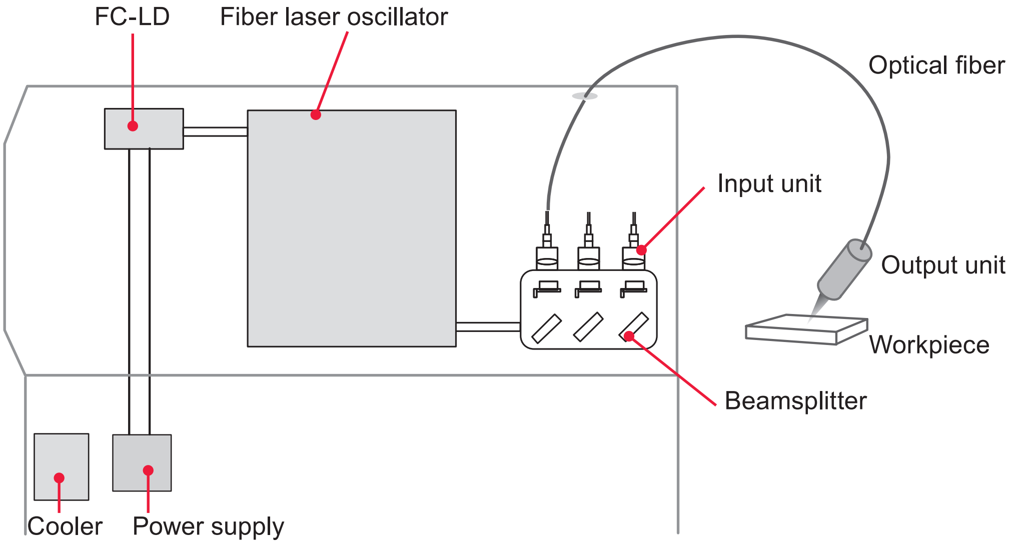
When single laser light is split into multiple beams by using a beamsplitter, multiple workpieces (or multiple positions of a single workpiece) can be simultaneously welded. This method is called "powersharing."
Supposing that the energy of a single laser light beam is 100%, 50% laser light is simultaneously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

Timesharing

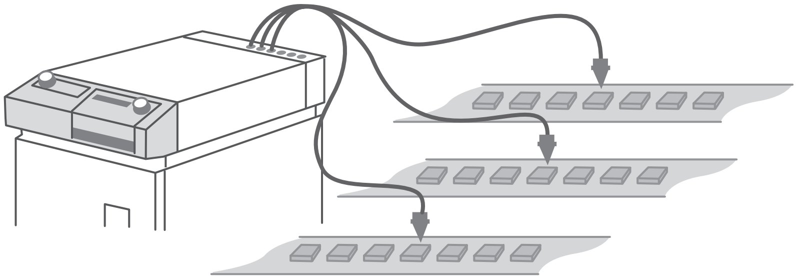
100% energy is applied to multiple workpieces by changing the reflection angle with the mirror of the timesharing unit without splitting the laser light. This welding method for multiple workpieces is called "timesharing."

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

Common Fiber Laser Equipment Configuration



Example of 3 deliveries



3. Functions of the LF1000A

Fiber laser oscillator

- The laser is capable of processing workpieces using a small spot diameter.
- Capable of CW and pulsed output.
- The laser employs an LD excitation system which significantly reduces the number of required maintenance operations.
- The laser provides high energy efficiency for lower power consumption.

Laser power feedback control and optional waveform control functions

- The Laser can handle a wide variety of workpieces. Up to 256 different settings for weld schedules using waveform control are available.
- High-repetition laser output (5000 pps max.) supports high-speed seam welding.
- The welding schedule can be momentarily switched. This permits high-speed and high-quality welding.
- 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 3 deliveries of laser output, including powersharing and timesharing, are available. (The beamsplitter and safety shutter are options.)
- Powersharing permits obtaining uniform outputs for each delivery without splitting the beam.
- With the optional scanning unit the laser provides accurate, high-speed processing.
- Various kinds of processing can be done with the modulation function.

Simple operations and maintenance

- For greater convenience the Laser is designed to allow the maintenance technician to work on the Laser from the front for tasks such as power supply connection and filter replacement.
- Remote control is available because the Laser Control Pendant is detachable.
- Welding schedules are input from the large touch panel type color display. Accordingly, operations can be easily and accurately performed.
- A variety of input and output signals allow the Laser to be connected to automatic machines.
- The output of each FC-LD (Fiber Coupled Laser Dioded) is monitored.
- Both the laser energy (J) and its average power (W) are monitored. If the desired energy range has been set and the laser energy is out of the range, a trouble signal is output. This function is provided for quality control purposes.
- Optical fiber detection is available to check fiber connection and breakage. (An optional output unit with fiber sensor is required.)
- The external communication function permits managing data such as welding schedules and monitor values in centralized form.
- Dust-proof and drip-proof construction that meet IP54.

Compact design is ideal for factory environments

- 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”

In compliance with IEC Standards IEC60825-1:2007 “Safety of laser products Part1: Equipment Classifications, requirements and use’s guide”

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. 1110.4(H)×569.5(W)×1068.8(D) mm	Approx. 380 kg
Package for accessories	Approx. 580(H)×330(W)×460(D) mm	Approx. 30 kg

Checking the Packaged Products

Make sure that all the packaged products are included.

Package for main unit

Product name	Model No.	Item No.	Q'ty
Fiber Laser Welder	LF1000A	-	1

Package for accessories

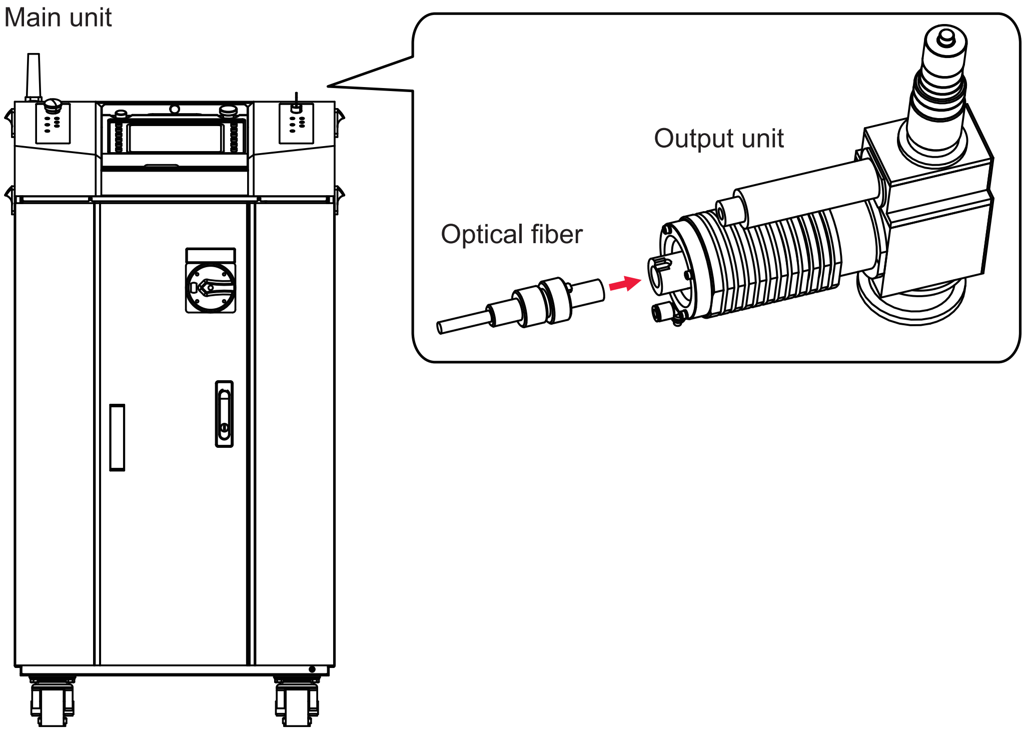
Product name	Model No.	Item No.	Q'ty
Ion-exchange resin refill	MLF-0021	1039562	1
Water filter	MLF-0006	1009281	2
Capsule filter	AAS1154769	1154769	2
Ion-exchange resin replacing tool	MLF-0005	1034142	1
Secondary cooling water (Refined water)	MLU-0604-00 (20L)	1010677	1
Adjuster pressure plate	KC-1275C-3	1025270	4
Protective glasses	CE YL-717 Nd-YAG	1151776	1
Braided hose	φ15mm x φ22 10m	1027697	1
Hose band	HS-10	1027593	4
Water feed hand pump	PH-10	1040392	1
Drain hose (air piping assembly)	AS1156566	1156566	1
Gloves (vinyl)	Emboss L	1040393	2
Operation manual	AS1156443	1156443	1
Power cable	A-04774-001	1016944	1
Cable gland	BS-M20 x 1.5	1024638	3
Locking nut	GMP-M20 x 1.5	1024647	3
Spanner	103KM8 x 10	1040336	1

Cap	VCP-8 04 L=8mm	1024579	1
Ball point hex driver	BS 2.5mm	1040340	1
	BS 3mm	1150113	1
	BS 4mm	1040341	1
Warning label	P-0211	1029797	1
	P-0212	1029798	1
	P-0213	1029799	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



The LF1000A main unit is provided with safety shutters with open/close sensor based on the number of installed beam delivery outputs.

Model	Sharing method	Specification
LF1000A-010	Single delivery	Output from a single fiber
LF1000A-020	2-powersharing	Simultaneous output from 2 fibers
LF1000A-030	3-powersharing	Simultaneous output from 3 fibers
LF1000A-002	2-timesharing	Output from one optionally selected from 2 fibers
LF1000A-003	3-timesharing	Output from one optionally selected from 3 fibers

- For the optical fiber and output unit specifications refer to their Operation Manual or Specification.

Options

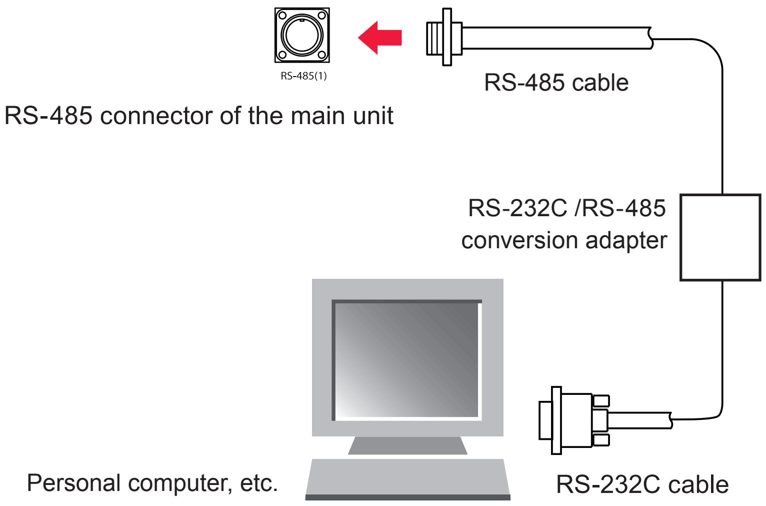
The following goods are options separately sold. Purchase them as required.

Part name		Model No.	Item No.
RS-232C/RS-485 conversion adapter		MSC-08S	1026325
AC adapter for RS-232C/RS-485 conversion adapter		-	1026326
RS-485 cable 10 m		A-05391-001	1017048
RS-232C cable 0.2 m		KRS-9F25F02K	1026274
End face checker	For the transimission fiber	EC-02/D209	1158716
	For the fiber connected to the FC-LD	EC-02/SMA	1040311
Output unit with fiber sensor		Please contact us for information.	Please contact us for information.

- For the maintenance parts sold separately, refer to Maintenance, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection" on page 171.

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.


RS-485(1)
RS-485 cable
RS-485 connector of the main unit
RS-232C /RS-485 conversion adapter
Personal computer, etc.
RS-232C cable

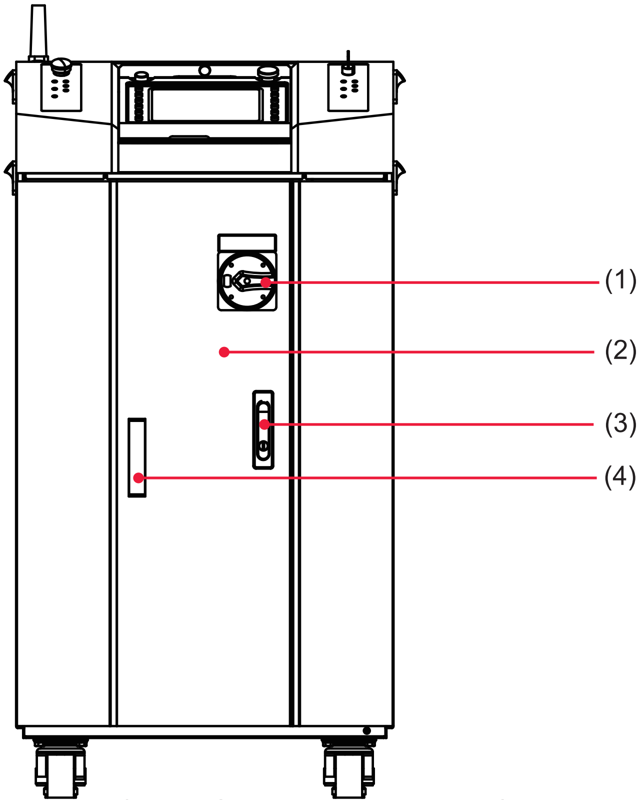
Chapter 2

● Machine Overview

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

Front View

This section explains the front view of the main unit.

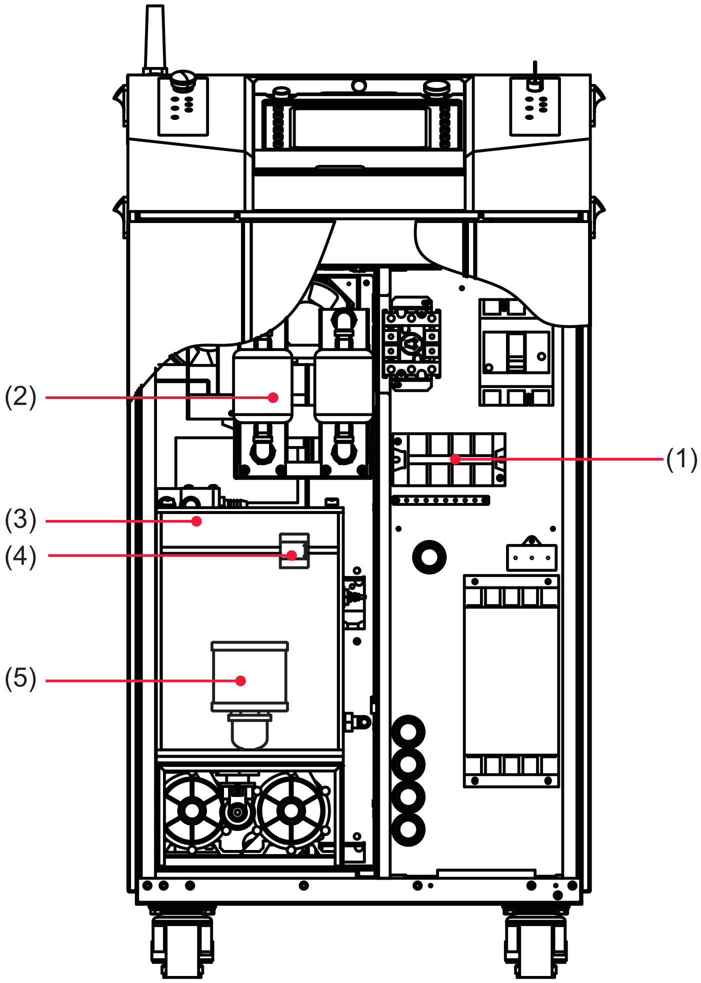


Function of Each Section on the Front Cover

(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 the Front Cover

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



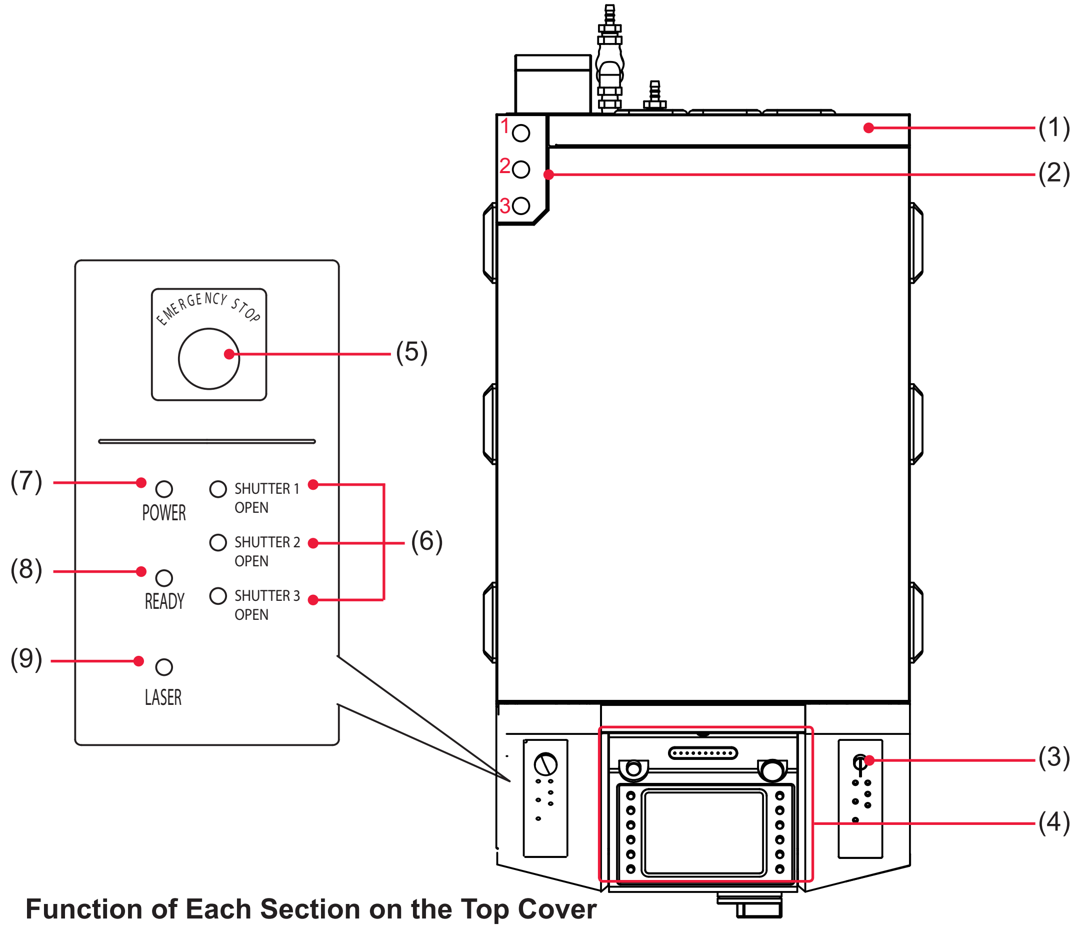
Function of Each Section inside the Front Side

(1) Power Supply Terminals	Connects the 3-phase power supply of 200 V AC to 400 V AC, and the grounding conductor. Remove the plastic cover before use.
(2) Capsule Filter	Removes smaller fibers and other contaminants from the secondary cooling water that has passed through the Water Filter.
(3) Cooling Water Tank	Holds secondary cooling water used for cooling the FC-LD and its power supply.
(4) Water Level Label	Shows proper level of the secondary cooling water.
(5) Ion Exchanger	Increases purity of the secondary cooling water.

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

Top View

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



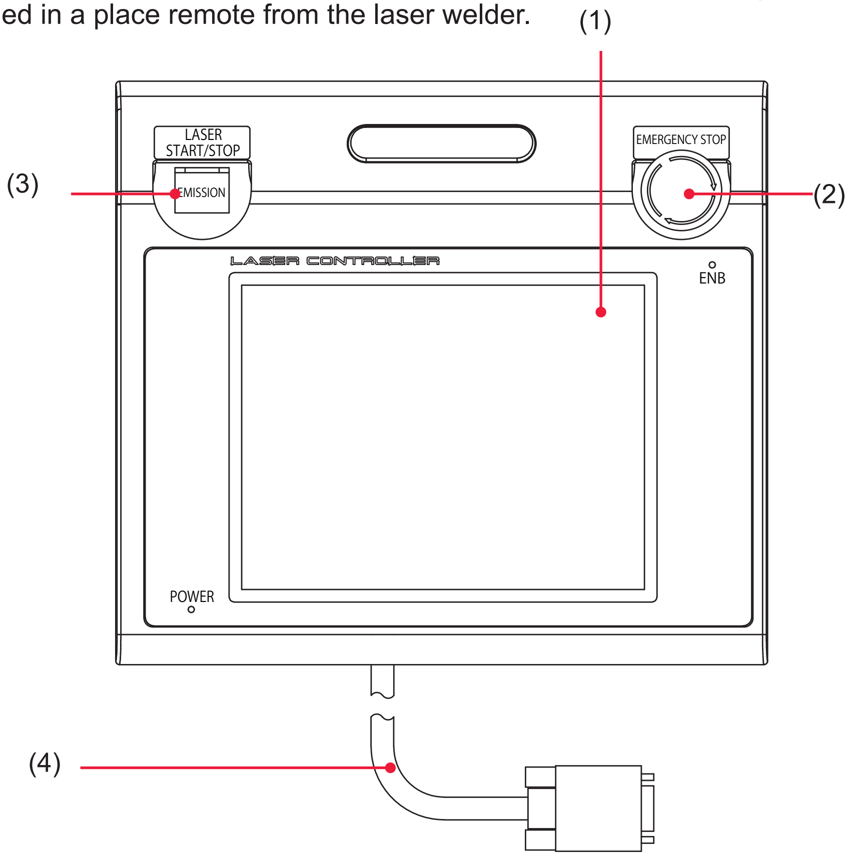
Function of Each Section on the Top Cover

(1) Head Cover	This is the cover for the laser oscillator section.
(2) Optical Fiber Inlets **Cable Lead-In Port**	Pierce the required number of rubber caps to match the number of beam deliveries. Pass the optical fibers through these holes and connect them to the laser beam input units. The output units connected to the optical fiber input ports are numbered as 1, 2, and 3, from the top. Also equipped with a hole to pass the cable (option) for optical fiber mounting/breakage detection.
(3) CONTROL Keyswitch	When the CONTROL keyswitch is turned ON with the MAIN POWER switch ON the machine will begin the enable process. 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.
(4) Laser Controller	This controller sets welding conditions and operates the laser welder. Setting items and set values are displayed on the touch panel type 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. When the pressed button is turned in the direction of RESET (clockwise), the power supply circuit is alive.
(6) SHUTTER Lamp (1 to 3)	Stay(s) on while some (one) of the safety shutters 1 to 3 are (is) open.
(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) READY Lamp	Lights up when the LD is turned on for outputting the laser.
(9) LASER Lamp	Indicates that laser is being output.

Laser Controller (MLE-116A)

The laser controller is located in the control panel on the top surface of the main unit and used to set welding conditions and control operations that output laser light. If the laser controller is dismounted from the main unit, machine operation can be performed in a place remote from the laser welder.

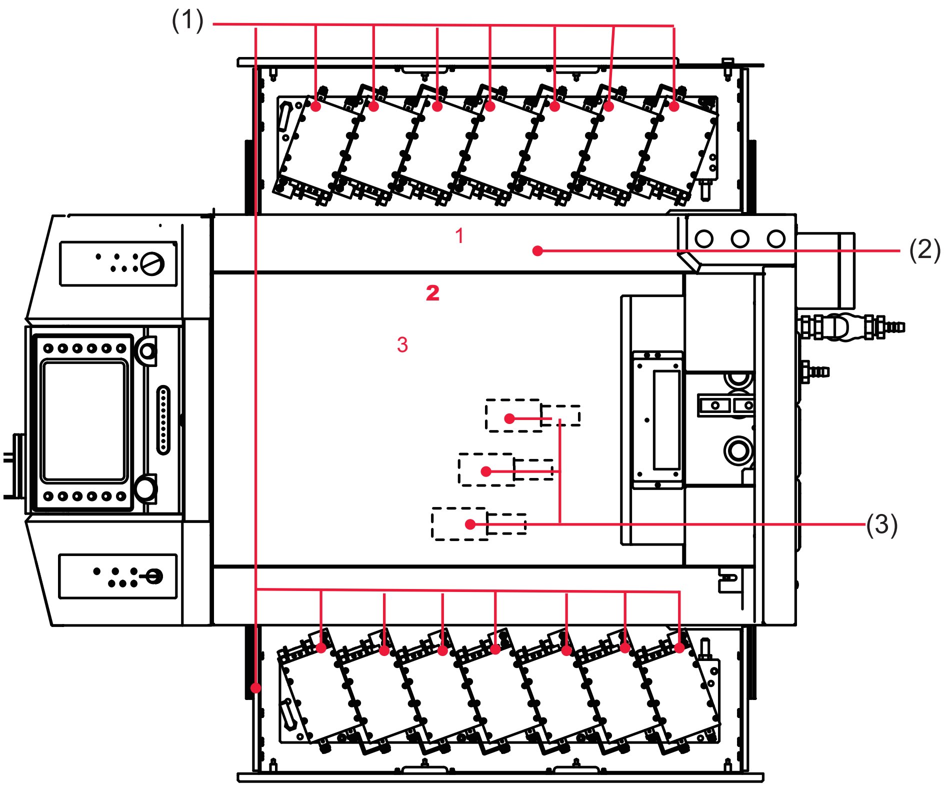


Function of Each Section on the Laser Controller

(1) Liquid Crystal Display	Displays the setting conditions and monitor data.
(2) 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) 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 set for repeated output, the repeated output is stopped. * If Pin No.25 (control switching) of the EXT. I/O (1) connector is in a closed circuit and the LD is turned on.
EMISSION (Lamp)	When the LD is turned on, the EMISSION lamp comes on.
(4) Circuit Cable	Connects the laser controller to the main unit.

Laser Oscillator Section

The laser oscillator section that makes its appearance after the top cover and drawer are opened is explained below.

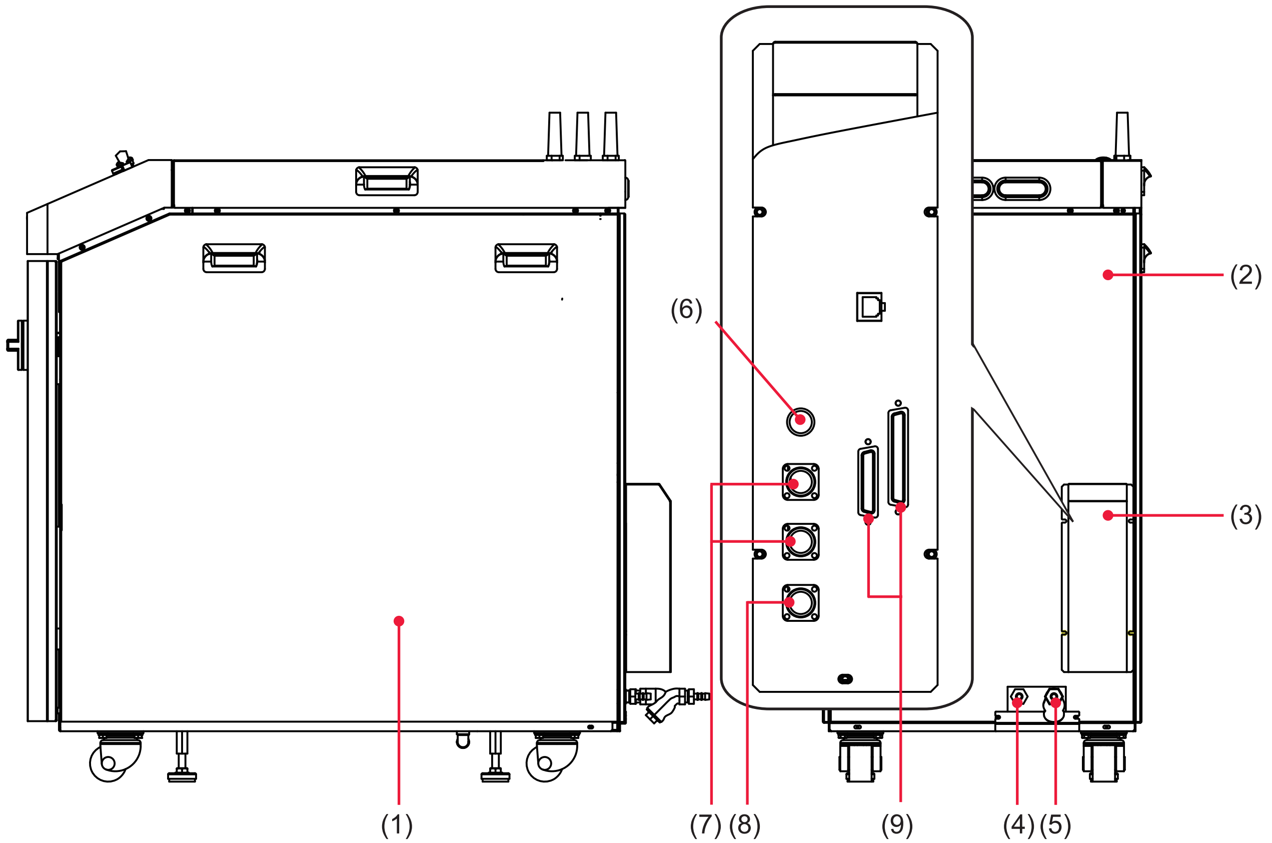


Function of Each Section on the Laser Oscillator

(1) FC-LD	Contains the excitation diode laser. There are fourteen FC-LDs in the both side drawers as shown figure above.

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

This section explains each section on the left, right and rear of the unit.



Function of Each Section on the Left and Right Sides and Rear

(1) Side Covers	Both sides of the laser power supply and cooler are behind the cover.
(2) Rear Cover	The rear side of the laser. power supply and cooler are behind this cover.
(3) Connector Cover	For external I/O connectors.
(4) Cooling Water Inlet	Primary cooling water inlet
(5) Cooling Water Outlet	Primary cooling water outlet
(6) SIGNAL Connector	BNC connector used to output the analog signal representing the monitor waveform of laser power. Connect to an oscilloscope to view output.
(7) RS-485 (1), (2) Connectors	Used for serial communication control
(8) REMOTE INTERLOCK Connector	Connects to the Remote Interlock . When this connector is opened the safety shutters of the laser welder are closed to shut off the laser light output.
(9) 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.

II. Installation and Preparation

Chapter 1

Installation

This chapter explains where to install the laser welder, how to securly attach it, and specifics on cooling water.

- At installation of this laser welder our engineer will take charge of setup and calibration. Accordingly, this Operation Manual does not describe the adjusting method during inital 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 Site

This section explains the environment suitable for the installation.

- Install the laser welder in a secure place at level with the ground surface. If the product is operated in inclined or non-upright position a failure will occur.

External Power Supply Requirments

- **220V**: The AC power source must be 3-phase 200 V/220 V/240 V AC (50/60 Hz) with capacity of 75 A or more

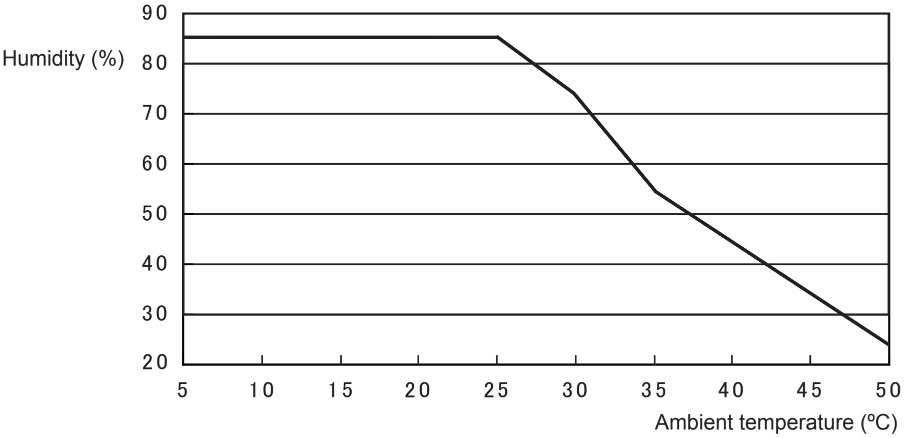
- **400V**: The AC power source must be 3-phase 380 V/400 V AC (50/60 Hz) with capacity of 50 A or more.

Ensure appropriate grounding in accordance with all applicable local regulations.

Environment Suitable for Installation and Precautions

- Use the product only when the ambient temperature is between 5 to 50ºC and the ambient humidity is 50 to 85% RH. without sudden temperature changes.

Upper limit of ambient temperature



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

- 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 for the Cooler Unit" on page 183.

When a sudden temperature change occurs, for example,during initial power on heating, condensation can be caused on the surface of the lens or the mirror, attracting dust and leading to damaged optics. Avoid such a sudden temperature change if possible. When there is a possibility of condensation, turn first turn ON the power supply of the laser but do not start to use it. In about 2 hours, start to operate the laser.

2. Securing the Laser Welder

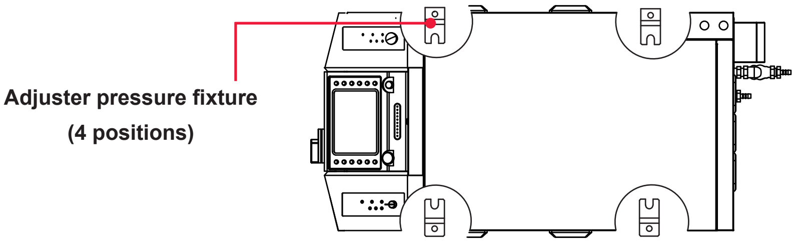
This section explains how to affix the laser welder to the floor.

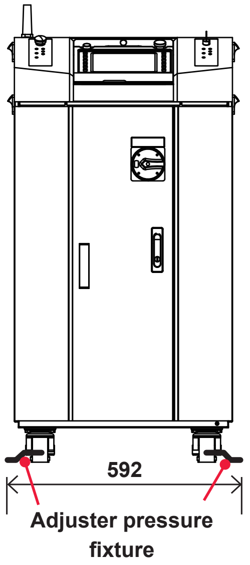
Item required

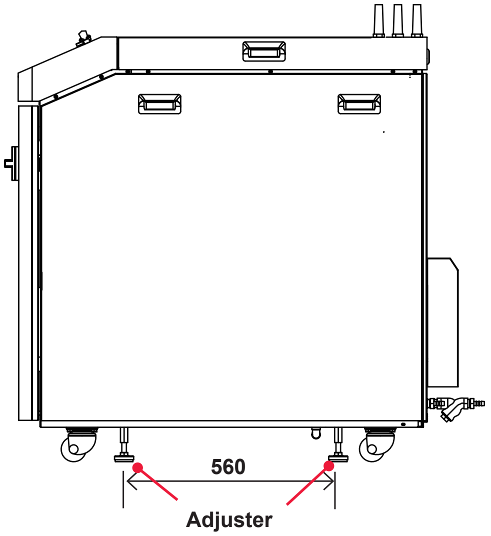
Phillips screwdriver, adjuster pressure fixture, and anchor, etc.

Operating Procedure

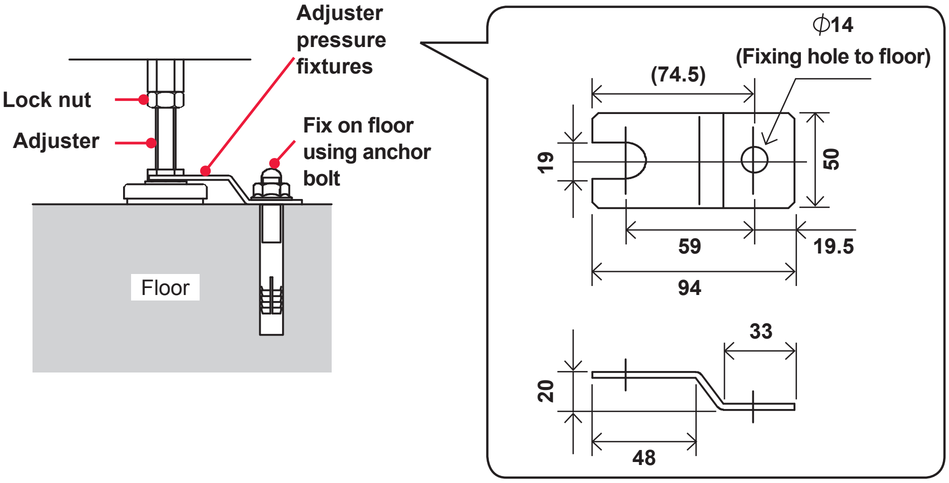
(1) Install the attached adjuster pressure fixtures on the adjuster feet provided in 4 positions in the lower part of the main unit.


Adjuster pressure fixture
(4 positions)


592
Adjuster pressure
fixture


560
Adjuster

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


Adjuster
pressure
fixtures
Lock nut
Adjuster
Fix on floor
using anchor
bolt
Floor
ϕ14
(Fixing hole to floor)
(74.5)
19
50
59
19.5
94
33
20
48

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

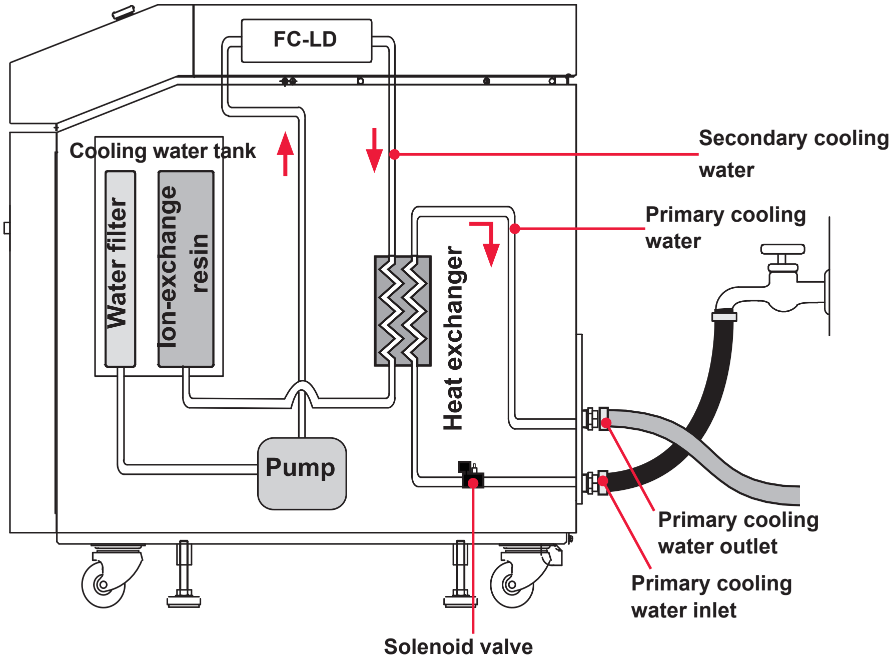
3. Cooling Water

To cool the FC-LD and its power supply, two types of cooling water are used.

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

The secondary cooling water is used to cool the FC-LD and its power supply. Use ion exchange water or distilled water for the secondary cooling water.

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

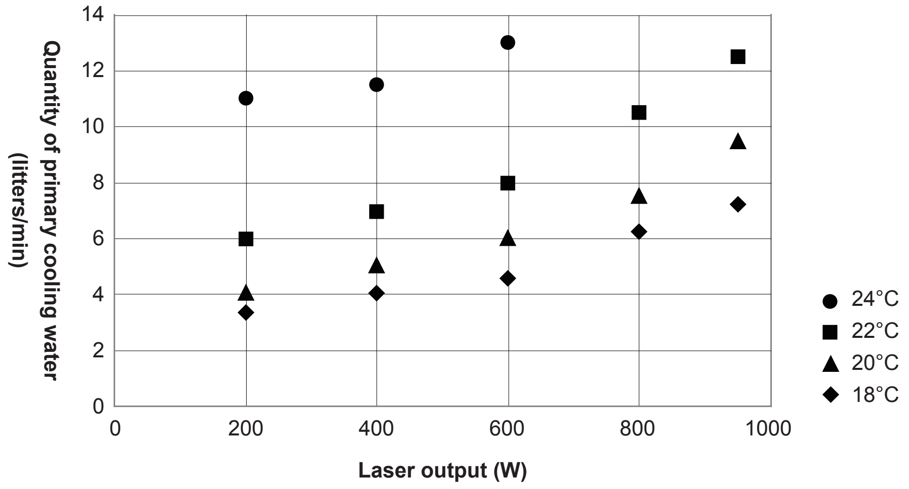

FC-LD
Cooling water tank
Water filter
Ion-exchange resin
Heat exchanger
Pump
Secondary cooling water
Primary cooling water
Primary cooling water outlet
Primary cooling water inlet
Solenoid valve

Required Quantity of Primary Cooling Water

The following graph shows the required quantity of primary cooling water at each water temperature of 18ºC, 20ºC, 22ºC, and 24ºC when the using ratio is 100%.

As the laser output becomes higher, the required quantity of primary cooling water is increased more.

Required quantity of primary cooling water at a water temperature of 18ºC to 24ºC
(Using ratio: 100%)



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 75 A or more (for 200 V/220 V/240 V) or 50 A or more (380 V/400 V), which is applicable to a high surge for an inverter.

Item required

Phillips screwdriver

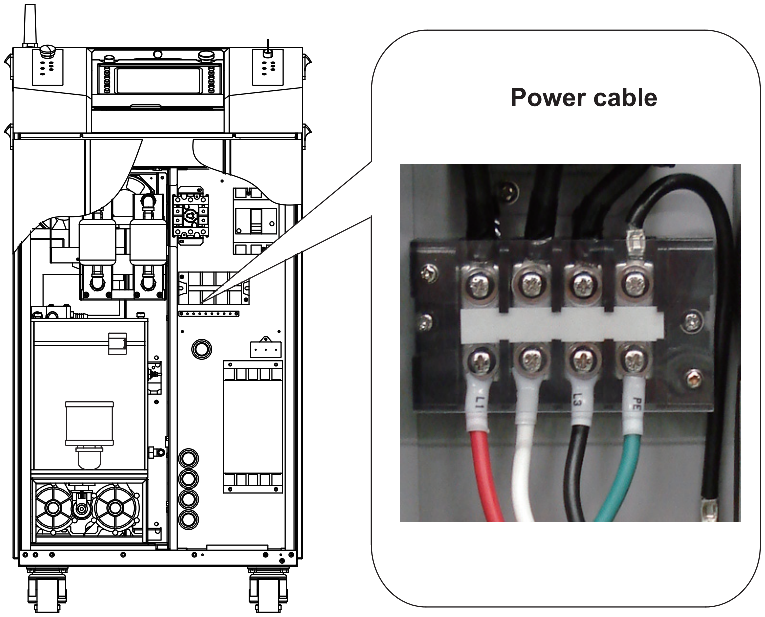
Operating Procedure

(1) Open the front door and remove the plastic cover on the power supply terminals.

(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 (red), L2 (white), L3 (black), and ground/PE (green) 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 water for industrial use, as the primary cooling water, with a pressure of 294 kPa (3 kgf/cm^2) max. and a differential pressure of 98 to 294 kPa (1 to 3 kgf/cm^2). A recirculating chiller is recommended.

- 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 38.

Item required

Braided hose (Inner diameter: φ 15 mm) and hose band

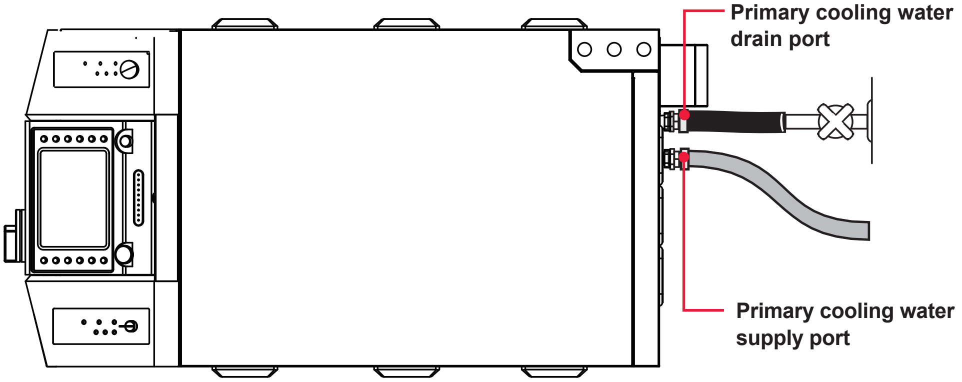
Operating Procedure

(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 a recirculating chiller.

- **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 return line of the recirculating chiller, or if absolutely necessary the drain port of the installation place.


Primary cooling water drain port
Primary cooling water supply port

3. Preparing the Secondary Cooling Water

⚠ CAUTION

Use ion-exchanged water or distilled water as secondary cooling water. Tap water, water for industrial use, ground water or super 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 allow dirt on the floating panel.**

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

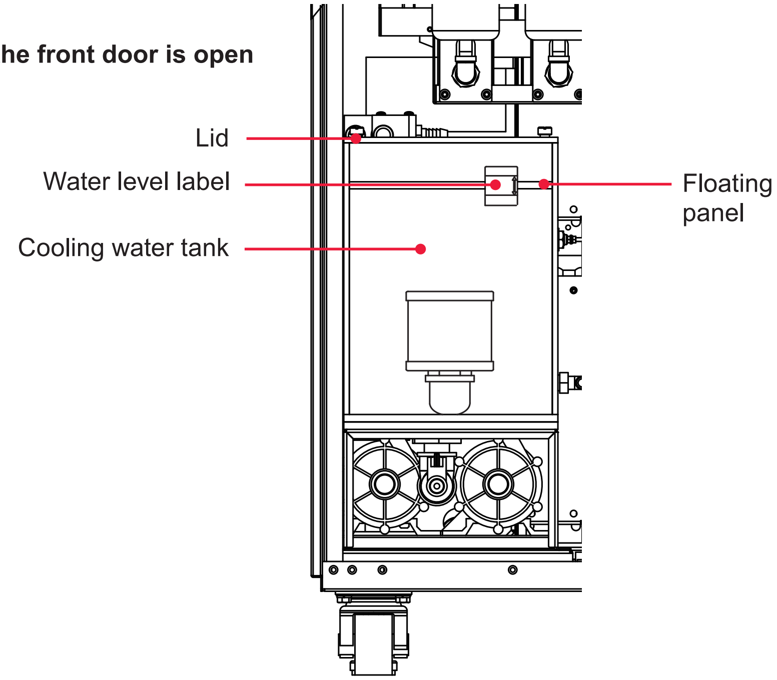
- **Use the water feed pump only for secondary cooling water and do not use for other uses including kerosene.**

(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 ion exchange water or distilled water before use.

When the cooler is operated for the first time after filling the water level will lower. Replenish the cooling water as necessary. Before filling with 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 used. Once the incident optical axis is adjusted, this optical axis does not need to be adjusted again after the fiber is mounted.

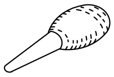
For connecting to the laser beam input unit, contact us for information.

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.

To check for damage use the optional end face checker.

Use an air bellows designed for cameras as shown at right. If rubber is deteriorated, dust may enter the optical fiber. Use a clean bellows.



Precautions during Operation

During operation, take care not to shock the optical fiber or bend it below the minimum bending radius (R100 mm).

Do not tighten the ring of fiber plug too firmly, or the incident laser beam may become dislocated. Tighten the ring by hand without using a tool.

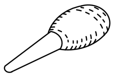
Item required

Air bellows for cleaning camera equipment

Operating Procedure

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

Use an air bellows designed for cameras as shown at right. If rubber is deteriorated, dust may enter the optical fiber. Use a clean air bellows.



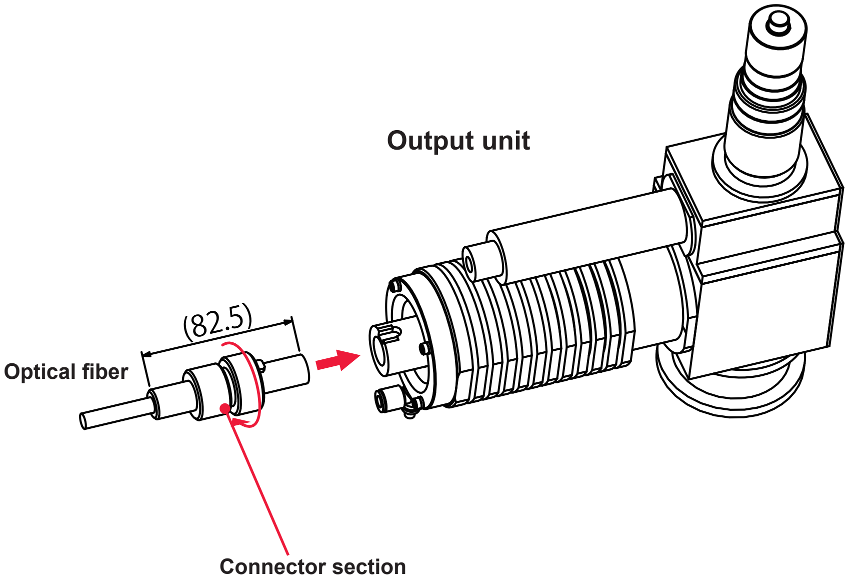
(2) Insert the key provided on the optical fiber plug along the groove on the output unit side.

(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 connection section must not be bent. Take care not to apply excessive force to this section.

- Keep the cap in a clean place. If a dirty cap is mounted it will cause seizure.


Output unit
(82.5)
Optical fiber
Connector section

5. Removing the Laser Controller

To use the laser welder in with the laser controller separated from the main unit, remove the laser controller from the main unit as shown below.

⚠ CAUTION

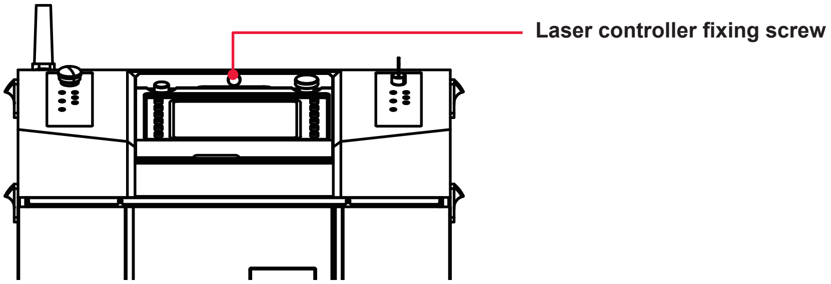
Be sure to turn OFF the power supply before removing the laser controller.

Item required

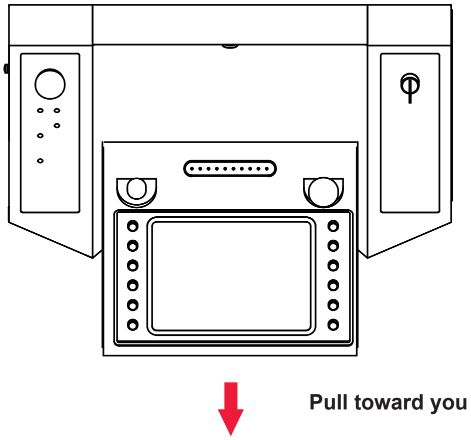
Phillips screwdriver

Operating Procedure

(1) Remove the laser controller fixing screw.



(2) Slide the laser controller forward to remove it.



6. Connecting the External Communication Conversion Adapter (Optional)

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

- To connect to a PLC provided with RS-485, the conversion adapter for external communication is not required.

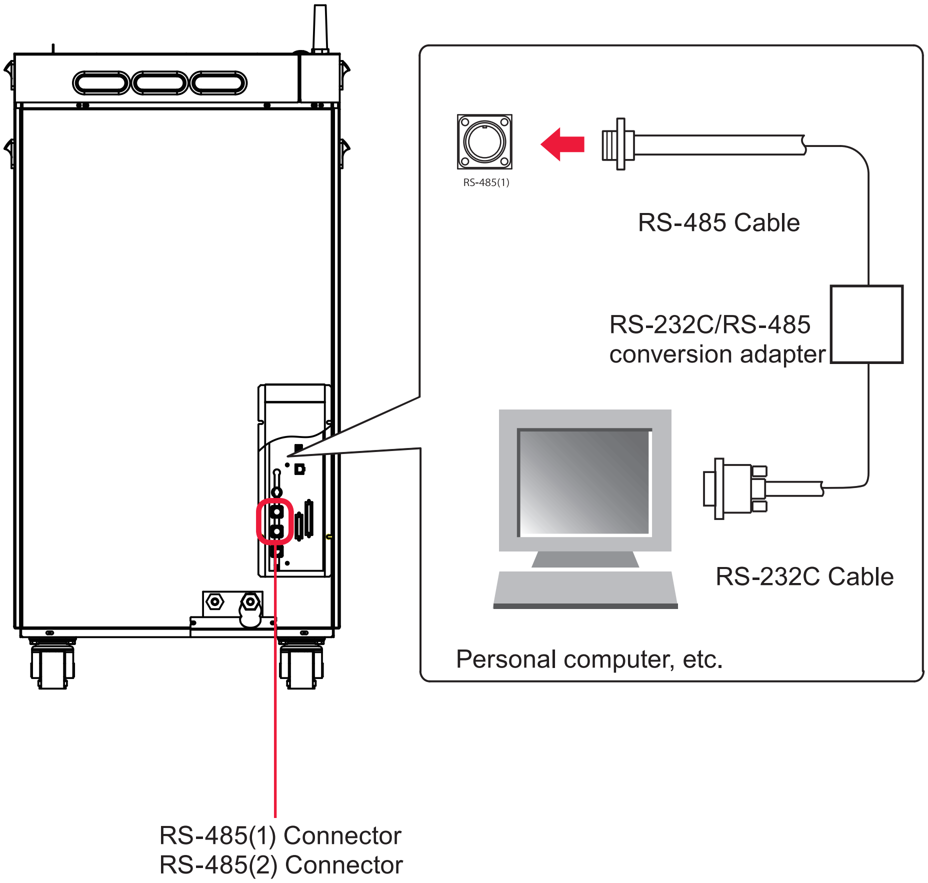
Item required

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."


RS-485(1)
RS-485 Cable
RS-232C/RS-485
conversion adapter
RS-232C Cable
Personal computer, etc.
RS-485(1) Connector
RS-485(2) Connector

III. Operation

Chapter 1

● Control Method, Start and Stop

1. Control Method

This section explains the control methods used to control the laser.

The following 3 control methods are available: 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 appropriate welding work. The selected control method is displayed on the STATUS screen.

*: PLC: Programmable Logic Controller is a unit which performs sequence control by executing programmed control code 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 by itself or when the power supply of the PLC or personal computer connected to the laser is OFF the laser is considered under control of the laser controller and in PANEL CONTROL mode.

- To switch the control with external input/output signals over to PANEL MODE, turn OFF pin No.25 (control switching) on EXT. I/O (1) connector.
- To switch the control by external communication control over to PANEL MODE, send a command to set the control method over the RS485 interface
- If the CONTROL keyswitch of the main unit is turned OFF the laser will enter PANEL MODE even if another control method is active. When the CONTROL keyswitch is turned on again the control method will switch to PANEL MODE unless 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.25 (control switching) of the EXT. I/O (1) connector is ON (closed circuit) or RS485 control is active.

Control by External Input/Output Signals (EXTERNAL CONTROL)

When the PLC is connected to the main unit and pin No.25 (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 PANEL MODE, 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 via PLC, switch the control method, select output schedules, set the sharing method, and press the LASER START/STOP button to output laser light.
- For the control by external communication control, execute the program, switch the control method, set output schedules, set the sharing meth od, and press the LASER START/STOP button to output laser light.
- Pressing LASER START/STOP will stop the fire sequence.

How to Turn Off the Laser

Operating Procedure

(1) Turn OFF the LD using the liquid crystal screen display.

(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

● Settings

1. Setting Weld Schedules

This section explains how to program laser weld schedules and set parameters using the laser controller. The schedules can be protected so that they cannot be changed without authorization.

Welding Schedule Setting Screens

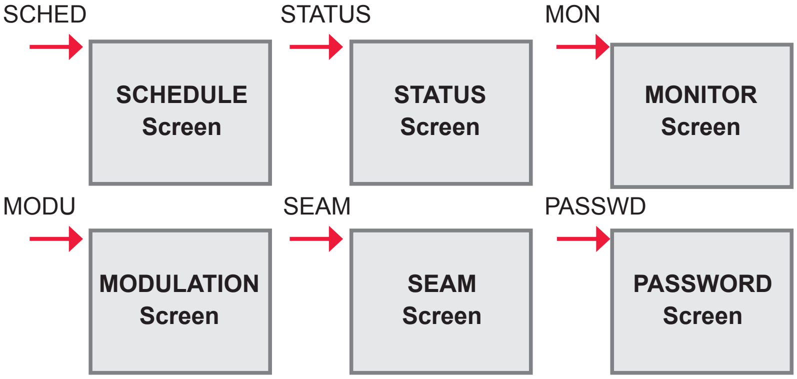
This section explains how to access the SCHEDULE, STATUS, MONITOR, MODULATION, SEAM, and PASSWORD screens to set a welding schedule, and also the INITIALIZE screen.

There are 6 types of basic screens as shown below which are displayed on the liquid crystal display of the laser controller. Each screen is selected using touch buttons displayed on the screen itself.

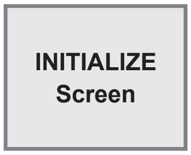
Each time the screen selection button on the right side of each screen is pressed, the SCHEDULE screen, STATUS screen, MONITOR screen, MODULATION screen, SEAM screen, and PASSWORD screen appear in sequence from top to bottom. When laser light is emitted the MONITOR screen is automatically displayed so 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:



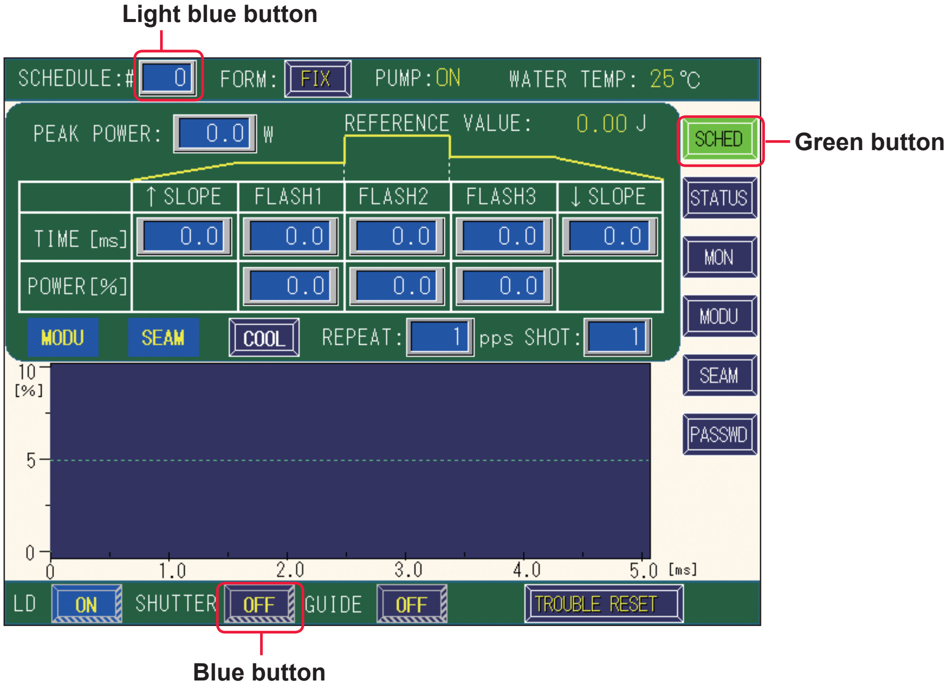
When the power supply is turned ON with the CONTROL keyswitch OFF and the right and left buttons of the laser controller are pressed simultaneously for 2 seconds:



How to Use the LCD Touch Panel

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

The colors of the setting buttons displayed on the basic screens are blue, green, and light blue.


Light blue button

Green button

Blue button

SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25℃

PEAK POWER: 0.0 W REFERENCE VALUE: 0.00 J

	↑SLOPE	FLASH1	FLASH2	FLASH3	↓SLOPE
TIME [ms]	0.0	0.0	0.0	0.0	0.0
POWER[%]		0.0	0.0	0.0	

REPEAT: 1 pps SHOT: 1

LD ON SHUTTER OFF GUIDE OFF

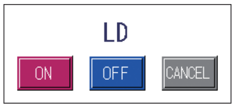
OFF (blue) / SCHED (green) button

The blue and green buttons are used to change screens or ON/OFF settings.

The selected screen button is displayed in green on the right side of the screen.

When the OFF/ON parameters are selected OFF lights up and ON blinks. When the OFF button is pressed, a confirmation window is displayed. If OFF is switched over to ON by pressing the ON or YES button, the ON setting blinks.

Example: OFF →



When pressing ON → ON (blinking)

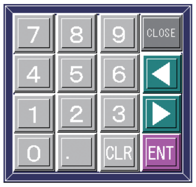
* There are some buttons that change the setting without displaying a confirmation window.

100.0 (light blue) button

The light blue button is used to set a numeric value.

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.

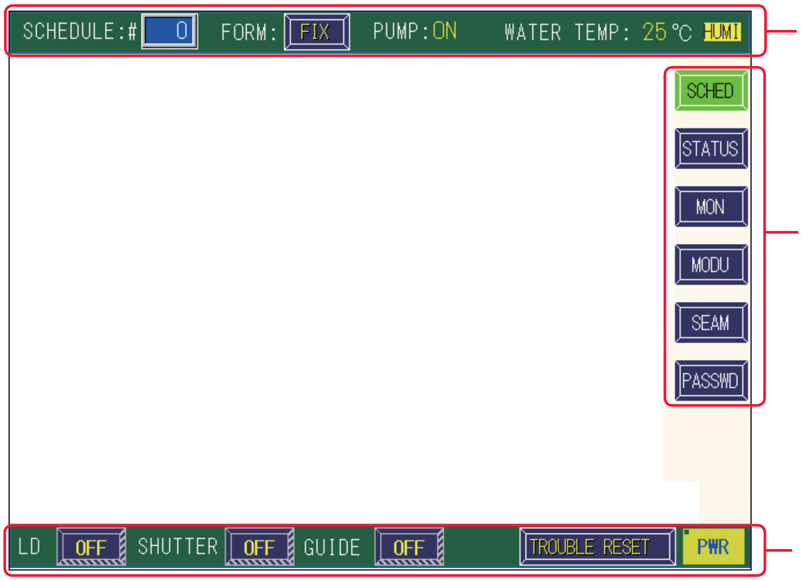
Example: 0.0 →



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 all 6 basic function screens.



Display items and setting buttons

Screen selection buttons

Display items and setting buttons

Display Items and How to Use the Setting Buttons

▨ : Settable item

SCHEDULE	Sets the SCHEDULE No. specifying laser output. Output conditions can be registered by setting the 256 numbers of #0 to #255 or set schedule can be called. When the button is pressed, a numeric keypad is displayed. Press an optional schedule number and then the ENT key. The set schedule number is displayed on the button.
FORM	Sets the waveform creation method. When this button is pressed, a window to select "FIX" (fixed waveform) or "FLEX" (flexible waveform) is displayed. Select a method by pressing an optional button. The set method (FIX or FLEX) is displayed at the button.
PUMP	Displays the current ON/OFF status of the cooling water pump
WATER TEMP	Displays the temperature of cooling water.
HUMI	Blinks when error No.075 to 088/LD No.1 to No.14 DESICCANT CHANGE occurs.
LD	Turns the LD ON/OFF. When this button is pressed a window is displayed allowing ON/OFF control. At ON, the LD lamp comes on. At OFF, the LD lamp does not come on and no laser light is output. The set value (ON or OFF) is displayed at the button.
SHUTTER	Sets the selected beam ON/OFF by opening the safety shutter or engaging timeshare hardware. With this button pressed, a window to set the opening/closing of the safety shutter or beamsplitter is displayed. (The window depends on the setting of the memory switch.) When ON, the safety shutter is opened and the beam output is ON. When OFF, the safety shutter is closed. When there is even one safety shutter or beamsplitter set to ON, the button is displayed in blinking green.

GUIDE	Turns the internal guide laser ON/OFF. When the button is pressed a window to select ON/OFF is displayed. When ON, the guide laser is output. When OFF, no guide beam 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 "GUIDE AUTO-OFF" on the PREFERENCE screen.
TROUBLE RESET	Resets the screen by clearing the error display after error correction 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.
PWR	Blinks when error No.119/FC-LD POWER DOWN occurs. When this button is pressed, the LD DETERIORATION RATE screen appears.

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 safety shutter.
MON	When this button is pressed, the MONITOR screen appears. Select this button to check the measured value of laser light.
MODU	When this button is selected the MODULATION screen appears. Select this button to set a modulated waveform.
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.

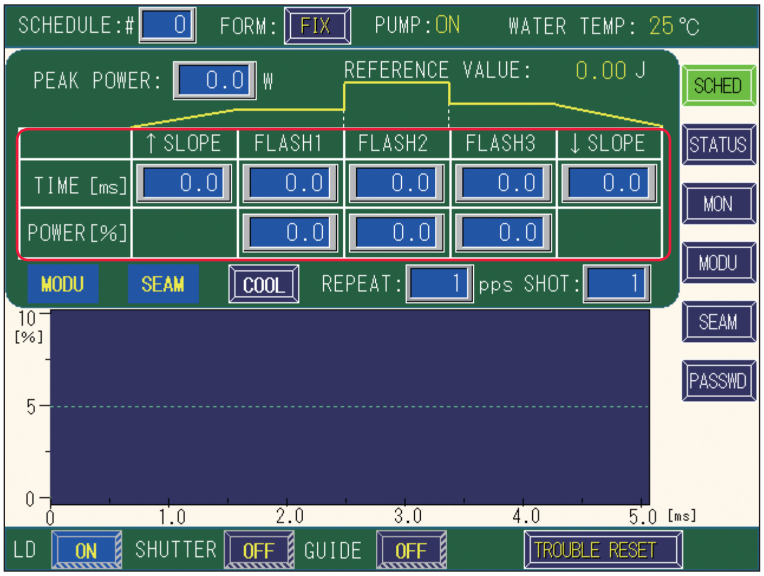
SCHEDULE Screen

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

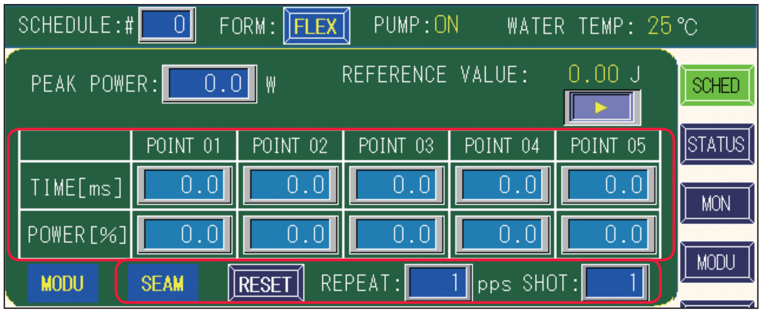
If a registered SCHEDULE number is entered, the corresponding output schedules can be called.

The setting items of laser output time and laser output value are different between fixed waveform (FIX) and flexible waveform (FLEX).

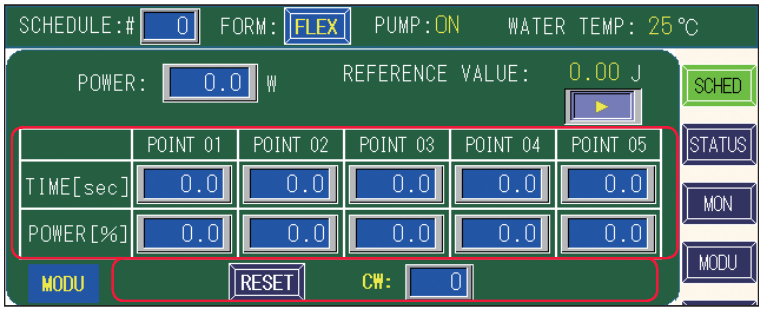
Fixed waveform (FIX)


SCHEDULE:# 0
FORM: FIX
PUMP: ON
WATER TEMP: 25 °C
PEAK POWER: 0.0 W
REFERENCE VALUE: 0.00 J
↑SLOPE
FLASH1
FLASH2
FLASH3
↓SLOPE
TIME [ms] 0.0 0.0 0.0 0.0 0.0
POWER [%] 0.0 0.0 0.0
MODU
SEAM
COOL
REPEAT: 1 pps
SHOT: 1
SCHED
STATUS
MON
MODU
SEAM
PASSWD
10 [%]
5
0
0
1.0
2.0
3.0
4.0
5.0 [ms]
LD ON
SHUTTER OFF
GUIDE OFF
TROUBLE RESET

Flexible waveform (FLEX:REPEAT)


SCHEDULE:# 0
FORM: FLEX
PUMP: ON
WATER TEMP: 25 °C
PEAK POWER: 0.0 W
REFERENCE VALUE: 0.00 J
▶
POINT 01
POINT 02
POINT 03
POINT 04
POINT 05
TIME[ms] 0.0 0.0 0.0 0.0 0.0
POWER[%] 0.0 0.0 0.0 0.0 0.0
MODU
SEAM
RESET
REPEAT: 1 pps
SHOT: 1
SCHED
STATUS
MON
MODU

Flexible waveform (FLEX:CW)


SCHEDULE:# 0
FORM: FLEX
PUMP: ON
WATER TEMP: 25 °C
POWER: 0.0 W
REFERENCE VALUE: 0.00 J
▶
POINT 01
POINT 02
POINT 03
POINT 04
POINT 05
TIME[sec] 0.0 0.0 0.0 0.0 0.0
POWER[%] 0.0 0.0 0.0 0.0 0.0
MODU
RESET
CW: 0
SCHED
STATUS
MON
MODU

Displayed Information

▨ : 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 is 1000 W.

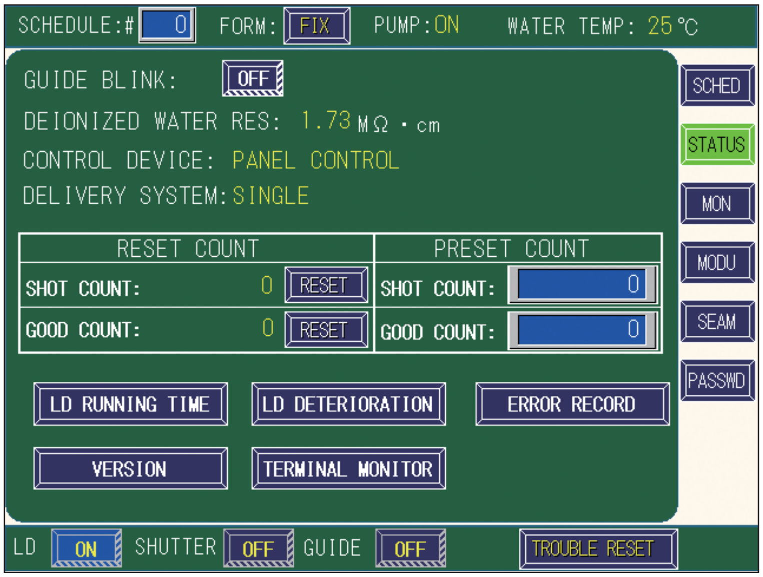
Fixed waveform (FIX)	**↑SLOPE**	Sets the up-slope (the laser output becomes gradually stronger) time to "FLASH1." After setting "FLASH1", set this time in the range of ↑SLOPE ≦ FLASH1.
	FLASH1	Sets the laser output time TIME [ms] and laser output value POWER [%] of the first laser in the following range. Laser output time (TIME [ms]) When "PULSE WIDTH RESOL" is 0.0 ms: 0.0 to 499.9 ms When "PULSE WIDTH RESOL" is 0.00 ms: 0.00 to 49.95 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-slope (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. The threshold value of PEAK POWER is 1000 W. (The laser output value of FLASH is up to 100% when PEAK POWER is set to 1000 W.) - Set the laser output time so as to satisfy the expression of 0.05 ms ≦ FLASH1 + FLASH2 + FLASH3 ≦ 500.0 ms. - Set the total time of FLASH1 + COOL1 + FLASH2 + COOL2 + FLASH3 to a less value than 500.0 ms. - The minimum power (approx. 20 W) of laser is output for the set laser output time regardless of the laser output value (%).
Flexible waveform (FLEX)	◄ ►	Scrolls the POINT display column of POINT 01 to POINT 20 to the right and left. When 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 and laser output value (POWER [%]) at each point of "POINT 01" to "POINT 20" in the following range. REPEAT laser output time (TIME [ms]): 0.0 to 499.9 ms When "PULSE WIDTH RESOL" is 0.0 ms: 0.0 to 499.9 ms When "PULSE WIDTH RESOL" is 0.00 ms: 0.00 to 49.95 ms CW laser output time (TIME [sec]) When "CW TIME RESOL" is 0.1 s: 0.0 to 999.9 sec When "CW TIME RESOL" is 0.01 s: 0.00 to 99.99 sec When "CW TIME RESOL" is 1 s: 0 to 9999 sec Laser output value (POWER [%]): 0 to 200% ***<Note>*** The minimum power (approx. 20 W) of laser is output for the set laser output time regardless of the laser 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 estimated 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.
MODU	Blinks when the modulation function is enabled for the specified schedule number. The function can be set on the MODULATION screen.
SEAM	Blinks when the fade function for seam welding is enabled for the specified schedule number. The function can be set on the SEAM screen.
COOL	Sets the COOL1/COOL2. COOL1: Sets a value other than 0.0 ms to insert the output time of the minimum power (approx. 20 W) of laser between FLASH1 and FLASH2. COOL2: Sets a value other than 0.0 ms to insert the output time of the minimum power (approx. 20 W) of laser between FLASH2 and FLASH3.
REPEAT	Sets the number of laser light pulses per second in the range of 1 to 5000 pps (pulse per second). When 1 is set, the single output is set. To set to the CW mode, select "CW" by using the numeric keypad at FLEX.
SHOT	Sets the number of laser outputs in the range of 1 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 9999 is set, laser light is continuously output until a laser stop signal is input. When CW is selected for REPEAT, SHOT is not displayed.

☐ For the common items in the upper/lower part of the screen, refer to page 53.

STATUS Screen

On the STATUS screen, the laser control method can be checked and the safety shutter and beam selection to output laser light can be controlled. In addition, the counter of laser light outputs and the good output count can be set.


SCHEDULE:# 0 FORM: FIX PUMP:ON WATER TEMP: 25 ℃

GUIDE BLINK: OFF
DEIONIZED WATER RES: 1.73 MΩ・cm
CONTROL DEVICE: PANEL CONTROL
DELIVERY SYSTEM:SINGLE

RESET COUNT			PRESET COUNT	
SHOT COUNT:	0	RESET	SHOT COUNT:	0
GOOD COUNT:	0	RESET	GOOD COUNT:	0

LD ON SHUTTER OFF GUIDE OFF

Displayed Information

▨ : Settable item

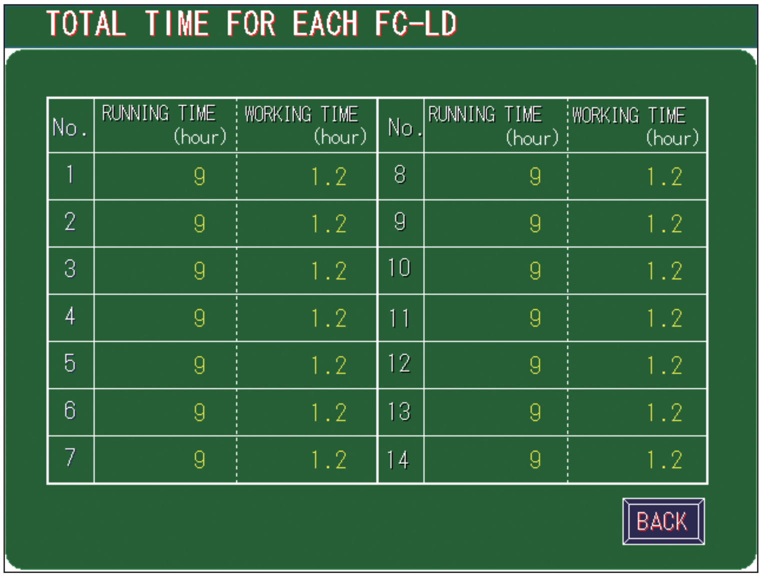
GUIDE BLINK	Sets the guide light blinking status (GUIDE) or continuous lighting to ON or OFF. When GUIDE is set to ON with the guide light ON, the guide light blinks. If it is set to OFF, the guide light is put into a continuous ON status.
DEIONIZED WATER RES	Displays the resistivity level of the secondary cooling water.
CONTROL DEVICE	Displays the current laser control method. EXTERNAL CONTROL (external control): Control is exerted by a 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.
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.
LD RUNNING TIME	Displays the TOTAL TIME FOR EACH FC-LD screen. Then, the total time of each FC-LD and laser output time are displayed.
LD DETRIORATION	Displays the LD DETERIORATION RATE screen. Then, the output and deteriaration rate of each FC-LD are displayed.

ERROR RECORD	Displays the ERROR RECORD screen. Then, the error history is displayed.
VERSION	Displays the SOFTWARE VERSION screen. Then, the version of each software is displayed.
TERMINAL MONITOR	Displays the TERMINAL MONITOR screen. Then, the external input/output monitor is displayed.

☐ For the common items in the upper/lower part of the screen, refer to page 53.

TOTAL TIME FOR EACH FC-LD Screen

When the LD RUNNING TIME button is pressed on the STATUS screen, the TOTAL TIME FOR EACH FC-LD screen appears. On this screen, the total time of each FC-LD and laser output time are displayed.



No.	RUNNING TIME (hour)	WORKING TIME (hour)	No.	RUNNING TIME (hour)	WORKING TIME (hour)
1	9	1.2	8	9	1.2
2	9	1.2	9	9	1.2
3	9	1.2	10	9	1.2
4	9	1.2	11	9	1.2
5	9	1.2	12	9	1.2
6	9	1.2	13	9	1.2
7	9	1.2	14	9	1.2

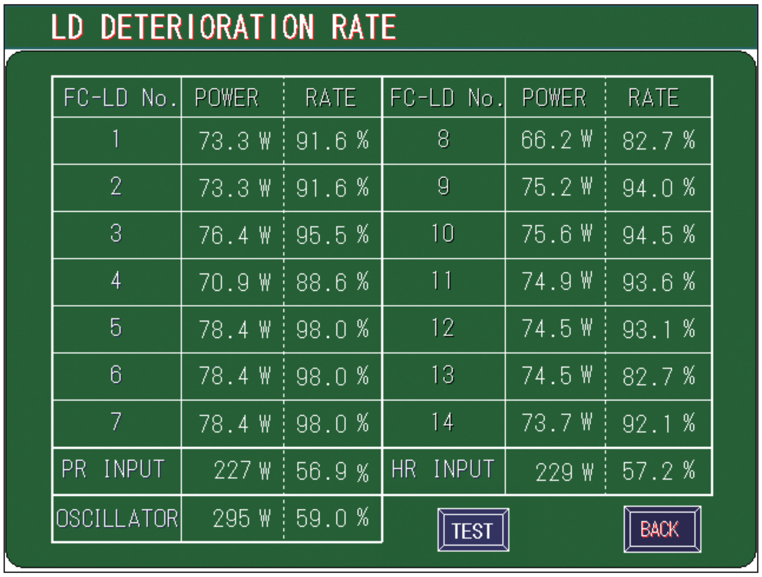
Displayed Information

▨ : Settable item

RUNNING TIME	Displays the total time of each FC-LD.
WORKING TIME	Displays the laser output time.
BACK	Returns to the STATUS screen.

LD DETERIORATION RATE Screen

When the LD DETERIORATION button is pressed on the STATUS screen, the LD DETERIORATION screen appears. On this screen the power and deterioration rate of each FC-LD at test shot are displayed.



LD DETERIORATION RATE

FC-LD No.	POWER	RATE	FC-LD No.	POWER	RATE
1	73.3 W	91.6 %	8	66.2 W	82.7 %
2	73.3 W	91.6 %	9	75.2 W	94.0 %
3	76.4 W	95.5 %	10	75.6 W	94.5 %
4	70.9 W	88.6 %	11	74.9 W	93.6 %
5	78.4 W	98.0 %	12	74.5 W	93.1 %
6	78.4 W	98.0 %	13	74.5 W	82.7 %
7	78.4 W	98.0 %	14	73.7 W	92.1 %
PR INPUT	227 W	56.9 %	HR INPUT	229 W	57.2 %
OSCILLATOR	295 W	59.0 %			

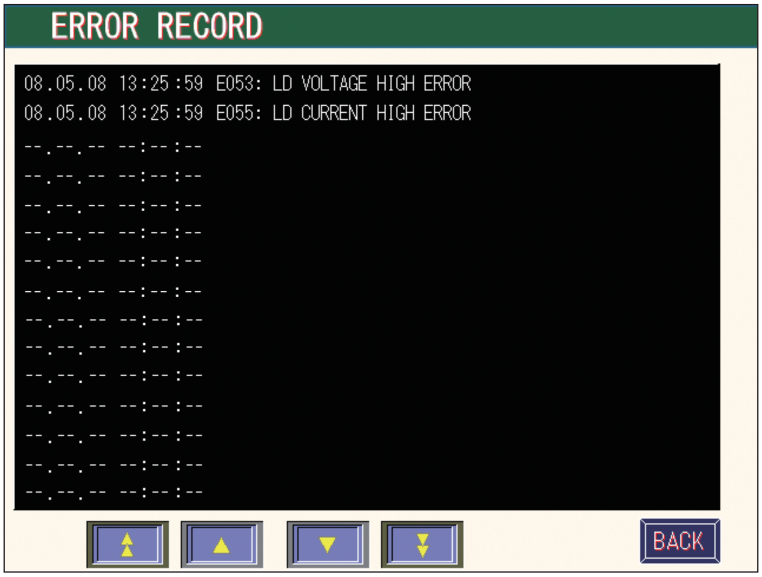
Displayed Information

▨ : Settable item

POWER	Displays the power of each FC-LD and oscillator at test shot.
RATE	Displays the deterioration rate of each FC-LD and oscillator.
TEST	Performs test shot. When the LD SELF CHECK on the PREFERENCE (LASER CONTROL) screen is OFF, this cannot be changed.
BACK	Returns to the STATUS screen.

ERROR RECORD Screen

When the ERROR RECORD button is pressed on the STATUS screen, the ERROR RECORD screen appears. On this screen up to a thousand error histories are displayed in chronological order. When the number of records exceed a thousand, the oldest records.



```
08.05.08 13:25:59 E053: LD VOLTAGE HIGH ERROR
08.05.08 13:25:59 E055: LD CURRENT HIGH ERROR
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
--.--.-- --:--:--
```

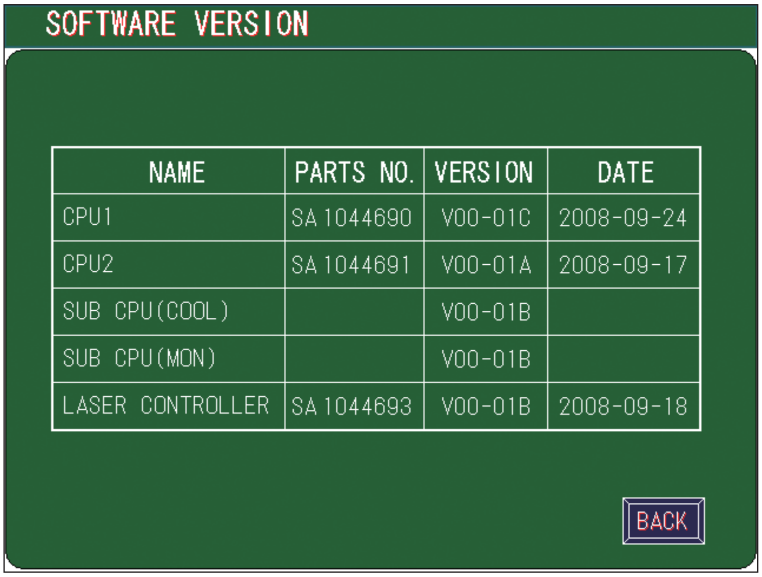
Displayed Information

▨ : Settable item

--.--.--	Displays the date when the error occurred.
--:--:--	Displays the time when the error occurred.
E***	Displays the error code.
: -----	Displays the error messages corresponding to error codes.
▲ ▼	Scrolls the line up and down. When a line is not displayed, press this button to display it.
⏫ ⏬	Scrolls the page up and down. When a page is not displayed, press this button to display it.
BACK	Returns to the STATUS screen.

SOFTWARE VERSION Screen

When the VERSION button is pressed on the STATUS screen the SOFTWARE VERSION screen appears. On this screen the version of each software is displayed.



SOFTWARE VERSION

NAME	PARTS NO.	VERSION	DATE
CPU1	SA1044690	V00-01C	2008-09-24
CPU2	SA1044691	V00-01A	2008-09-17
SUB CPU(COOL)		V00-01B	
SUB CPU(MON)		V00-01B	
LASER CONTROLLER	SA1044693	V00-01B	2008-09-18

Displayed Information

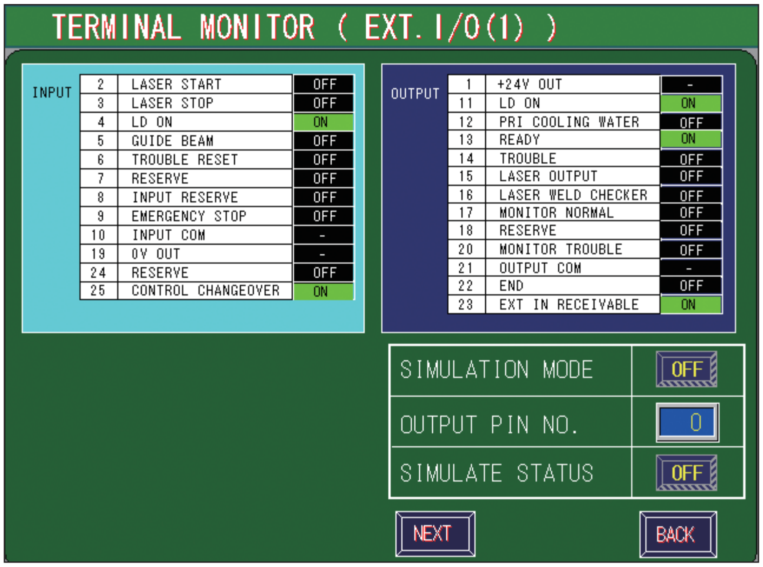
▨ : Settable item

NAME	Displays the name of the software unit.
PARTS NO.	Displays the part number of software.
VERSION	Displays the software version.
DATE	Displays the updated date of software.
BACK	Returns to the STATUS screen.

TERMINAL MONITOR Screen

When the TERMINAL MONITOR button is pressed on the STATUS screen the TERMINAL MONITOR screen appears. On this screen, the external input/outputs are monitored.

EXT. I/O (1)



TERMINAL MONITOR (EXT. I/O(1))

INPUT

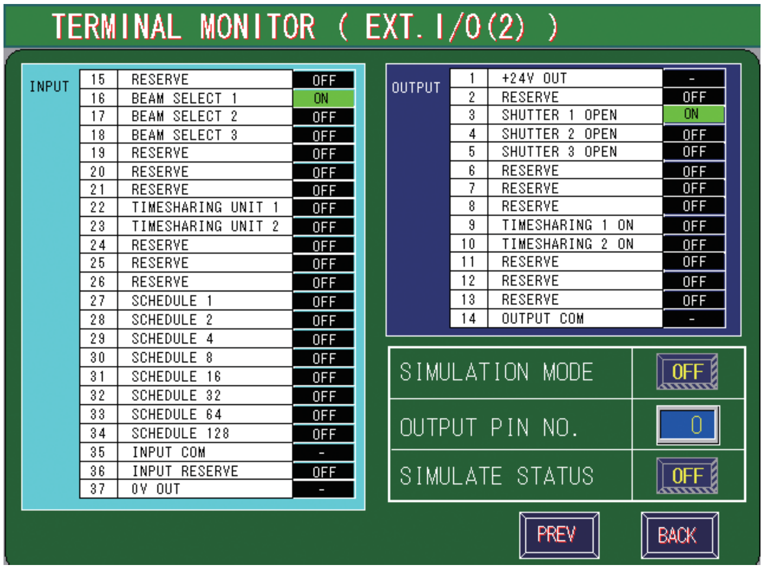
2	LASER START	OFF
3	LASER STOP	OFF
4	LD ON	ON
5	GUIDE BEAM	OFF
6	TROUBLE RESET	OFF
7	RESERVE	OFF
8	INPUT RESERVE	OFF
9	EMERGENCY STOP	OFF
10	INPUT COM	-
19	0V OUT	-
24	RESERVE	OFF
25	CONTROL CHANGEOVER	ON

OUTPUT

1	+24V OUT	-
11	LD ON	ON
12	PRI COOLING WATER	OFF
13	READY	ON
14	TROUBLE	OFF
15	LASER OUTPUT	OFF
16	LASER WELD CHECKER	OFF
17	MONITOR NORMAL	OFF
18	RESERVE	OFF
20	MONITOR TROUBLE	OFF
21	OUTPUT COM	-
22	END	OFF
23	EXT IN RECEIVABLE	ON

SIMULATION MODE	OFF
OUTPUT PIN NO.	0
SIMULATE STATUS	OFF

EXT. I/O (2)



TERMINAL MONITOR (EXT. I/O(2))

INPUT

15	RESERVE	OFF
16	BEAM SELECT 1	ON
17	BEAM SELECT 2	OFF
18	BEAM SELECT 3	OFF
19	RESERVE	OFF
20	RESERVE	OFF
21	RESERVE	OFF
22	TIMESHARING UNIT 1	OFF
23	TIMESHARING UNIT 2	OFF
24	RESERVE	OFF
25	RESERVE	OFF
26	RESERVE	OFF
27	SCHEDULE 1	OFF
28	SCHEDULE 2	OFF
29	SCHEDULE 4	OFF
30	SCHEDULE 8	OFF
31	SCHEDULE 16	OFF
32	SCHEDULE 32	OFF
33	SCHEDULE 64	OFF
34	SCHEDULE 128	OFF
35	INPUT COM	-
36	INPUT RESERVE	OFF
37	0V OUT	-

OUTPUT

1	+24V OUT	-
2	RESERVE	OFF
3	SHUTTER 1 OPEN	ON
4	SHUTTER 2 OPEN	OFF
5	SHUTTER 3 OPEN	OFF
6	RESERVE	OFF
7	RESERVE	OFF
8	RESERVE	OFF
9	TIMESHARING 1 ON	OFF
10	TIMESHARING 2 ON	OFF
11	RESERVE	OFF
12	RESERVE	OFF
13	RESERVE	OFF
14	OUTPUT COM	-

SIMULATION MODE	OFF
OUTPUT PIN NO.	0
SIMULATE STATUS	OFF

Displayed Information

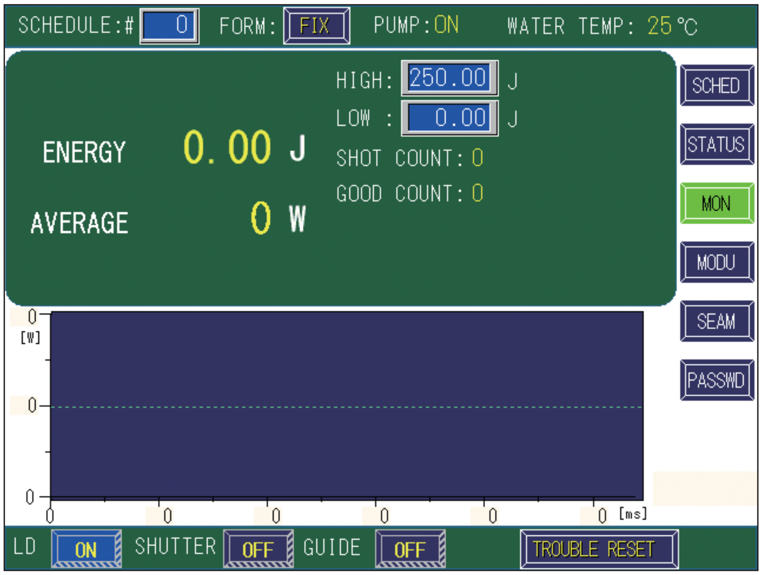
▨ : Settable item

INPUT	Displays the current status of external inputs.
OUTPUT	Displays the current status of external outputs.
SIMULATION MODE	Sets the external output simulation mode to ON/OFF.
OUTPUT PIN NO.	Sets the output pin No. When the SIMULATION MODE is OFF, this cannot be changed.
SIMULATE STATUS	Sets the status of output simulation to ON/OFF. When the SIMULATION MODE is OFF this cannot be changed.
NEXT/ PREV	Moves to the EXT. I/O (2) screen. Returns to the EXT. I/O (1) screen.
BACK	Returns to the STATUS screen. When the SIMULATION MODE is ON this cannot be changed.

MONITOR Screen

On the MONITOR screen, the measured value of monitored laser light is checked and the monitor value range is set.

FIX/ FLEX:REPEAT



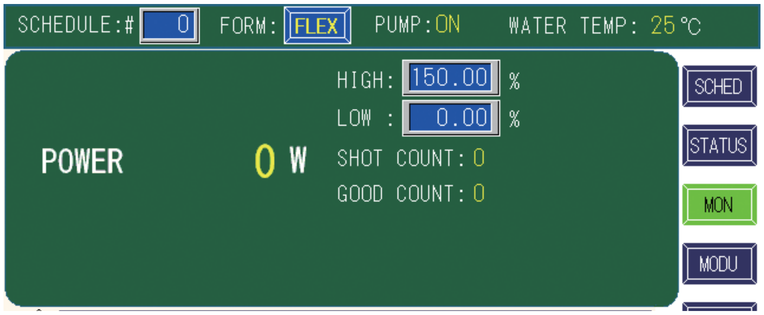
SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 ℃

HIGH: 250.00 J
LOW : 0.00 J
SHOT COUNT: 0
GOOD COUNT: 0

ENERGY 0. 00 J
AVERAGE 0 W

LD ON SHUTTER OFF GUIDE OFF

FLEX:CW



SCHEDULE:# 0 FORM: FLEX PUMP: ON WATER TEMP: 25 ℃

HIGH: 150.00 %
LOW : 0.00 %
SHOT COUNT: 0
GOOD COUNT: 0

POWER 0 W

Displayed Information

🟥 : Settable item

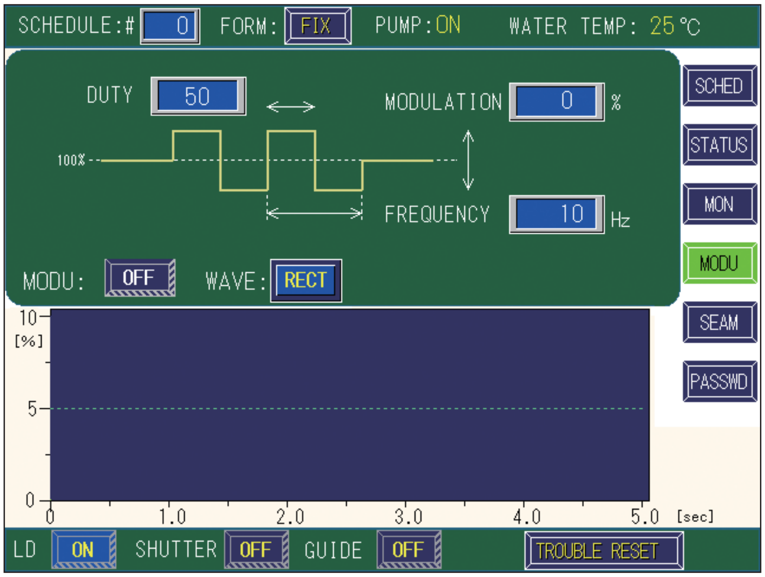
ENERGY	Displays the measured value (J) of laser energy. Each time laser light is output, the laser energy is measured and its value is displayed. In the case of a high-speed repeated output the energy is displayed at certain intervals because the display timing is too quick for per-shot updates.
AVERAGE (FIX/REPEAT) **POWER (CW)**	Displays the average power (W) of output laser light. 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 key to clear the trouble. *: The ratio of the average power in the CW mode. Use the value reference.
SHOT COUNT	Displays the total number of laser light outputs. Refer to this number when replacing the FC-LD. To reset the display to 0 perform a reset operation on the STATUS screen.
GOOD COUNT	Displays the number of laser light outputs that fall within the HIGH/LOW range. 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.

- For the common items in the upper/lower part of the screen, refer to page 53.

MODULATION Screen

On the MODULATION screen the laser light modulation degree and the modulation frequency are set.

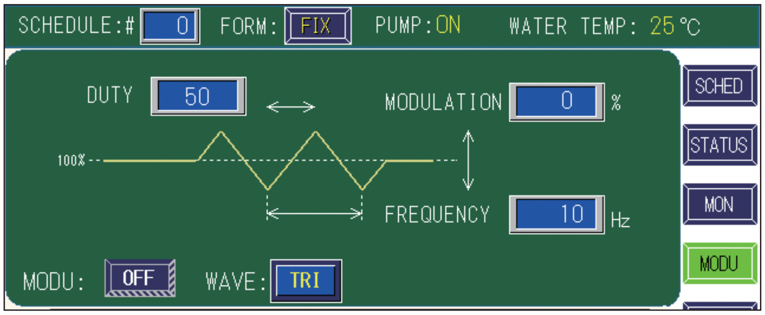
Rectangular wave (RECT)



SCHEDULE:# 0
FORM: FIX
PUMP: ON
WATER TEMP: 25 °C
DUTY 50
MODULATION 0 %
FREQUENCY 10 Hz
MODU: OFF
WAVE: RECT
LD ON
SHUTTER OFF
GUIDE OFF

100%
SCHED
STATUS
MON
MODU
SEAM
PASSWD
10
[%]
5
0
0
1.0
2.0
3.0
4.0
5.0
[sec]
TROUBLE RESET

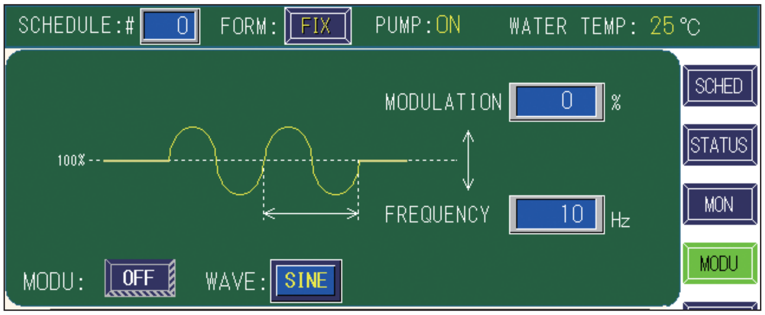
Triangular wave (TRI)



SCHEDULE:# 0
FORM: FIX
PUMP: ON
WATER TEMP: 25 °C
DUTY 50
MODULATION 0 %
FREQUENCY 10 Hz
MODU: OFF
WAVE: TRI

100%
SCHED
STATUS
MON
MODU

Sinusoidal wave (SINE)



SCHEDULE:# 0
FORM: FIX
PUMP: ON
WATER TEMP: 25 °C
MODULATION 0 %
FREQUENCY 10 Hz
MODU: OFF
WAVE: SINE

100%
SCHED
STATUS
MON
MODU

Displayed Information

🟥 : Settable item

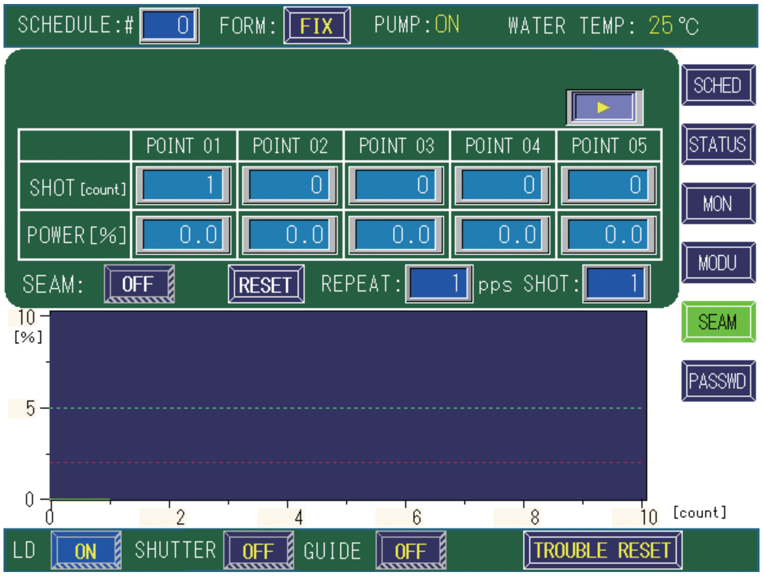
DUTY	Sets the duty ratio. The setting range is 10 to 90. Inputs a percentage of High side for PEAK.

MODULATION	Sets the modulation multiplier. The setting range is 0 to 100%. Sets the CW laser output value as a percentage of power. ***<Notes>*** - The modulated width cannot be set more than the maximum peak output value. Ex.) 500 W max. Power 333 W x Modulated width 50% = 500 W - The minimum power (approx. 20 W) of laser is output regardless of the modulation width (%).
FREQUENCY	Sets the frequency. The setting range is 1 to 5000 Hz. Sets the cycle of modulation.
MODU	Set the modulation function to ON or OFF. When this item is set to ON, the settings is enabled. When the item is set to OFF, this function is disabled. ***<Note>*** When using the modulation function, set the laser output value (POWER [%]) to 100%.
WAVE	Sets the type of modulation waveform from rectangular wave (RECT), triangular wave (TRI), or sinusoidal wave (SINE).

☐ For the common items in the upper/lower part of the screen, refer to page 53.

SEAM Screen

On the SEAM screen it is possible to set a process-wide multiplier waveform which can be used to fade the laser intensity in/out during various phases of the weld. This function lowers and raises the laser energy in a gentle slope form to provide a continuous waveform suitable for seam welding.



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 °C

	POINT 01	POINT 02	POINT 03	POINT 04	POINT 05
SHOT [count]	1	0	0	0	0
POWER [%]	0.0	0.0	0.0	0.0	0.0

SEAM: OFF REPEAT: 1 pps SHOT: 1

LD ON SHUTTER OFF GUIDE OFF

Displayed Information

▨ : Settable item

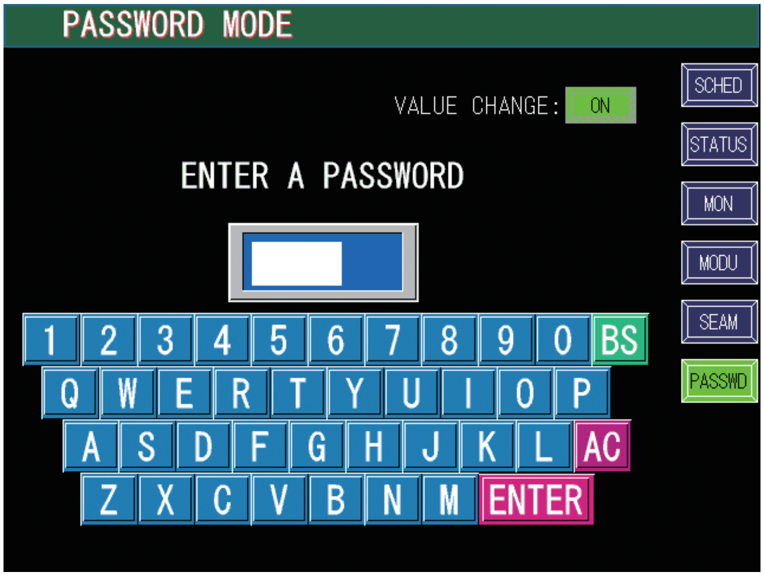
◄ ►	Scrolls the POINT display column of POINT 01 to POINT 20 to the right and left. When a POINT is not displayed, press this button to display it.
SHOT [COUNT]	Sets the laser light output count of POINT 01 to POINT 20 in the range of 1 to 9999.
POWER [%]	Sets the laser output value of each "SHOT" of POINT 01 to POINT 02 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. ***<Note>*** The minimum power (approx. 20 W) of laser is output for the set laser output time regardless of the laser output value (%).
SEAM	When REPEAT/SHOT ≧ 1, set 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.
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 1 to 5000 pps (pulse per second). When 1 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 1 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 9999 is set, 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 53.

PASSWORD Screen

On the PASSWORD screen, a password can be set to protect the welding schedules.



PASSWORD MODE

VALUE CHANGE: ON

ENTER A PASSWORD

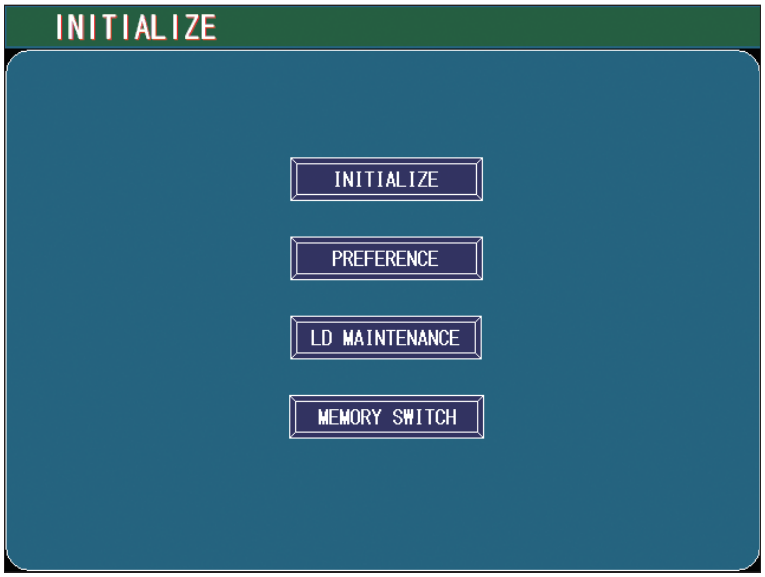
Displayed Information

▨ : Settable item

VALUE CHANGE	If Value Change is OFF the password is validated and the set values are protected from changing without entering the proper password. When 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 the entered characters one by one. ENTER: Checks the entered password for correctness.

INITIALIZE Screen

On the INITIALIZE screen the settings can be initialized and the equipment No. and communication schedules for using the external communication function and the alarm range of secondary cooling water temperature are set.



Displayed Information

▨ : Settable item

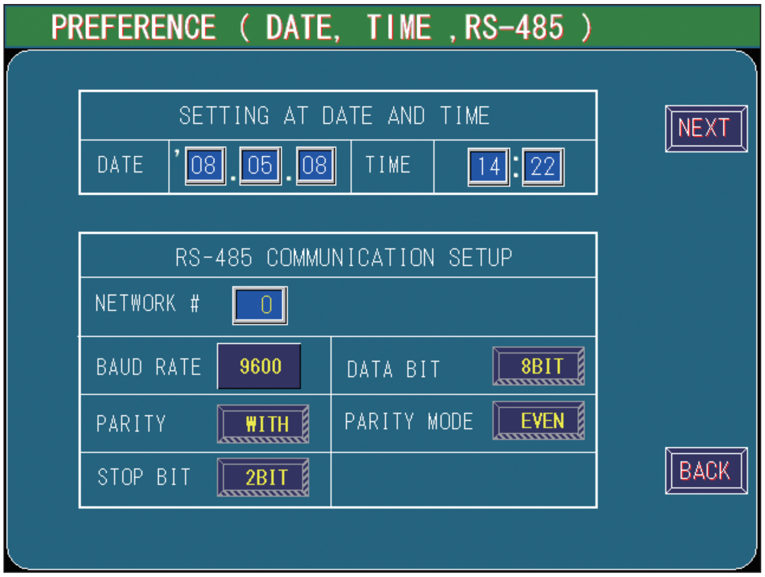
INITIALIZE	Changes the initialization of set values to factory defaults ON/OFF. When the initialization is set to ON, the set values on the INITIALIZE screen are initialized. After replacing the lithium battery, rewriting the program, or replacing the control board (ME-2097), the set values may change or be lost. Accordingly, perform initialization and set the values again. Note: When selected, all schedule information will be erased.
PREFERENCE	Displays the PREFERENCE screen. Then, date/time, communication schedules, and laser/cooler control parameters can be set.
LD MAINTENANCE	Displays the LD MAINTENANCE screen where the LD ON time and laser output time of the specified LD can be reset, and the LD initial power can be set.
MEMORY SWITCH	Displays the MEMORY SWITCH screen. The settings can be checked by the ON/OFF status of the memory switch. For details, refer to the Appendix "Definition of Memory Switch."

PREFERENCE Screen

When the PREFERENCE button is pressed on the INITIALIZE screen, the PREFERENCE screen appears. On this screen date/time, communication schedules, and laser/cooler control parameters can be set.

There are five pages in total.

DATE, TIME, RS-485



PREFERENCE (DATE, TIME ,RS-485)

SETTING AT DATE AND TIME
DATE '08.05.08
TIME 14:22

RS-485 COMMUNICATION SETUP
NETWORK # 0
BAUD RATE 9600
DATA BIT 8BIT
PARITY WITH
PARITY MODE EVEN
STOP BIT 2BIT

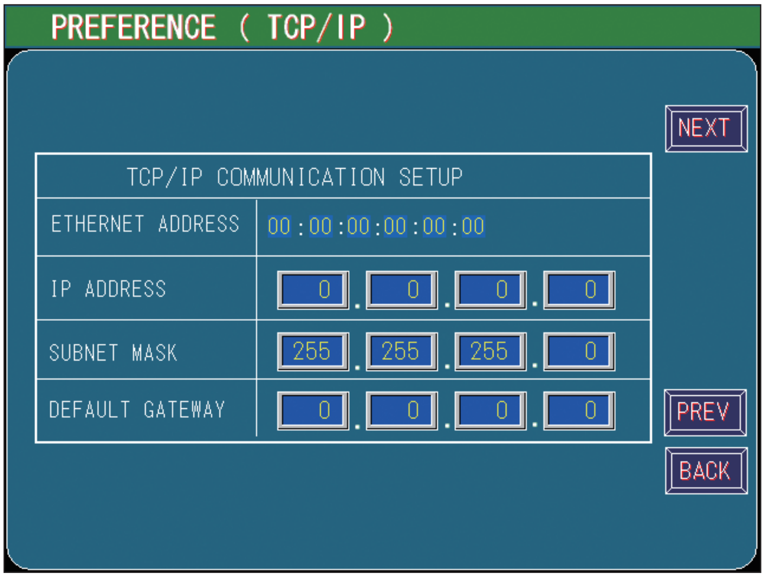
Displayed Information

🟥 : Settable item

DATE	Sets the current date. (YEAR.MONTH.DAY)
TIME	Sets the current time.
NETWORK	Sets the equipment No. in the range of #0 to #15 to perform remote operations by using the external communication function.
BAUD RATE	Sets the communication speed from 9600, 19200, 38400, 57600, or 115200 bps.
DATA BIT	Sets the length of data bit from 8bit or 7bit.
PARITY	Sets the parity from WITH or WITHOUT.
PARITY MODE	Sets the parity mode from EVEN or ODD.
STOP BIT	Sets the stop bit from 2bit or 1bit.
NEXT	Moves to the next screen.
BACK	Returns to the INITIALIZE screen.

- When the setting has been changed, be sure recycle the power to make the setting changes effective before use.

TCP/IP


PREFERENCE (TCP/IP)

TCP/IP COMMUNICATION SETUP

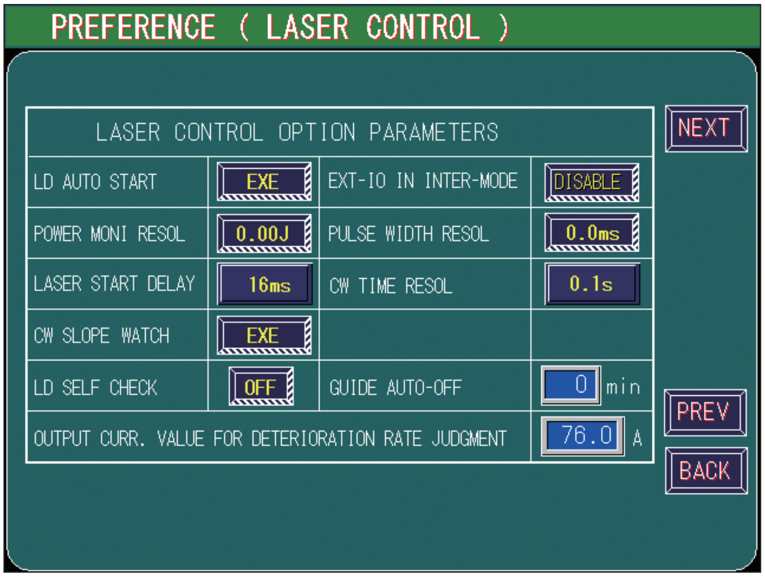
ETHERNET ADDRESS	00 : 00 : 00 : 00 : 00 : 00
IP ADDRESS	0 . 0 . 0 . 0
SUBNET MASK	255 . 255 . 255 . 0
DEFAULT GATEWAY	0 . 0 . 0 . 0

Displayed Information

▨ : Settable item

ETHERNET ADDRESS	Displays thr ethernet address.
IP ADDRESS	Sets the IP address.
SUBNET MASK	Sets the subnet mask.
DEFAULT GATEWAY	Sets the default gateway address.
NEXT	Moves to the next screen.
PREV	Returns to the previous screen.
BACK	Returns to the INITIALIZE screen.

LASER CONTROL


PREFERENCE (LASER CONTROL)

LASER CONTROL OPTION PARAMETERS

LD AUTO START	EXE	EXT-IO IN INTER-MODE	DISABLE
POWER MONI RESOL	0.00J	PULSE WIDTH RESOL	0.0ms
LASER START DELAY	16ms	CW TIME RESOL	0.1s
CW SLOPE WATCH	EXE		
LD SELF CHECK	OFF	GUIDE AUTO-OFF	0 min
OUTPUT CURR. VALUE FOR DETERIORATION RATE JUDGMENT			76.0 A

Displayed Information

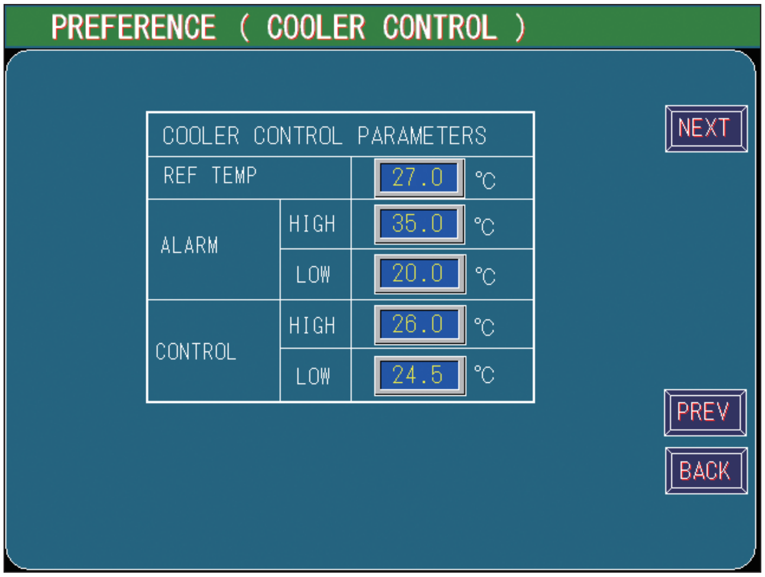
▨ : Settable item

LD AUTO START	Sets the LD to ON or OFF. When set to EXE the LD is turned ON automatically at AUTO START and the screen is displayed in the status of LD: OFF.
EXT-IO IN INTER-MODE	Switches the laser start/stop control by using the EXT. I/O connector. When set to ENABLE 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).
POWER MONI RESOL	Switches the measurement accuracy of the measured laser energy value (J) from 000.00 J or 00.000 J. ***<Note>*** To set this item to 00.000 J it is necessary to set the "PEAK POWER" value to 1.00 kW or less on the SCHEDULE screen.
PULSE WIDTH RESOL	Switches the setting resolution of pulse width (laser output time TIME [ms]) from 0.0 ms or 0.00 ms. ***<Note>*** To set this item to 0.00 ms you must set the value of "FLASH1" + "FLASH2" + "FLASH3" to 50 ms or less.
LASER START DELAY	Sets the acceptance time for laser start signal and schedule signal from 1 ms, 4 ms, 8 ms, or 16 ms.
CW TIME RESOL	Sets the setting resolution of CW from 0.01 s, 0.1 s, or 1 s.
CW SLOPE WATCH	Sets the slope portion to be monitored or not in the CW envelope monitoring. When set to EXE, the slope portion is monitored.
LD SELF CHECK	Sets the LD deterioration detecting function to ON/OFF.
GUIDE AUTO-OFF	Sets the time required for the guide light diode laser to go out automatically in the range of 1 to 98 minutes. This can be set in units of one minute. When 0 is set, no guide light is output. When 99 is set, the guide light does not go out automatically.

OUTPUT CURR. VALUE FOR DETERIORATION RATE JUDGMENT	Sets the LD current output for judgment of LD deterioration rate to the range of 5.0 to 114.0 A.
NEXT	Moves to the next screen.
PREV	Returns to the previous screen.
BACK	Returns to the INITIALIZE screen.

- When finished changing settings be sure to recycle power OFF so the setting takes effect before use.

COOLER CONTROL



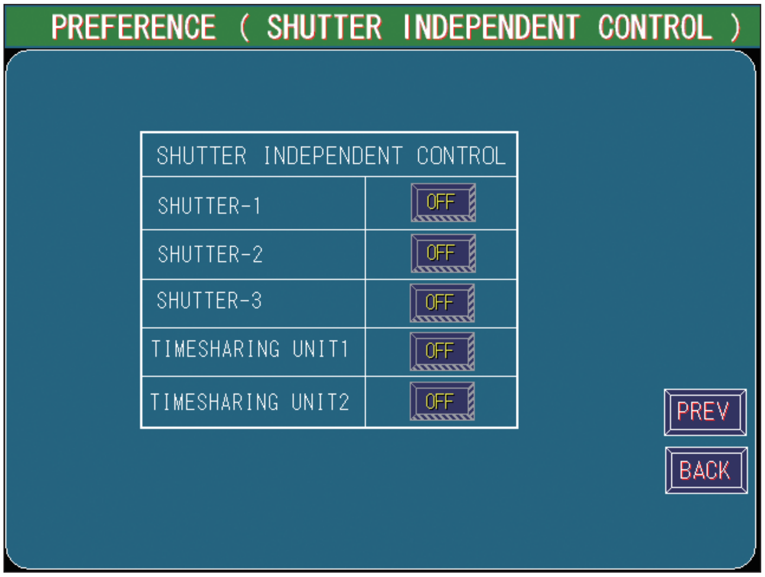
COOLER CONTROL PARAMETERS			
REF TEMP		27.0	℃
ALARM	HIGH	35.0	℃
	LOW	20.0	℃
CONTROL	HIGH	26.0	℃
	LOW	24.5	℃

Displayed Information

▨ : Settable item

REF TEMP	The temperature of secondary cooling water. Do NOT change the default value.
ALARM **HIGH** **LOW**	The lower limit value (LOW) and upper limit value (HIGH) of alarm temperature. Do NOT change the default values. ***<Note>*** When the temperature of secondary cooling water goes down below the value set in "LOW", Error No.039/COOLING WATER TEMP. LOW ERROR occurs. When the above temperature exceeds the value set in "HIGH", Error No.038/COOLING WATER TEMP. HIGH ERROR occurs. If the temperature of secondary cooling water does not reach "LOW + 2ºC or more" and "HIGH or less", Error No.038 or Error No.039 occurs.
CONTROL **HIGH** **LOW**	The lower limit value (LOW) and upper limit value (HIGH) of water temperature control. Do NOT change the default value.
NEXT	Moves to the next screen.
PREV	Returns to the previous screen.
BACK	Returns to the INITIALIZE screen.

SHUTTER INDEPENDENT CONTROL



PREFERENCE (SHUTTER INDEPENDENT CONTROL)

SHUTTER INDEPENDENT CONTROL	
SHUTTER-1	OFF
SHUTTER-2	OFF
SHUTTER-3	OFF
TIMESHARING UNIT1	OFF
TIMESHARING UNIT2	OFF

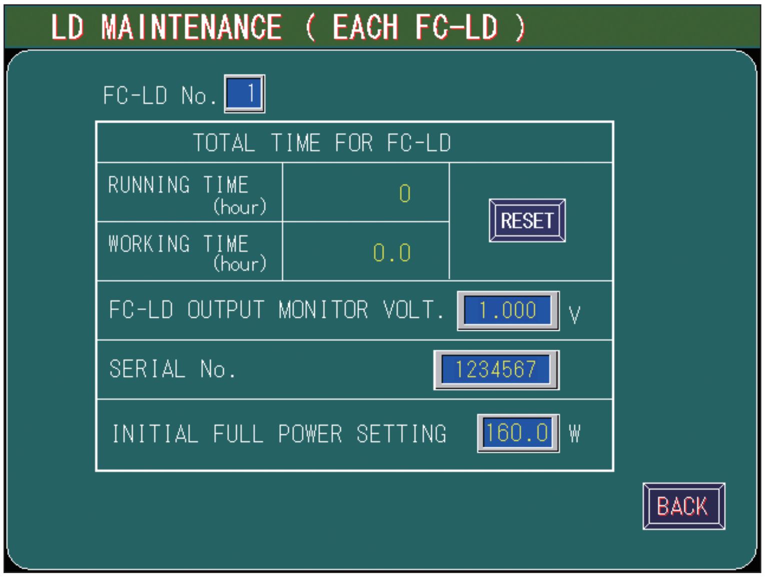
Displayed Information

▨ : Settable item

SHUTTER-1	When set to ON the safety shutter 1 is controlled independentlly.
SHUTTER-2	When set to ON the safety shutter 2 is controlled independentlly.
SHUTTER-3	When set to ON the safety shutter 3 is controlled independentlly.
TIMESHARING UNIT1	When set to ON the timesharing unit 1 is controlled independentlly.
TIMESHARING UNIT2	When set to ON the timesharing unit 2 is controlled independentlly.
PREV	Returns to the previous screen.
BACK	Returns to the INITIALIZE screen.

LD MAINTENANCE Screen

When the LD MAINTENANCE button is pressed on the INITIALIZE screen, the LD MAINTENANCE screen appears. On this screen the LD total time and output time can be reset after FC-LD replacement.


LD MAINTENANCE (EACH FC-LD)

FC-LD No. 1

TOTAL TIME FOR FC-LD
RUNNING TIME (hour) 0
WORKING TIME (hour) 0.0
FC-LD OUTPUT MONITOR VOLT. 1.000 V
SERIAL No. 1234567
INITIAL FULL POWER SETTING 160.0 W

Displayed Information

▨ : Settable item

FC-LD No.	Sets the FC-LD No. in the range of 1 to 14.
RUNNING TIME	Displays the total time for the specified FC-LD No. Press the RESET button to return the value to 0.
WORKING TIME	Displays the laset output time for the specified FC-LD No. Press the RESET button to return the value to 0.
FC-LD OUTPUT MONITOR VOLT.	Sets the output monitor voltage for the specified FC-LD No.
SERIAL No.	Sets the serial number for the specified FC-LD No.
INITIAL FULL POWER SETTING	Sets the initial power for the specified FC-LD No.
BACK	Returns to the INITIALIZE screen.

Setting Laser 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 stored after SCHEDULE numbers are assigned to them.

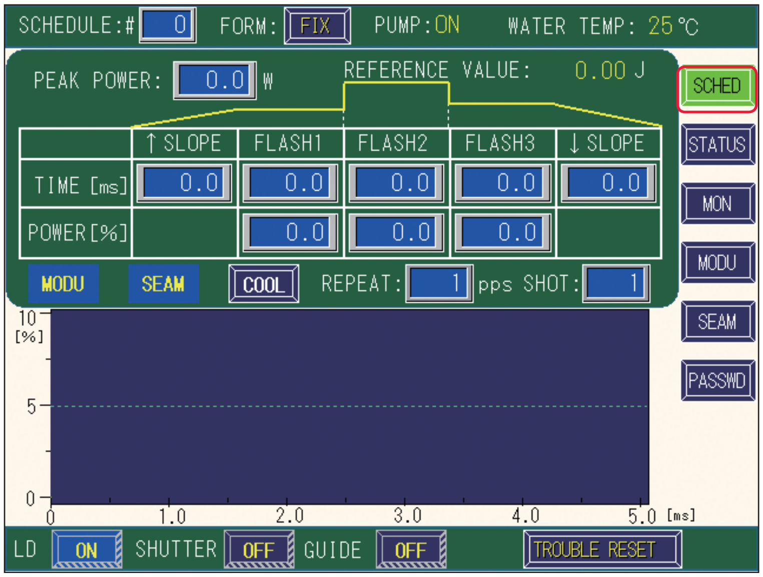
- 256 different output schedules can be created and stored with SCHEDULE numbers of #0 to #255. To perform laser welding, enter the stored SCHEDULE numbers and the laser welder will load the schedule for welding.
- It is convenient if you record the programmed output schedules in the Appendix "Output Schedule Data Entry Table" to create a permanent record of process parameters
- For details on setting specific items, refer to "Welding Schedule Setting Screen" on page 55.

1 Setting Output Schedules by Fixed Waveform (FIX)

Set the output time and output value of laser light in "FLASH1" (first segment) through "FLASH3" (third segment) in "FIX." mode You can program a pulse with up to three segments plus ramp up and ramp down.

In the following example, SCHEDULE No.: #0, peak value: 100 W, FLASH1: 3.6 ms/100%, COOL1: 0.0 ms, FLASH2: 2.4 ms/85%, COOL2: 0.0 ms, FLASH3: 1.9 ms/50%, up slope: 0.6 ms, and down slope: 1.2 ms are set as output schedules.

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



SCHEDULE:# 0 FORM: FIX PUMP:ON WATER TEMP: 25 ℃

PEAK POWER: 0.0 W REFERENCE VALUE: 0.00 J

	↑SLOPE	FLASH1	FLASH2	FLASH3	↓SLOPE
TIME [ms]	0.0	0.0	0.0	0.0	0.0
POWER[%]		0.0	0.0	0.0	

REPEAT: 1 pps SHOT: 1

LD ON SHUTTER OFF GUIDE OFF

(2) Press the "SCHEDULE" setting button.
Enter the SCHEDULE number by using the numeric keypad and then press the ENT key.

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

(4) Press the "PEAK POWER" setting button.
Enter the laser output peak value by using the numeric keypad and then press the ENT key.

<Note>

The maximum settable value of laser output peak value is 1000 W.

(5) Press the laser output time "TIME [ms]" and laser output value "POWER [%]" setting buttons of "FLASH1" to "FLASH3."
Enter each value by using the numeric keypad and then press the ENT key.

- The laser output time is set in the range of 0.0 to 499.9 ms. Regarding the laser output value, the ratio (%) based on the case where the set laser output peak value 100% is set.

<Note>

Set the laser output time to fit the following criteria.

0.05 ms ≦ FLASH1 + FLASH2 + FLASH3 ≦ 500.0 ms

<Note>

To protect the laser oscillator, the minimum power (approx. 20 W) of laser is output for the set laser output time regardless of the laser output value (%).

(6) To insert the output time of the minimum power (approx. 20 W) of laser between "FLASH1" and "FLASH2", press the COOL button to set the output stop time (ms) in "COOL1."

(7) To insert the output time of the minimum power (approx. 20 W) of laser 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 by using the numeric keypad, and then press the ENT key.

<Note>

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

Set the "↑SLOPE" to fit the following criteria:

↑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 by using the numeric keypad, and then press the ENT key.

<Note>

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

Set the "↓SLOPE" to fit the following criteria:

↓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 1 to 5000 pps (pulse per second) by using the numeric keypad.

- When 1 is set, a single output is performed.

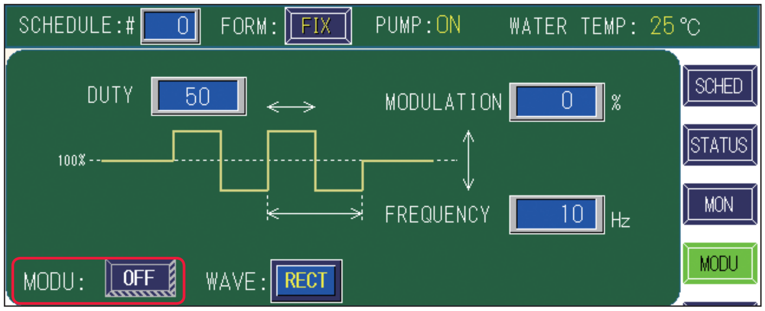
(11) To output laser light repeatedly, press the "SHOT" setting button and set the laser light output count in the range of 1 to 9999 by using the numeric keypad.

2 Setting ON/OFF for the Modulation Function

(1) Press the "MODU" button to display the MODULATION screen.

(2) Move the cursor to "MODU" and press the ON or OFF key to set whether the modulation function is valid or not.
When ON, the modulation function set on the MODULATION screen is enabled.
When this function is not used, set OFF.

- For the setting method of the modulation function, refer to "Setting the Modulated waveform" on page 84.



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 °C

DUTY 50

MODULATION 0 %

FREQUENCY 10 Hz

MODU: OFF WAVE: RECT

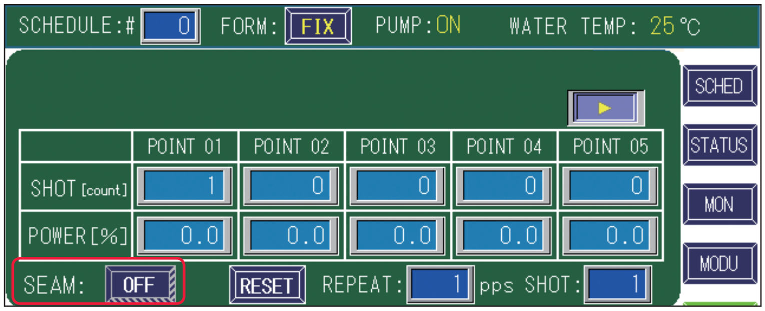
(3) Press the "SCHED" button to display the SCHEDULE screen.

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

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

(2) 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.

- For the setting method of the output conditions for seam welding, refer to "Setting the Output Conditions for Seam Welding" on page 86.



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 °C

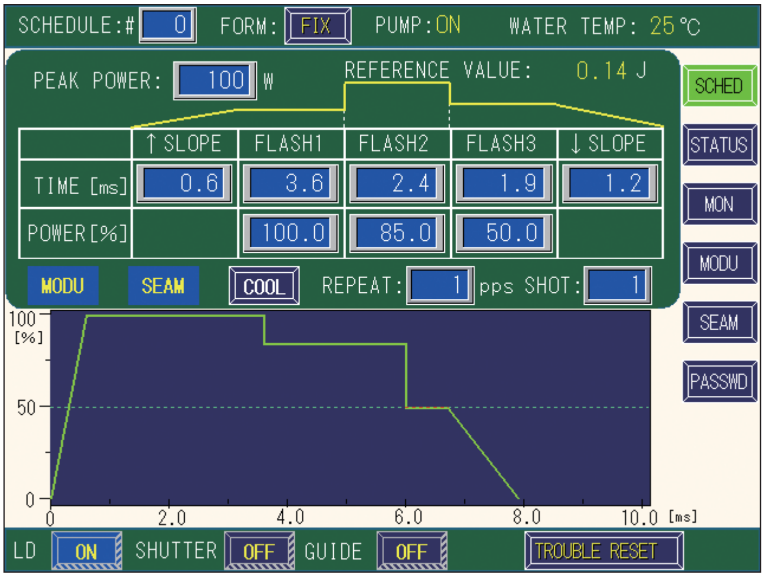
	POINT 01	POINT 02	POINT 03	POINT 04	POINT 05
SHOT [count]	1	0	0	0	0
POWER [%]	0.0	0.0	0.0	0.0	0.0

SEAM: OFF RESET REPEAT: 1 pps SHOT: 1

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

4 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.

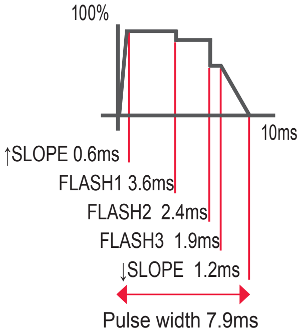

SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25℃

PEAK POWER: 100 W REFERENCE VALUE: 0.14 J

	↑SLOPE	FLASH1	FLASH2	FLASH3	↓SLOPE
TIME [ms]	0.6	3.6	2.4	1.9	1.2
POWER [%]		100.0	85.0	50.0	

MODU SEAM COOL REPEAT: 1 pps SHOT: 1

LD ON SHUTTER OFF GUIDE OFF TROUBLE RESET



- 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. This value is provided as a reference to help ease schedule configuration.

1 Setting Output Schedules by Flexible Waveform (FLEX)

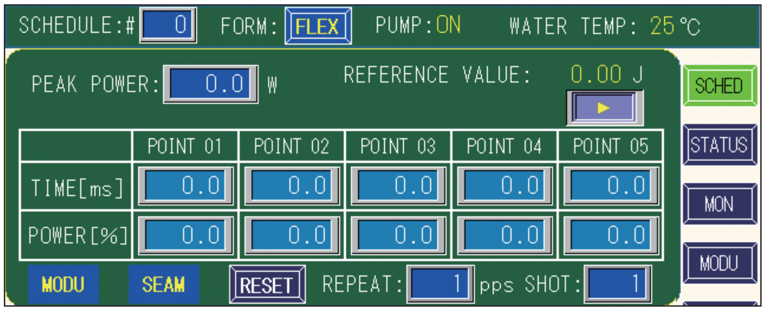
Set the output time and output value of each POINT in the range of "POINT 01" to "POINT 20" by "FLEX" and set the laser light output using the flexible waveform function.

In this example, SCHEDULE No.: #5, peak value: 100 W, POINT 01: 2.0 ms/80%, POINT 02: 1.2 ms/72%, POINT 03: 1.3 ms/56.5%, POINT 04: 2.3 ms/98.2%, and POINT 05: 1.4 ms/62% are set as output schedules.

- In the CW mode, the unit of TIME is sec.

(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.



SCHEDULE:# 0 FORM: FLEX PUMP: ON WATER TEMP: 25 °C

PEAK POWER: 0.0 W REFERENCE VALUE: 0.00 J

	POINT 01	POINT 02	POINT 03	POINT 04	POINT 05
TIME[ms]	0.0	0.0	0.0	0.0	0.0
POWER[%]	0.0	0.0	0.0	0.0	0.0

REPEAT: 1 pps SHOT: 1

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

(4) Press the "PEAK POWER" setting button.
Enter the laser output peak value by using the numeric keypad and then press the ENT key.

<Note>

The maximum settable laser output peak value is 1000 W.

(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 by using the numeric keypad and then press the ENT key.

- 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 0.0 to 499.9 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.

<Note>

To protect the laser oscillator, the minimum power (approx. 20 W) of laser is output for the set laser output time regardless of the laser output value (%).

(6) To output laser light several times repeatedly press the "REPEAT" setting button and set the laser light output count for one second in the range of 1 to 5000 pps (pulse per second) by using the numeric keypad.

- When 1 is set a single output is performed.
- To set to the CW mode select "CW" by using the numeric keypad.

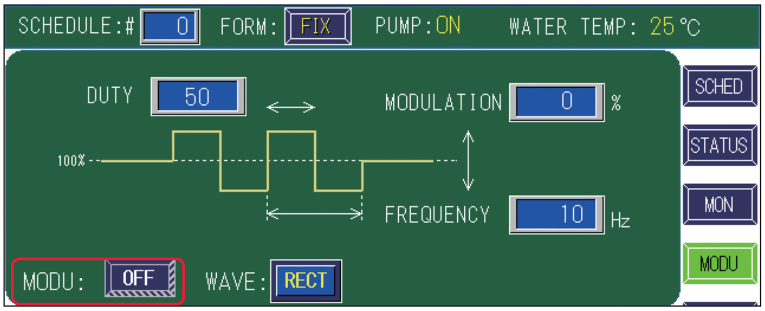
(7) To output laser light repeatedly press the "SHOT" setting button and set the laser light output count in the range of 1 to 9999 by using the numeric keypad.

2 Setting ON/OFF for the Modulation Function

(1) Press the "MODU" button to display the MODULATION screen.

(2) Move the cursor to "MODU" and press the ON or OFF key to set whether the modulation function is enabled.
When ON, the modulation function set on the MODULATION screen is enabled. When this function is not used set OFF.

- To program the modulation function refer to "Setting the Modulated waveform" on page 84.



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 ℃

DUTY 50

MODULATION 0 %

FREQUENCY 10 Hz

MODU: OFF WAVE: RECT

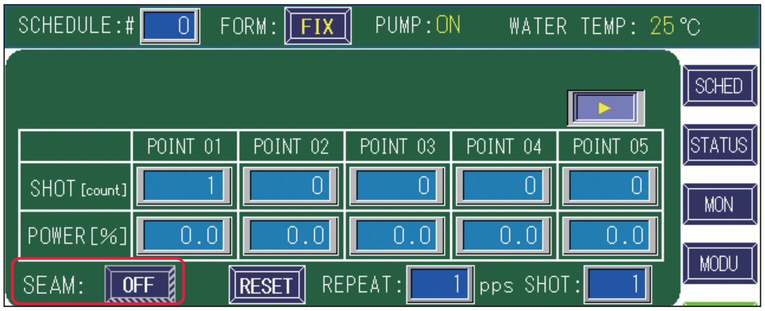
(3) Press the "SCHED" button to display the SCHEDULE screen.

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

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

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

- For the setting method of the output conditions for seam welding, refer to "Setting the Output Conditions for Seam Welding" on page 86.



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 ℃

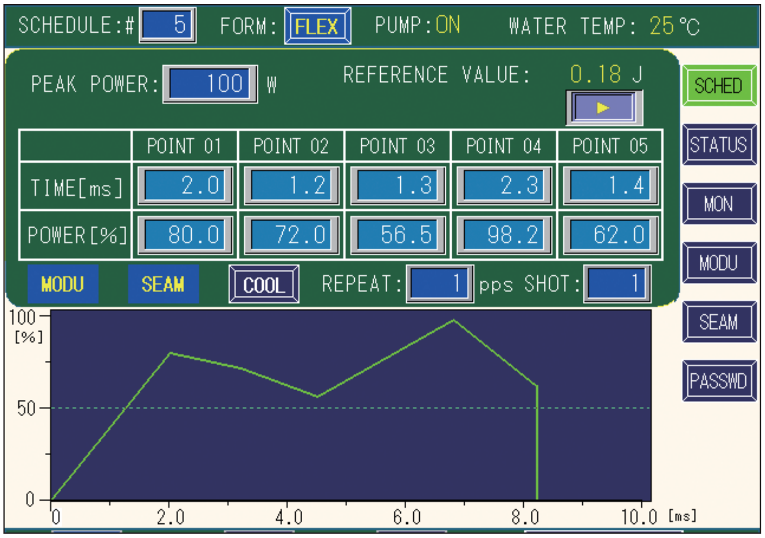
	POINT 01	POINT 02	POINT 03	POINT 04	POINT 05
SHOT [count]	1	0	0	0	0
POWER [%]	0.0	0.0	0.0	0.0	0.0

SEAM: OFF RESET REPEAT: 1 pps SHOT: 1

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

4 Checking Output Schedules

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



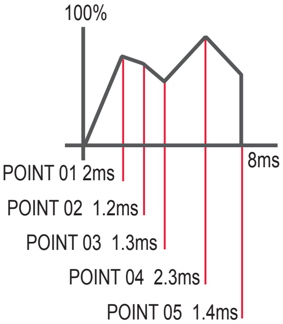
SCHEDULE:# 5 FORM: FLEX PUMP: ON WATER TEMP: 25 ℃

PEAK POWER: 100 W REFERENCE VALUE: 0.18 J

	POINT 01	POINT 02	POINT 03	POINT 04	POINT 05
TIME[ms]	2.0	1.2	1.3	2.3	1.4
POWER[%]	80.0	72.0	56.5	98.2	62.0

REPEAT: 1 pps SHOT: 1

SCHED
STATUS
MON
MODU
SEAM
PASSWD
MODU
SEAM
COOL
100
[%]
50
0
0
2.0
4.0
6.0
8.0
10.0 [ms]



100%
8ms
POINT 01 2ms
POINT 02 1.2ms
POINT 03 1.3ms
POINT 04 2.3ms
POINT 05 1.4ms

- 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. This value is designed to be used as a reference to assist in designing weld schedules.

Setting the Modulated Waveform (MODULATION Screen)

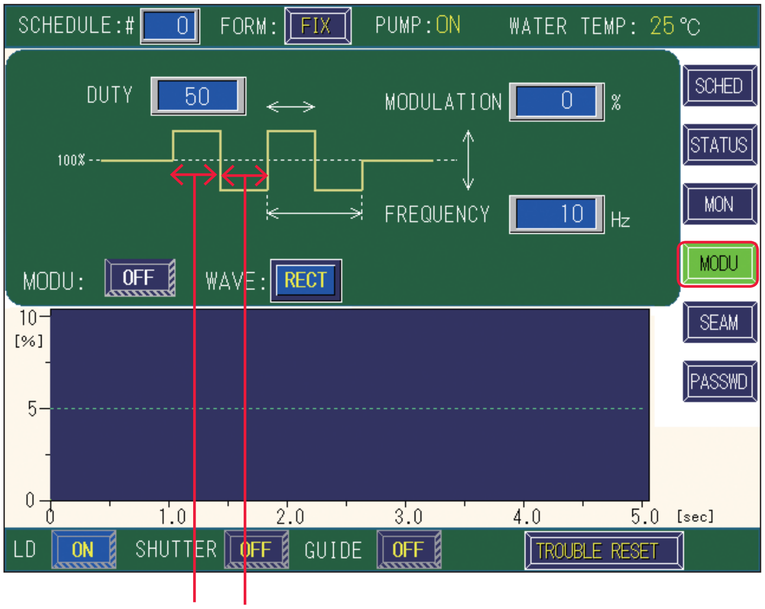
Setting the modulated waveform is explained below. The modulated waveform enables various kinds of processing since it modulates the pulse width by setting a certain modulated width and frequency.

- When using the modulated waveform, set the laser output value "POWER [%]" to 100% for normal use.
- When the modulated laser is output the output time may be slightly longer than the programmed value.

1 Setting the Modulated Waveform

(1) Press the "MODU" button to display the MODULATION screen.

- Data for a single representative modulation cycle is displayed as a graph on the MODULATION screen. Set the ratio of the period of High in a cycle in "DUTY", the modulaton width in "MODULATION", and the repetition period (frequency) in "FREQUENCY."



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 °C

DUTY 50

MODULATION 0 %

FREQUENCY 10 Hz

MODU: OFF WAVE: RECT

LD ON SHUTTER OFF GUIDE OFF

High Low

(2) Press the "DUTY" setting button.
Enter the duty cycle (%) using the numeric keypad and then press the ENT key.

(3) Press the "MODULATION" setting button.
Enter the modulated width by using the numeric keypad and then press the ENT key.

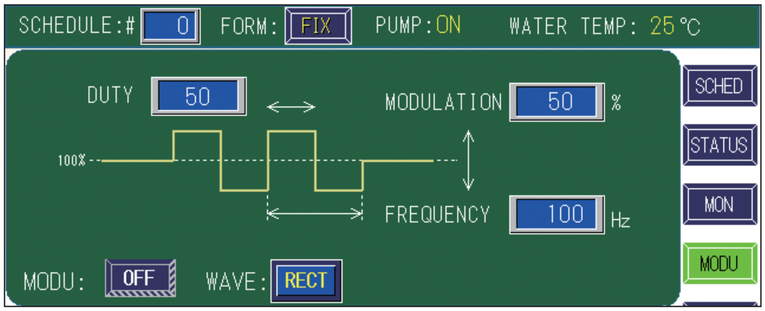
<Note>

The modulated width cannot exceed the maximum peak output value. For example, when "POWER" is 410 W, the result is "POWER 410 W x Modulated width 25% = 513 W." The setting more than 50% cannot be set.

<Note>

To protect the laser oscillator the minimum power (approx. 20 W) of laser is output regardless of the modulation width (%).

(4) Press the "FREQUENCY" setting button.
Enter the repetition frequency by using the numeric keypad and then press the ENT key.



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 °C

DUTY 50

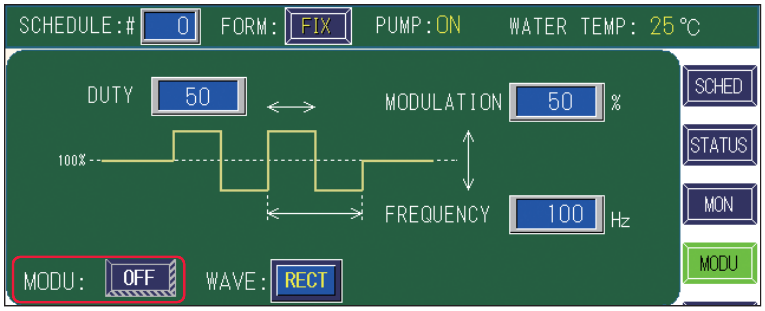
MODULATION 50 %

FREQUENCY 100 Hz

MODU: OFF WAVE: RECT

2. Enabling the Modulation Function

(1) Press the "MODU" setting button to set it to ON.



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 °C

DUTY 50

MODULATION 50 %

FREQUENCY 100 Hz

MODU: OFF WAVE: RECT

- When the modulation function is not used, keep the "MODU" setting button OFF.

<Notes>

When the moduation function is set there is input limit even if the "MODU" setting button is set to OFF. When you cannot change "POWER" on the SCHEDULE screen or the settings on the MODULATION screen, refer to the following.

- **When "POWER" on the SCHEDULE screen cannot be changed**
  Check the settings of modulation function on the MODULATION screen and change the settings so as not to exceed the input limit.
- **When the settings on the MODULATION screen cannot be changed**
  Check schedules and change the value of "POWER" so as not to exceed the input limit.

Setting the Output Conditions for Seam Welding (SEAM Screen)

Setting the output waveform for seam welding 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 seam weld can be made beautiful and more resistant to leakage sites.

- Only when REPEAT/SHOT is ≧ 1, can the SEAM function be set.

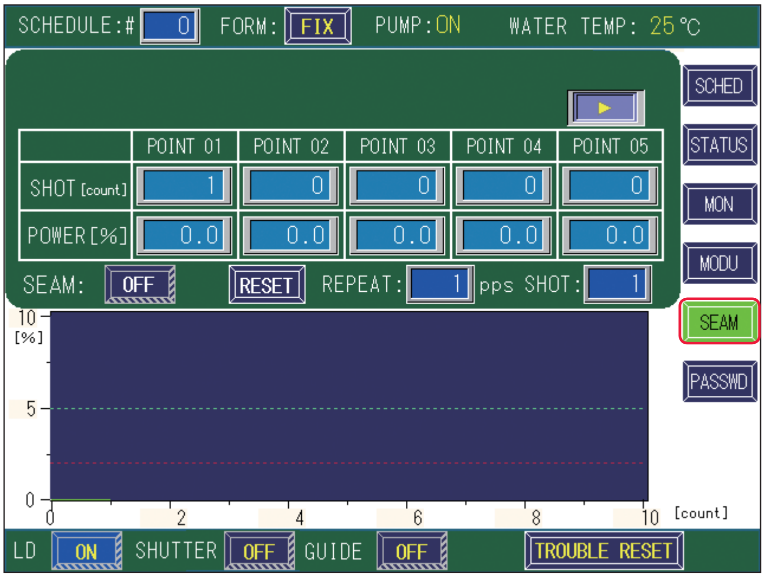
1

Setting the Output Conditions

Using a seam weld in which laser light is continuously output 100 times as an example, the output count of "POINT 01" to "POINT 20" and energy are programmed. The energy at the beginning/end of laser light output is made weaker by the fade out 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.



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 ℃

	POINT 01	POINT 02	POINT 03	POINT 04	POINT 05
SHOT [count]	1	0	0	0	0
POWER [%]	0.0	0.0	0.0	0.0	0.0

SEAM: OFF RESET REPEAT: 1 pps SHOT: 1

LD ON SHUTTER OFF GUIDE OFF TROUBLE RESET

2

Setting the Fade-in/out Function

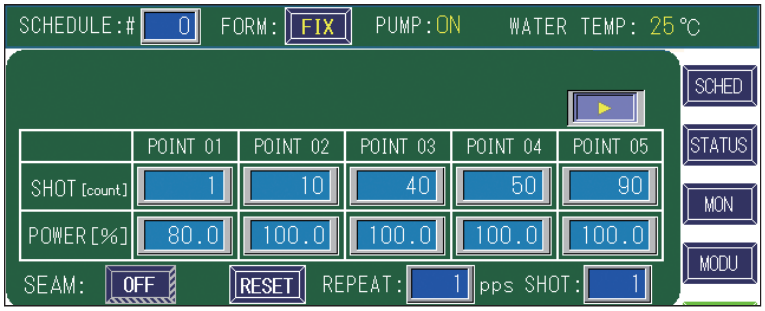
(1) Press the "SHOT [COUNT]" setting button of "POINT 01."
Enter the starting laser light output count by using the numeric keypad and then press the ENT key. Set 0001

For "SHOT [COUNT]" of "POINT 01", only 1 can be set.

(2) Press the "POWER [%]" setting button of "POINT 01."
Enter the laser output value (%) by using the numeric keypad and then press the ENT key.
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 to access "POINT 06".



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 °C

	POINT 01	POINT 02	POINT 03	POINT 04	POINT 05
SHOT [count]	1	10	40	50	90
POWER [%]	80.0	100.0	100.0	100.0	100.0

SEAM: OFF RESET REPEAT: 1 pps SHOT: 1

<Note>

If the output count set in "SHOT" is smaller than that set in "SHOT [COUNT]", any values >SHOT in SHOT[COUNT] are 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 40 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.)

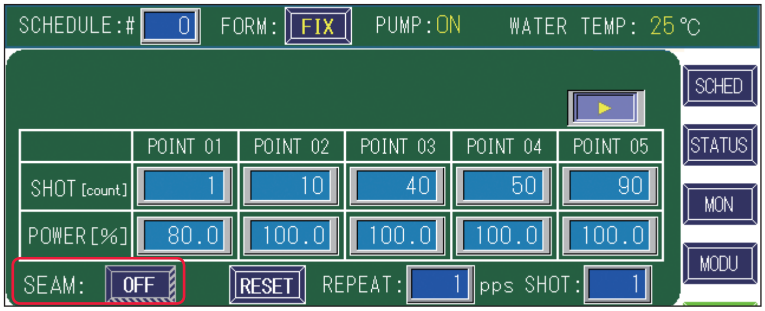
<Note>

To protect the laser oscillator, the minimum power (approx. 20 W) of laser is output for the set laser output time regardless of the laser output value (%).

3 Enabling the Fade Function

(1) Press the "SEAM" setting button 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.



SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 °C

	POINT 01	POINT 02	POINT 03	POINT 04	POINT 05
SHOT [count]	1	10	40	50	90
POWER [%]	80.0	100.0	100.0	100.0	100.0

SEAM: OFF RESET REPEAT: 1 pps SHOT: 1

Setting the Output Status (STATUS Screen)

This section explains the STATUS screen. On this screen the user can check the displayed control method and the set the safety shutter at the output destination to OPEN. It is possible to set or reset the number of shots.

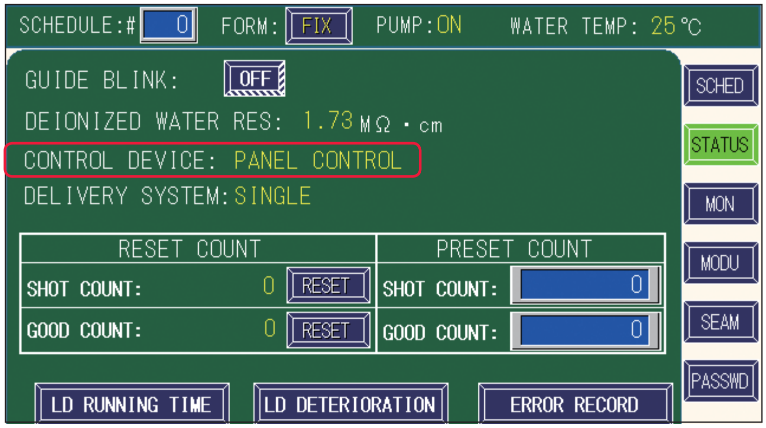
- For details of setting items, refer to "Welding Schedule Setting Screen" on page 58.

Checking the Control Method

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

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 control is exerted from the laser controller and "PANEL CONTROL" is displayed in "CONTROL DEVICE."



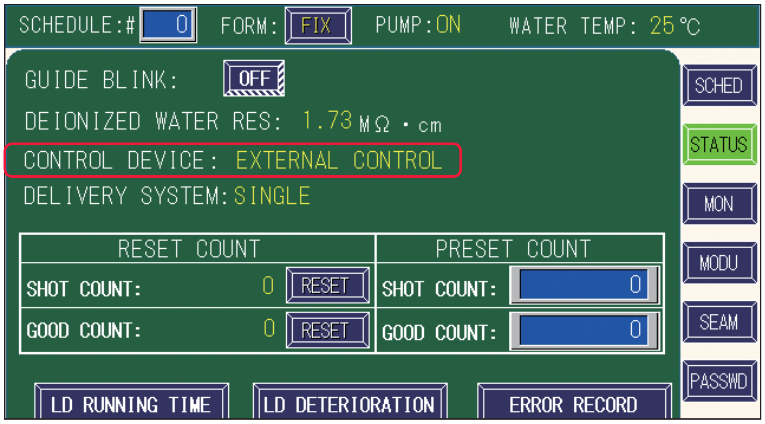
SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25℃
GUIDE BLINK: OFF
DEIONIZED WATER RES: 1.73 MΩ・cm
CONTROL DEVICE: PANEL CONTROL
DELIVERY SYSTEM: SINGLE

RESET COUNT		PRESET COUNT	
SHOT COUNT:	0	SHOT COUNT:	0
GOOD COUNT:	0	GOOD COUNT:	0

RESET
RESET
SCHED
STATUS
MON
MODU
SEAM
PASSWD
LD RUNNING TIME
LD DETERIORATION
ERROR RECORD

Control by External Input Signal (EXTERNAL CONTROL)

Connect the main unit to the PLC or other external controller and turn ON pin No.25 (control switching) of the EXT. I/O (1) connector. The control method is switched over to external input/output signal control (EXTERNAL CONTROL) and "EXTERNAL CONTROL" is displayed in "CONTROL DEVICE."



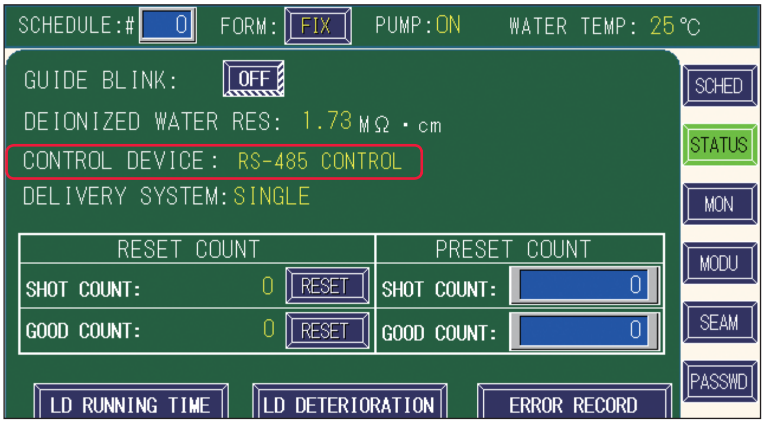
SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25℃
GUIDE BLINK: OFF
DEIONIZED WATER RES: 1.73 MΩ・cm
CONTROL DEVICE: EXTERNAL CONTROL
DELIVERY SYSTEM: SINGLE

RESET COUNT		PRESET COUNT	
SHOT COUNT:	0	SHOT COUNT:	0
GOOD COUNT:	0	GOOD COUNT:	0

RESET
RESET
SCHED
STATUS
MON
MODU
SEAM
PASSWD
LD RUNNING TIME
LD DETERIORATION
ERROR RECORD

Control by External Communication Control (RS-485 CONTROL)

When a command is sent from a personal computer for control, "RS-485 CONTROL" is displayed in "CONTROL DEVICE" on the STATUS screen.



SCHEDULE:# 0
FORM: FIX
PUMP: ON
WATER TEMP: 25 °C
GUIDE BLINK: OFF
DEIONIZED WATER RES: 1.73 MΩ・cm
CONTROL DEVICE: RS-485 CONTROL
DELIVERY SYSTEM: SINGLE

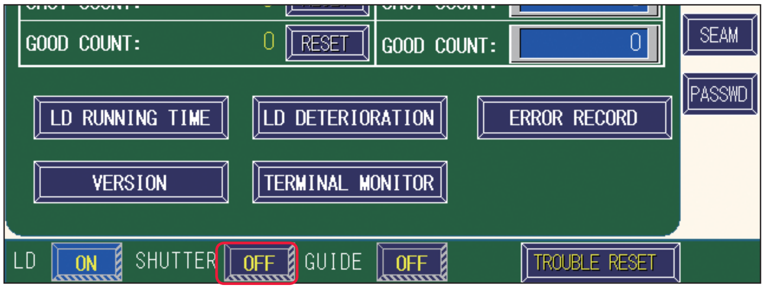
RESET COUNT		PRESET COUNT	
SHOT COUNT:	0	SHOT COUNT:	0
GOOD COUNT:	0	GOOD COUNT:	0

RESET
RESET
SCHED
STATUS
MON
MODU
SEAM
PASSWD
LD RUNNING TIME
LD DETERIORATION
ERROR RECORD

Setting the Opening/Closing Status of the Safety Shutter

To control the laser welder from the laser controller press the "SHUTTER" button on the STATUS screen to open/close the safety shutter. "SHUTTER 1" to "SHUTTER 3" are associated with safety shutters 1 to 3.

When ON, the corresponding safety shutter is opened and laser light is output.



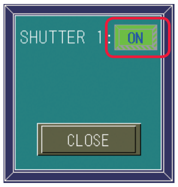
GOOD COUNT: 0
GOOD COUNT: 0
LD: ON
SHUTTER: OFF
GUIDE: OFF

RESET
SEAM
PASSWD
LD RUNNING TIME
LD DETERIORATION
ERROR RECORD
VERSION
TERMINAL MONITOR
TROUBLE RESET

(1) Press the "SHUTTER" button.
A window to open/close the safety shutter and beamsplitter will open.

- The displayed window will depend on the laser configuration.

(2) Press the setting buttons for "SHUTTER 1" through "SHUTTER 3" to open/close of the safety shutters as indicated by ON/OFF.



SHUTTER 1: ON

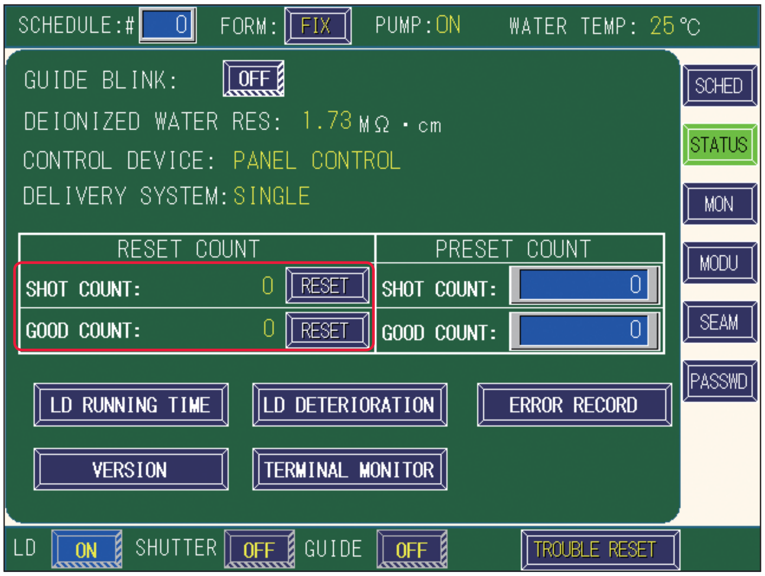
(For single delivery specification)

(3) Press the "CLOSE" button.
The opening/closing of the safety shutter is set and the window will close.

Resetting the Laser Count

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

(1) Press the "RESET" button under "SHOT COUNT" or "GOOD COUNT" in the RESET COUNT section.
The numeric value is reset and "0" is displayed.



SCHEDULE:# 0
FORM: FIX
PUMP: ON
WATER TEMP: 25 ℃
GUIDE BLINK: OFF
DEIONIZED WATER RES: 1.73 MΩ・cm
CONTROL DEVICE: PANEL CONTROL
DELIVERY SYSTEM: SINGLE

RESET COUNT			PRESET COUNT	
SHOT COUNT:	0	RESET	SHOT COUNT:	0
GOOD COUNT:	0	RESET	GOOD COUNT:	0

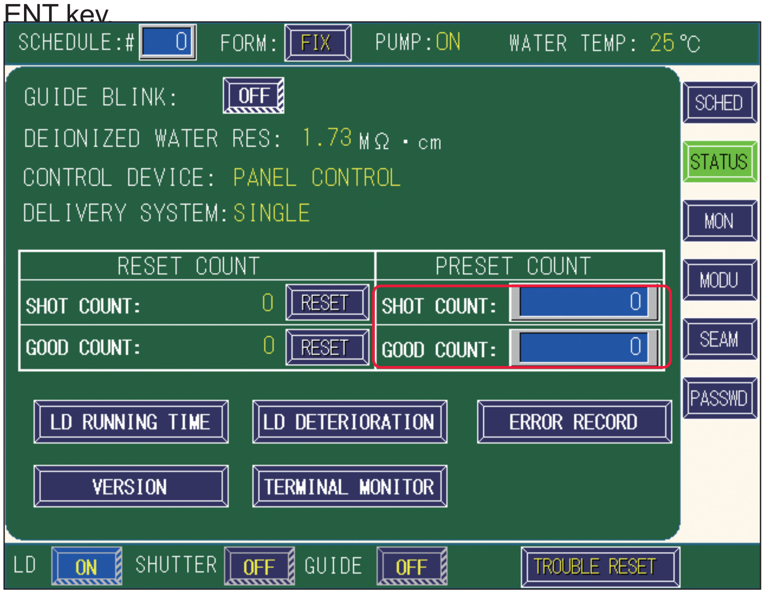
LD ON
SHUTTER OFF
GUIDE OFF

SCHED
STATUS
MON
MODU
SEAM
PASSWD
LD RUNNING TIME
LD DETERIORATION
ERROR RECORD
VERSION
TERMINAL MONITOR
TROUBLE RESET

Setting the Count-Notification Function

When "SHOT COUNT" (total number of laser outputs) or "GOOD COUNT" (appropriate number of laser outputs) that are displayed on the MONITOR screen reaches the threshold 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 under the PRESET COUNT section.
Enter an optional output count by using the numeric keypad and then press the ENT key.



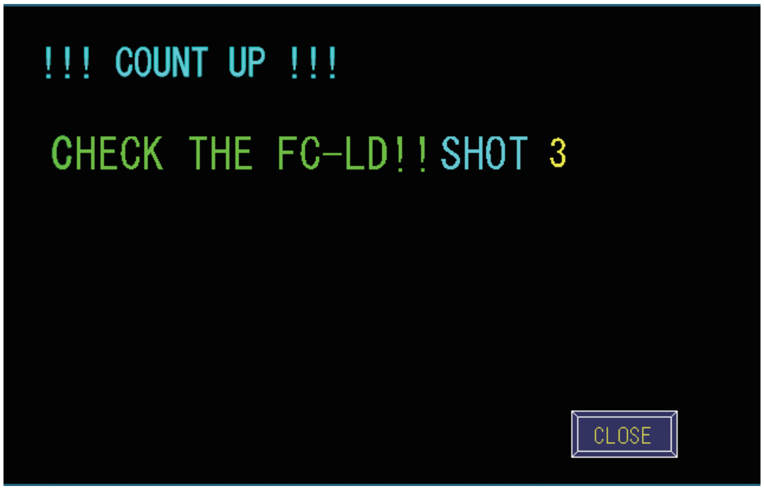
SCHEDULE:# 0
FORM: FIX
PUMP: ON
WATER TEMP: 25 ℃
GUIDE BLINK: OFF
DEIONIZED WATER RES: 1.73 MΩ・cm
CONTROL DEVICE: PANEL CONTROL
DELIVERY SYSTEM: SINGLE

RESET COUNT			PRESET COUNT	
SHOT COUNT:	0	RESET	SHOT COUNT:	0
GOOD COUNT:	0	RESET	GOOD COUNT:	0

LD ON
SHUTTER OFF
GUIDE OFF

SCHED
STATUS
MON
MODU
SEAM
PASSWD
LD RUNNING TIME
LD DETERIORATION
ERROR RECORD
VERSION
TERMINAL MONITOR
TROUBLE RESET

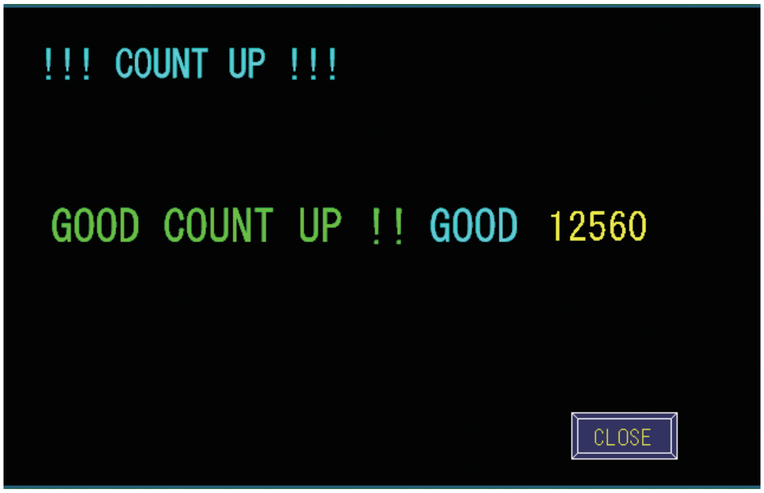
When "SHOT COUNT" reaches the set value a screen to prompt the operator to check the FC-LD is displayed.



!!! COUNT UP !!!

CHECK THE FC-LD!! SHOT 3

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



!!! COUNT UP !!!

GOOD COUNT UP !! GOOD 12560

Press the "CLOSE" button to return the current screen to the initial screen.

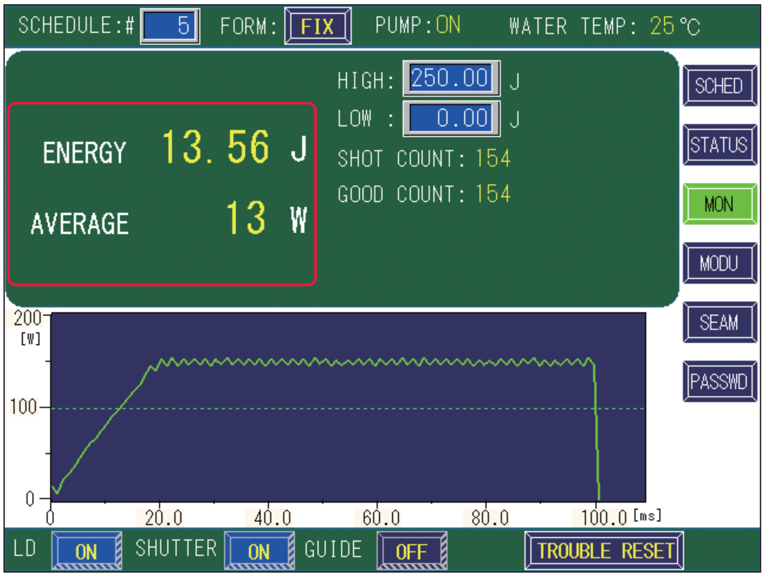
Setting the Output Status Check Screen (MONITOR Screen)

On this screen, the measured energy value of output laser light is checked, and the energy range to be monitored is set.

Checking the Measured Energy Value of Laser Pulses

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

(1) Press the "SCHEDULE" setting button.
Enter the SCHEDULE number by using the numeric keypad and then press the ENT key.
The measured energy value of the last output laser light and laser light waveform are displayed according to the set SCHEDULE.


SCHEDULE:# 5 FORM: FIX PUMP: ON WATER TEMP: 25 ℃

HIGH: 250.00 J

LOW : 0.00 J

SHOT COUNT: 154

GOOD COUNT: 154

ENERGY 13.56 J

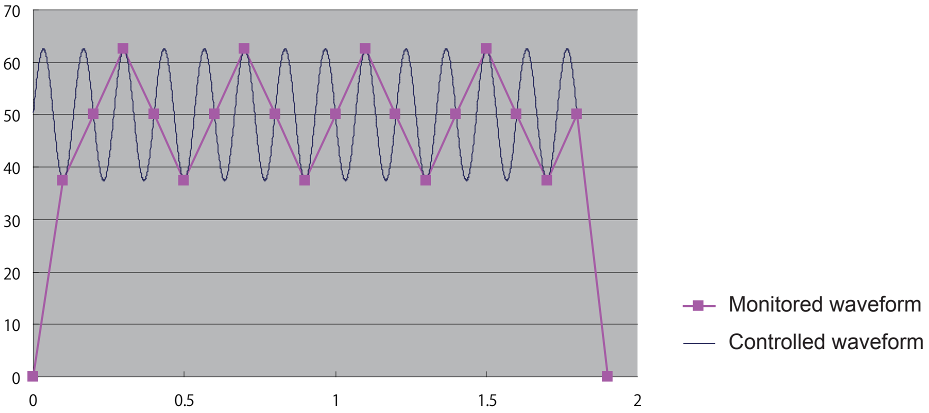
AVERAGE 13 W

LD ON SHUTTER ON GUIDE OFF

<Note>

In the CW waveform, the displayed waveform may be different from the actual laser output due to the sampling period of data for displaying a waveform.

Ex.) CW modulation setting: Frequency = 15 Hz, Modulation width = 25%

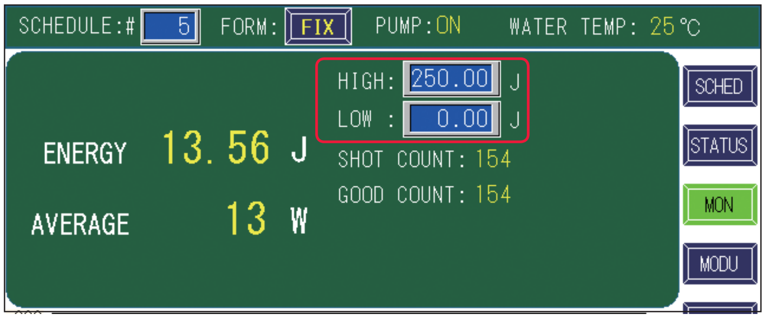


Setting the Laser Energy Range To Be Monitored

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

(1) Press the "HIGH" setting button.
Enter the upper limit value by using the numeric keypad and then press the ENT key.
The upper limit value of allowable energy is registered.

(2) Press the "LOW" setting button.
Enter the lower limit value by using the numeric keypad and then press the ENT key.
The lower limit value of allowable energy is registered.


SCHEDULE:# 5 FORM: FIX PUMP:ON WATER TEMP: 25℃

HIGH: 250.00 J
LOW : 0.00 J
ENERGY 13. 56 J
SHOT COUNT: 154
GOOD COUNT: 154
AVERAGE 13 W

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

Switching the Pulse Width Setting Resolution (PREFERENCE Screen)

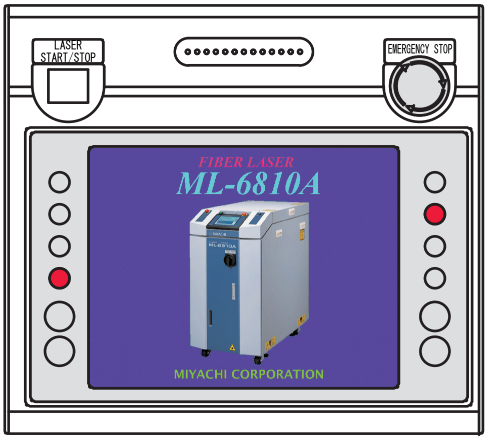
Use the following method to set the pulse width setting resolution for laser light (laser output time). First, accessing the PREFERENCE screen from the INITIALIZE screen is explained.

This setting permits switching the pulse width of 0.1 ms (0.1 s) step over to 0.05 ms (0.01 s or 1 s) step so that more minute welding work can be performed.

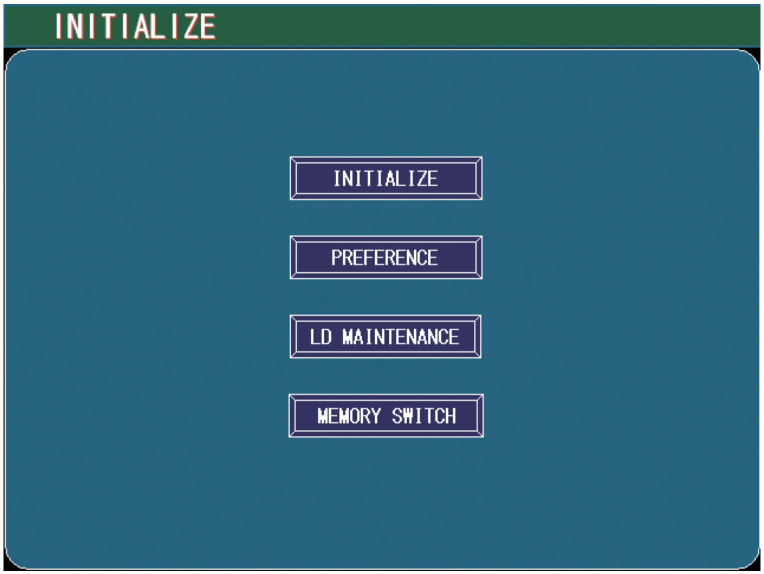
1.

Displaying the PREFERENCE Screen

(1) Turn OFF the CONTROL switch and turn ON the MAIN POWER switch.
When power is supplied and the POWER lamp comes on the and a picture of the laser with the model name will appear.

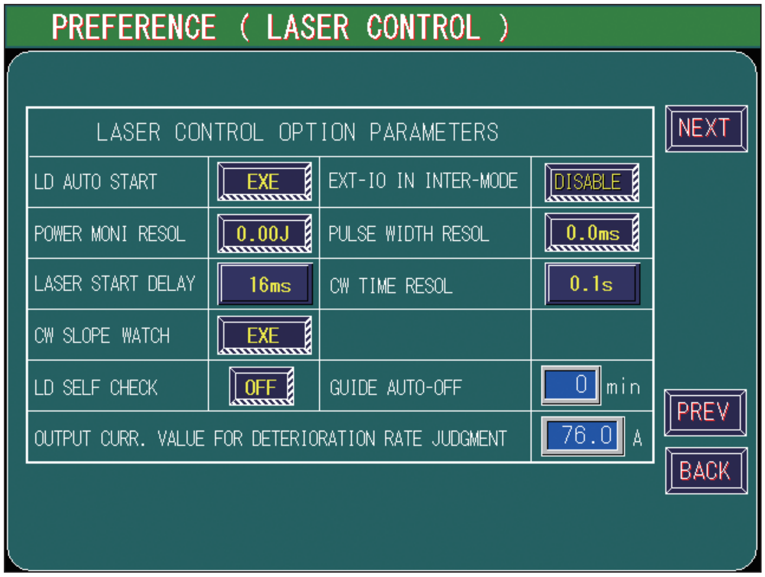

LASER START/STOP
EMERGENCY STOP
FIBER LASER
ML-6810A
MIYACHI CORPORATION

(2) While the laser model screen is displayed (for about 3 seconds), press the right and left buttons (red portions in the above figure) of the laser controller simultaneously for 2 seconds.
The INITIALIZE screen appears.


INITIALIZE
INITIALIZE
PREFERENCE
LD MAINTENANCE
MEMORY SWITCH

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

(3) Press the PREFERENCE button.
The PREFERENCE screen appears. Press the "NEXT" button to display the page of LASER CONTROL.

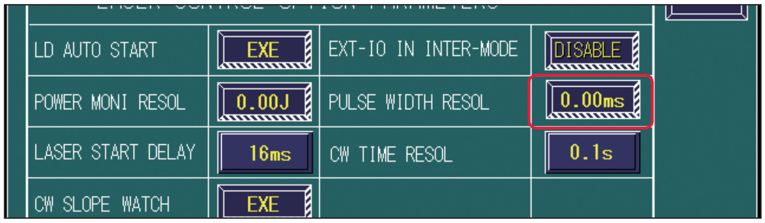

PREFERENCE (LASER CONTROL)

LASER CONTROL OPTION PARAMETERS

LD AUTO START	EXE	EXT-IO IN INTER-MODE	DISABLE
POWER MONI RESOL	0.00J	PULSE WIDTH RESOL	0.0ms
LASER START DELAY	16ms	CW TIME RESOL	0.1s
CW SLOPE WATCH	EXE		
LD SELF CHECK	OFF	GUIDE AUTO-OFF	0 min
OUTPUT CURR. VALUE FOR DETERIORATION RATE JUDGMENT			76.0 A

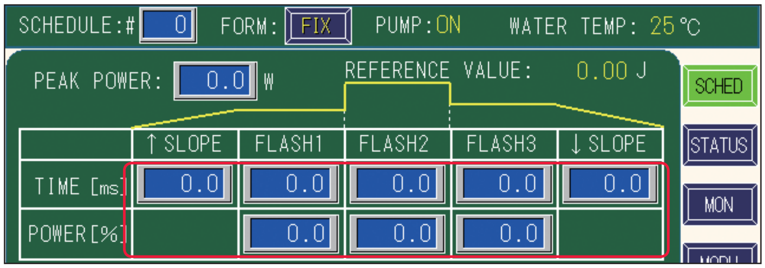
2 Switching the Pulse Width Setting Resolution

(1) Press the "PULSE WIDTH RESOL" setting button.



LD AUTO START	EXE	EXT-IO IN INTER-MODE	DISABLE
POWER MONI RESOL	0.00J	PULSE WIDTH RESOL	0.00ms
LASER START DELAY	16ms	CW TIME RESOL	0.1s
CW SLOPE WATCH	EXE		

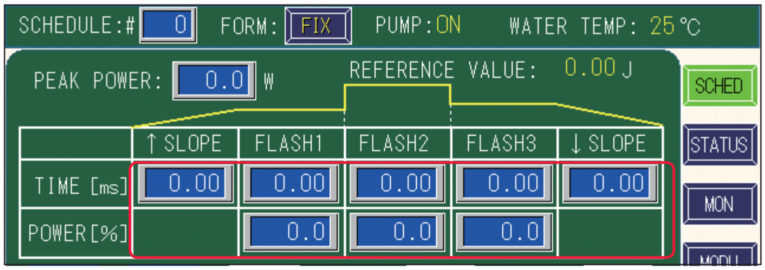
(2) Press the "BACK" button.
The INITIALIZE screen reappears and the setting resolution for pulse width on the SCHEDULE screen is switched.
Setting example before switching ("PULSE WIDTH RESOL": 0.0 ms)


SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 ℃

PEAK POWER: 0.0 W REFERENCE VALUE: 0.00 J

	↑SLOPE	FLASH1	FLASH2	FLASH3	↓SLOPE
TIME [ms]	0.0	0.0	0.0	0.0	0.0
POWER [%]		0.0	0.0	0.0	

Setting example after switching ("PULSE WIDTH RESOL": 0.00 ms)


SCHEDULE:# 0 FORM: FIX PUMP: ON WATER TEMP: 25 ℃

PEAK POWER: 0.0 W REFERENCE VALUE: 0.00 J

	↑SLOPE	FLASH1	FLASH2	FLASH3	↓SLOPE
TIME [ms]	0.00	0.00	0.00	0.00	0.00
POWER [%]		0.0	0.0	0.0	

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

<Notes>

- To change the SWITCH setting the value of "FLASH1" + "FLASH2" + "FLASH3" of each SCHEDULE must be 50.0 ms or less.
- The value of "FLASH1" + "FLASH2" + "FLASH3" is as follows after the setting of "PULSE WIDTH RESOL."

Setting	Maximum value (ms)	Minimum value (ms)	Step (ms)
0.00 ms	50.00	0.05	0.05
0.0 ms	500.0	0.1	0.1

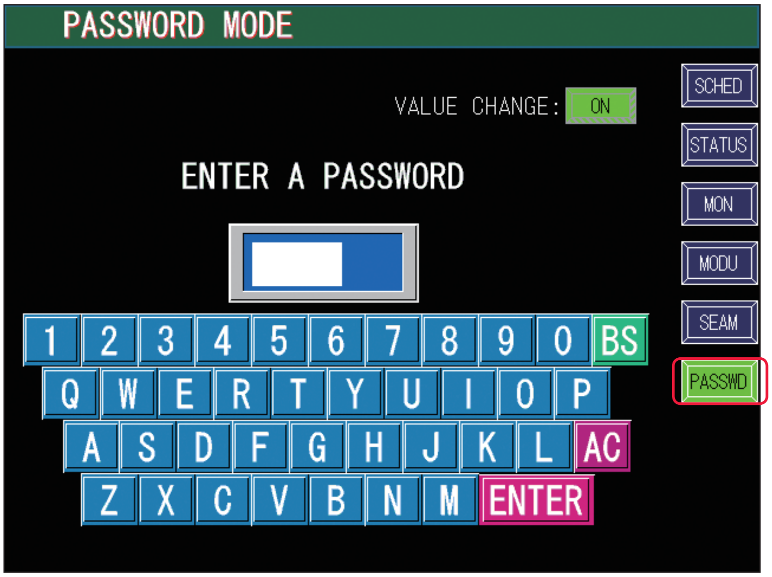
- Set the values of output time in 0.05 step after setting "PULSE WIDTH RESOL" to 0.00 ms.

Protecting Set Values (PASSWORD Screen)

The method of protecting programmed values by setting the password is explained below. When the password is set and validated setting 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.

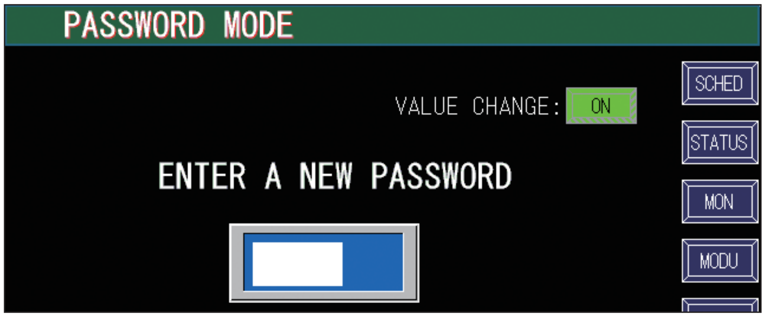

PASSWORD MODE
VALUE CHANGE: ON
ENTER A PASSWORD
SCHED
STATUS
MON
MODU
SEAM
PASSWD
1 2 3 4 5 6 7 8 9 0 BS
Q W E R T Y U I O P
A S D F G H J K L AC
Z X C V B N M ENTER

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 the entered characters 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.

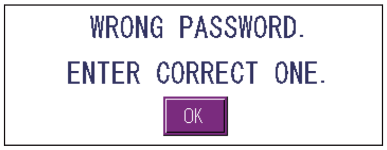
(2) Press the ENTER key on the keyboard.
When the entered password is correct the new password setting screen is displayed.


PASSWORD MODE

VALUE CHANGE: ON

ENTER A NEW PASSWORD

When the entered password is wrong the WRONG PASSWORD screen is displayed.
Enter the set password once again.


WRONG PASSWORD.
ENTER CORRECT ONE.

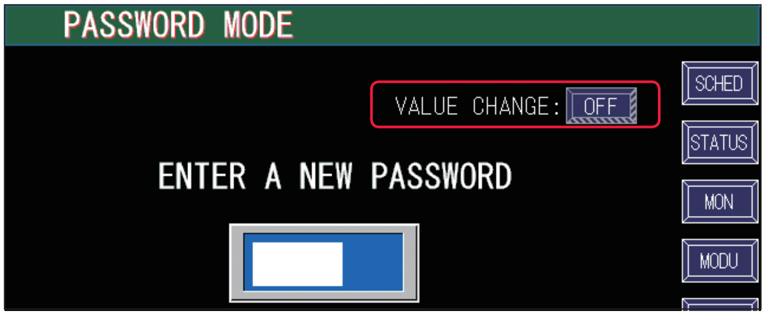
3 Validating the Password

(1) Press the "VALUE CHANGE" setting button.
A window to select ON/OFF is opened.
At ON, the set password can be changed. When OFF, it is impossible to change the set values without the 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 setting items are protected, disabling change.

- Unless "VALUE CHANGE" is set to OFF the setting items are not protected, and any person can change the settings. This is true even if a password is set.

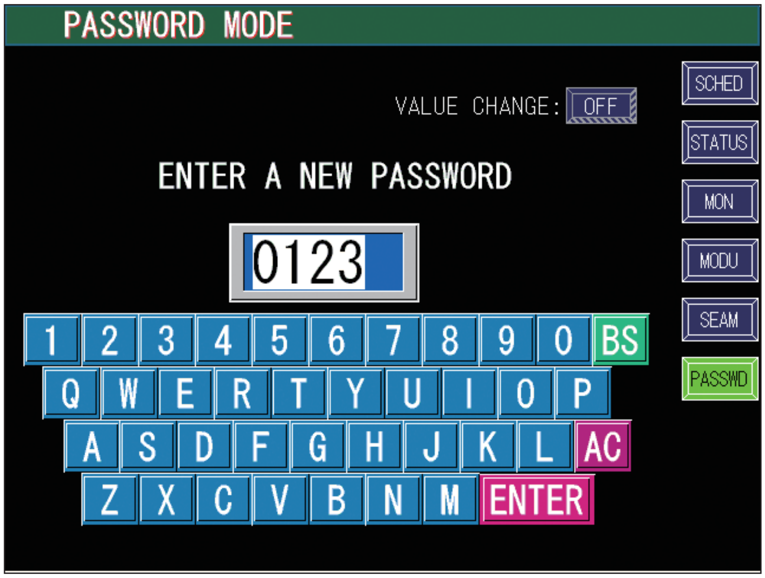

PASSWORD MODE

VALUE CHANGE: OFF

ENTER A NEW PASSWORD

Setting a New Password

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


PASSWORD MODE

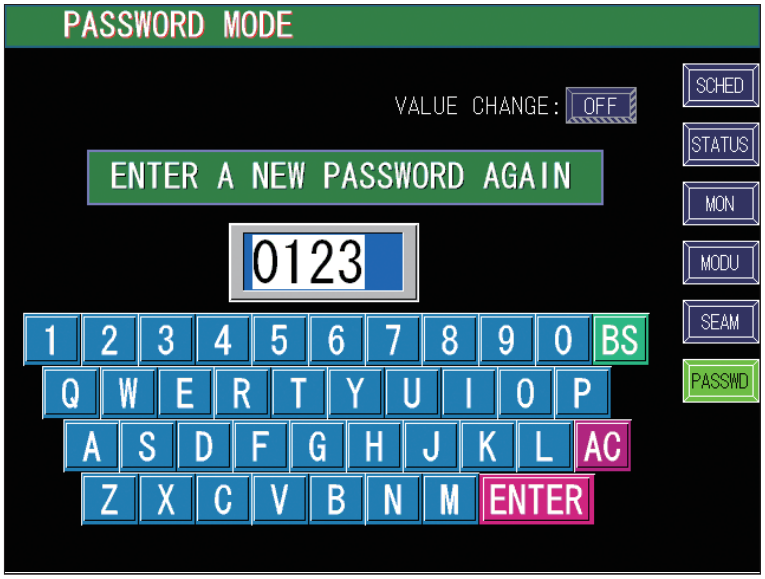
VALUE CHANGE: OFF

ENTER A NEW PASSWORD

0123

SCHED
STATUS
MON
MODU
SEAM
PASSWD
1 2 3 4 5 6 7 8 9 0 BS
Q W E R T Y U I O P
A S D F G H J K L AC
Z X C V B N M ENTER

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


PASSWORD MODE

VALUE CHANGE: OFF

ENTER A NEW PASSWORD AGAIN

0123

SCHED
STATUS
MON
MODU
SEAM
PASSWD
1 2 3 4 5 6 7 8 9 0 BS
Q W E R T Y U I O P
A S D F G H J K L AC
Z X C V B N M ENTER

(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) ↑SLOPE (Time for up-sloping to FLASH1) FLASH1 (Output time and output value of the first laser) COOL1 (Output time of the minimum power of laser to be inserted between FLASH1 and FLASH2) FLASH2 (Output time and output value of the second laser) COOL2 (Output time of the minimum power of laser to be inserted between FLASH2 and FLASH3) FLASH3 (Output time and output value of the third laser) ↓SLOPE (Time for down-sloping to the last FLASH) POINT 01 to 20 (Output time and output value of each point for FLEX) REPEAT (Number of laser light outputs per second) SHOT (Total number of laser light outputs)
STATUS Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX waveform switching) GUIDE BLINK (Guide light blinking or lighting ON/OFF) 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 (Conut-notification setting of the total number of laser light outputs, SHOT COUNT) GOOD COUNT (Conut-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)
MODULATION Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX waveform switching) MODU (Modulation function ON/OFF) DUTY (Duty ratio) MODULATION (Modulation degree) FREQUENCY (Frequency)
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) SEAM (Fade function ON/OFF)
Maintenance Screen*	FLASH CONTROL MODE in the maintenance mode

* The maintenance screen is a maintenance mode display screen to be used when our engineer performs maintenance. Usually, the customer does not use it.

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."

2. Setting the Laser Light Delivery

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

Laser Beam Sharing

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

While power sharing laser light is split into multiple beams by beamsplitter and then transfered 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 output beams become weaker than the original beam.

While timesharing a single laser beam reflected on the mirror of the timesharing unit is transferred to a single optical fiber to perform welding. A selected safety shutter is opened, so that laser light is output as 100% energy without being split. Each beam has full power but no two beams can be output at the same time since they "share time"

The LF1000A main unit is provided with a safety shutter with opening/closing sensors and a single output. The unit can be configured for multiple outputs by adding optomechanical hardware and changing dipswitch settings on the PCB control.

The following 5 types of sharing specification are available.

Sharing method	Corresponding model
Single: Output by single optical fiber	LF1000A-1E
2-powersharing: Output from 2 optical fibers at the same time	LF1000A-2E
3-powersharing: Output from 3 optical fibers at the same time	LF1000A-3E
2-timesharing: Output from one optionally selected out of 2 optical fibers	LF1000A-2T
3-timesharing: Output from one optionally selected out of 3 optical fibers	LF1000A-3T

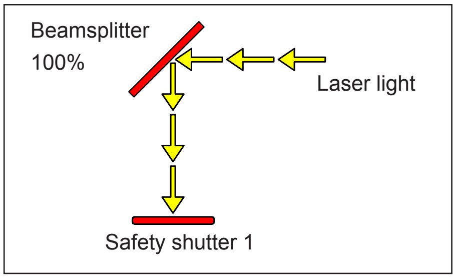
In the above timesharing examples, as soon as the safety shutters are opened by setting "SHUTTER 1" to "SHUTTER 3" to ON after pressing the "SHUTTER" button, the timesharing unit is automatically operated to redirect laser light.

More complicated control schemes are available. For this setting, set the independent control of the safety shutter by using the DIP switch in the main unit and then set the safety shutter and timesharing unit to be operated on the PREFERENCE screen.

- For how to set the independent control of the safety shutter refer to "Controlling Safety Shutters Independently" on page 103.

Single

A single safety shutter is opened to output laser light through a single optical fiber.

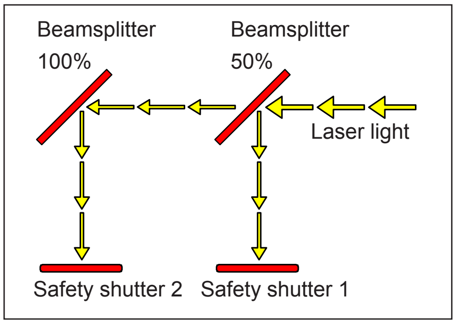

Beamsplitter
100%
Laser light
Safety shutter 1

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

2-powershare delivery to 3-powershare delivery

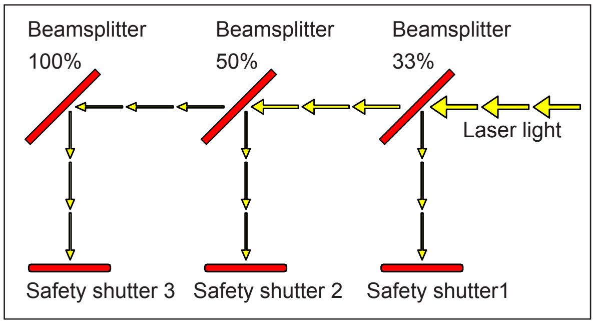
Laser light is split according to the number of built-in safety shutters and then simultaneously output. For example, in the 2-powershare delivery, two safety shutters are opened to branch laser light into 2 beams, so that these beams are output simultaneously. When using 3-powershare delivery three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

2-powersharing


Beamsplitter
100%
Beamsplitter
50%
Laser light
Safety shutter 2
Safety shutter 1

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

3-powersharing

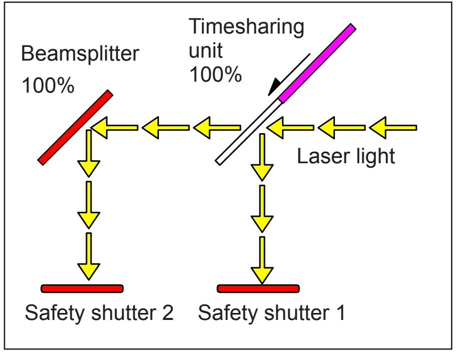

Beamsplitter
100%
Beamsplitter
50%
Beamsplitter
33%
Laser light
Safety shutter 3
Safety shutter 2
Safety shutter1

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

2-timesharing delivery to 3-timesharing delivery

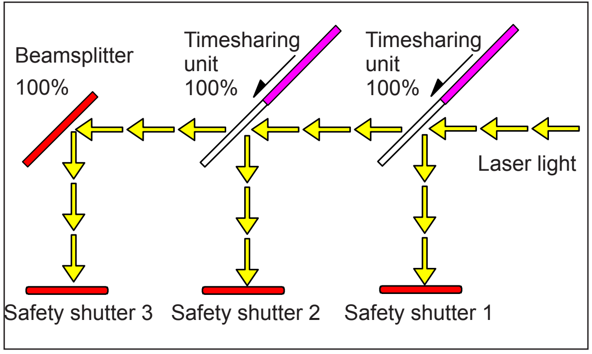
While timesharing only one of the built-in safety shutters is opened to output laser light at any given time. For example, when safety shutter 2 is opened, laser light is output to the optical fiber connected to input unit 2. If an operation is performed to open two safety shutters or more, the safety shutter with a smaller No. has priority because two or more safety shutters can not be opened at one time.

2-timesharing


Beamsplitter
100%
Timesharing
unit
100%
Laser light
Safety shutter 2
Safety shutter 1

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

3-timesharing


Beamsplitter
100%
Timesharing
unit
100%
Timesharing
unit
100%
Laser light
Safety shutter 3
Safety shutter 2
Safety shutter 1

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

Operating Safety Shutters on the STATUS Screen

Performing open/close operations on the safety shutters using the STATUS screen.

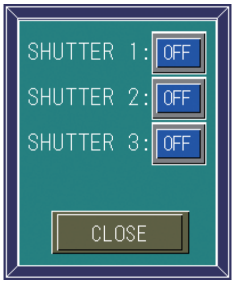
On the STATUS screen it is possible to perform open/close operations to allow safety shutters to transfer laser light.

For this laser the following 5 types of sharing specification are available. The DIP switches on the Main PCB 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
2-timesharing	OFF	ON	OFF	OFF
3-timesharing	OFF	ON	OFF	ON

Operating Procedure

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



SHUTTER 1: OFF
SHUTTER 2: OFF
SHUTTER 3: OFF

(2) Press the setting button for "SHUTTER 1" to "SHUTTER 3" corresponding to the connected optical fiber to set it to ON.
"SHUTTER 1" to "SHUTTER 3" are associated with safety shutters 1 to 3 and input units 1 to 3. The safety shutter that is set to ON is opened to allow laser light to be transmitted. The safety shutters that are set to OFF are not opened, so laser light is interrupted.

- The display 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.

<Note>

When powersharing, do not output a laser with either one of branch shutters closed. Excessive emission into the shutter will be detected as internal overheating and the Laser will stop.

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

Controlling Safety Shutters Independently

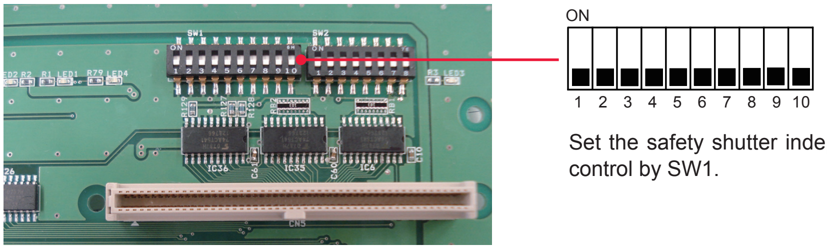
Setting safety shutters to independent control by setting DIP switches.

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

When "SHUTTER 1" to "SHUTTER 3" are set to ON and the safety shutter is opened, the safety shutter and the timeshare unit are automatically operated to transmit laser light. When safety shutters are put under independent control the timesharing unit and the safety shutter are not operated together even if "SHUTTER" is set to ON. Accordingly laser light can be transferred by a sharing method other than the standard 5 types of sharing specification.

The DIP switches of SW1 are provided on the interface board in the main unit. The independent control function for safety shutter is assigned to No.5, No.6, No.7, and No.8 of SW1. Remove the right side cover of the main unit and set SW1 to ON/OFF to set this function.

Interface board in the main unit (ME-2111)

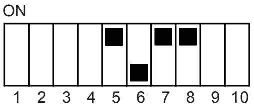


Set the safety shutter independent control by SW1.

Setting Independent Control

(1) Remove the side cover of the main unit and set No.5 of DIP switch SW1 to ON, No.6 to OFF, and No.7 and No.8 to ON.

SW1



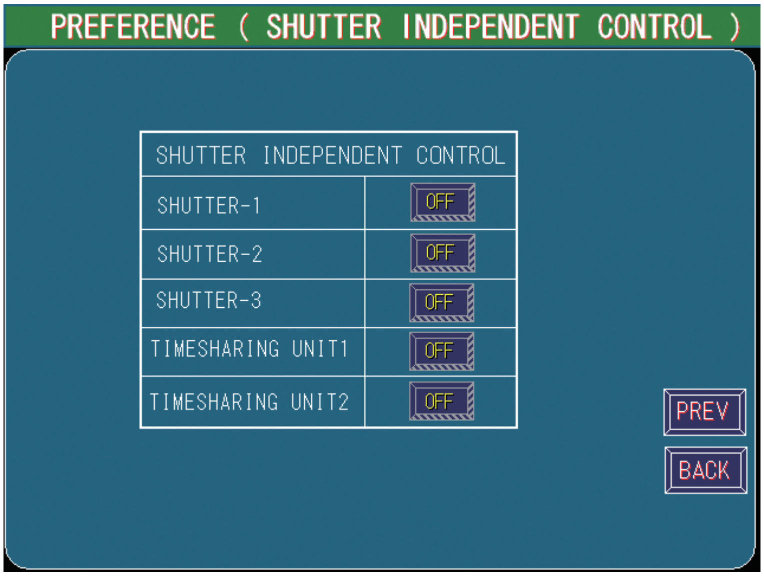
Set No.5 to ON.
Set No.6 to OFF.
Set No.7 to ON.
Set No.8 to ON.

Safety shutter independent control

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

Operating a custom safety shutter and timesharing setup

(1) After putting the safety shutter in independent control press the PREFERENCE button on the INITIALIZE screen.
The PREFERENCE screen is displayed. Press the "NEXT" button to display the page of SHUTTER INDEPENDENT CONTROL.



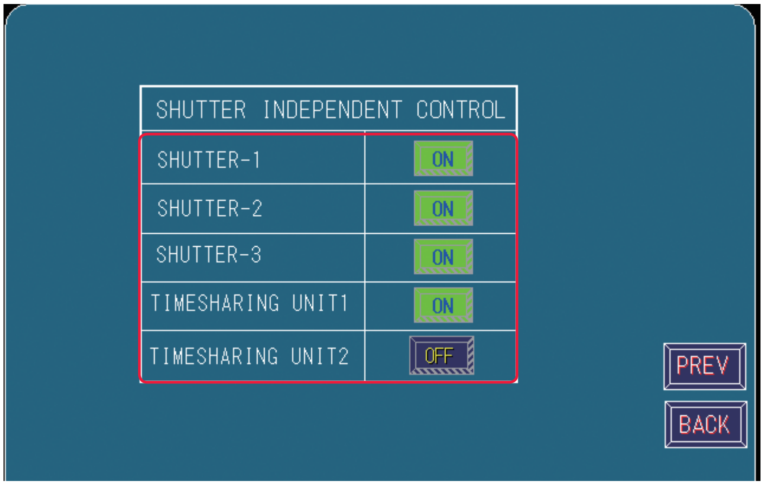
PREFERENCE (SHUTTER INDEPENDENT CONTROL)

SHUTTER INDEPENDENT CONTROL	
SHUTTER-1	OFF
SHUTTER-2	OFF
SHUTTER-3	OFF
TIMESHARING UNIT1	OFF
TIMESHARING UNIT2	OFF

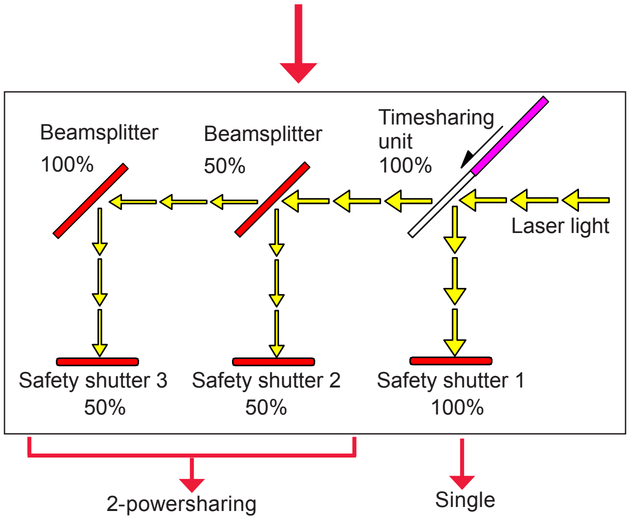
(2) Press the "SHUTTER-1" to "SHUTTER-3" setting buttons to set the safety shutter No. to be turned ON.
"SHUTTER-1" to "SHUTTER-3" are associated with safety shutters 1 to 3. Accordingly, set them to ON within the number of mounted safety shutters.

(3) Set the timeshare unit numbers to be operated to ON by "TIMESHARING UNIT1" and "TIMESHARING UNIT2."

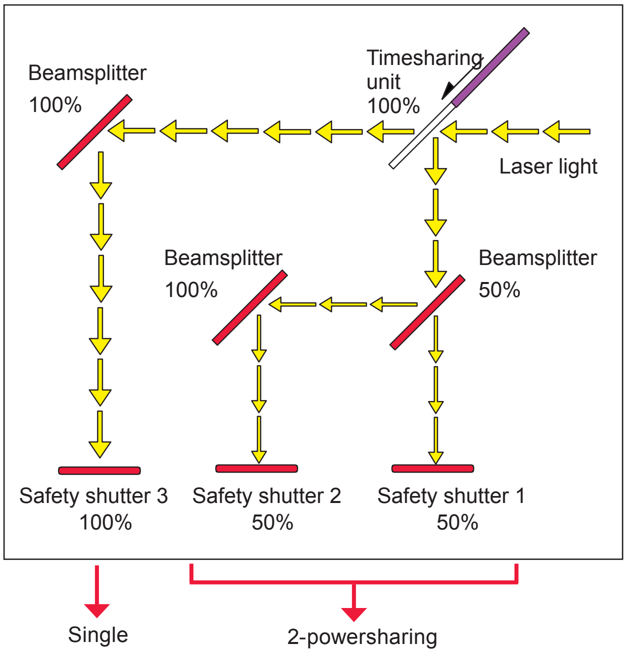
For example, in the case of single delivery + 2-powersharing delivery, set ON by "SWITCH 4" and "SWITCH 5" as shown below. Then, laser light is output from safety shutter 1 as a single delivery and from safety shutter 2 and 3 as 2-powersharing delivery.



SHUTTER INDEPENDENT CONTROL	
SHUTTER-1	ON
SHUTTER-2	ON
SHUTTER-3	ON
TIMESHARING UNIT1	ON
TIMESHARING UNIT2	OFF


Beamsplitter
100%
Beamsplitter
50%
Timesharing unit
100%
Laser light
Safety shutter 3
50%
Safety shutter 2
50%
Safety shutter 1
100%
2-powersharing
Single

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


Beamsplitter
100%
Timesharing unit
100%
Laser light
Beamsplitter
100%
Beamsplitter
50%
Safety shutter 3
100%
Safety shutter 2
50%
Safety shutter 1
50%
Single
2-powersharing

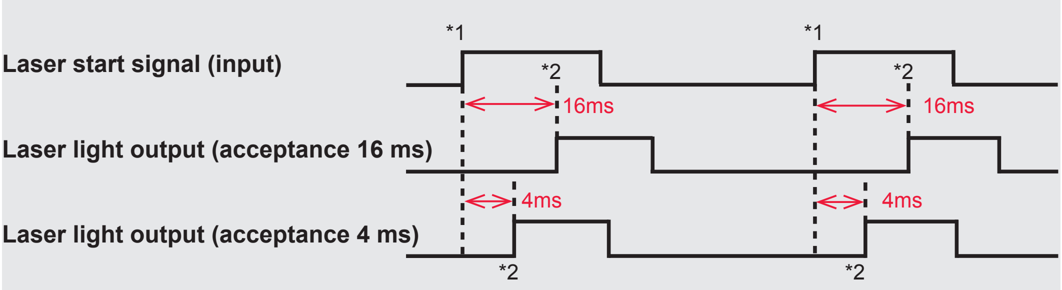
3. Changing the Acceptance Time for Laser Start Signal/ Schedule Signal (PREFERENCE Screen)

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) and (2) connectors. This is accomplished by using the PREFERENCE screen while EXTERNAL CONTROL is exerted by external input/output signals.

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


Laser start signal (input)
Laser light output (acceptance 16 ms)
Laser light output (acceptance 4 ms)
*1
*2
16ms
4ms
*1
*2
16ms
4ms
*2
*2

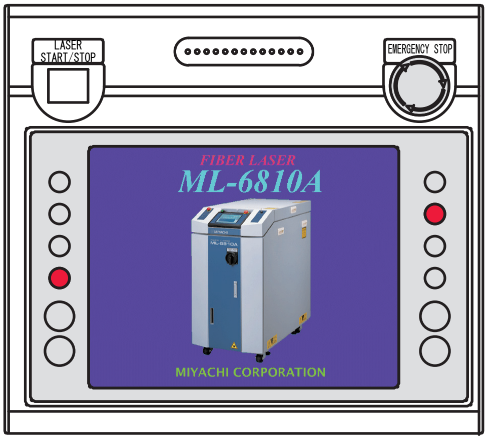
- The laser start signal acceptance time and the schedule signal acceptance time are common. A different value cannot be set for each time.

1 ms, 4 ms, 8 ms, and 16 ms are available. At delivery the acceptance time is set to 16 ms.

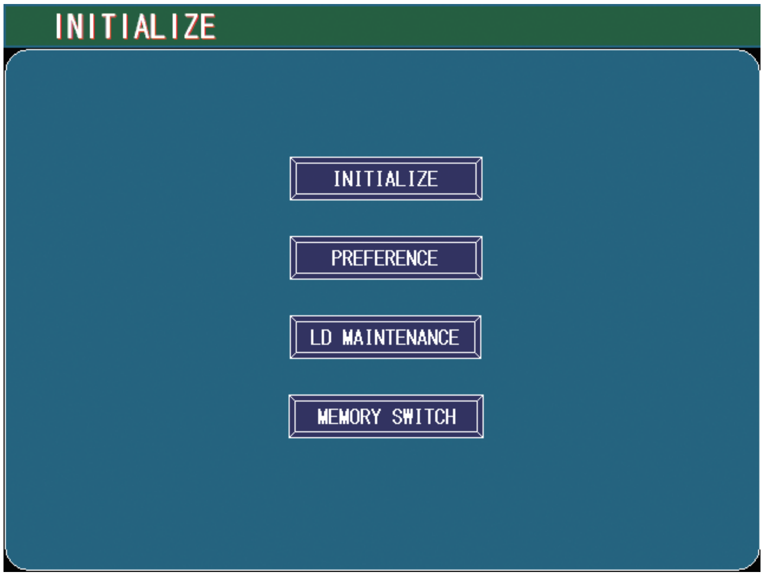
Usually, the acceptance time for laser start signal is 16 ms but can be shortened as required. To change this setting, switch the setting of "LASER START DELAY" on the PREFERENCE screen as shown below.

1 Displaying the PREFERENCE Screen

(1) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch. When power is supplied the POWER lamp comes on and a picture of the laser model will appear.

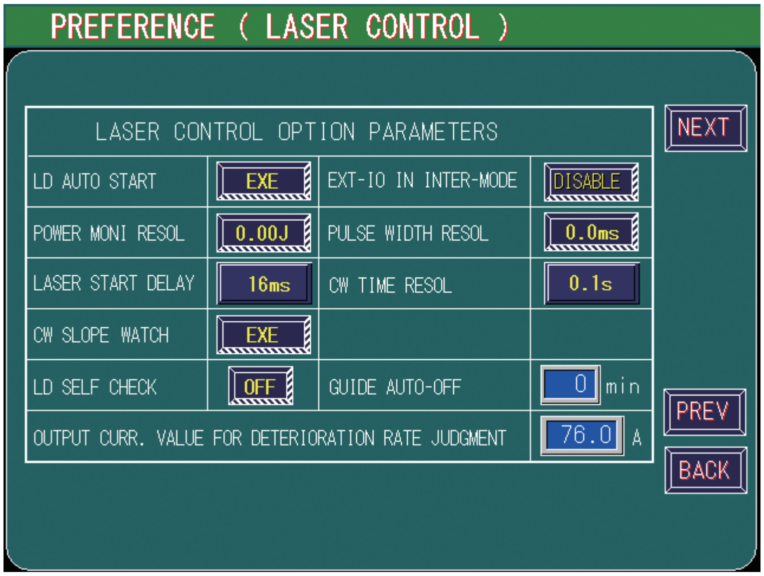

LASER START/STOP
EMERGENCY STOP
FIBER LASER
ML-6810A
MIYACHI CORPORATION

(2) While the laser model screen is displayed (for about 3 seconds), press the right and left buttons (red portions in the above figure) of the laser controller simultaneously for 2 seconds.
The INITIALIZE screen appears.



- If the CONTROL keyswitch is OFF the INITIALIZE screen will not display.

(3) Press the "PREFERENCE" button.
The PREFERENCE screen appears. Press the "NEXT" button to display the page of LASER CONTROL.

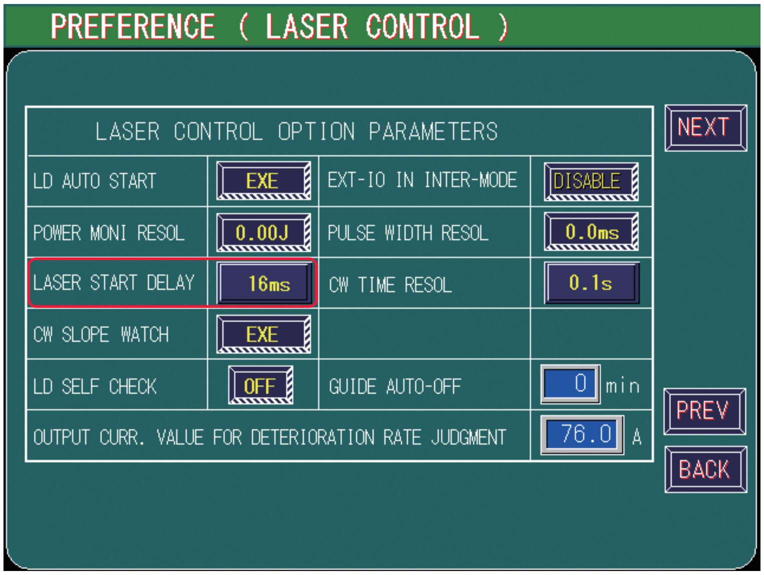

PREFERENCE (LASER CONTROL)

LASER CONTROL OPTION PARAMETERS			
LD AUTO START	EXE	EXT-IO IN INTER-MODE	DISABLE
POWER MONI RESOL	0.00J	PULSE WIDTH RESOL	0.0ms
LASER START DELAY	16ms	CW TIME RESOL	0.1s
CW SLOPE WATCH	EXE		
LD SELF CHECK	OFF	GUIDE AUTO-OFF	0 min
OUTPUT CURR. VALUE FOR DETERIORATION RATE JUDGMENT			76.0 A

2

Changing the Acceptance Time

(1) Set the "LASER START DELAY."



PREFERENCE (LASER CONTROL)

LASER CONTROL OPTION PARAMETERS			
LD AUTO START	EXE	EXT-IO IN INTER-MODE	DISABLE
POWER MONI RESOL	0.00J	PULSE WIDTH RESOL	0.0ms
LASER START DELAY	16ms	CW TIME RESOL	0.1s
CW SLOPE WATCH	EXE		
LD SELF CHECK	OFF	GUIDE AUTO-OFF	0 min
OUTPUT CURR. VALUE FOR DETERIORATION RATE JUDGMENT			76.0 A

(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)

If using the output unit with fiber sensor (option) set the DIP switches provided in the side surface and top surface of the main unit.

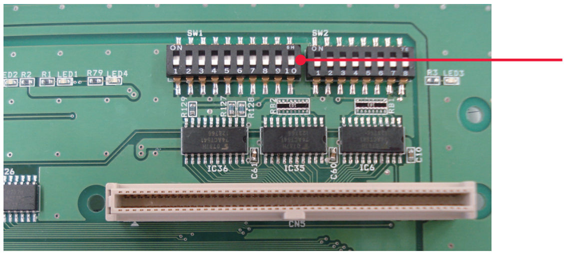
This section explains how to set the function of the output unit with fiber sensor.

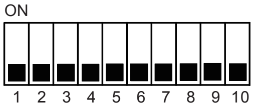
The output unit with fiber sensor is provided with the following 3 functions.

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 LD-ON lamp of the output unit lights when the LD is turned on.

DIP switches are provided on the interface 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 SW1 provided on the interface board to ON to enable the fiber breaking detecting function. Next, set the fiber mounting check function and the LED ON check function by SW1 and SW2 provided on the fiber breaking sensor board in the top surface.

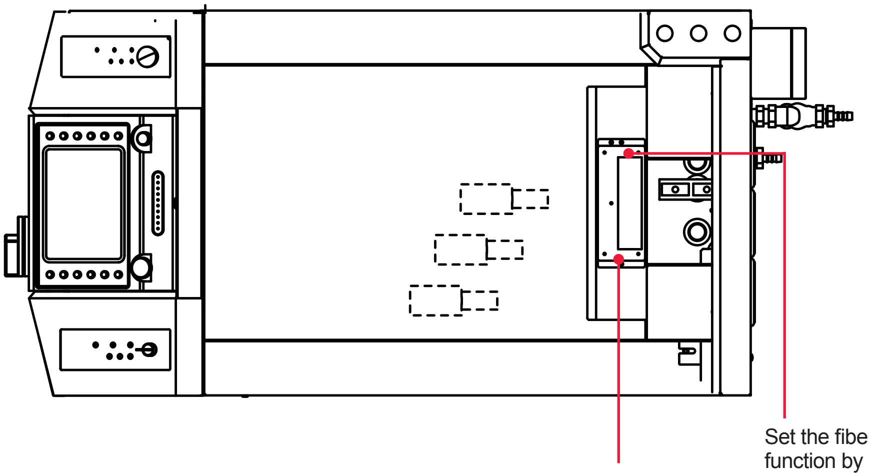
Interface board in the main unit (ME-2111)





Set the fiber breakage detecting function by SW1.

Inside of the top surface of the main unit



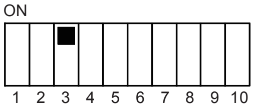
Set the fiber mounting check function by SW2.

Set the LED ON check function by SW1.

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.190 to 192/Fiber SENSOR 1 to 3 TROUBLE is displayed.

SW1



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.3 of SW2 to OFF. Set the other switches to OFF.
The fiber mount checking function is set. When the optical fiber or trouble detecting cable is not connected Error No.194/FIBER SWITCH TROUBLE is displayed.

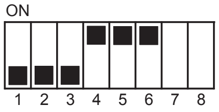
- Set the fiber unit mounting check function after setting the fiber breakage detecting function in (1).

(3) Set the LED ON checking function.
Out of No.1 to No.3 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 (LD-ON lamp) ON status of the specified output unit is not checked, Error No.024/E.INDICATOR TROUBLE (LASER CONT.) is displayed.

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

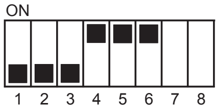
As an example of (2) and (3) settings, set No.1 to No.3 of SW1 and SW2 to OFF to use output units No.1 to No.3.

SW2



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

Operation

Chapter 3

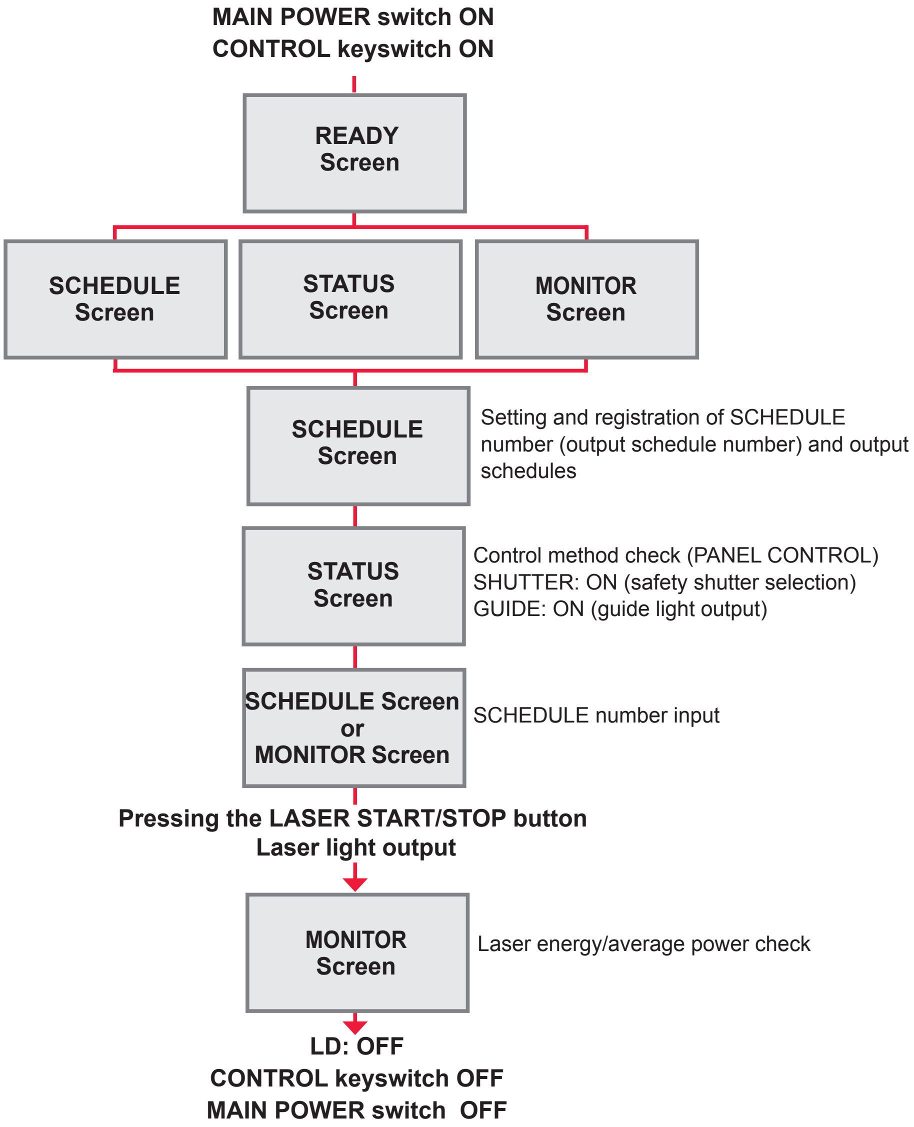
● Laser Welding by Laser Controller (PANEL CONTROL)

1. Operation Flow

This section explains laser welding operation flow using the 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 personal computer connected to an connentor (RS-485 CONTROL).

In PANEL CONTROL welding schedules are set using the laser controller and laser light output is controlled

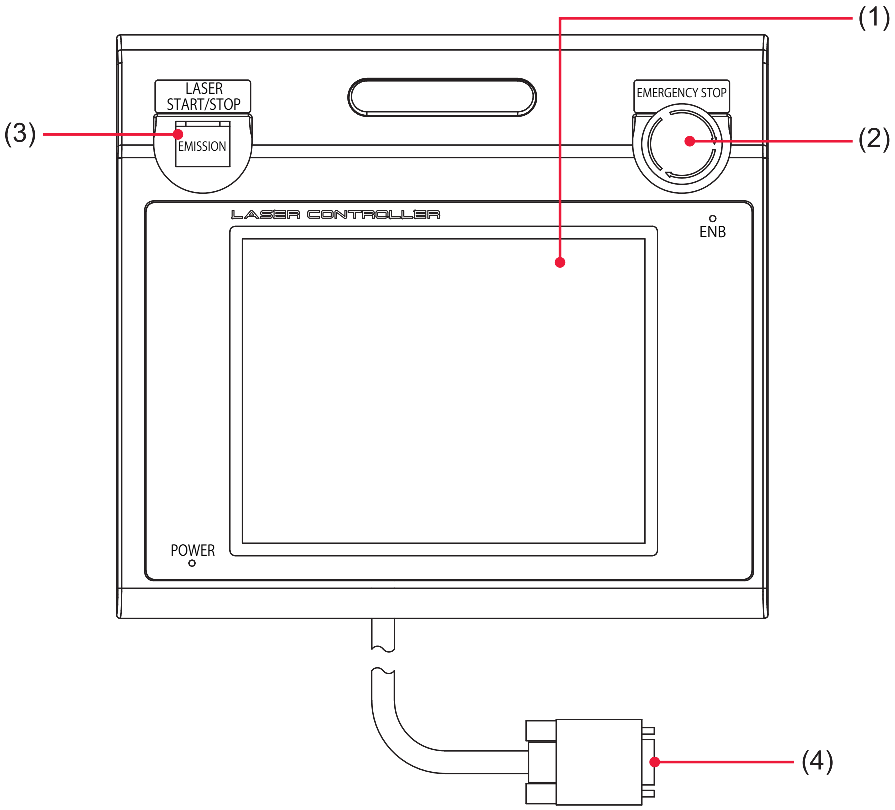

MAIN POWER switch ON
CONTROL keyswitch ON
READY Screen
SCHEDULE Screen
STATUS Screen
MONITOR Screen
SCHEDULE Screen
Setting and registration of SCHEDULE number (output schedule number) and output schedules
STATUS Screen
Control method check (PANEL CONTROL)
SHUTTER: ON (safety shutter selection)
GUIDE: ON (guide light output)
SCHEDULE Screen or MONITOR Screen
SCHEDULE number input
Pressing the LASER START/STOP button
Laser light output
MONITOR Screen
Laser energy/average power check
LD: OFF
CONTROL keyswitch OFF
MAIN POWER switch OFF

2. Laser Controller Functions

This section explains the functions of the laser controller.

In PANEL CONTROL mode 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 output you can check the laser output energy on the MONITOR screen.

- It is possible to perform laser welding operations remotely after removing the laser controller from the main unit.



Function of Each Section on the Laser Controller

(1) 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 control interface windows required to input settings.
(2) EMERGENCY STOP (Button)	This is an emergency stop button. With this button pressed 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) LASER START/STOP (Button)	If you press this button when the laser is ready, output laser light is emitted. If the button is pressed again while laser emission is in progress in repeat mode the repeated output is stopped immediately. * If Pin No.25 (control switching) of the EXT. I/O (1) connector is in a closed circuit and the LD is turned on.
EMISSION (Lamp)	When the LD is turned on, the EMISSION lamp comes on.
(4) Control Cable	Connects the laser controller to the main unit.

3. Operating Procedure

This section explains the operating procedure for laser welding controlled from the control panel.

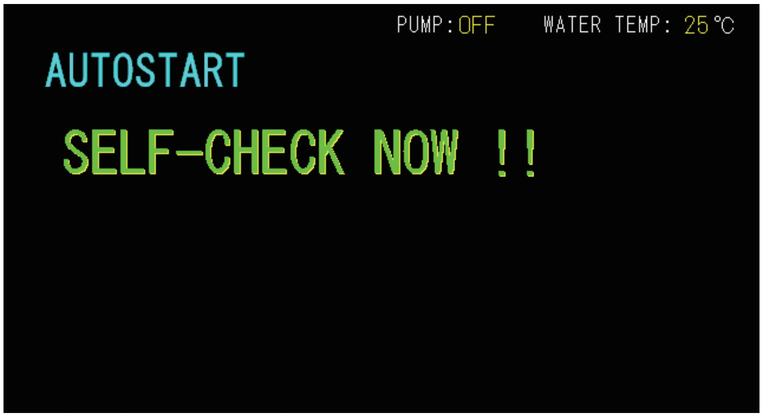
- For the details of welding schedule settings refer to "1. Setting Weld Schedules" on page 51. For connector functions refer to Chapter 4, "3. Connector Functions" on page 123.
- Before turning on the power supply ensure Pin No.25 (control switching) of the EXT. I/O (1) connector is not connected to any circuit, "PANEL CONTROL" will be displayed in the "CONTROL DEVICE" field 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 will turn ON and the POWER lamp will. Then, the SELF-CHECK NOW !! screen will appear.

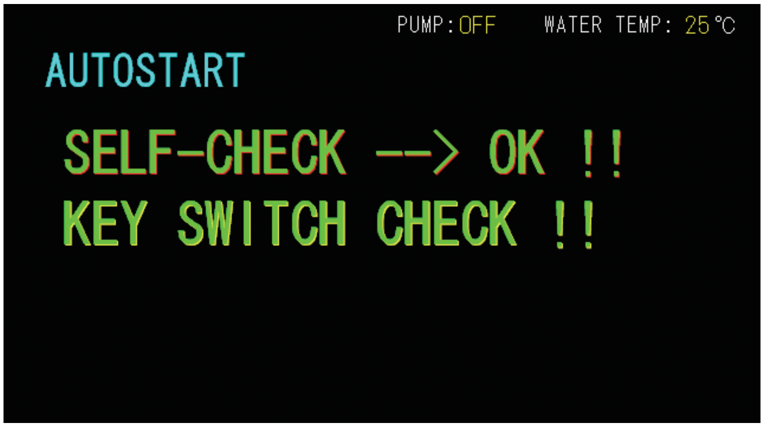


PUMP:OFF WATER TEMP: 25℃

AUTOSTART

SELF-CHECK NOW !!

The timesharing unit, safety shutter, memory, and power supply unit are automatically checked. When no error is found the KEY SWITCH CHECK !! screen will display.



PUMP:OFF WATER TEMP: 25℃

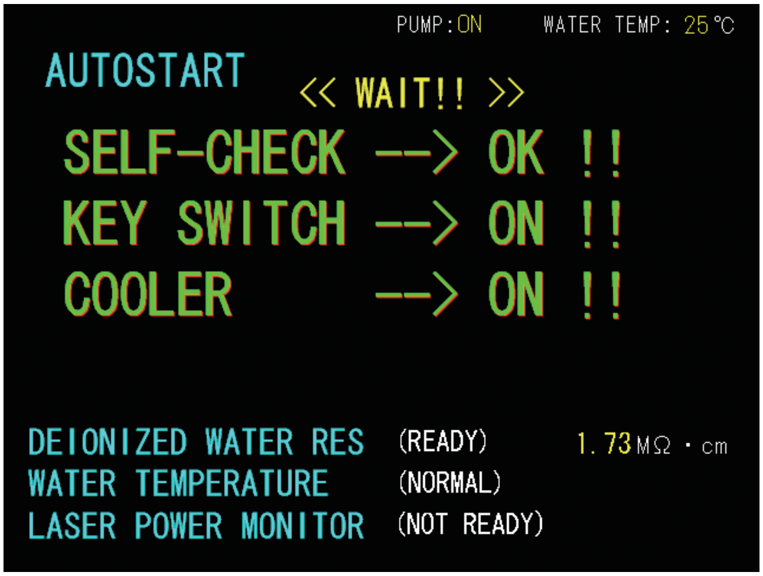
AUTOSTART

SELF-CHECK --> OK !!

KEY SWITCH CHECK !!

(2) Turn ON the CONTROL keyswitch.

The laser is put to an operable status and the COOLER --> ON !! screen will appear.

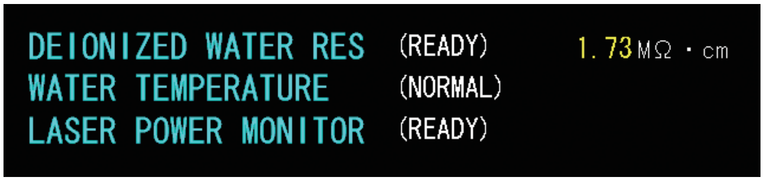


```
                          PUMP:ON     WATER TEMP: 25℃
 AUTOSTART
                << WAIT!! >>
  SELF-CHECK --> OK !!
  KEY SWITCH --> ON !!
  COOLER     --> ON !!

DEIONIZED WATER RES  (READY)       1.73MΩ・cm
WATER TEMPERATURE    (NORMAL)
LASER POWER MONITOR  (NOT READY)
```

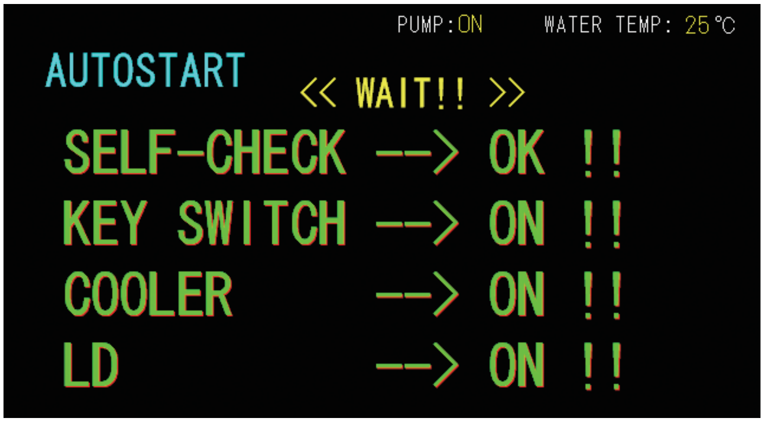
How to interpret the displayed items

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 1.1 MΩ cm or above 2.5 MΩ cm. READY: Indicated when the resistivity is 1.2 MΩ cm to 2.4 MΩ cm.
WATER TEMPERATURE	Indicates the secondary cooling water temperature status. LOW: Displayed at 22°C or less. NOR READY: Displayed at 23°C to 26°C. NORMAL: Displayed at 27°C to 35°C. HIGH: Indicated at 36°C 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.



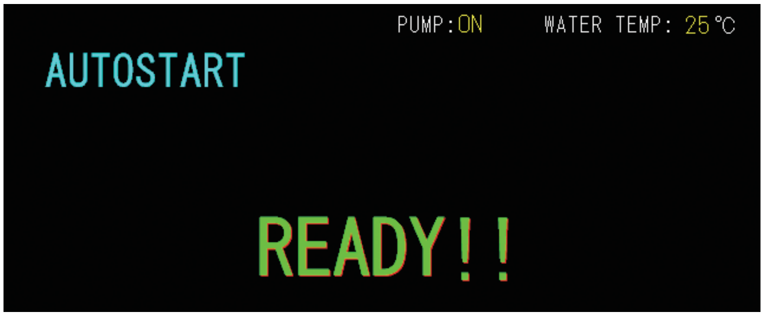
```
DEIONIZED WATER RES  (READY)       1.73MΩ・cm
WATER TEMPERATURE    (NORMAL)
LASER POWER MONITOR  (READY)
```

When "DEIONIZED WATER RES" is (READY), "WATER TEMPERATURE" is (NORMAL), and "LASER POWER MONITOR" is (READY), the LD is turned ON. Then, the LD --> ON !! screen appears.



```
                    PUMP:ON     WATER TEMP: 25℃
AUTOSTART
               << WAIT!! >>
 SELF-CHECK  --> OK !!
 KEY SWITCH  --> ON !!
 COOLER      --> ON !!
 LD          --> ON !!
```

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



```
                    PUMP:ON     WATER TEMP: 25℃
AUTOSTART


          READY!!
```

After the READY !! screen appears, the main screen options (SCHEDULE screen, STATUS screen, or MONITOR screen) explained in the previous section will appear.

2. Setting Output Schedules

EXAMPLE: The procedure for setting SCHEDULE No.5, laser output peak value 300 W, FLASH1 laser output time 100 ms/output value 50%, and up-slope 20 ms is explained below.

(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

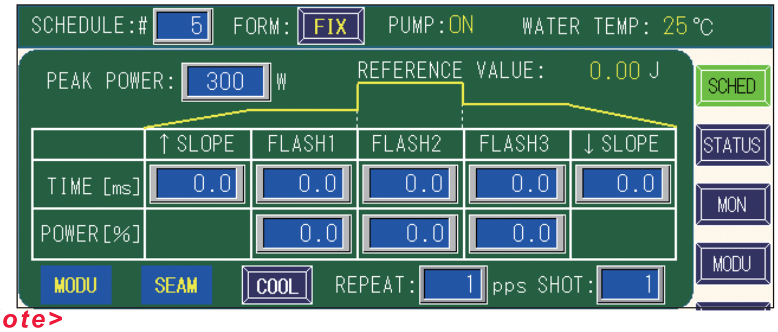
In this example, set #5.

- Valid SCHEDULE numbers: It is possible to set 256 schedules from #0 to #255. 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 300 W.



SCHEDULE:# 5 FORM: FIX PUMP: ON WATER TEMP: 25 ℃

PEAK POWER: 300 W REFERENCE VALUE: 0.00 J

	↑SLOPE	FLASH1	FLASH2	FLASH3	↓SLOPE
TIME [ms]	0.0	0.0	0.0	0.0	0.0
POWER [%]		0.0	0.0	0.0	

REPEAT: 1 pps SHOT: 1

<Note>

The maximum settable value of laser output peak value is 1000 W. To ensure that maximum average power lmits are not exceeded set the total settings such that the overall schedule does not exceed this maximum average power value.

(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 100.0 ms in "FLASH1."

<Note>

Set the laser output time to ensure that the following condition is maintained:

0.05 ms ≦ "FLASH1" + "FLASH2" + "FLASH3" ≦ 500.0 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 20.0 ms.

<Note>

Set "↑SLOPE" to maintain the following condition:

↑SLOPE ≦ FLASH1

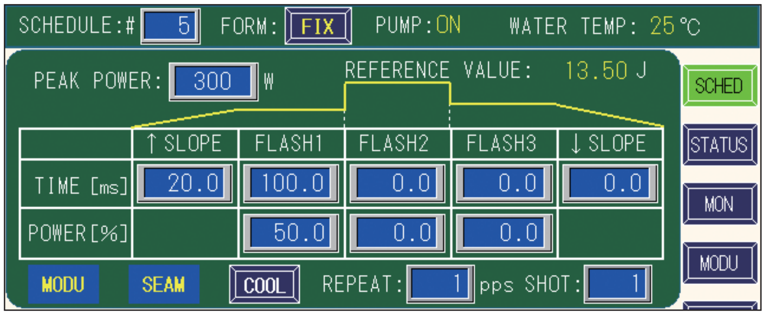
When setting "FLASH2" or "FLASH3", set the time required for laser output downslope (the laser output becomes gradually weaker) to FLASH. Set "↓SLOPE" so to maintain the following condition:

↓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 50.0% in "FLASH1."



SCHEDULE:# 5 FORM: FIX PUMP: ON WATER TEMP: 25 °C

PEAK POWER: 300 W REFERENCE VALUE: 13.50 J

	↑SLOPE	FLASH1	FLASH2	FLASH3	↓SLOPE
TIME [ms]	20.0	100.0	0.0	0.0	0.0
POWER [%]		50.0	0.0	0.0	

REPEAT: 1 pps SHOT: 1

- For the laser output value set the ratio (%) supposing that the programmed laser output peak value is 100%. In this example, this peak value is 50% of "PEAK POWER=300 W", so that the actual laser output value is 150 W. In this case, even if "PEAK POWER=150 W" and "FLASH1 100 ms 100%" are set, the actual laser output value is the same.
- To set the number of continuous repeated laser shots, set the number of outputs per second in "REPEAT" in the range from 1 to 5000 pps (pulse per second). When 1 is set, a single output is performed.
- To set the schedule's total number of laser light outputs set "SHOT" in the range of 1 to 9999. Using a REPEAT value with a SHOT of 0 will result in continuous emission until a stop signal is provided.

<Note>

To protect the laser oscillator the minimum power (approx. 20 W) of laser is output for the set laser output time regardless of the laser output value (%) if the laser output value totals <20W.

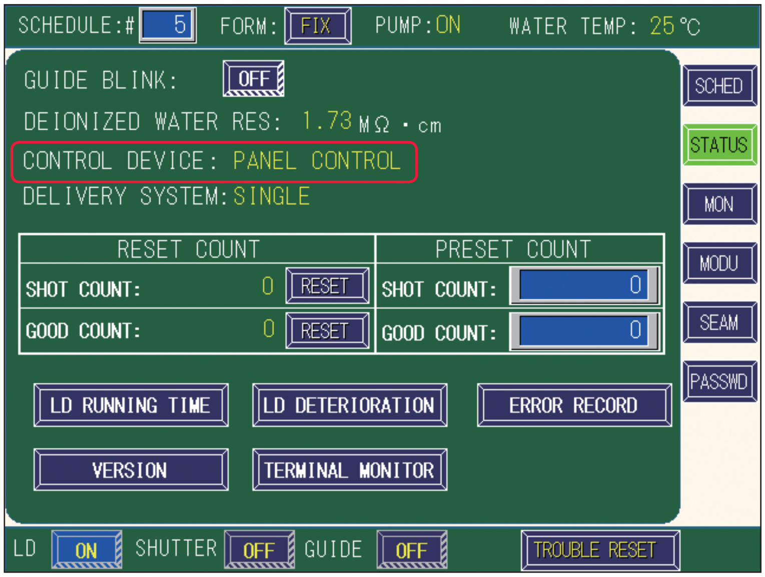
3 Firing the Laser

⚠ WARNING

Be sure to wear adequate protective glasses during laser light output operation and observe all safety precautions. If laser light enters the eyes directly, loss of eyesight may occur.

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

When Pin No.25 (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."



SCHEDULE:# 5 FORM: FIX PUMP: ON WATER TEMP: 25 °C

GUIDE BLINK: OFF

DEIONIZED WATER RES: 1.73 MΩ・cm

CONTROL DEVICE: PANEL CONTROL

DELIVERY SYSTEM: SINGLE

RESET COUNT		PRESET COUNT	
SHOT COUNT:	0	SHOT COUNT:	0
GOOD COUNT:	0	GOOD COUNT:	0

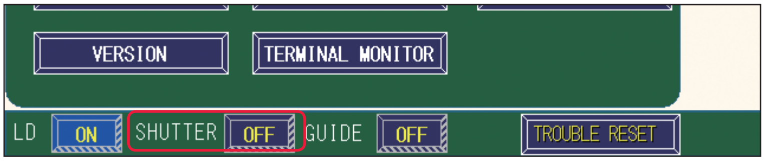
LD ON SHUTTER OFF GUIDE OFF

(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 "SHUTTER" button.

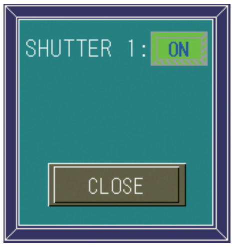
The beam selection window allowing opening/closing of the safety shutter and beamsplitter is opened.

- The displayed window depends on the specification.


VERSION
TERMINAL MONITOR
LD
ON
SHUTTER
OFF
GUIDE
OFF
TROUBLE RESET

(4) Press the setting buttons for "SHUTTER 1" to "SHUTTER 3" to open/close the safety shutters.

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


SHUTTER 1:
ON
CLOSE

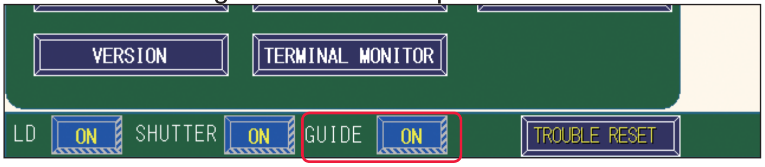
(5) Press the "CLOSE" button.

The opening/closing of the safety shutter occurs and the window is closed.

- For powersharing set all the SHUTTERs to be used to ON to open all the safety shutters.

(6) Press the "GUIDE" setting button to turn ON the output guide light.

When the "GUIDE" setting button is set to ON and the shutter/beam shares are open a red dot of guide light appears from the focus head. This location marks where the welding laser will hit the part.


VERSION
TERMINAL MONITOR
LD
ON
SHUTTER
ON
GUIDE
ON
TROUBLE RESET

(7) Verify the target.

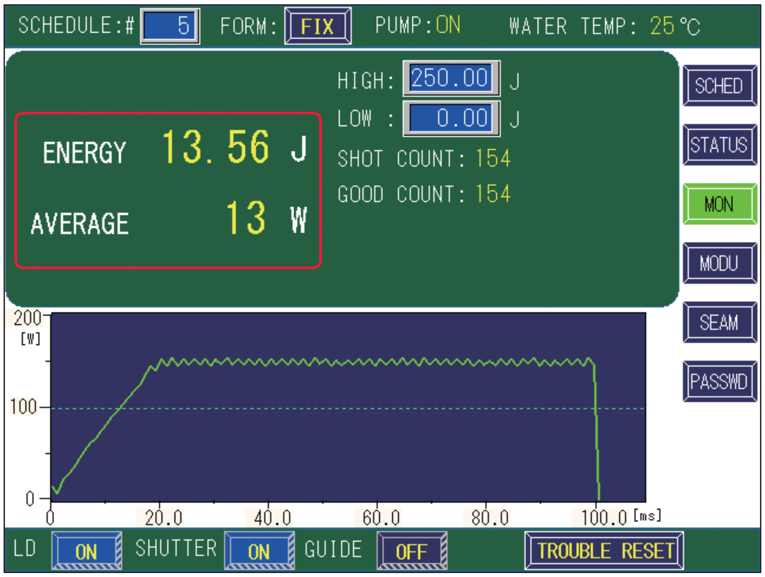
If the workpiece is not aligned with the red dot, adjust the position by moving the output unit or workpiece.

(8) Press the LASER START/STOP button.

The laser will fire

- Before pressing the LASER START/STOP button again, display the SCHEDULE screen or MONITOR screen and input another registered SCHEDULE number. The next laser event will reflect the conditions of this SCHEDULE.

(9) 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.



SCHEDULE:# 5
FORM: FIX
PUMP: ON
WATER TEMP: 25 ℃
HIGH: 250.00 J
LOW : 0.00 J
SHOT COUNT: 154
GOOD COUNT: 154
ENERGY 13.56 J
AVERAGE 13 W
LD ON
SHUTTER ON
GUIDE OFF

4 Stopping Laser Welding

⚠ CAUTION

DO NOT turon OFF the MAIN POWER switch during a laser fire sequence or for 5 minutes immediately following laser emission to allow internal components to cool.

(1) Press the "LD" setting button on any screen to turn the LD OFF.

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

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

- Return the CONTROL key to the laser safety supervisor so that it can be kept in a secure location.

Chapter 4

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

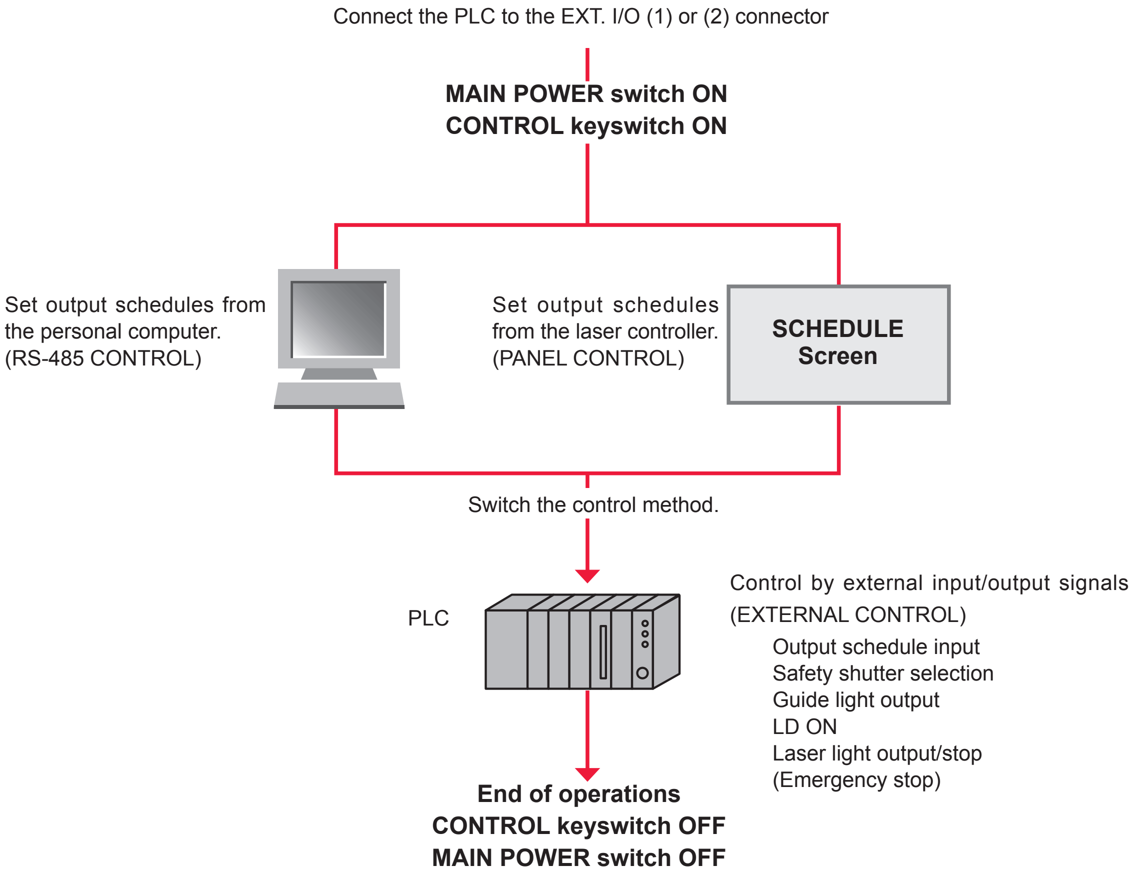
1. Operation Flow

This section explains operation flow during laser welding using 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 personal computer connected to an connector (RS-485 CONTROL).

When using control by external input/output signals (EXTERNAL CONTROL), output schedules are first programmed using another method (PANEL CONTROL/RS-485 CONTROL) in advance. After that controls such control as schedule selection, laser light output, and emergency stop can be exerted using external control.

* 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).



Connect the PLC to the EXT. I/O (1) or (2) connector

MAIN POWER switch ON
CONTROL keyswitch ON

Set output schedules from the personal computer.
(RS-485 CONTROL)

Set output schedules from the laser controller.
(PANEL CONTROL)

SCHEDULE Screen

Switch the control method.

PLC

Control by external input/output signals (EXTERNAL CONTROL)
Output schedule input
Safety shutter selection
Guide light output
LD ON
Laser light output/stop
(Emergency stop)

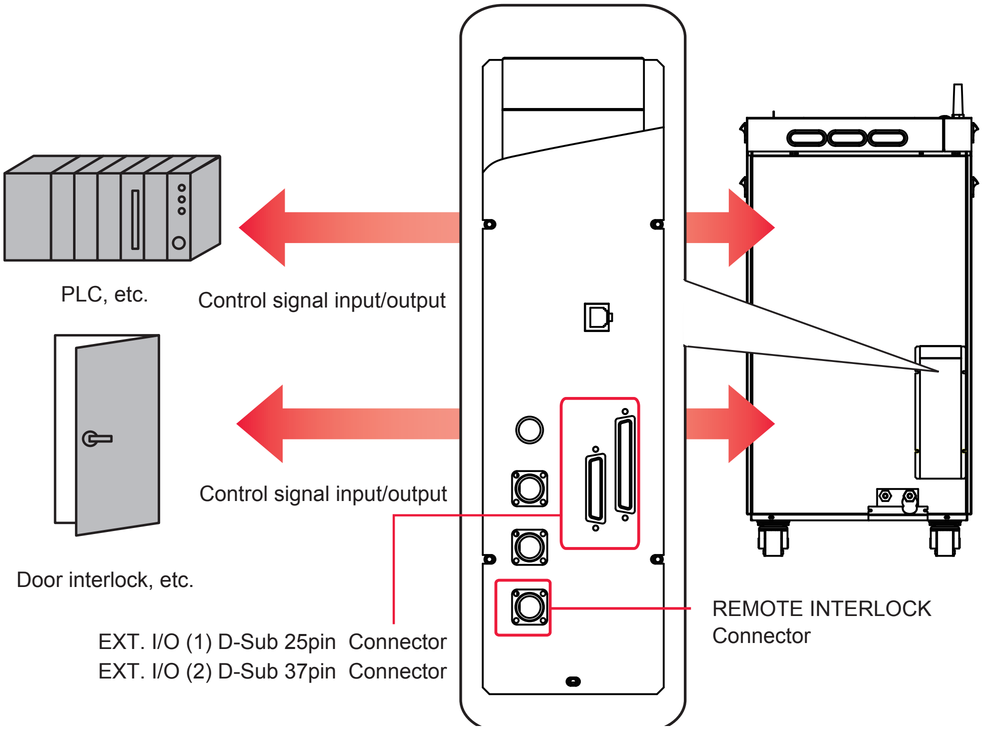
End of operations
CONTROL keyswitch OFF
MAIN POWER switch OFF

2. Preparing for Operation

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

Connect the PLC to the EXT. I/O (1) or (2) connectors provided at the rear of the main unit to control the main unit via external control.

The REMOTE INTERLOCK must be connected for safety. The REMOTE INTERLOCK connector must be connected to the interlock switch attached to the of the laser welding enclosure or the door of the room used for laser welding. If the door is suddenly opened, the safety shutter is closed to cut off laser light. Consult your local safety regulations for proper interlocking and safety procedures


PLC, etc.
Control signal input/output
Door interlock, etc.
Control signal input/output
EXT. I/O (1) D-Sub 25pin Connector
EXT. I/O (2) D-Sub 37pin Connector
REMOTE INTERLOCK
Connector

The connector and backshell models are as follows.

	Connector	Cover	Manufacturer
EXT. I/O (1)	250-479	250-536	HIROSE ELECTRIC CO., LTD.
EXT. I/O (2)	250-409	250-537	
REMOTE INTERLOCK	451-035		TAJIMI ELECTRONICS CO., LTD.

3. Connector Functions

Pin Arrangement and Functions

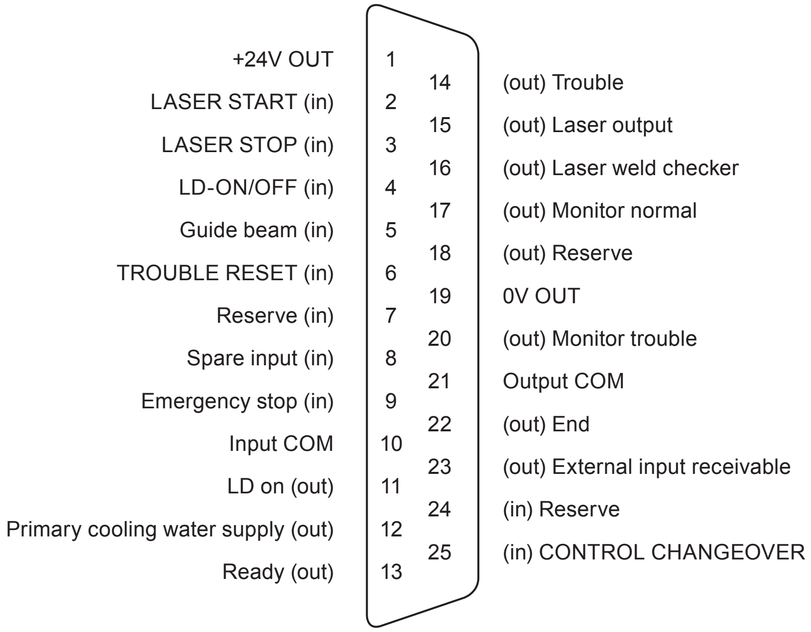
There are 3 connectors that must be connected for the control by external input/output. This section explains the arrangement and functions of the respective pins.

EXT. I/O (1) Connector (D-Sub 25 pin)

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

- Use the following recommended connector.

Connector	Cover	Manufacturer
250-479	250-536	HIROSE ELECTRIC CO., LTD.


+24V OUT
1
LASER START (in)
2
LASER STOP (in)
3
LD-ON/OFF (in)
4
Guide beam (in)
5
TROUBLE RESET (in)
6
Reserve (in)
7
Spare input (in)
8
Emergency stop (in)
9
Input COM
10
LD on (out)
11
Primary cooling water supply (out)
12
Ready (out)
13
14
(out) Trouble
15
(out) Laser output
16
(out) Laser weld checker
17
(out) Monitor normal
18
(out) Reserve
19
0V OUT
20
(out) Monitor trouble
21
Output COM
22
(out) End
23
(out) External input receivable
24
(in) Reserve
25
(in) CONTROL CHANGEOVER

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

- Close pin No.25.

Pin No.	Description
1	+24 V OUT Power supply for external input signals. This pin is exclusively used for I/O connections made to the LF1000A. Do not use it for any other purpose.
2	LASER START When Pin 3 is closed the laser beam is triggered. Make sure that the circuit is left closed for at least 1 ms. When the signal is input repeatedly make sure that the circuit is left open for at least 1 ms between each input.
3	LASER STOP To output laser emission using Pin 2 the circuit to this pin must be closed. For repeated output set in "REPEAT" on the SCHEDULE screen, laser output is stopped by closing this pin during laser output sequence. The closed circuit time should be 1 ms or more.
4	LD-ON/OFF When this pin is closed the LD is turned ON. When this pin is opened the LD is turned OFF.
5	Guide beam While this pin is closed, the guide beam is output.
6	TROUBLE RESET If trouble arises an alarm is activated. When the cause of trouble has been eliminated and this pin is closed the alarm will be cleared.
7	Reserve (unused)
8	Spare input (unused)
9	Emergency stop When this pin is opened, the equipment is brought to an emergency stop, which is in the same state as the CONTROL keyswitch OFF.
10	Input COM
19	0 V OUT Power supply ground for external input signals. This pin is exclusively used for LF1000A I/O Control. Do not use it for any other purpose.
24	Reserve (unused)
25	CONTROL CHANGEOVER While this pin is closed the external input signals are enabled and the laser is put into EXTERNAL CONTROL mode.

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

Pin No.	Description
11	LD ON While the LD is turned on this pin is closed internally.
12	Primary cooling water supply While the solenoid valve for the primary cooling water supply is opened this pin is closed internally.
13	Ready When the high voltage is turned ON and the capacitor is fully charged this pin is closed internally.

Pin No.	Description
14	Trouble If trouble arises this pin is opened internally until it is reset.
15	Laser output While the laser is output this pin is closed internally. This is a signal for turning on an indicator during laser output. Do not use for timing control.
16	Laser weld checker This pin is dedicated to the laser weld checker (MML-100A). Do not connect to other pins.
17	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 20 ms.
18	Reserve (unused)
20	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 20 ms.
21	Output COM
22	End After the lamp has flashed this pin is closed internally for 20 ms.
23	External input receivable When an external input signal is acceptable (when pin No.25 is closed) the circuit is losed. In the open circuit state an external input signal is not acceptable if it is input.

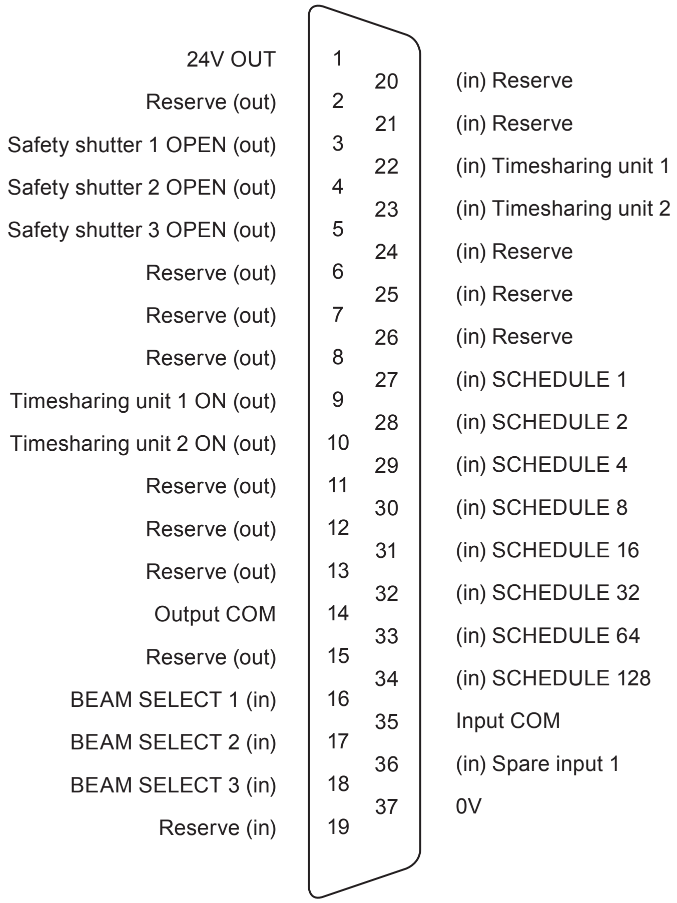
Type of output: Photo MOS relay output
Rating of output: 24 V DC, 20 mA max.

EXT. I/O (2) Connector (D-Sub 37 pin)

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

- Use the following recommended connector.

Connector	Cover	Manufacturer
250-409	250-537	HIROSE ELECTRIC CO., LTD.


24V OUT 1
Reserve (out) 2
Safety shutter 1 OPEN (out) 3
Safety shutter 2 OPEN (out) 4
Safety shutter 3 OPEN (out) 5
Reserve (out) 6
Reserve (out) 7
Reserve (out) 8
Timesharing unit 1 ON (out) 9
Timesharing unit 2 ON (out) 10
Reserve (out) 11
Reserve (out) 12
Reserve (out) 13
Output COM 14
Reserve (out) 15
BEAM SELECT 1 (in) 16
BEAM SELECT 2 (in) 17
BEAM SELECT 3 (in) 18
Reserve (in) 19
20 (in) Reserve
21 (in) Reserve
22 (in) Timesharing unit 1
23 (in) Timesharing unit 2
24 (in) Reserve
25 (in) Reserve
26 (in) Reserve
27 (in) SCHEDULE 1
28 (in) SCHEDULE 2
29 (in) SCHEDULE 4
30 (in) SCHEDULE 8
31 (in) SCHEDULE 16
32 (in) SCHEDULE 32
33 (in) SCHEDULE 64
34 (in) SCHEDULE 128
35 Input COM
36 (in) Spare input 1
37 0V

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

Pin No.	Description
16	BEAM SELECT 1 When this pin is closed, laser beam input unit 1 is selected and the unit becomes ready to project a laser beam.
17	BEAM SELECT 2 When this pin is closed, laser beam input unit 2 is selected and the unit becomes ready to project a laser beam.
18	BEAM SELECT 3 When this pin is closed, laser beam input unit 3 is selected and the unit becomes ready to project a laser beam.
19	Reserved (unused)
20	Reserved (unused)
21	Reserved (unused)
22	Timesharing unit 1 (Enabled only when the safety shutter is put under independent control) When this pin is closed, timesharing 1 is operated so that laser light can be output from input unit 1.

Pin No.	Description	
23	Timesharing unit 2 (Enabled only when the safety shutter is put under independent control) When this pin is closed timesharing 2 is operated so that laser light can be output from input unit 2.	
24	Reserved (unused)	
25	Reserved (unused)	
26	Reserved (unused)	
27	SCHEDULE 1	Select a registered SCHEDULE number by combining schedule signal inputs 1, 2, 4, 8, 16, 32, 64 and 128.
28	SCHEDULE 2	
29	SCHEDULE 4	
30	SCHEDULE 8	
31	SCHEDULE 16	
32	SCHEDULE 32	
33	SCHEDULE 64	
34	SCHEDULE 128	
35	Input COM Common terminal for input signals.	
36	Spare input 1 (unused)	
37	0V Ground for +24 V DC output.	

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

Pin No.	Description
1	24V OUT Power supply for external I/O.
2	Reserved (unused)
3	Safety shutter 1 OPEN While safety shutter 1 is open this pin closes internally.
4	Safety shutter 2 OPEN While safety shutter 2 is open this pin closes internally.
5	Safety shutter 3 OPEN While safety shutter 3 is open this pin closes internally.
6	Reserved (unused)
7	Reserved (unused)
8	Reserved (unused)
9	Timesharing unit 1 ON While timesharing unit 1 is operated this pin closes internally.
10	Timesharing unit 2 ON While timesharing unit 2 is operated this pin closes internally.
11	Reserved (unused)
12	Reserved (unused)
13	Reserved (unused)
14	Output COM
15	Reserved (unused)

REMOTE INTERLOCK Connector

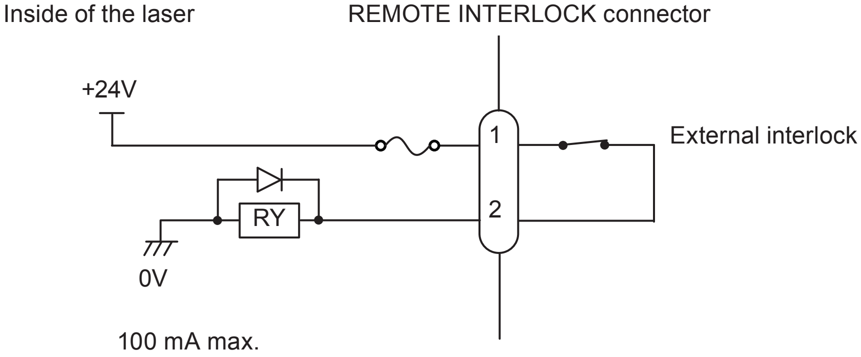
The REMOTE INTERLOCK connector closes the safety shutter and connects the interlock to cut off laser light if an unsafe condition occurs.

Use the following attached connector.

Connector	Cover	Manufacturer
451-035		TAJIMI ELECTRONICS CO., LTD.

Pin No.	Description
1	When the connection between pin No.1 and pin No.2 is opened the safety shutter will close.
2	

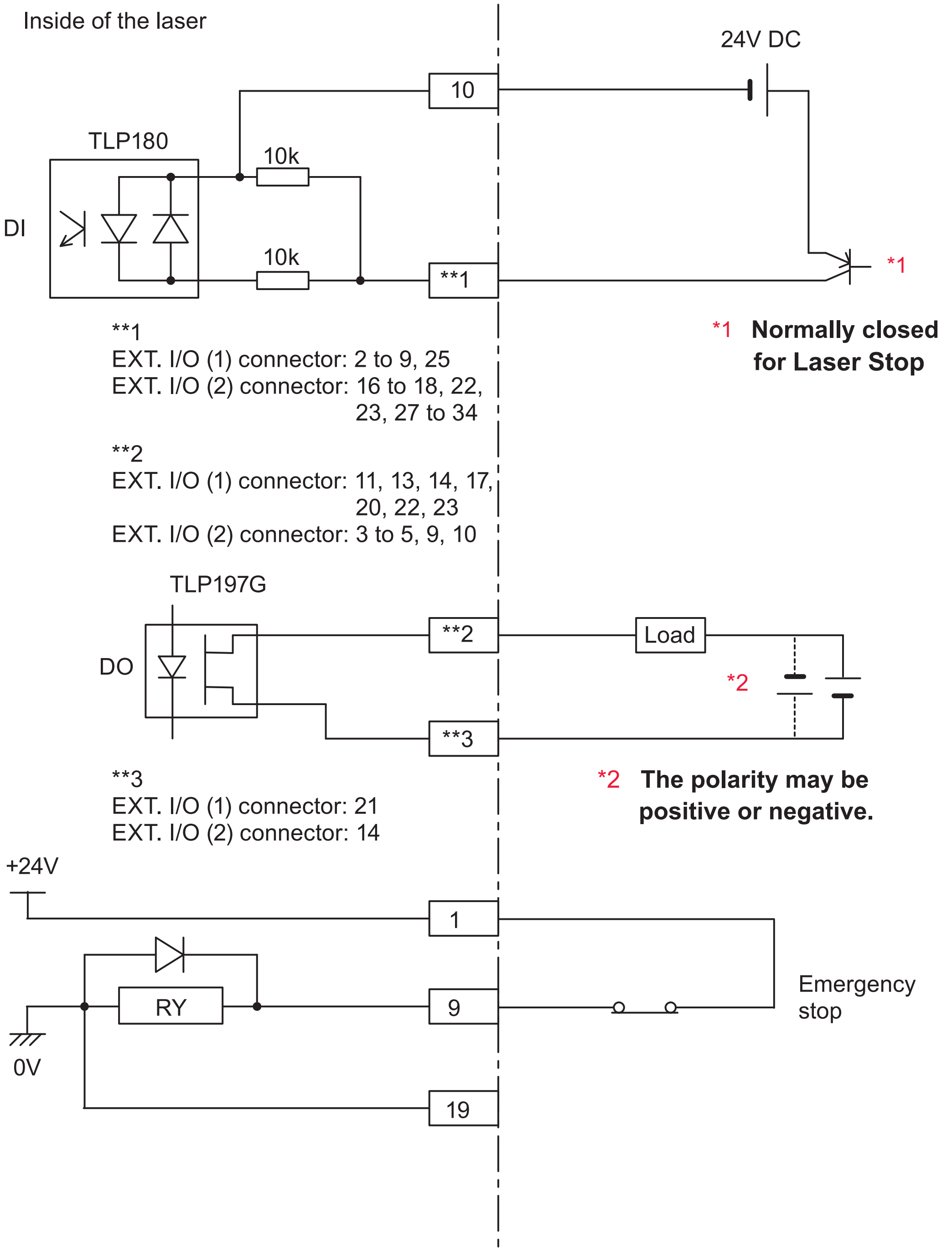
- When the connection between the 2 pins of this connector are opened by operating the external interlock, the safety shutter will close and both guide light and laser output are stopped. Connect this connector to the main interlock, chamber interlock, door interlock, or other interlock. A multiple number of these interlocks may be connected in series as required. At delivery the connector for short circuit is installed. This connecter must be utilized according to all local standards and regulations for safe operation of the laser.
- To release the interlock, close the circuit between pin No.1 and pin No.2 and press the TROUBLE RESET button displayed on the laser controller.



Example Connections of External Input/Output Signals

An example of external input/output signal connections is explained below.

When Connected to an Output PLC with a 24 V DC Source


Inside of the laser
24V DC
10
TLP180
10k
DI
10k
**1
*1
TLP197G
**2
DO
Load
*2
**3
+24V
1
RY
9
0V
19
Emergency stop

**1
EXT. I/O (1) connector: 2 to 9, 25
EXT. I/O (2) connector: 16 to 18, 22, 23, 27 to 34

**2
EXT. I/O (1) connector: 11, 13, 14, 17, 20, 22, 23
EXT. I/O (2) connector: 3 to 5, 9, 10

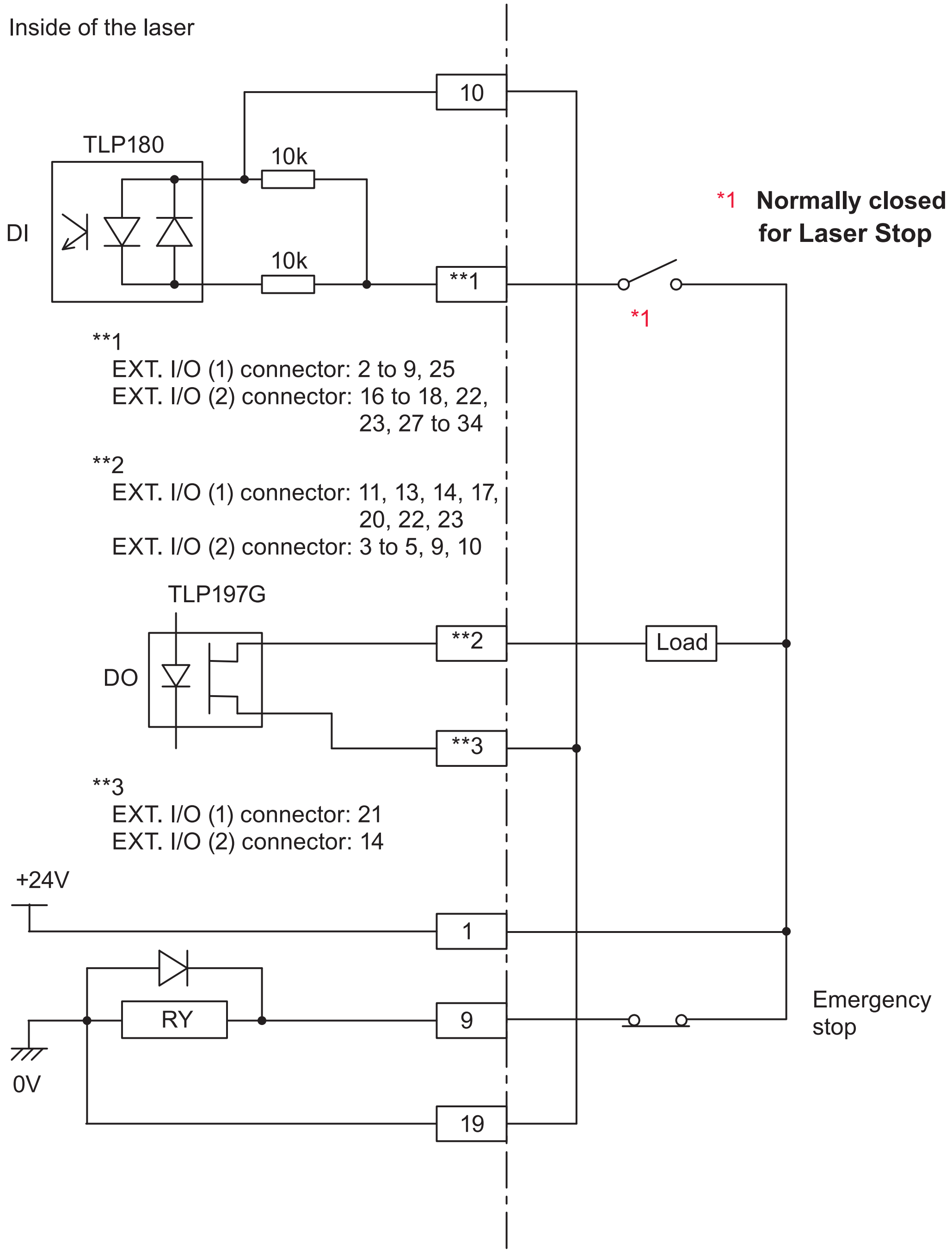
**3
EXT. I/O (1) connector: 21
EXT. I/O (2) connector: 14

*1 **Normally closed for Laser Stop**

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

External signal power supply: 24 V DC, 100 mA max.

When Using a Contact Signal

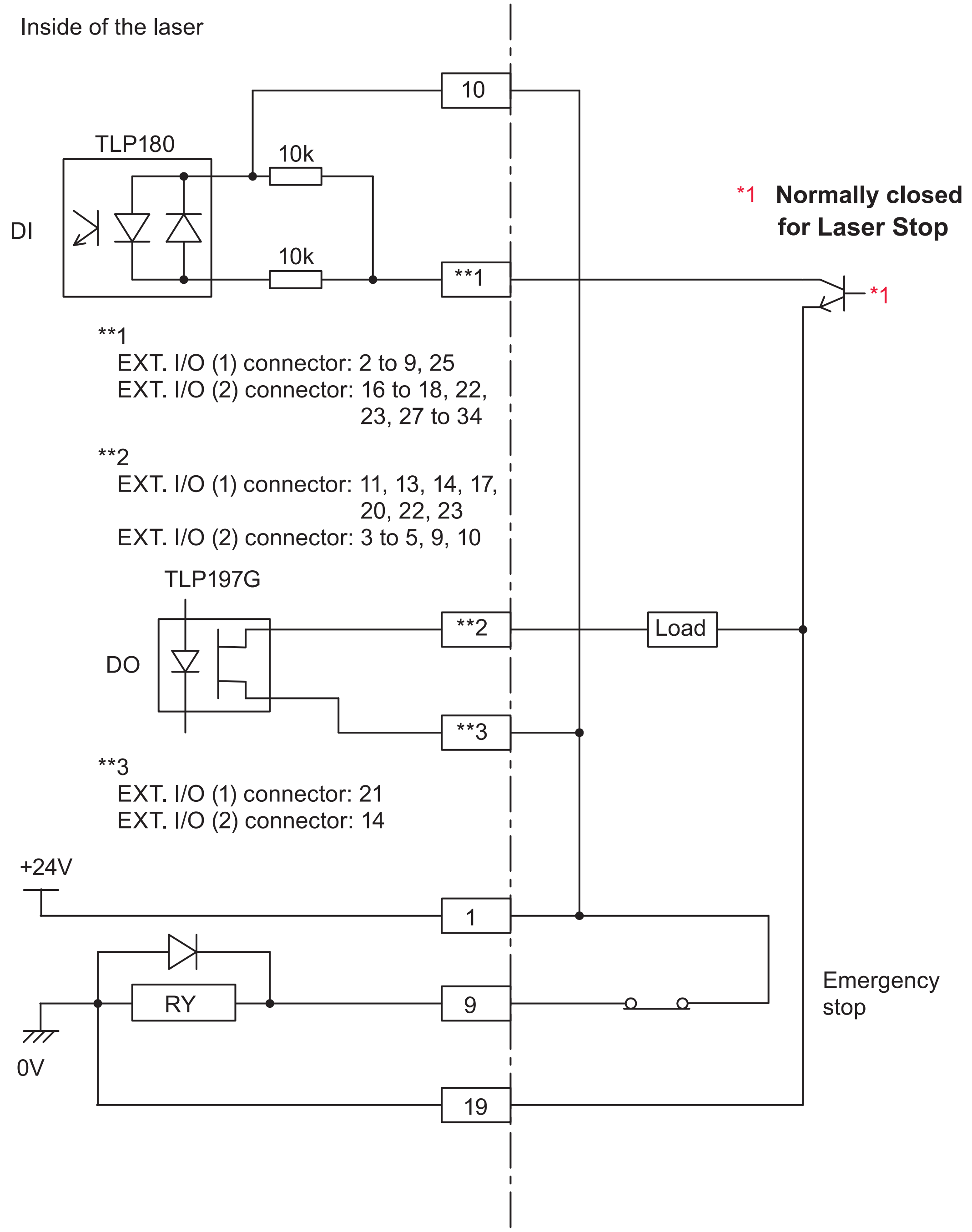

Inside of the laser
10
TLP180
10k
10k
DI
**1
*1
*1 Normally closed for Laser Stop
TLP197G
DO
**2
**3
Load
+24V
1
RY
9
0V
19
Emergency stop

**1
EXT. I/O (1) connector: 2 to 9, 25
EXT. I/O (2) connector: 16 to 18, 22, 23, 27 to 34

**2
EXT. I/O (1) connector: 11, 13, 14, 17, 20, 22, 23
EXT. I/O (2) connector: 3 to 5, 9, 10

**3
EXT. I/O (1) connector: 21
EXT. I/O (2) connector: 14

When Using an Open-Collector Signal


Inside of the laser
TLP180
DI
10k
10k
10
**1
*1 Normally closed for Laser Stop
*1
TLP197G
DO
**2
Load
**3
+24V
1
RY
9
0V
19
Emergency stop

**1
EXT. I/O (1) connector: 2 to 9, 25
EXT. I/O (2) connector: 16 to 18, 22, 23, 27 to 34

**2
EXT. I/O (1) connector: 11, 13, 14, 17, 20, 22, 23
EXT. I/O (2) connector: 3 to 5, 9, 10

**3
EXT. I/O (1) connector: 21
EXT. I/O (2) connector: 14

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.

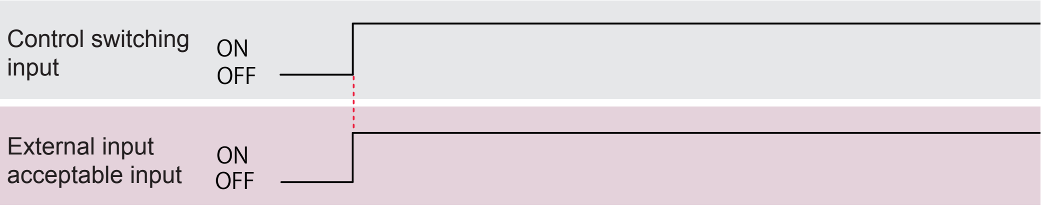
In the following, control flow is explained using an example whereby "Schedule 1" is first specified and then "Schedule 2" is specified to perform a single laser light output by 2-powersharing from Safety shutter 1 and Safety shutter 2.

1 Switching the Control Method

(1) Put pin No.25 (control switching) of the EXT. I/O (1) connector in a closed circuit.

Pin No.23 of the EXT. I/O (1) connector is put in a closed circuit and the signal (external input acceptable) is returned from the laser.

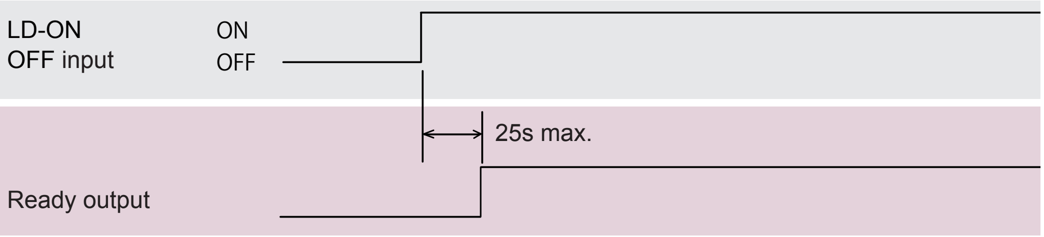
- Press the STATUS button on the laser controller to display the STATUS screen. Then, you can confirm that "EXTERNAL CONTROL" is selected as the control method.



2 Turning ON the LD

(1) Put pin No.11 of the EXT. I/O (1) connector in a closed circuit to turn ON the LD.

When the LD is turned on, pin No.13 of the EXT. I/O (1) connector is put in a closed circuit and the signal (Ready) is returned from the laser after 25 seconds maximum.



3 Selecting a Beam (Setting the Safety Shutter)

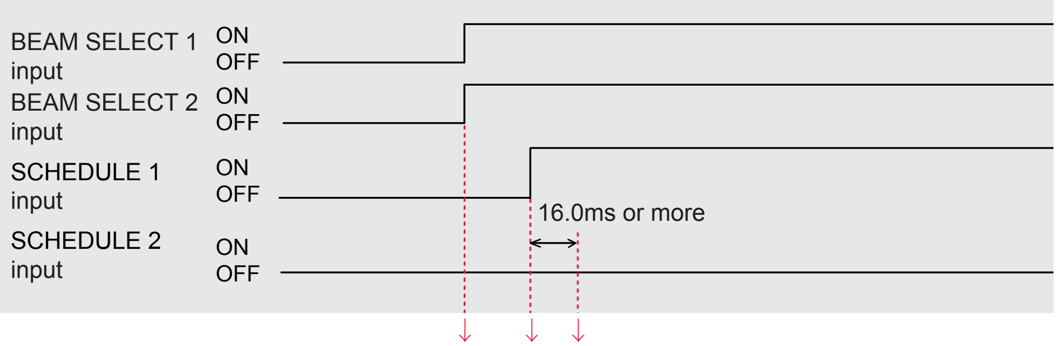
(1) Put the pin corresponding to the desired beam in a closed circuit. In this example, the section between pin No.16 and pin No.17 of the EXT. I/O (2) connector is put in a closed circuit to select Beam 1 and Beam 2.

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

4 Setting Output Schedules (SCH.#01)

(1) Set the SCHEDULE number by combining pin No.27 to pin No.34 of the EXT. I/O (2) connector. In this example, pin No.27 of the EXT. I/O (2) connector is put in a closed circuit for 16 ms or more to set SCH.#01.

- 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, 1.0 ms, 4.0 ms, 8.0 ms, or 16.0 ms can be selected by displaying the PREFERENCE screen from the INITIALIZE screen. For details, refer to "3. Changing the Acceptance Time for Laser Start Signal/Schedule Signal" on page 106.

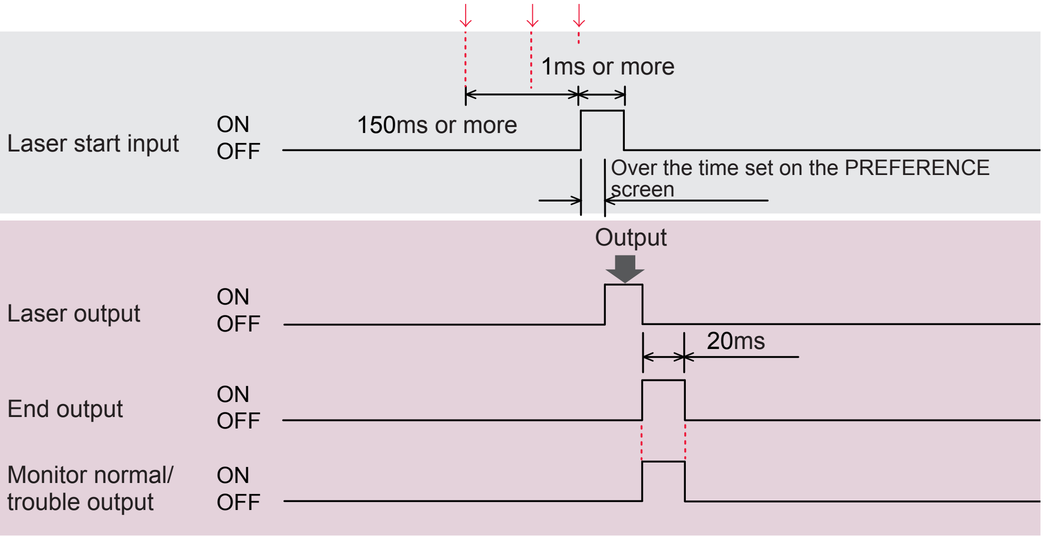


5 Outputting Laser Light

(1) Put pin No.2 (Laser Start) of the EXT. I/O (1) connector in a closed circuit.

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

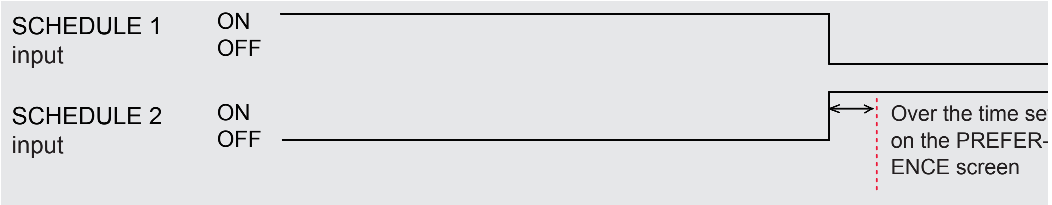
Pin No.22 (End output) of the EXT. I/O (1) connector is put in a closed circuit for 20 ms and a signal is returned from the laser. Pin No.17 (Monitor normal output) or pin No.20 (Monitor trouble output) of the EXT. I/O (1) connector is put in a closed circuit for 20 ms and a signal is returned from the laser.



- 150 ms after a beam select signal input or in more than the time set on the PREFERENCE 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. Set the circuit to close for a period of time that matches this value. The laser start acceptance timecan be set to 1.0 ms, 4.0 ms, 8.0 ms, or 16.0 ms by displaying the PREFERENCE screen through the INTIALIZE screen.

6 Setting Output Schedules (SCH.#02)

(1) Set the SCHEDULE number by connecting pin No.27 to pin No.34 of the EXT. I/O (2) connector. In this example, put Pin No.27 of the EXT. I/O (2) connector to an open circuit to turn OFF SCH.#01, and put pin No.28 in a closed circuit to turn on SCH.#02.

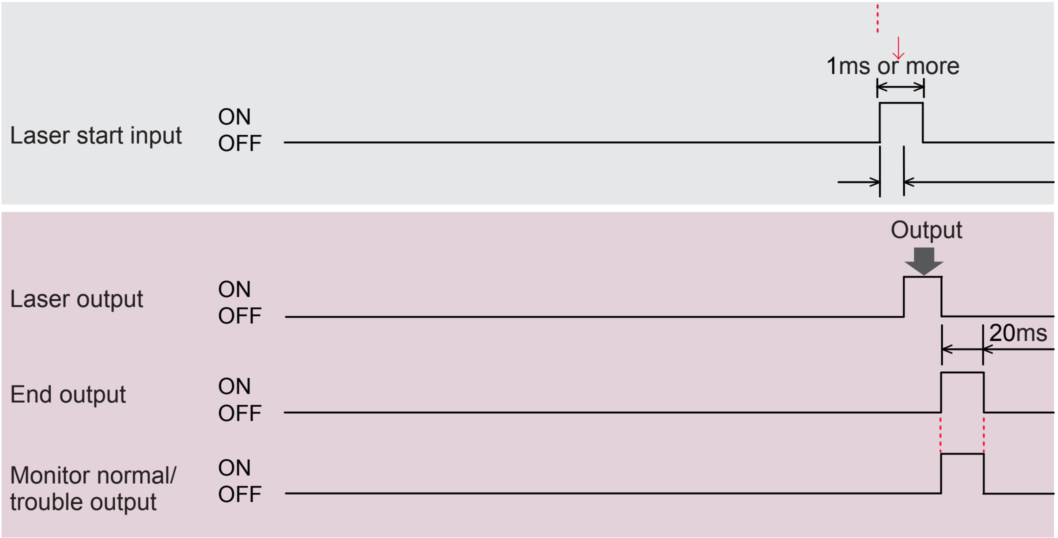

SCHEDULE 1 input
ON
OFF
SCHEDULE 2 input
ON
OFF
Over the time se
on the PREFER-
ENCE screen

7 Outputting Laser Light

(1) Close pin No.2 (Laser start) of the EXT. I/O (1) connector.

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

☐ The details are the same as Step 5.


1ms or more
Laser start input
ON
OFF
Output
Laser output
ON
OFF
20ms
End output
ON
OFF
Monitor normal/ trouble output
ON
OFF

8

Stopping the Operation

(1) Put pin No.11 of the EXT. I/O (1) connector in an open circuit to turn off the LD.

(2) Put pin No.25 (control switching) of the EXT. I/O (1) in an open circuit to stop receiving external input signals.

Adjusting position using the Guide Light

Adjust the position using the 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 pin No.5 of the EXT. I/O (1) connector in a closed circuit.
The guide light can be seen as a red point. The welding laser will hit this red point position.

(3) Fire the laser and check the laser light irradiation position.
If the desired welding point deviates from the red point of guide light, move the output unit or workpiece to adjust the position.

Chapter 5

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

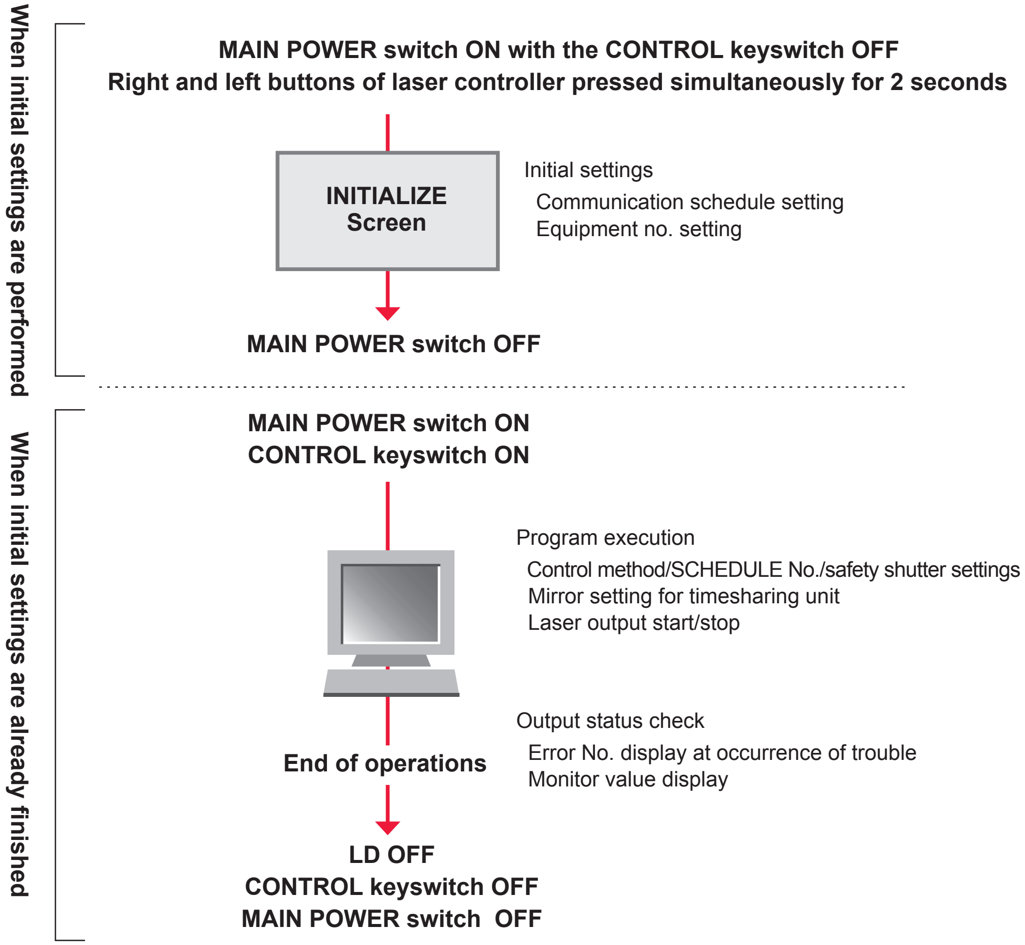
1. Operation Flow

This section explains operation flow for laser welding using 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 personal computer connected to an connector (RS-485 CONTROL).

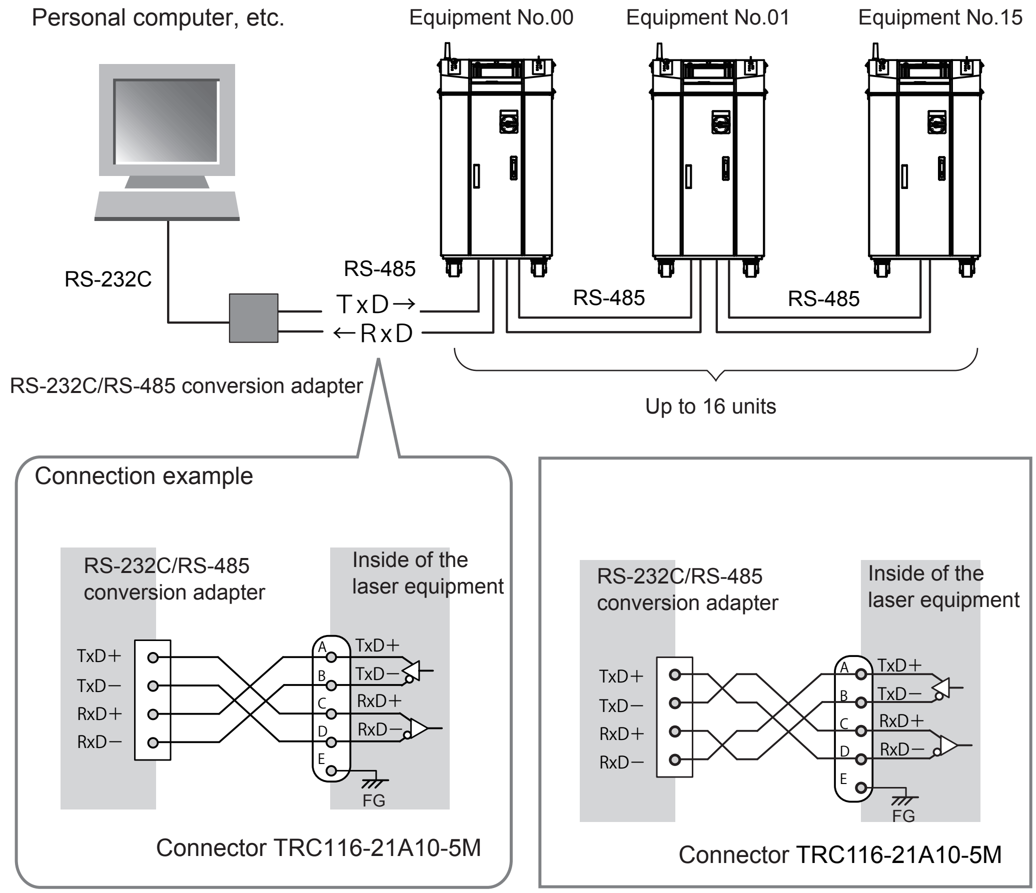
When using control by external communication (RS-485 CONTROL) the original customer-developed program is executed on the personal computer to set laser output schedules and read monitor data and various types of status. A programmable Logic Controller (PLC) with RS232 or RS485 output can be used as well.

* 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).


When initial settings are performed
MAIN POWER switch ON with the CONTROL keyswitch OFF
Right and left buttons of laser controller pressed simultaneously for 2 seconds
INITIALIZE Screen
Initial settings
Communication schedule setting
Equipment no. setting
MAIN POWER switch OFF
When initial settings are already finished
MAIN POWER switch ON
CONTROL keyswitch ON
Program execution
Control method/SCHEDULE No./safety shutter settings
Mirror setting for timesharing unit
Laser output start/stop
Output status check
Error No. display at occurrence of trouble
Monitor value display
End of operations
LD OFF
CONTROL keyswitch OFF
MAIN POWER switch OFF

2. Preparing for Operation

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


Personal computer, etc.
Equipment No.00
Equipment No.01
Equipment No.15
RS-232C
RS-485
TxD→
←RxD
RS-485
RS-485
RS-232C/RS-485 conversion adapter
Up to 16 units
Connection example
RS-232C/RS-485 conversion adapter
Inside of the laser equipment
TxD+
TxD−
RxD+
RxD−
A
B
C
D
E
TxD+
TxD−
RxD+
RxD−
FG
Connector TRC116-21A10-5M
RS-232C/RS-485 conversion adapter
Inside of the laser equipment
TxD+
TxD−
RxD+
RxD−
A
B
C
D
E
TxD+
TxD−
RxD+
RxD−
FG
Connector TRC116-21A10-5M

- For controlling multiple lasers with a single personal computer it is necessary to register an equipmnet number (NETWORK #) for each equipment. Set equipment No. without duplication. If duplication of equipment No. exists data collision will occur on the communication line and the laser cannot be correctly operated.
- An RS-232C/RS-485 conversion adapter is available separately. Purchase it as required. For details, refer to the Introduction Part, Chapter 1 "Options" on page 26.
- Prepare the communication program and its development environment for laser control on the customer side using the commandset located in this manual.
- Connect the cable shield 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. using the laser control panel in pendant mode.

The communication schedules for data transfer are as follows.

Data transfer system	Conforming to RS-485, asynchronous, full duplex	
Transfer rate	9600, 19200, 38400, 57600, 115200 bps	
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 PREFERENCE screen from the INITIALIZE screen by the laser controller of each equipment that is connected to the personal computer, etc.

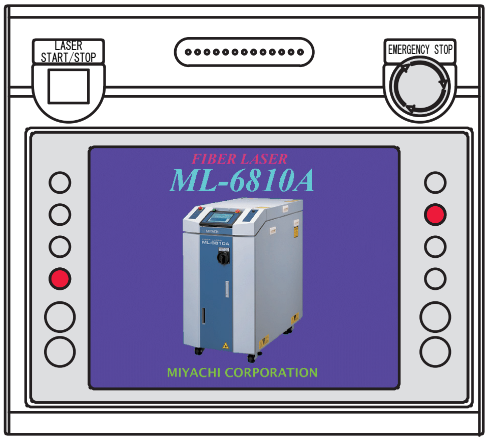
Setting Communication Schedules and Equipment No.

Set the communication conditions and equipment No. by displaying the PREFERENCE screen from the INITIALIZE screen by the laser controller of the equipment.

1 Displaying the PREFERENCE Screen

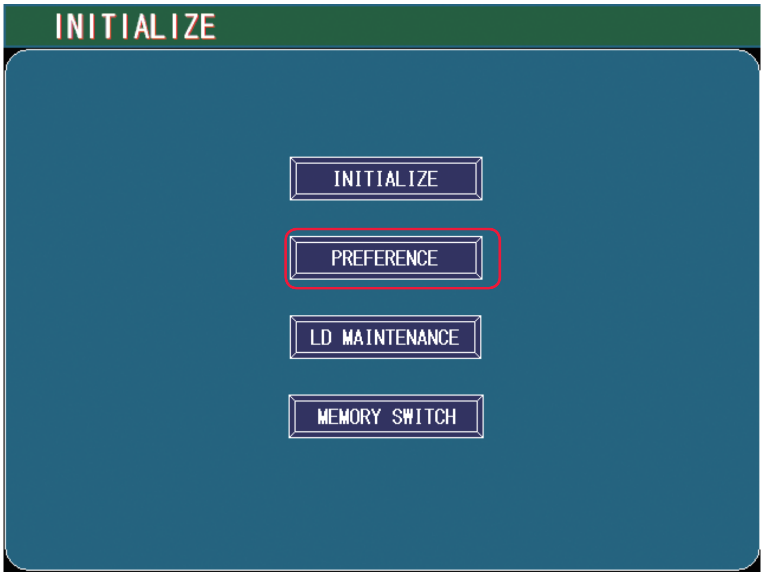
(1) Turn OFF the CONTROL keyswitch, and turn ON the MAIN POWER switch.

When power is supplied the POWER lamp comes on and a picture of the laser model will appear



(2) While the laser model screen is displayed (for about 3 seconds) press the appropriate right and left buttons (red portions in the above figure) of the laser controller simultaneously for 2 seconds.

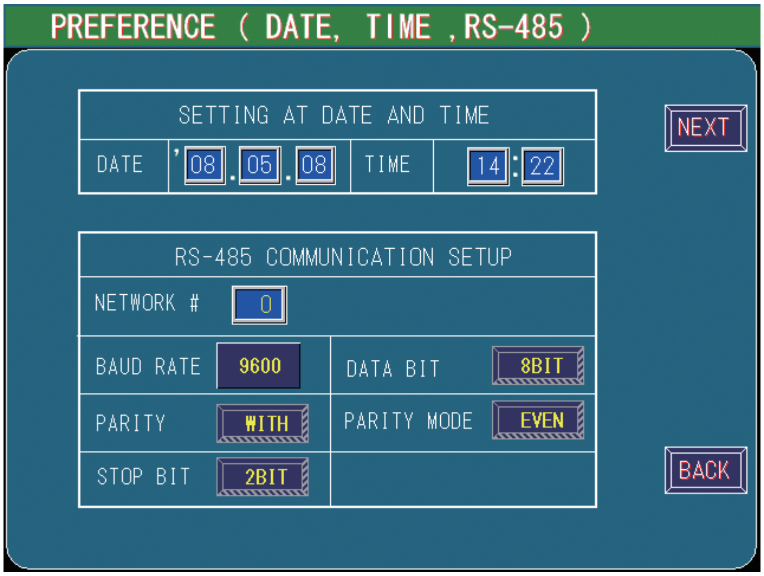
The INITIALIZE screen appears.


INITIALIZE
INITIALIZE
PREFERENCE
LD MAINTENANCE
MEMORY SWITCH

- If the CONTROL keyswitch is OFF the INITIALIZE screen will not display

(3) Press the "PREFERENCE" button.

The PREFERENCE screen is displayed.



PREFERENCE (DATE, TIME ,RS-485)

SETTING AT DATE AND TIME

DATE '08.05.08 TIME 14:22

RS-485 COMMUNICATION SETUP

NETWORK # 0

BAUD RATE 9600

DATA BIT 8BIT

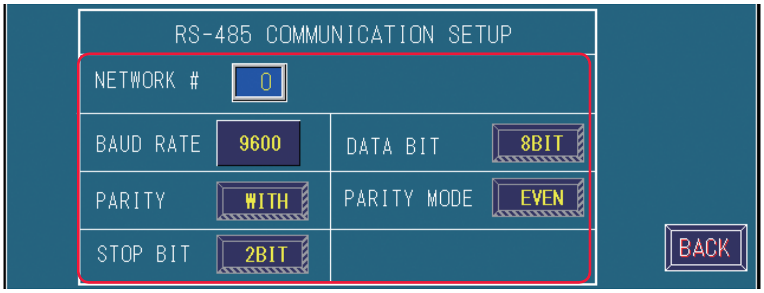
PARITY WITH

PARITY MODE EVEN

STOP BIT 2BIT

2 Specifying Communication Schedules

(1) Set communication schedules in "RS-485 COMMUNICATION SETUP." Press the setting button to change this setting.



RS-485 COMMUNICATION SETUP

NETWORK # 0

BAUD RATE 9600

DATA BIT 8BIT

PARITY WITH

PARITY MODE EVEN

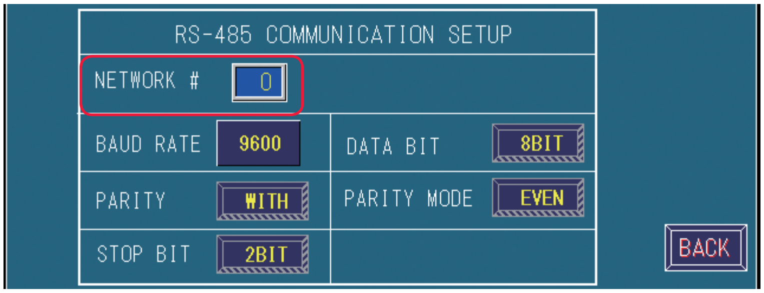
STOP BIT 2BIT

3 Specifying Equipment No.

(1) Press the "NETWORK#" setting button.

Enter the laser welder No. in the range of 0 to 15 using the numeric keypad and then press the ENT key.

- To control multiple lasers with a single personal computer it is necessary to register an equipment No. (NETWORK #) for each piece of equipment. Set a unique equipment No. for each machine. If duplication of the equipment No. exists data collision will occur on the communication line and the laser cannot be correctly operated.



RS-485 COMMUNICATION SETUP

NETWORK # 0

BAUD RATE 9600

DATA BIT 8BIT

PARITY WITH

PARITY MODE EVEN

STOP BIT 2BIT

(2) Press the "BACK" button.

Returns to the INITIALIZE screen.

<Note>

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

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 144 to "Reading the Equiment Name" on page 167.

Control Codes (Hexadecimal Codes)

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

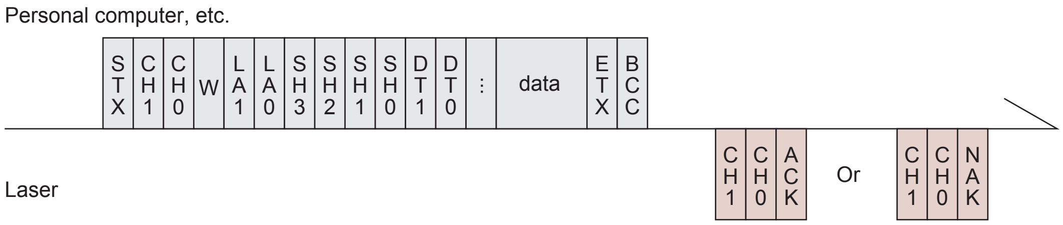
BCC (block check code) ... 1-byte horizontal even parity up to ETX excluding STX

Code	Contents	Text structure																	
W	Setting data	PC to laser	STX	CH1	CH0	W	LA1	LA0	SH3	SH2	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	SH3	SH2	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., safety shutter, etc.	PC to laser	STX	CH1	CH0	W	S	SH3	SH2	SH1	SH0	cnt	s1	s2	…	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.							
WD	Setting the system date and time	PC to laser	STX	CH1	CH0	W	D	Y3 …	Y0	MO1	MO0	D1	D0	H1	H0	MI1	MI0	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., safety shutter, etc.	PC to laser	STX	CH1	CH0	R	S	ETX	BCC										
		Laser to PC	STX	CH1	CH0	SH3	SH2	SH1	SH0	cnt	s1	s2	s3	…	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	m1	m2	m3	m4	m5	ETX	BCC									

Code	Contents	Text structure															
RD	Reading the system date and time	PC to laser	STX	CH1	CH0	R	D	ETX	BCC								
		Laser to PC	STX	Y3	Y2	Y1	Y0	MO1	MO0	D1	D0	H1	H0	MI1	MI0	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 LD is OFF, trouble occurs, or external communication control is not performed.					
$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	E2	E1	E0	,	E2	E1	E0	,	…	E2	E1	E0	ETX	BCC
RH	Reading the error history	PC to laser	STX	CH1	CH0	R	H	ID3	ID2	ID1	ID0	ETX	BCC				
		Laser to PC	STX	error			ETX	BCC									
RV	Reading the software version	PC to laser	STX	CH1	CH0	R	V	CP1	CP0	ETX	BCC						
		Laser to PC	STX	version			ETX	BCC									
RN	Reading the equipment name	PC to laser	STX	CH1	CH0	R	N	ETX	BCC								
		Laser to PC	STX	name			ETX	BCC									

Setting Data

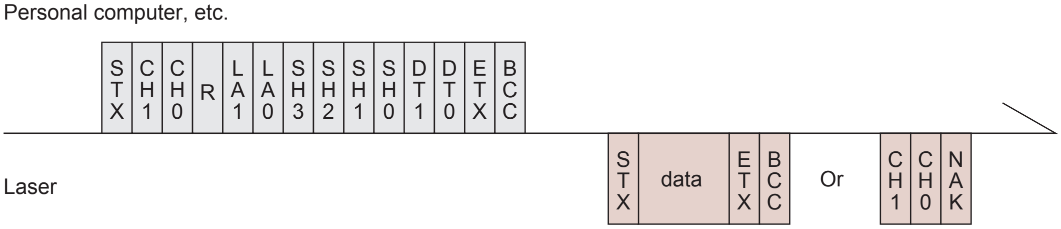
The command (code: W) to set welding schedules by specifying equipment No. and schedule No. is explained below.



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. [SH3/SH2/SH1/SH0] to 0000.) 84 Schedule settings for FIX and FLEX 85 Schedule settings for FIX 86 Schedule settings for FLEX (REPEAT), TIME 01 to 10 87 Schedule settings for FLEX (REPEAT), TIME 11 to 20 88 Schedule settings for FLEX (REPEAT), POWER 01 to 10 89 Schedule settings for FLEX (REPEAT), POWER 11 to 20 66 Schedule settings for FLEX (CW), TIME 01 to 10 67 Schedule settings for FLEX (CW), TIME 11 to 20 68 Schedule settings for FLEX (CW), POWER 01 to 10 69 Schedule settings for FLEX (CW), 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 64 Modulation function ON/OFF 65 Modulation function settings
SH3/SH2/SH1/SH0	Schedule No. (SH3 = thousands digit, SH2 = hundreds digit, SH1 = tens digit, SH0 = units digit) Enter the No. of the schedule you want to change within the data range of 0000 to 0255. 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 147. • 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. [SH3/SH2/SH1/SH0] to 0000.) 84 Schedule settings for FIX and FLEX 85 Schedule settings for FIX 86 Schedule settings for FLEX (REPEAT), TIME 01 to 10 87 Schedule settings for FLEX (REPEAT), TIME 11 to 20 88 Schedule settings for FLEX (REPEAT), POWER 01 to 10 89 Schedule settings for FLEX (REPEAT), POWER 11 to 20 66 Schedule settings for FLEX (CW), TIME 01 to 10 67 Schedule settings for FLEX (CW), TIME 11 to 20 68 Schedule settings for FLEX (CW), POWER 01 to 10 69 Schedule settings for FLEX (CW), 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 64 Modulation function ON/OFF 65 Modulation function settings 50 LD ON total time 51 Laser output total time 52 LD test shot power 53 LD deterioration rate 54 LD serial No. 55 LD initial power 40 Backup memory settings 95 Laser power monitor — Shot count, Good count, average 00 Laser power monitor — Energy, number of waveform data 01 Laser power monitor — Waveform data 000 to 004 : : 22 Laser power monitor — Waveform data 105 to 109
SH3/SH2/SH1/SH0	Schedule No. (SH3 = thousands digit, SH2 = hundreds digit, SH1 = tens digit, SH0 = units digit) Enter the No. of the schedule you want to read within the data range of 0000 to 0255. 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 147. • 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 value can be read out but cannot be set.
- The value in ( ) indicates the unit.
- The unit of time setting depends on the setting of "PULSE WIDTH RESOL" on the PREFERENCE screen. When setting to 0.00ms, set the values in increment of 5.

99 Settings for Cooler (Set the schedule No. [SH3/SH2/SH1/SH0] to 0000.)

Data No.	Item	Data Range
01*	Coolant temperature	000 – 999 (× 1°C)
02	Unused	Fixed to 00
03	Unused	Fixed to 00
04	Unused	Fixed to 00
05*	Coolant resistivity	000 – 999 (× 0.01MΩ)
06	[REF TEMP] on the [PREFERENCE] screen Target temperature	000 – 999 (×0.1°C)
07	[HIGH] of CONTROL on the [PREFERENCE] screen Control temperature (high)	000 – 999 (×0.1°C)
08	[LOW] of CONTROL on the [PREFERENCE screen Control temperature (low)	000 – 999 (×0.1°C)
09	[HIGH] of ALARM on the [PREFERENCE] screen Coolant temperature high alarm	000 – 999 (×0.1°C)
10	[LOW] of ALARM on the [PREFERENCE] screen Coolant temperature low alarm	000 – 999 (×0.1°C)

84 Schedule Settings for 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	Turning ON/OFF the graph display of the [SCHEDULE] screen 0: OFF 1: ON	Fixed to 1
03	[PEAK POWER] on the [SCHEDULE] screen Laser output peak value	00010 – 01000 (×1W)
04	[REPEAT] on the [SCHEDULE] screen Pulse repetition rate	FIX : 00001 – 05000 FLEX : 00000 – 05000
05	[SHOT] on the [SCHEDULE] screen Number of consecutive shots	0001 – 9999
06	[HIGH] on the [MONITOR] screen Energy monitor upper limit setting	000000 – 060000 (×0.01J)
07	[LOW] on the [MONITOR] screen Energy monitor lower limit setting	000000 – 060000 (×0.01J)
08	Turning ON/OFF the graph display of the [MONITOR] screen 0: OFF 1: ON	Fixed to 1

Data No.	Item	Data Range
09	Unused	Fixed to 100

85 Schedule Settings for FIX

Data No.	Item	Data Range
01	[↑ SLOPE] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
02	[FLASH 1] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
03	[FLASH 2] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
04	[FLASH 3] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
05	[↓ SLOPE] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
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	00000 – 99999 (×0.01J)
12	[COOL 1] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
13	[COOL 2] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)

86 Schedule Settings for FLEX (REPEAT) — TIME 01 to 10

Data No.	Item	Data Range
01	[POINT 01] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
02	[POINT 02] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
03	[POINT 03] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
04	[POINT 04] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
05	[POINT 05] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
06	[POINT 06] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
07	[POINT 07] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
08	[POINT 08] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
09	[POINT 09] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
10	[POINT 10] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)

87 Schedule Settings for FLEX (REPEAT) — TIME 11 to 20

Data No.	Item	Data Range
01	[POINT 11] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
02	[POINT 12] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
03	[POINT 13] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
04	[POINT 14] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
05	[POINT 15] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
06	[POINT 16] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)

Data No.	Item	Data Range
07	[POINT 17] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
08	[POINT 18] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
09	[POINT 19] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)
10	[POINT 20] TIME on the [SCHEDULE] screen	0000 – 4999 (×0.1ms/×0.01ms)

88 Schedule Settings for FLEX (REPEAT) — 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%)

89 Schedule Settings for FLEX (REPEAT) — 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%)

66 Schedule Settings for FLEX (CW) — TIME 01 to 10

Data No.	Item	Data Range
01	[POINT 01] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
02	[POINT 02] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
03	[POINT 03] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
04	[POINT 04] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
05	[POINT 05] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
06	[POINT 06] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)

Data No.	Item	Data Range
07	[POINT 07] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
08	[POINT 08] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
09	[POINT 09] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
10	[POINT 10] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)

67 Schedule Settings for FLEX (CW) — TIME 11 to 20

Data No.	Item	Data Range
01	[POINT 11] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
02	[POINT 12] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
03	[POINT 13] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
04	[POINT 14] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
05	[POINT 15] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
06	[POINT 16] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
07	[POINT 17] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
08	[POINT 18] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
09	[POINT 19] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)
10	[POINT 20] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s)

68 Schedule Settings for FLEX (CW) — 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%)

69 Schedule Settings for FLEX (CW) — 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%)

Data No.	Item	Data Range
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%)

75 SEAM setting value SEAM ON/OFF

Data No.	Item	Data Range
01	[SEAM] on the [SEAM] 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%)

64 Modulation Function ON/OFF

Data No.	Item	Data Range
01	[MODU] on the [MODULATION] screen Modulation function ON/OFF 0: OFF 1: ON	0 − 1

65 Modulation Function Settings

Data No.	Item	Data Range
01	[WAVE] on the [MODULATION] screen Selection of modulated waveform 0: Rectangular wave 1: Triangular wave 2: Sinusoidal wave	0 − 2
02	[FREQUENCY] on the [MODULATION] screen Setting of modulation frequency	1 – 5000
03	[MODULATION] on the [MODULATION] screen Setting of modulated width	0 – 100
04	[DUTY] on the [MODULATION] screen Setting of modulation duty ratio	10 – 90

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	000000 – 999999 (×1W)

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

Data No.	Item	Data Range
01*	Schedule No. of laser power monitor data	0000 – 0255
02*	Unused	Fixed to 000
03*	[ENERGY] on the [MONITOR] screen Laser Energy	000000 – 999999 (×0.01J)
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	0000 – 5000 (×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	0000 – 0255
02*	Laser power monitor waveform data 1/5	00000 – 99999 (×0.1W)
03*	Laser power monitor waveform data 2/5	00000 – 99999 (×0.1W)
04*	Laser power monitor waveform data 3/5	00000 – 99999 (×0.1W)
05*	Laser power monitor waveform data 4/5	00000 – 99999 (×0.1W)
06*	Laser power monitor waveform data 5/5	00000 – 99999 (×0.1W)

- 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 40.0 ms, a measured value is sent at intervals of 0.40 ms.

  * When the pulse width is 40.1 to 80.0 ms, a measured value is sent at intervals of 0.80 ms.

  * When the pulse width is 80.1 to 100.0 ms, a measured value is sent at intervals of 1.00 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.

50 LD ON Total Time

Data No.	Item	Data Range
01*	No. 1 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
02*	No. 2 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
03*	No. 3 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
04*	No. 4 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
05*	No. 5 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
06*	No. 6 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
07*	No. 7 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
08*	No. 8 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
09*	No. 9 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
10*	No. 10 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
11*	No. 11 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
12*	No. 12 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
13*	No. 13 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)
14*	No. 14 RUNNING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×1H)

51 LD Output Total Time

Data No.	Item	Data Range
01*	No. 1 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
02*	No. 2 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
03*	No. 3 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
04*	No. 4 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
05*	No. 5 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)

Data No.	Item	Data Range
06*	No. 6 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
07*	No. 7 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
08*	No. 8 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
09*	No. 9 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
10*	No. 10 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
11*	No. 11 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
12*	No. 12 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
13*	No. 13 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)
14*	No. 14 WORKING TIME on the [TOTAL TIME FOR EACH FC-LD] screen	0000000 – 9999999 (×0.1H)

52 LD Test Shot Power

Data No.	Item	Data Range
01*	FC-LD No.1 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
02*	FC-LD No.2 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
03*	FC-LD No.3 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
04*	FC-LD No.4 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
05*	FC-LD No.5 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
06*	FC-LD No.6 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
07*	FC-LD No.7 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
08*	FC-LD No.8 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
09*	FC-LD No.9 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
10*	FC-LD No.10 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
11*	FC-LD No.11 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
12*	FC-LD No.12 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
13*	FC-LD No.13 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)

Data No.	Item	Data Range
14*	FC-LD No.14 POWER on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1W)
15*	HR INPUT POWER on the [LD DETERIORATION RATE] screen	00000 – 99999 (×1W)
16*	PR INPUT POWER on the [LD DETERIORATION RATE] screen	00000 – 99999 (×1W)
17*	OSCILLATOR POWER on the [LD DETERIORATION RATE] screen	00000 – 99999 (×1W)

53 LD Deterioration Rate

Data No.	Item	Data Range
01*	FC-LD No.1 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
02*	FC-LD No.2 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
03*	FC-LD No.3 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
04*	FC-LD No.4 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
05*	FC-LD No.5 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
06*	FC-LD No.6 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
07*	FC-LD No.7 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
08*	FC-LD No.8 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
09*	FC-LD No.9 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
10*	FC-LD No.10 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
11*	FC-LD No.11 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
12*	FC-LD No.12 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
13*	FC-LD No.13 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
14*	FC-LD No.14 RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
15*	HR INPUT RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
16*	PR INPUT RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)
17*	OSCILLATOR RATE on the [LD DETERIORATION RATE] screen	0000 – 9999 (×0.1%)

54 LD Serial No.

Data No.	Item	Data Range
01*	FC-LD No.1 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
02*	FC-LD No.2 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
03*	FC-LD No.3 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
04*	FC-LD No.4 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
05*	FC-LD No.5 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
06*	FC-LD No.6 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
07*	FC-LD No.7 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
08*	FC-LD No.8 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
09*	FC-LD No.9 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
10*	FC-LD No.10 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
11*	FC-LD No.11 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
12*	FC-LD No.12 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
13*	FC-LD No.13 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999
14*	FC-LD No.14 SERIAL No. on the [LD MAINTENANCE] screen	0000000 – 9999999

55 LD Initial Power

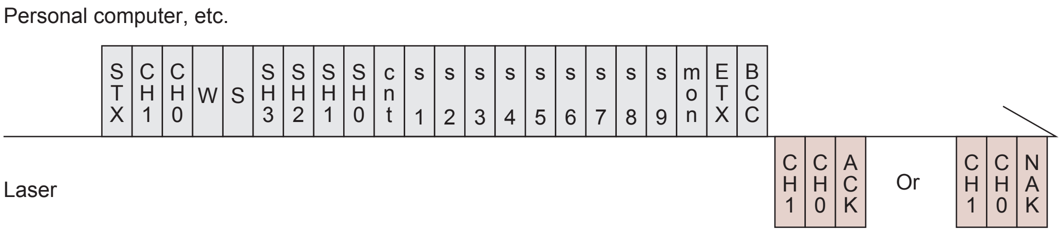
Data No..	Item	Data Range
01*	No.1 POWER on the maintenance screen	0000 – 9999 (×0.1W)
02*	No.2 POWER on the maintenance screen	0000 – 9999 (×0.1W)
03*	No.3 POWER on the maintenance screen	0000 – 9999 (×0.1W)
04*	No.4 POWER on the maintenance screen	0000 – 9999 (×0.1W)
05*	No.5 POWER on the maintenance screen	0000 – 9999 (×0.1W)
06*	No.6 POWER on the maintenance screen	0000 – 9999 (×0.1W)
07*	No.7 POWER on the maintenance screen	0000 – 9999 (×0.1W)
08*	No.8 POWER on the maintenance screen	0000 – 9999 (×0.1W)
09*	No.9 POWER on the maintenance screen	0000 – 9999 (×0.1W)
10*	No.10 POWER on the maintenance screen	0000 – 9999 (×0.1W)
11*	No.11 POWER on the maintenance screen	0000 – 9999 (×0.1W)
12*	No.12 POWER on the maintenance screen	0000 – 9999 (×0.1W)
13*	No.13 POWER on the maintenance screen	0000 – 9999 (×0.1W)
14*	No.14 POWER on the maintenance screen	0000 – 9999 (×0.1W)
15*	HR INPUT POWER on the maintenance screen	00000 – 99999 (×1W)
16*	PR INPUT POWER on the maintenance screen	00000 – 99999 (×1W)
17*	OSCILLATOR POWER on the maintenance screen	00000 – 99999 (×1W)

40 Backup Memory Settings

Data No.	Item	Data Range
01*	[NETWORK #] on the [PREFERENCE] screen	00 – 15
02*	[IP ADDRESS] on the [PREFERENCE] screen	000000000000 – 999999999999
03*	[SUBNET MASK] on the [PREFERENCE] screen	000000000000 – 999999999999
04*	[DEFAULT GATEWAY] on the [PREFERENCE] screen	000000000000 – 999999999999
05*	[GUIDE AUTO-OFF] on the [PREFERENCE] screen The time required for guide light to go out automatically	00 – 99 (×1 min)
06*	[OUTPUT CURR. VALUE FOR DETERIORATION RATE JUDGMENT] on the [PREFERENCE] screen LD current output value for judgment of LD deterioration rate	0050 – 1140 (×0.1A)
07*	[FLASH CONTROL MODE] on the maintenance screen LD output mode 0: Power 1: Current	0 – 1
08*	[SWITCH 1] on the [MEMORY SWITCH] screen 0: OFF 1: ON	00000000 – 11111111
09*	[SWITCH 2] on the [MEMORY SWITCH] screen 0: OFF 1: ON	00000000 – 11111111
10*	[SWITCH 3] on the [MEMORY SWITCH] screen 0: OFF 1: ON	00000000 – 11111111
11*	[SWITCH 4] on the [MEMORY SWITCH] screen 0: OFF 1: ON	00000000 – 11111111
12*	[SWITCH 5] on the [MEMORY SWITCH] screen 0: OFF 1: ON	00000000 – 11111111
13*	[SWITCH 6] on the [MEMORY SWITCH] screen 0: OFF 1: ON	00000000 – 11111111

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

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

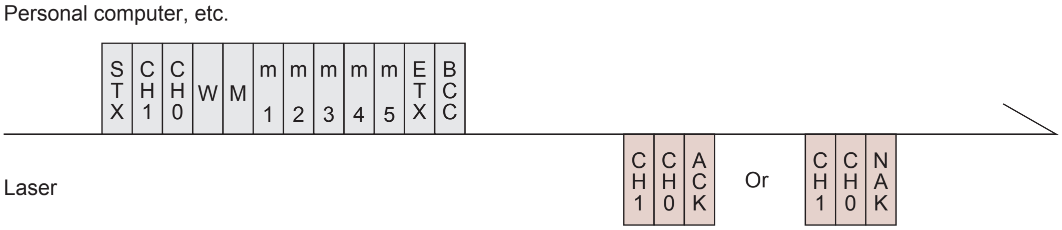


<table>
<tr><td>CH1/CH0</td><td>Equipment No. (CH1 = tens digit, CH0 = units digit)</td></tr>
<tr><td>SH3/SH2/SH1/SH0</td><td>Schedule No. (SH3 = thousands digit, SH2 = hundreds digit, SH1 = tens digit, SH0 = units digit)
The data range is 0000 to 0255, and the schedule No. to be changed is entered.
For □□□□ (space), the current schedule No. in use is entered.</td></tr>
<tr><td>cnt</td><td>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: (NOT USED)
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.
<table>
<tr><th>Control by external input/output signals</th><th>Set value</th><th>Control method to be set</th></tr>
<tr><td rowspan="2">At OFF</td><td>0</td><td>0: Control by laser controller</td></tr>
<tr><td>2</td><td>2: Control by external communication control</td></tr>
<tr><td rowspan="2">At ON</td><td>0</td><td>1: Control by external input/output signals (Output schedules are set on the laser controller.)</td></tr>
<tr><td>2</td><td>5: Control by external input/output signals (Output schedules are set on the personal computer.)</td></tr>
</table>
</td></tr>
</table>

	* 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	LD (0: OFF 1: ON □: Current status kept)
s2	Guide light (0: OFF 1: ON □: Current status kept)
s3	Unused (fixed to □)
s4	Safety shutter 1 (0: OFF 1: ON □: Current status kept)
s5	Safety shutter 2 (0: OFF 1: ON □: Current status kept)
s6	Safety shutter 3 (0: OFF 1: ON □: Current status kept)
s7	Unused (fixed to □)
s8	Unused (fixed to □)
s9	Unused (fixed to □)
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 153 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.

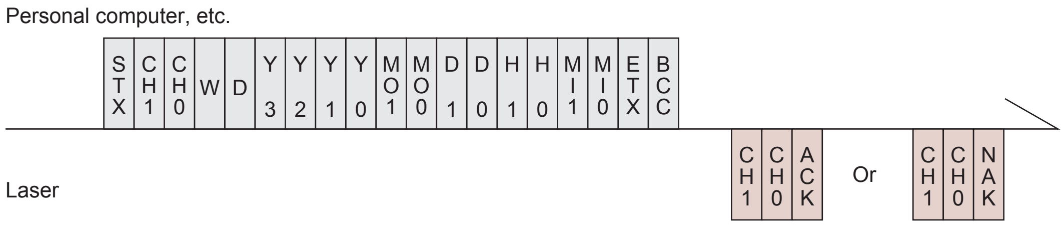


CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
m1	Timesharing unit 1 (0: OFF 1: ON □: Current status kept)
m2	Timesharing unit 2 (0: OFF 1: ON □: Current status kept)
m3	Unused (fixed to □)

m4	Unused (fixed to □)
m5	Unused (fixed to □)
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 System Date and Time

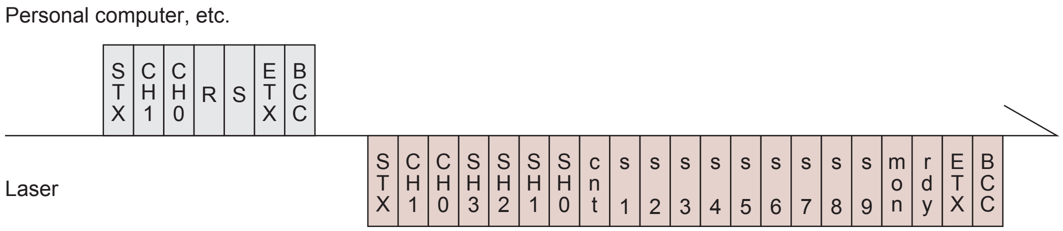
The command (code: WD) to set the system date and time is explained below.


Personal computer, etc.
STX
CH1
CH0
W
D
Y3
Y2
Y1
Y0
MO1
MO0
D1
D0
H1
H0
MI1
MI0
ETX
BCC
Laser
CH1
CH0
ACK
Or
CH1
CH0
NAK

CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
Y3/Y2/Y1/Y0	Year (Y3 = thousands digit, Y2 = hundreds digit, Y1 = tens digit, Y0 = units digit)
MO1/MO0	Month (MO1 = tens digit, MO0 = units digit)
D1/D0	Day (D1 = tens digit, D0 = units digit)
H1/H0	Hour (H1 = tens digit, H0 = units digit)
MI1/MI0	Minute (MI1 = tens digit, MI0 = units digit)
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., Safety Shutter, etc.

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

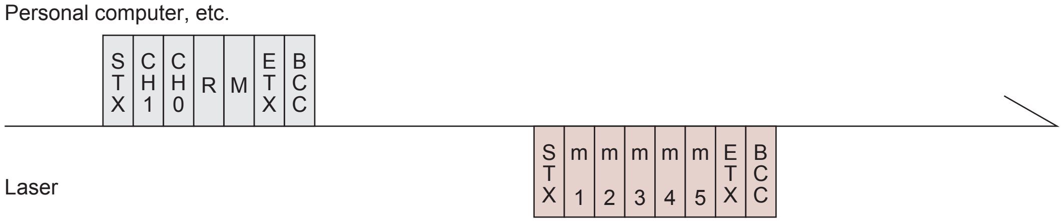

Personal computer, etc.
STX
CH1
CH0
R
S
ETX
BCC
Laser
STX
CH1
CH0
SH3
SH2
SH1
SH0
cnt
s1
s2
s3
s4
s5
s6
s7
s8
s9
mon
rdy
ETX
BCC

CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
SH3/SH2/SH1/SH0	Schedule No. (SH3 = thousands digit, SH2 = hundreds digit, 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	LD (0: OFF 1: ON)
s2	Guide light (0: OFF 1: ON)
s3	Unused (fixed to 0)
s4	Safety shutter 1 (0: OFF 1: ON)
s5	Safety shutter 2 (0: OFF 1: ON)
s6	Safety shutter 3 (0: OFF 1: ON)
s7	Unused (fixed to 0)
s8	Unused (fixed to 0)
s9	Unused (fixed to 0)
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 153 is sent.
rdy	READY status (0: Laser start enabled 1: Laser start disabled)

Reading the Timesharing Unit Status

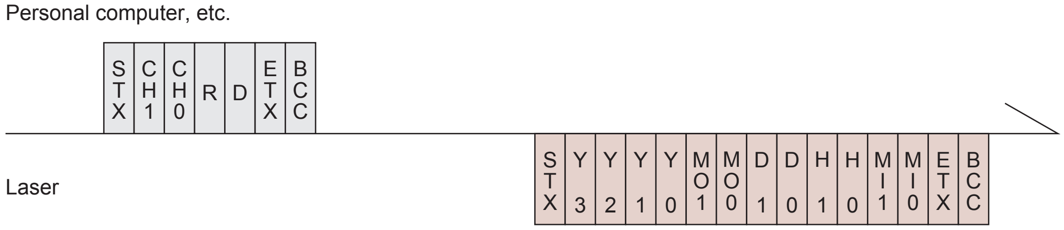
The command (code: RM) to read the timesharing unit status is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
m1	Timesharing unit 1 (0: OFF 1: ON)
m2	Timesharing unit 2 (0: OFF 1: ON)
m3	Unused (fixed to 0)
m4	Unused (fixed to 0)
m5	Unused (fixed to 0)

Reading the System Date and Time

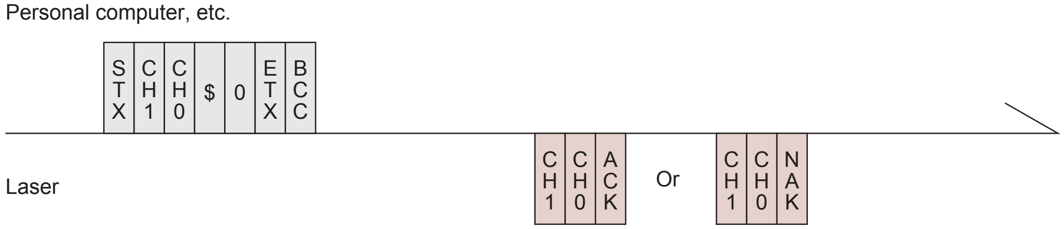
The command (code: RD) to read the system date and time is explained below.


Personal computer, etc.
STX
CH1
CH0
R
D
ETX
BCC
Laser
STX
Y3
Y2
Y1
Y0
MO1
MO0
D1
D0
H1
H0
MI1
MI0
ETX
BCC

CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
Y3/Y2/Y1/Y0	Year (Y3 = thousands digit, Y2 = hundreds digit, Y1 = tens digit, Y0 = units digit)
MO1/MO0	Month (MO1 = tens digit, MO0 = units digit)
D1/D0	Day (D1 = tens digit, D0 = units digit)
H1/H0	Hour (H1 = tens digit, H0 = units digit)
MI1/MI0	Minute (MI1 = tens digit, MI0 = units digit)

Starting a Laser Light Output

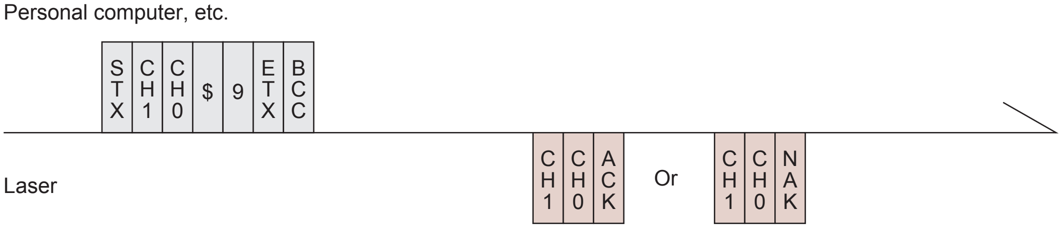
The command (code: $0) to start a laser light output is explained below.


Personal computer, etc.
STX
CH1
CH0
$
0
ETX
BCC
Laser
CH1
CH0
ACK
Or
CH1
CH0
NAK

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. • LD is OFF. • The Laser is not in external communication control mode.

Stopping a Laser Light Output

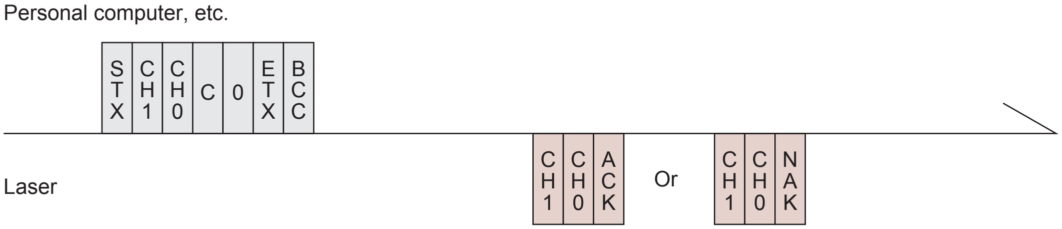
The command (code: $9) to stop a laser light output is explained below.


Personal computer, etc.
STX
CH1
CH0
$
9
ETX
BCC
Laser
CH1
CH0
ACK
Or
CH1
CH0
NAK

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

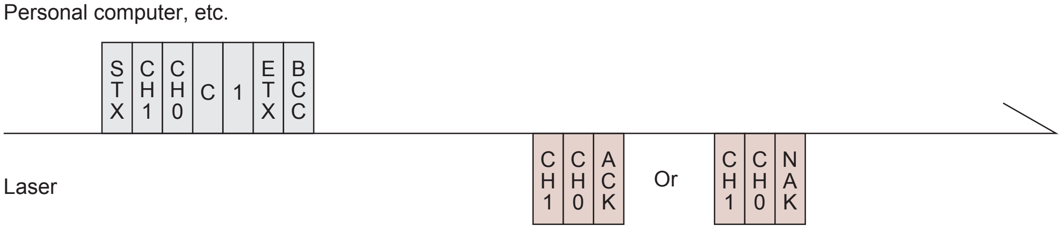
The command (code: C0) to stop an error signal output is explained below.


Personal computer, etc.
STX
CH1
CH0
C
0
ETX
BCC
Laser
CH1
CH0
ACK
Or
CH1
CH0
NAK

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

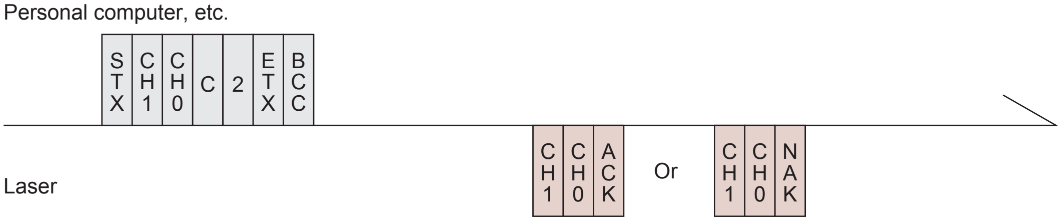
The command (code: C1) to reset the total number of outputs (SHOT COUNT) is explained below.


Personal computer, etc.
STX
CH1
CH0
C
1
ETX
BCC
Laser
CH1
CH0
ACK
Or
CH1
CH0
NAK

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

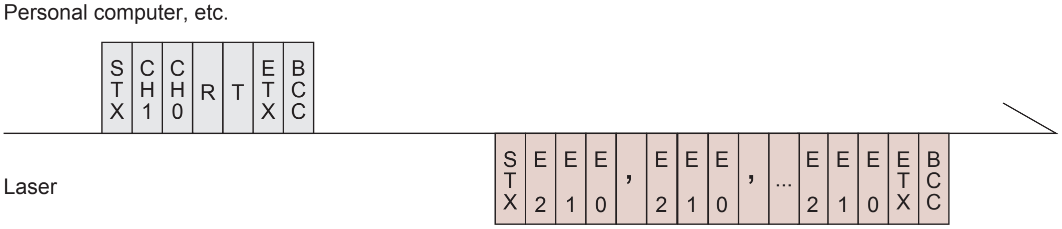
The command (code: C2) to reset the appropriate number of outputs (GOOD COUNT) is explained below.


Personal computer, etc.
STX
CH1
CH0
C
2
ETX
BCC
Laser
CH1
CH0
ACK
Or
CH1
CH0
NAK

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

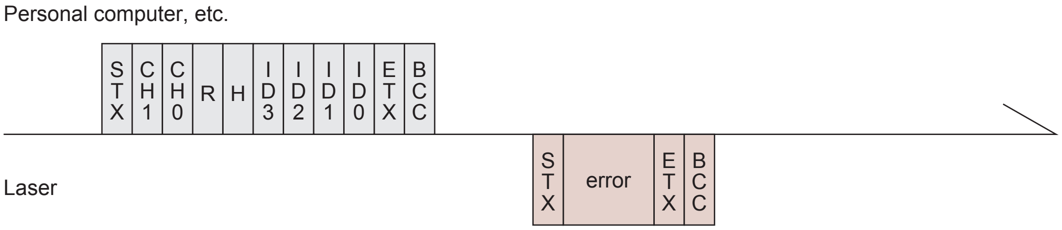
The command (code: RT) to read error No. at occurrence of trouble is explained below.


Personal computer, etc.
STX
CH1
CH0
R
T
ETX
BCC
Laser
STX
E2
E1
E0
,
E2
E1
E0
,
...
E2
E1
E0
ETX
BCC

CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
E2/E1/E0	Error No. (E2 = hundreds digit, E1 = tens digit, E0 = units digit) All error numbers are transmitted. If no error has occurred, the error No. is to be [000]. For the contents corresponding to error No., refer to the Maintenance Part, Chapter 2 "1. Error Display and How to Take a Measure" on page 189.

Reading the Error History

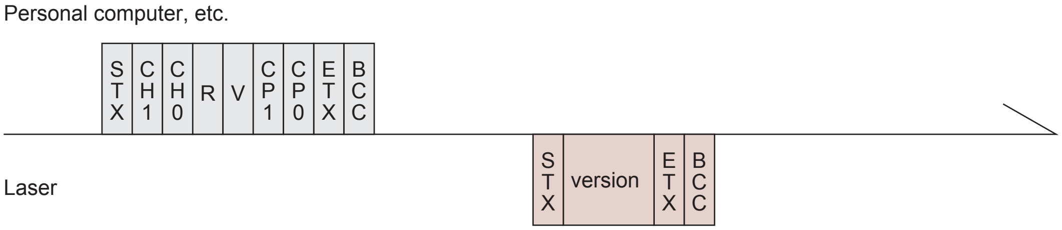
The command (code: RH) to read the error histoty is explained below.


Personal computer, etc.
STX
CH1
CH0
R
H
ID3
ID2
ID1
ID0
ETX
BCC
Laser
STX
error
ETX
BCC

CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
ID3/ID2/ID1/ID0	Index No. (ID3 = thousands digit, ID2 = hundreds digit, ID1 = tens digit, ID0 = units digit) Ten histories of trouble are read from the specified index No.
error	Error history (yyyymmddhhmm Ennn) yyyy Year mm Month dd Day hh Hour mm Minute Ennn Error No. error: (Data No.1), (Data No.2), (Data No.3), … (the last Data No.) Insert [,] between individual data. If the history does not exist, "000000000000 E000" is read.

Reading the Software Version

The command (code: RV) to read the software version is explained below.

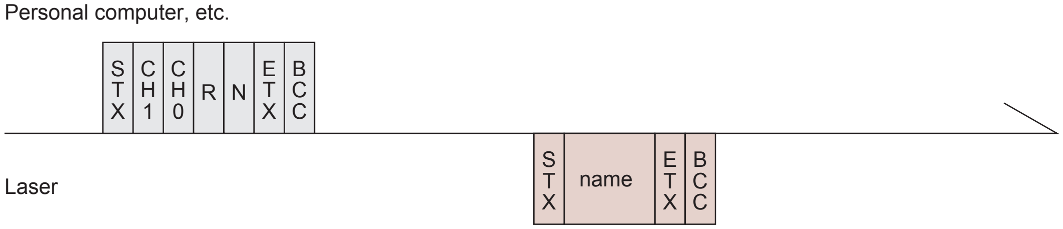

Personal computer, etc.
STX
CH1
CH0
R
V
CP1
CP0
ETX
BCC
Laser
STX
version
ETX
BCC

CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
CP1/CP0	CPU No. (CP1 = tens digit, CP0 = units digit) 00: CPU1 01: CPU2 02: SUB CPU (COOL) 03: SUB CPU (MON) 04: SUB CPU (MON2) • If “99” is entered, data is read in a batch.

version	Version information (nnnnnnnnnnnnnnssssssssssvvvvvvvvyyyymmddhhmm) nnnnnnnnnnnnnn Software name ssssssssss Part No. vvvvvvvv Software version yyyy Year mm Month dd Day hh Hour mm Minute version: (Data No.1), (Data No.2), (Data No.3), … (the last Data No.) Insert [,] between individual data.

Reading the Equipment Name

The command (code: RN) to read the equipment name is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
name	Equipment name

Maintenance

Maintenance

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 wait at least 5 minutes for the internal supplies to de-energize.**
> - **Turning ON the power supply to check operation during maintenance puts the laser in oscillation mode. Take extreme care in this situation.**
> - **The operator and those who may receive laser light during maintenance must put on protective glasses and take all necessary safety precautions as determined by local rules and regulations.**

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.

Part name	Model No.	Item No.	Operation interval (standard) (*1)	Contents of operation (*2)
Ion-exchange resin refill	MLF-0021	318-026	6 months	Replace
Water filter	MLF-0006	MLF-0006	6 months	Clean
			3 years	Replace
Capsule filter	AAS1154769	AAS1154769	6 months	Replace
Floating panel	PC1152747	PC115L747	1 year	Replace
Secondary cooling water (Refined water) (20L)	MLU-0604-00	900-241	6 months	Replace
Lithium battery (*3)	CR2450	145-014	3 years	Replace
Replacement desiccant agent (8 pieces) (*4)	Molecular sieves 3A3g	1155073	6 months	Replace

Part name	Model No.	Item No.	Operation interval (standard) (*1)	Contents of operation (*2)
FC-LD 1 to 7	AS1156194	AS1156194	At the end of its useful life (*5)	Replace
FC-LD 8 to 14	AS1156202	AS1156202		
FC-LD 1 to 7 refurbished	AAS1155078	AAS1155078	At the end of its useful life (*5)	Replace
FC-LD 8 to 14 refurbished	AAS1155079	AAS1155079		
Protective glass	Specified glass for output unit	—	Everyday	Clean
			—	Replace

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

*2: Part replacement is performed when any damage or defect is found or the usable period ends.

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

*4: Start using the desiccant agent within three months of purchase. Since the desiccant ability decreases after three months even if the desiccant agent is unopened, the time for replacement may be earlier. To prevent the decrease in performance, purchase replacements when it is getting closer to the scheduled replacement time so it is on hand in case of slightly abbreviated dessicant life.

*5: If the output of an FC-LD or a diode laser drops down and the rated laser output level cannot be restored despite setting the maximum LD current, the LD has reached the end of its useful life.

The warranty is valid for a period of two years from the date of acceptance inspection or the shipping date of a new FC-LD. For a refurbished FC-LD, the warranty is valid for a period of one year from the shipping date. Replacement FC-LDs provided due to a malfunction of FC-LD while under warranty are covered until the original warranty period expires. A fee is required to replace FC-LDs that reach the end of their useful life after the warranty period. Refer to the following table for the customer's contribution ratio for the fee-paid replacement.

Note that in any case, operating the equipment at output levels exceeding the maximum permissible level, tearing off the seal attached on FC-LD, or replacing FC-LD without taking a course at our Technical School or in the presence of our field engineer will void the warranty.

Customer's contribution ratio for fee-paid replacement of FC-LD

Age of service	Number of months of service	Customer's contribution ratio (%)	
		New	Refurbished
1	0 to 12	0	0

Age of service	Number of months of service	Customer's contribution ratio (%)	
		New	Refurbished
2	13	0	40
	14	0	42
	15	0	43
	16	0	45
2	17	0	47
	18	0	48
	19	0	50
	20	0	52
	21	0	53
	22	0	55
	23	0	57
	24	0	58
3	25	50	60
	26	52	62
	27	54	63
	28	56	65
	29	58	67
	30	60	68
	31	62	70
	32	65	72
	33	67	73
	34	69	75
	35	71	77
	36	73	78
4	37	75	80
	38	77	82
	39	79	83
	40	81	85
	41	83	87
	42	85	88
	43	87	90
	44	90	92
	45	92	93
	46	94	95
	47	96	97
	48	98	98
5 or more	49 or more	100	100

2. Maintenance of the Cooler Unit

This section explains the maintenance procedures necessary for the cooler unit, including cleaning of the solenoid valve and strainer, draining water from the primary and secondary cooling water tanks, maintenance of the ion exchange unit, and draining water to prepare for situations in which the laser welder will not be used for a long time.

Cleaning the Solenoid Valve and Strainer

The solenoid valve adjusts the quantity of primary cooling water into the laser. If the solenoid valve is clogged with contaminants the primary cooling water flow can be restricted, thereby causing overheating. Perform cleaning of the solenoid valve once every year.

Item required

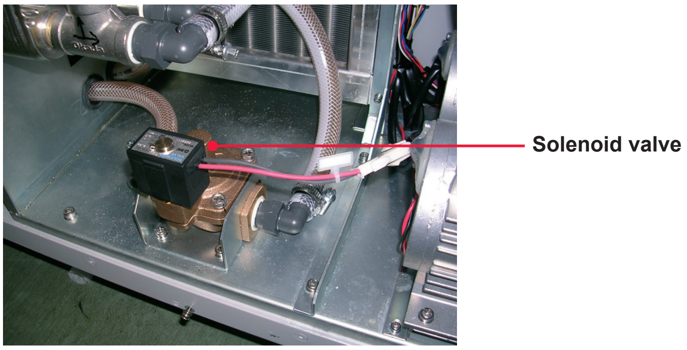
Brush, 10 mm and 21 mm spanners, and bucket (container to receive water)

1 Removing the Solenoid Valve

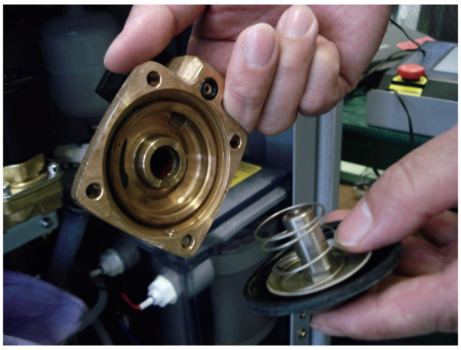
(1) Turn off the primary cooling water and disconnect the hose from the cooling water inlet, and drain the water.

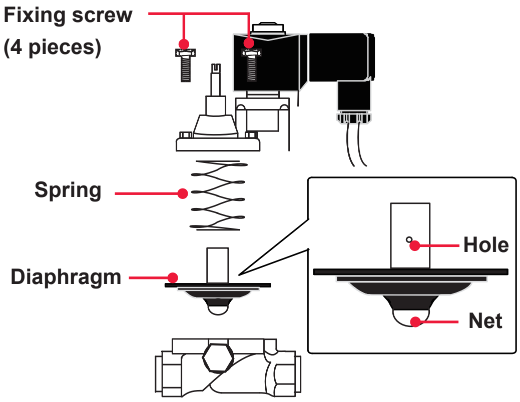
- Take care not to splash water over the Laser as it may spurt. If water has splashed, wipe it off completely.

(2) Remove the left side cover of the main unit.



(3) Remove the 4 screws from the solenoid valve and then remove the upper part of the solenoid valve. Then, pull out the spring and diaphragm.





(4) Check whether the filter screen and hole at the end of solenoid valve bolt are clogged with contaminants. Remove contaminants if present.

- If the filter screen and hole at the end of solenoid valve bolt are clogged the valve may be unable to close which will cause the primary cooling water to flow continously which will cause the laser to go below the operating temperature range. Check the bolt portion at the same time and clean as necessary.

(5) Install the diaphragm, spring, and upper part of the solenoid valve. Tighten the solenoid valve screws to prevent leaks (4 screws).

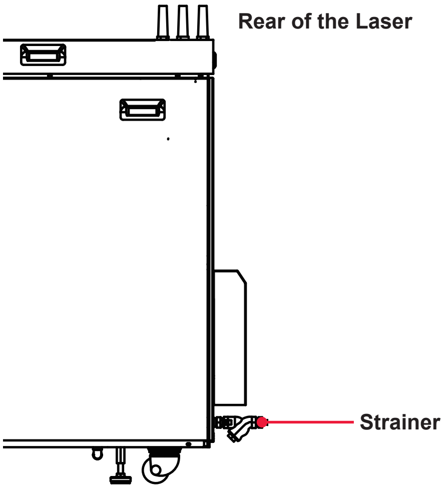
(6) Install the left side cover.

2 Cleaning the Strainer

(1) Take out the strainer with a spanner (21 mm) and wash any contaminants

(2) Reinstall the strainer and tighten it with a spanner (21 mm).

(3) Return the disconnected hose and secure it with the hose band.



Draining Water from the Primary Cooling Circuit

When the laser welder must be moved, or transferred, or will not be operated for over one month, drain the primary cooling water.

- When changing the ion exchange unit, cleaning the water filter, or changing the secondary cooling water the primary cooling water does not need to be drained.
- Use tap water or clean industrial water in the Primary Cooling Circuit.

Item required

Phillips screwdriver, siphon-type water feed pump, and bucket (container to receive water)

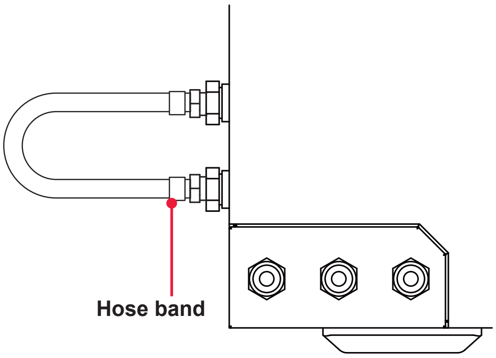
Operating Procedure

(1) Remove the 2 hoses connected from the outside and drain water.

- Sometimes water may spray when the hoses are removed. 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.

(2) Remove the solenoid valve plug (B portion in the previous figure) and apply clean compressed air at <40psi (294 kPa, or 3 kgf/cm^2) into the pipe to forcibly expel the remaining water in the pipe.

(3) Connect the cooling water inlet and outlet fittings together with a short hose as shown below to prevent contamination.



Draining Water from the Secondary Cooling Water Tank

When changing the ion exchange unit or changing the secondary cooling water (once every 6 months) drain all water from the cooling water tank. For moving or transporting the laser welder or stopping it for periods of over a month drain the cooling water tank.

Item required

Water feed pump and bucket

Operating Procedure

(1) Open the front door.

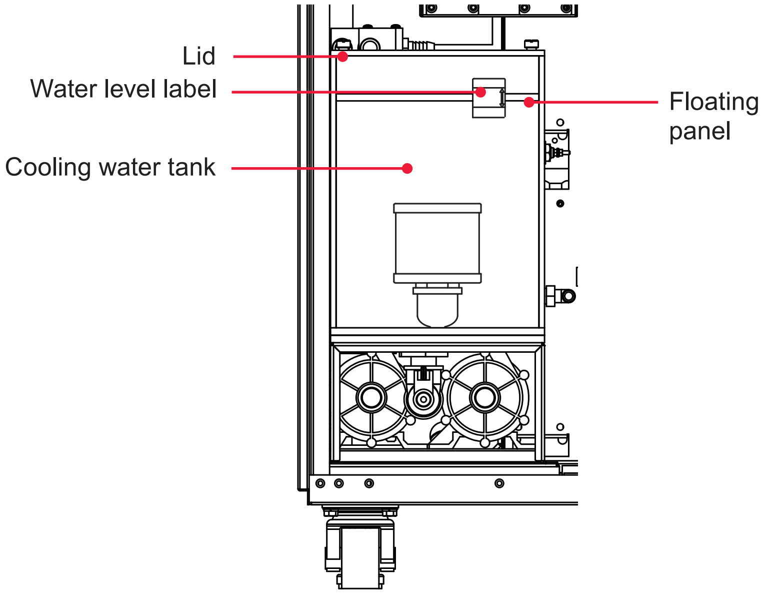
(2) Open the lid of the cooling water tank and take out the floating panel.

- Keep the panel clean.

(3) Pump out the water in the tank with the attached feed pump.

(4) Return the floating panel into the tank and install the tank lid as it was.

The Laser front (With front door opened)



Replacing the Capsule Filter

The capsule filter removes smal fibers and other contaminants from the secondary cooling water that has passed through the water filter. Change the capsule filter every 6 months.

Item required

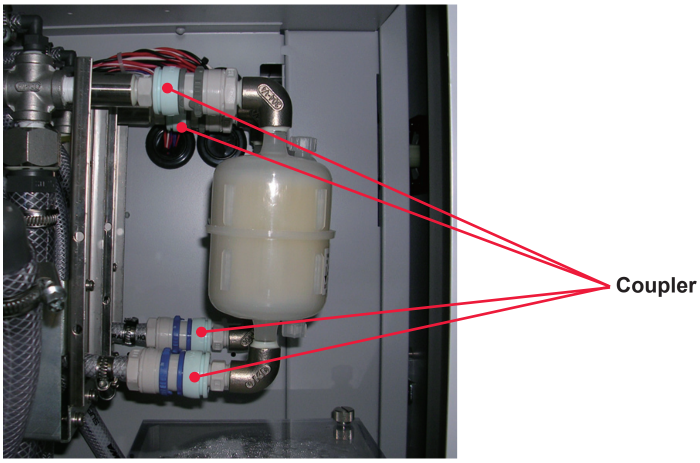
Water feed pump, bucket, and new capsule filter

1 Removing the Capsule Filter

(1) Open the front door.

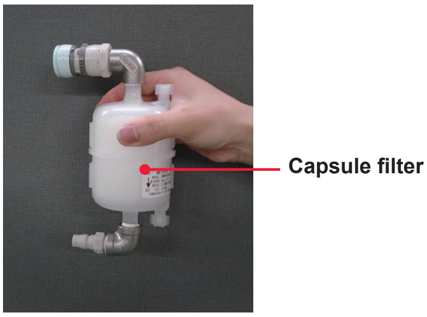
(2) Drain the secondary cooling water.
- For draining refer to page 177.

(3) Release the lock of the coupler at the upper and lower portions of the coolant filter then push up the coupler to remove two capsule filters.



2 Installing the Capsule Filter

(1) Install new capsule filters. Insert the upper and lower portions of the capsule filter into the coupler.
- Insert them until a tactile and click is felt indicating a good lock on the coupler.



(2) Supply the secondary cooling water.
- For filling refer to page 41.

(3) Turn ON the power supply and check for leaks and adequate water levels.

Changing the Ion Exchange Resin and Replacing the Ion Exchanger

The ion exchange resin in the ion exchanger keeps high water purity by removing ions generated by deteriorating secondary cooling water. Change the ion exchange resin with after every 6 months after use.

This laser adopts cartridge type ion exchangers. This type can be used multiple times if the internal ion exhange resin is changed.

Replace the ion exchanger cartridge every 3 years to prevent contamination.

- Keep new ion exchange resin 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/removal tool, ion exchange resin refill (or cartridge), secondary cooling water (12 liters), Phillips screwdriver, water feed pump, and gloves (vinyl, dust-free)

1 Removing the Ion Exchanger

(1) Open the lid of the cooling water tank and take out the floating panel.

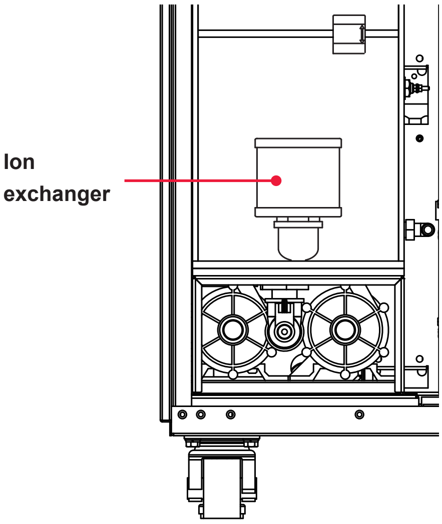
- Keep the panel clean.

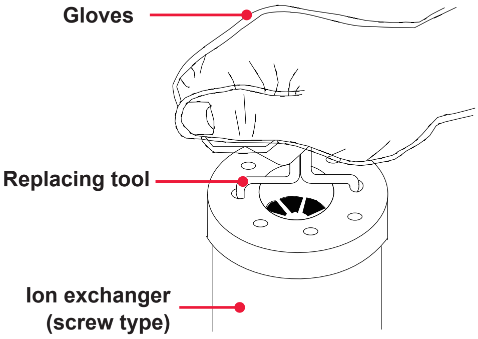
(2) Pump out water in the tank with the attached feed pump.

(3) Rotate the ion-exchanger in the tank counterclockwise with the replacing tool to remove it.

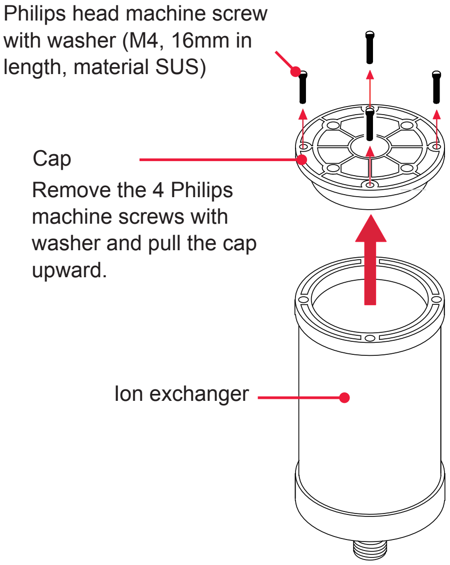
- To install a new ion exchange cartridge (with resin for change), proceed to Step 3.

The Laser front (With front door opened)



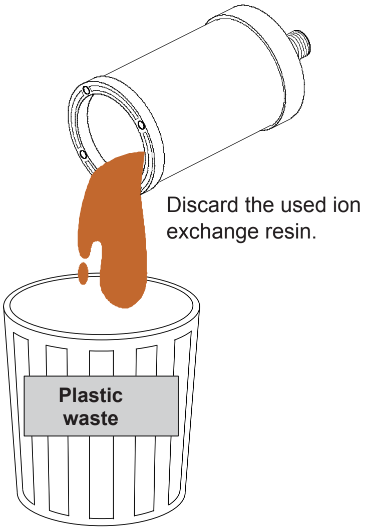


(4) Remove the cap of the ion exchanger and discard the used ion exchange resin.



Philips head machine screw with washer (M4, 16mm in length, material SUS)
Cap
Ion exchanger

Remove the 4 Philips machine screws with washer and pull the cap upward.



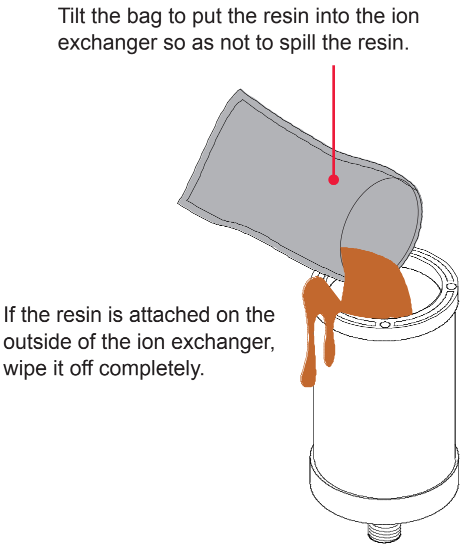
Plastic waste

Discard the used ion exchange resin.

- Dispose of the used ion exchange resin as plastic waste according to all local regulations. Product MSDS available from manufacturer

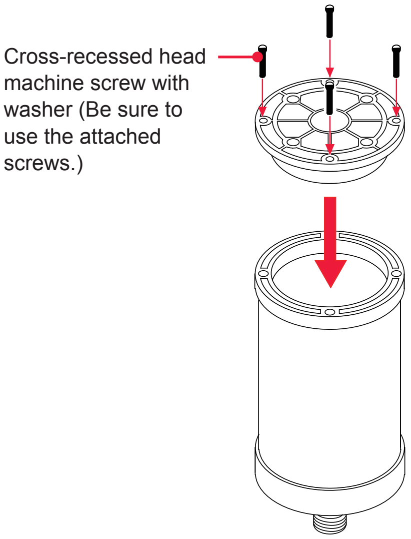
2 Adding New Ion Exchange Resin

(1) Put new ion exchange resin into the ion exchanger and reinstall the cap.



Tilt the bag to put the resin into the ion exchanger so as not to spill the resin.

If the resin is attached on the outside of the ion exchanger, wipe it off completely.



Cross-recessed head machine screw with washer

(Be sure to use the attached screws.)

<Notes>

- **If the ion exchange resin exposed to air it will deteriorate. Immediately after the package is opened put the ion exchange resin into the ion exchanger and return to the cooling water tank.**
- **Excess ion exchange resin more than the capacity of ion exchanger should be stored in the metallized bag and placed in a dark location sealed against air. Take care not to spill the ion exchange resin. Wipe off any ion exchange resin attached on the mouth of the ion exchanger.**

3 Installing the Ion Exchange Cartridge

(1) Insert the ion exchange cartridge and turn it clockwise with the mounting/removal tool.

<Note>

Use the mounting/removal tool to instal the ion exchanger. If the mounting/removal tool is over tightened the thread portion may be broken.

(2) Fill secendory cooling water tank with cooling water up to the HIGH line of the water level label with the attached water feed pump.

- For filling refer to page 41.

(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. The floating panel is polyethylene foam and must be disposed of properly.
- If the ion exchanger is used without the floating panel in the tank the ion exchange resin will deteriorate more quickly. Be sure to put the floating panel into the tank.

Cleaning the Water Filter

Two water filters are provided in the cooling water tank and filtrate cooling water.
Perform cleaning of the water filters every 6 months. Replace them every 3 years.

Item required

Gloves (vinyl), water feed pump, secondary cooling water (12 liters), and mounting/removal tool

1 Removing the Water Filters

(1) Open the cover of the cooling water tank and take out the floating panel.

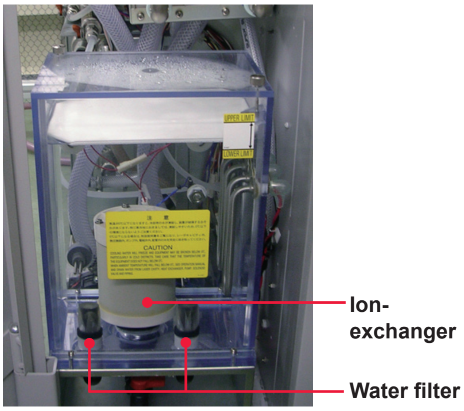
- Keep the panel clean.

(2) Pump out water in the tank with the attached feed pump.

(3) Turn the ion-exchanger in the tank to the counterclockwise with the removal tool to remove.

(4) Pull the water filters upward to remove them.

The Laser front (With front door opened)



2 Washing the Water Filters

(1) Wash the water filters with tap water, then rinse them with ion-exchanged water or distilled water.

(2) Replace the water filters and insert them fully. Ensure they are properly seated.
At this time, be careful not to remove the O-rings.

(3) Insert the ion-exchange resin cartridge and turn clockwise with the tool to reinstall.

(4) Refill the resevoir with cooling water with the attached feed pump until it reaches the HIGH-line on the water level label.
☐ For filling refer to page 41.

(5) Return the floating panel to the tank.
Return the cover of the cooling water tank and secure it.

Draining Water When the Laser Welder Will Not Be Used for over One Month or the Room Temperature at the Installation Site Goes Below 0ºC

When the laser welder will not be used for a period greater than one month or the room temperature at the installation site goes down below 0ºC, drain the primary cooling water and secondary cooling water, and also completely expel any remaining water in the piping.

Item required

Gloves (vinyl), drain hose, water feed pump, and clean cloth

1 Draining the Primary Cooling Water and the Secondary Cooling Water

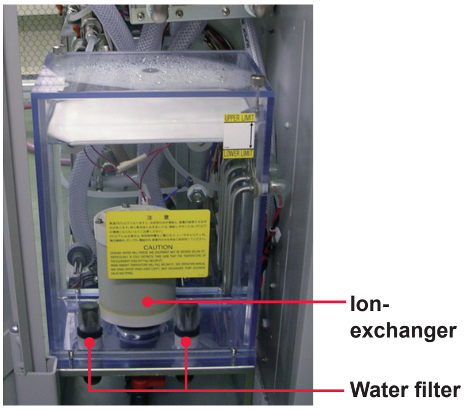
To drain refer to page 176 to page 177.

2 Removing the Water Filter

(1) Turn the ion-exchanger in the tank counterclockwise with the replacing tool to remove it.

(2) Pull the water filters upward to remove them.

The Laser front (With front door opened)



3 Draining Water from the Piping

(1) Connect the attached drain hose to the hole of the removed water filter and feed clean compressed air at <40 psi (294 kPa, 3 kgf/cm^2 or less) to drain the remaining water in the piping.

(2) Pump out water in the tank with the attached feed pump.

(3) After draining all the water return the water filters and ion exchanger.

3. Maintenance of Laser Oscillator

Replacing the FC-LD

The diode laser is provided in the FC-LD and used for excitation at laser oscillation.

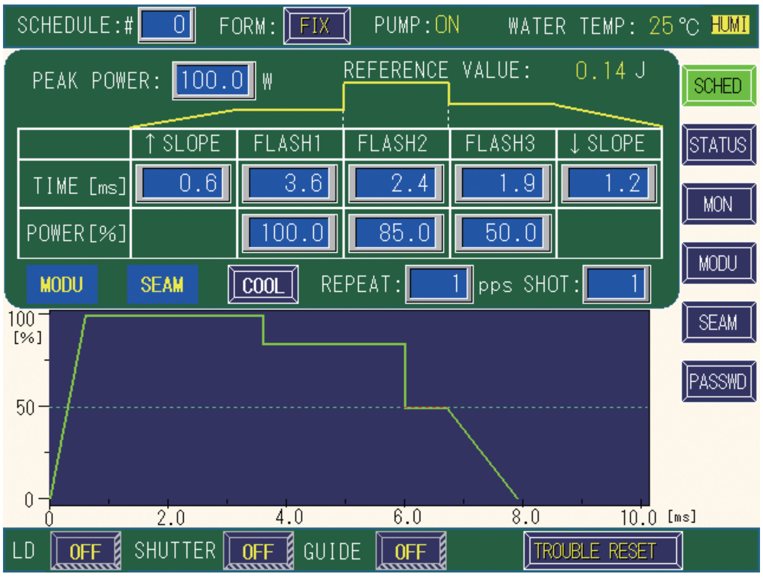
There are fourteen FC-LDs in LF1000A. Replace them when error No.119/FC-LD POWER DOWN occurs or error No.134 to 147/FC-LD No.1 to No.14 POWER ERROR occurs at the time of startup.

For FC-LD replacement be sure to take a course at our Technical School or enlist the services of a qualified field engineer. Replacing FC-LD without taking a course will void the warranty.

A clean room work environment with class 10000 or better is required for FC-LD replacement. If you are not in the clean room environment, prepare a simplified clean booth. Please contact us for details.

Replacing the Desiccant Agent

When the humidity warning of FC-LD occurs the HUMI indicator at the upper right of the LCD panel blinks. The laser welder works as usual but is warning you that it is almost necessary to replace the desiccant agent. Acquire new dessicant and replace when necessary



SCHEDULE:# 0

FORM: FIX

PUMP:ON

WATER TEMP: 25℃

PEAK POWER: 100.0 W

REFERENCE VALUE: 0.14 J

	↑SLOPE	FLASH1	FLASH2	FLASH3	↓SLOPE
TIME [ms]	0.6	3.6	2.4	1.9	1.2
POWER[%]		100.0	85.0	50.0	

REPEAT: 1 pps SHOT: 1

LD OFF SHUTTER OFF GUIDE OFF

⚠ CAUTION

When replacing the desiccant agent turn OFF the power to the Laser and wait for at least 5 minutes.

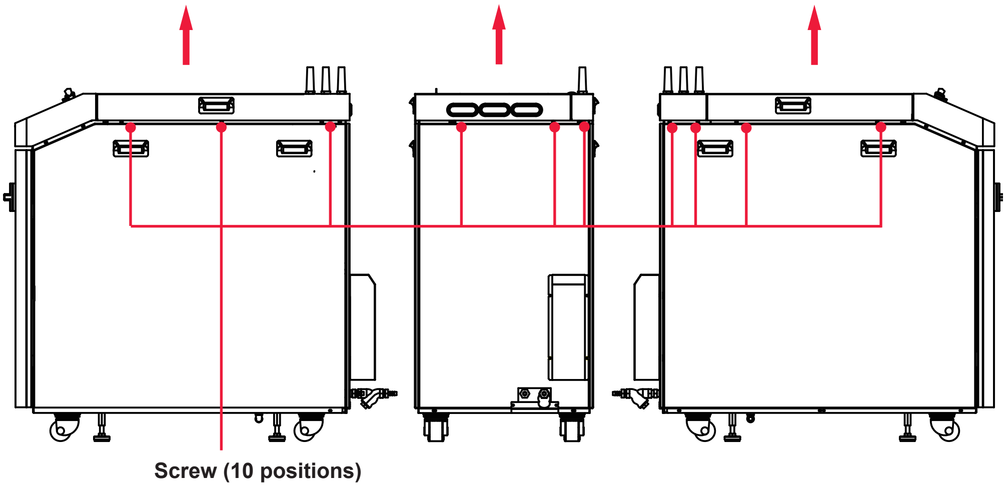
Item required

Phillips screwdriver, 2.5 mm ball-point screwdriver, desiccant agent (new), and gloves (vinyl)

1 Removing the FC-LD Cover

(1) Remove the top cover.

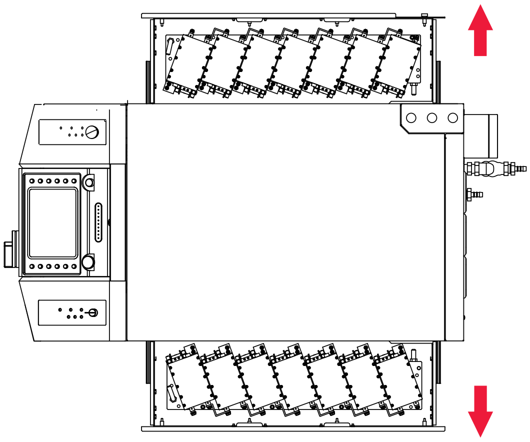
Remove ten screws provided on both sides and rear side with a Phillips screwdriver, and pull the top cover straight upward.



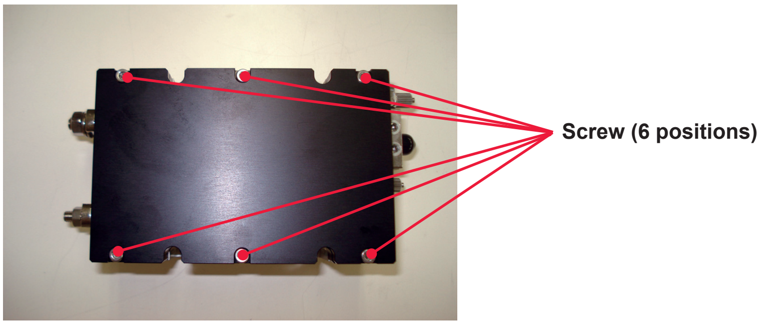
(2) Remove the side covers.

(3) Pull the drawer toward you.

Remove two screws with a Phillips screwdriver.



(4) Remove six hexagon screws at the top of FC-LD with a ball point hex driver (2.5 mm) to remove the lid.



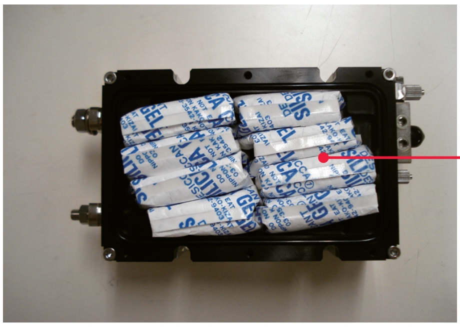
<Note>

Since a dust-proof filter is installed do not leave the FC-LD open. To prevent dirt or dust from getting into the module finish the work as soon as possible (within a few minutes).

2 Replacing the Desiccant Agent

(1) Remove old desiccant agents and install eight new ones.

- Do not touch the desicant agent with bare hands. Wear gloves when handling.



Desiccant agent

(2) Replace the lid and tighten six hexagon screws with a ball-point screwdriver (2.5 mm).

<Note>

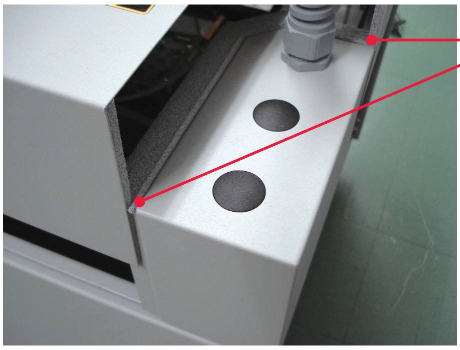
This desiccant agent is highly hygroscopic and always absorbs moisture in a room. To maximize the life time of the desiccant agent finish the work as soon as possible (within a few minutes).

3 Installing the Cover

(1) Replace the drawer and attach two screws with a Phillips screwdriver.

(2) Replace the side cover.

(3) Replace the top cover, keeping the left rear to the optical fiber inlets.
Attach ten screws at the both sides and rear side.



Keep the left rear to the optical fiber inlets.

4. Maintenance of the Power Supply

Replacing the Lithium Battery for Backup

Replace the lithium battery for backup provided on the control board in the main unit. The service life of the battery is about 3 years. Replace it within 3 years or data loss can occur when the battery reaches end of life.

ATTENTION

Follow your local environmental regulations for Lithium Ion battery disposal

Item required

Phillips screwdriver and lithium battery CR2450

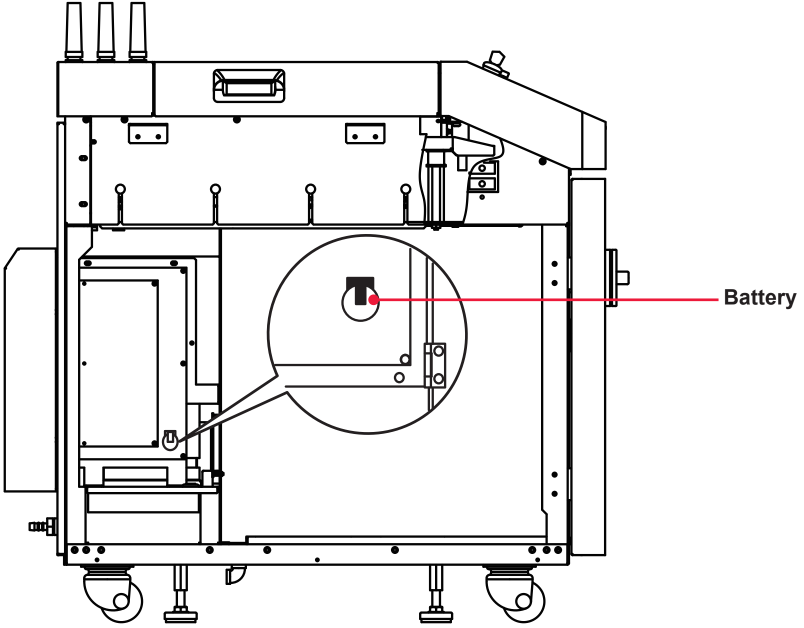
During battery replacement the registered output schedule data may be lost. We recommend recording the data into the attached output schedule data entry table before replacement.

Operating Procedure

(1) Turn OFF the MAIN POWER switch and wait for 5 minutes or more.

(2) Remove the left side cover of the main unit.

(3) Remove the battery on the control board and mount a new battery.
□ Mount the new battery taking care about its polarity so that the positive side may be visible on this side.



(4) Install the left side cover.

Maintenance

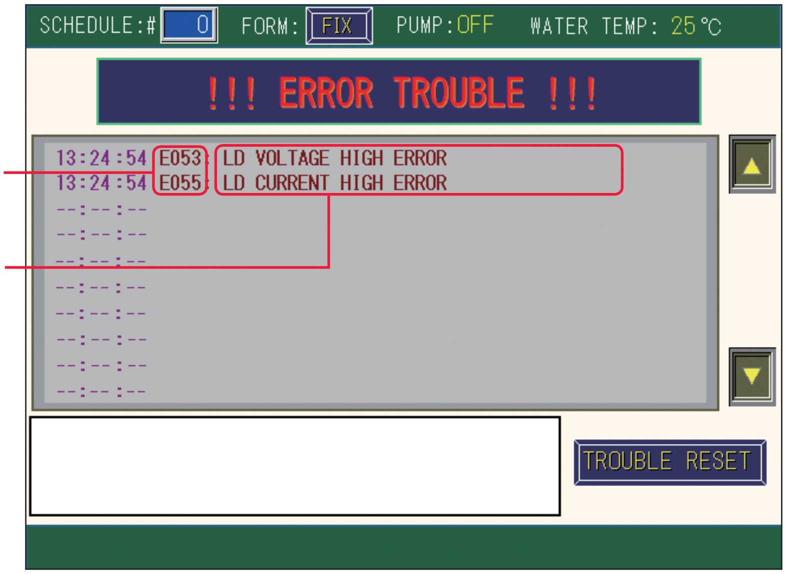
Chapter 2

● Troubleshooting Procedures and Error Resolution

1. Understanding the Error Display

When an error occurs in the laser the contents of the error are displayed on the control panel screen as shown below. The following section explains how to troubleshoot a series of simultaneous errors using the Error No. When an error occurs read this chapter carefully, inspect the laser for the cause of the trouble, and take any measures necessary to resolve.

* If any points are unclear contact the distributor or Miyachi Unitek Corp. for information



```
SCHEDULE:# 0   FORM: FIX   PUMP:OFF   WATER TEMP: 25 ℃

!!! ERROR TROUBLE !!!

13:24:54 E053 LD VOLTAGE HIGH ERROR
13:24:54 E055 LD CURRENT HIGH ERROR
--:--:--
--:--:--
--:--:--
--:--:--
--:--:--
--:--:--
--:--:--
--:--:--
```

Error No.

Contents of the error (Troubles are displayed up to ten occurrences.)

<Note>

If the safety interlock is activated a safety circuit will close the safety shutter and timeshare unit (depending on configuration). These errors are high priority since they relate to operator safety. For this reason, "SAFETY SHUTTER OPEN/CLOSE TROUBLE" or "BRANCH MIRROR OPEN/CLOSE TROUBLE" may be displayed and suppress the relevant error/fault message. In this case clear the interlock error to proceed with the troubleshooting process

LD "-":	State of LD doesn't change even if an error/fault occurs.
LD "OFF":	LD is turned off automatically if an error/fault occurs.
Alarm output "-":	Error/Fault signal is not output if an error/fault occurs.
Alarm output "ON":	Error/Fault signal is output if an error/fault occurs.

No.	Error Name	LD	Alarm output	Cause and Resolution Measures
000	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. Make sure the laser controller is correctly plugged in.
001	MEMORY BATTERY VOLT. LOW ERROR	-	ON	The voltage of the memory backup lithium battery is low. Replace it.
002	MEMORY ERROR	-	ON	The voltage of the memory backup lithium battery is low. Replace it.
003 004 005 008	INTERNAL COMM. ERROR(IL) INTERNAL COMM. ERROR(IO1) INTERNAL COMM. ERROR(IO2) INTERNAL COMM. ERROR(IO3)	OFF	ON	An error has occurred with the wiring in the laser. Consult Miyachi Unitek Corp.
006 007 009	INTERNAL COMM. ERROR(COOL) INTERNAL COMM. ERROR(MON) INTERNAL COMM. ERROR(MON2)	-	-	An error has occurred with the wiring in the laser. Consult Miyachi Unitek Corp.
010 to 013	CONTROL BOARD ERROR	OFF	ON	An error has occurred with the controller unit. Consult Miyachi Unitek Corp.
014	BOARD SETTING ERROR	OFF	ON	A setting error has occurred with the laser. Consult Miyachi Unitek Corp.
015	INTERFACE BOARD ERROR	-	-	A connection error has occurred with the laser. Consult Miyachi Unitek Corp.
016 017	CONTROL BOARD ERROR	OFF	ON	An error has occurred with the controller unit. Consult Miyachi Unitek Corp.
020	HEAD COVER OPENED	OFF	ON	The head cover is removed. Reinstall the cover.
021	SIDE COVER OPENED	OFF	ON	The side cover is removed. Reinstall the cover.
022	EXTERNAL INTERLOCK OPENED	-	-	The REMOTE INTERLOCK connector circuit is opened. Close it to turn off the [Trouble] output and fault code indication.
023	EMERGENCY STOP	OFF	ON	An emergency stop signal is input. Close Pin No.1 and Pin No.9 of the EXT. I/O (1) connector. Reset the EMERGENCY STOP buttons provided at the front surface of the main unit and of the laser controller.
024	E.INDICATOR TROUBLE (LASER CONT.)	OFF	ON	Emission lamp fault on laser controller. Consult Miyachi Unitek Corp.
030	CURRENT BALANCE ERROR	OFF	ON	An error has occurred with the consumption current monitoring circuit of control system. Consult Miyachi Unitek Corp.
031	OVERCURRENT ERROR	OFF	ON	An error has occurred with the consumption current monitoring circuit of control system. Consult Miyachi Unitek Corp.

No.	Error Name	LD	Alarm output	Cause and Resolution Measures
035	CONTROL BOARD TEMP. HIGH ERROR	OFF	ON	Overheating occurs in the discharge resistor provided in the main unit, or the temperature in the oscillator (resonator shutter or safety shutter) is abnormal. After waiting for several minutes, press the TROUBLE RESET button.
036	COOLING WATER TANK VOL. SHORT	OFF	ON	Secondary cooling water volume is insufficient. Add cooling water. If the equipment is swayed, the coolant level may change. Stabilize the equipment.
037	PUMP ABNORMAL	OFF	ON	Cooler pump fault. Consult Miyachi Unitek Corp.
038	COOLING WATER TEMP. HIGH ERROR	OFF	ON	Primary cooling water flow rate is low or the cooling water temperature is too high. Increase the primary cooling water flow rate. Check if the cooling water circulates normally.
039	COOLING WATER TEMP. LOW ERROR	OFF	ON	Temperature of the secondary cooling water is too low. 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.
040	COOLING WATER FLOW(LD) LOW ERR	OFF	ON	Secondary cooling water flow rate is low. The capsule filter or the water filter is clogged. Clean or replace the water filter.
041	COOLING WATER FLOW(LD) HIGH ERR	OFF	ON	The flow rate adjusting valve may be defective. Consult Miyachi Unitek Corp.
042	COOLING WATER FLOW(OTHER) LOW	OFF	ON	The secondary cooling water flow rate is low. The capsule filter or the water filter may be clogged. Clean the wire mesh or the water filter, or replace the water filter.
043	COOLING WATER FLOW(OTHER) HIGH	OFF	ON	The flow rate adjusting valve may be defective. Consult Miyachi Unitek Corp.
044	COOLING WATER DEIONIZE CAUTION	-	-	Purity of the deionized water is low. Allow the cooler to operate for 50–60 minutes. If this trouble still occurs, replace the ion-exchanger.
045	AC POWER DOWN(PDI)	OFF	ON	A temporary blackout of AC power supply was detected and the equipment restarted. Check the power supply environment.
046	MACHINE START ERROR	OFF	ON	A temporary blackout of AC power supply was detected, but the equipment did not restart. Check the power supply environment.
047	INTERLOCK SIGNAL ERROR	OFF	ON	An error of unknown cause has occurred with the interlock. Consult Miyachi Unitek Corp.
050	LD POWER SUPPLY ERROR	OFF	ON	The LD power supply fault. Consult Miyachi Unitek Corp.
051	LD CURRENT ERROR	OFF	ON	The LD power supply fault. Consult Miyachi Unitek Corp.

No.	Error Name	LD	Alarm output	Cause and Resolution Measures
052	LD VOLTAGE LOW ERROR	OFF	ON	Replace FC-LD when this trouble is displayed with E119. When displayed alone, consult Miyachi Unitek Corp.
053	LD VOLTAGE HIGH ERROR	OFF	ON	Replace FC-LD when this trouble is displayed with E119. When displayed alone, consult Miyachi Unitek Corp.
054	LD CURRENT LOW ERROR	OFF	ON	Replace FC-LD when this trouble is displayed with E119. When displayed alone, consult Miyachi Unitek Corp.
055	LD CURRENT HIGH ERROR	OFF	ON	Replace FC-LD when this trouble is displayed with E119. When displayed alone, consult Miyachi Unitek Corp.
060 to 073	FC-LD No.1 TEMP ERROR to FC-LD No.14 TEMP ERROR	OFF	ON	Abnormal temperature of FC-LD. After waiting for several minutes, press the TROUBLE RESET button. If trouble continues even after the above measures consult Miyachi Unitek Corp.
075 to 088	FC-LD No.1 DESICCANT CHANGE to FC-LD No.14 DESICCANT CHANGE	-	-	It is getting close to the time to replace the desiccant agent. Prepare new desiccant agent.
090 to 103	FC-LD No.1 CONDENSATION ERROR to FC-LD No.14 CONDENSATION ERROR	OFF	ON	There may be condensation or water leak in the FC-LD. Wait at least thirty minutes before turning ON the Laser. If the trouble continues even after the above measures, consult Miyachi Unitek Corp.
105 to 118	FC-LD No.1 FIBER TEMP ERROR to FC-LD No.14 FIBER TEMP ERROR	OFF	ON	Abnormal temperature of FC-LD fiber connector. After waiting for several minutes, press the TROUBLE RESET button. If trouble continues even after the above measures, consult Miyachi Unitek Corp.
119	FC-LD POWER DOWN	-	-	It is getting close to the time to replace the FC-LD. Prepare a new FC-LD.
120	OSCILLATOR WATER LEAK ERROR	OFF	ON	There is a water leak in the oscillator. Consult Miyachi Unitek Corp.
121	FC-LD UNIT WATER LEAK ERROR	OFF	ON	There is a water leak in the FC-LD. Consult Miyachi Unitek Corp.
122	PIPING WATER LEAK ERROR	OFF	ON	There is a water leak in the piping. Consult Miyachi Unitek Corp.
123 to 130	COOLING FAN 1 TROUBLE to COOLING FAN 8 TROUBLE	OFF	ON	The cooling fan is broken. Consult Miyachi Unitek Corp.
134 to 147	FC-LD No.1 POWER ERROR to FC-LD No.14 POWER ERROR	-	-	It is getting close to the time to replace the FC-LD. Prepare a new FC-LD.
150	HR INPUT SIDE PUMP POWER ERROR	OFF	ON	A bundled fiber may be broken. Consult Miyachi Unitek Corp.
151	PR INPUT SIDE PUMP POWER ERROR	OFF	ON	A bundled fiber may be broken. Consult Miyachi Unitek Corp.

No.	Error Name	LD	Alarm output	Cause and Resolution Measures
153	OSCILLATOR HR FIBER TEMP ERROR	OFF	ON	Abnormal temperature of oscillator. Consult Miyachi Unitek Corp.
154	OSCILLATOR PR FIBER TEMP ERROR	OFF	ON	Abnormal temperature of oscillator. Consult Miyachi Unitek Corp.
155	OSCILLATOR OUTPUT POWER ERROR	OFF	ON	An error has occurred with the oscillator. Consult Miyachi Unitek Corp.
160	LASER POWER HIGH ERROR	OFF	ON	The laser output energy exceeds the capacity. Consult Miyachi Unitek Corp if the desired power is within specification.
161	LASER POWER OUT OF RANGE	-	-	An error has occurred with the laser output. Consult Miyachi Unitek Corp if the desired power is within specification.
162	LASER CONTROL PARAMETER ERROR	-	-	Programmed value of laser energy (PEAK POWER, output time, REPEAT) exceeds laser capacity. The error message is displayed when inputting the set value. The set value is reset to the initial value before the change.
163	FC-LD POWER EXCESSIVE ERROR	-	-	The FC-LD output energy exceeds the capacity. Consult Miyachi Unitek Corp.
165	ISOLATOR TEMP ERROR	OFF	ON	A temperature error has occurred with the isolator. After waiting for several minutes, press the TROUBLE RESET button.
170 171 172	SAFETY SHUTTER 1 OPEN TROUBLE SAFETY SHUTTER 2 OPEN TROUBLE SAFETY SHUTTER 3 OPEN TROUBLE	OFF	ON	Safety shutter unit fault. Consult Miyachi Unitek Corp.
173 174 175	SAFETY SHUTTER 1 CLOSE TROUBLE SAFETY SHUTTER 2 CLOSE TROUBLE SAFETY SHUTTER 3 CLOSE TROUBLE	OFF	ON	A start signal was input while safety shutter is operating. Extend the time from input of beam select signal to input of laser start signal. If the trouble continues even after the above measures, consult Miyachi Unitek Corp.
176 177 178	SAFETY SHUTTER 1 TEMP ERROR SAFETY SHUTTER 2 TEMP ERROR SAFETY SHUTTER 3 TEMP ERROR	OFF	ON	Abnormal temperature of the safety shutter. After waiting for several minutes, press the TROUBLE RESET button.
179 180 181	FIBER 1 INPUT CONNECTION ERROR FIBER 2 INPUT CONNECTION ERROR FIBER 3 INPUT CONNECTION ERROR	OFF	ON	Optical fiber or a trouble detecting cable is disconnected. Connect them securely.
185 186	BRANCH MIRROR 1 OPEN TROUBLE BRANCH MIRROR 2 OPEN TROUBLE	OFF	ON	Timeshare unit fault. Consult Miyachi Unitek Corp.
187 188	BRANCH MIRROR 1 CLOSE TROUBLE BRANCH MIRROR 2 CLOSE TROUBLE	OFF	ON	Start signal was input while timeshare 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 Miyachi Unitek Corp.

No.	Error Name	LD	Alarm output	Cause and Resolution Measures
190 191 192	FIBER SENSOR 1 TROUBLE FIBER SENSOR 2 TROUBLE FIBER SENSOR 3 TROUBLE	OFF	ON	An optical fiber may be broken; or end face, damaged. Check all the optical fibers for breakage. If the end face is broken, consult Miyachi Unitek Corp.
193	E.INDICATOR TROUBLE (OUTPUT UNIT)	OFF	ON	Emission lamp fault on output unit. Consult Miyachi Unitek Corp.
194	FIBER SWITCH TROUBLE	OFF	ON	An optical fiber or a trouble detecting cable is disconnected. Connect them securely.
195	LASER POWER SENSOR TEMP. ERROR	OFF	ON	Power monitor unit fault. Consult Miyachi Unitek Corp.
200 to 213	FC-LD No.1 TEMP/HUMI SENSOR ERROR to FC-LD No.14 TEMP/HUMI SENSOR ERROR	OFF	ON	FC-LD temperature/humidity sensor fault. Consult Miyachi Unitek Corp.

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 be disconnected. For adjusting the axis, consult Miyachi Unitek Corp.
Laser output decreases though monitor displays normal value. (When welding is not performed or weld strength is not enough.)	

Appendices

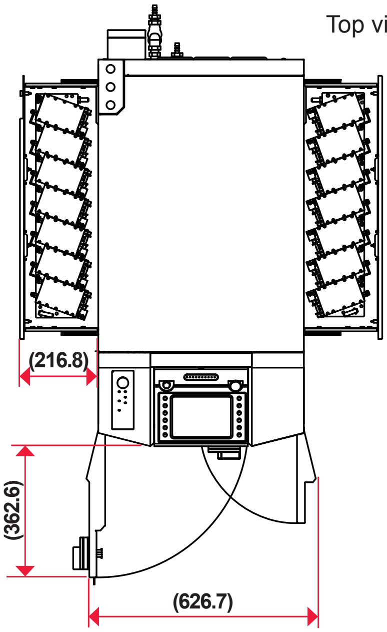
Specifications

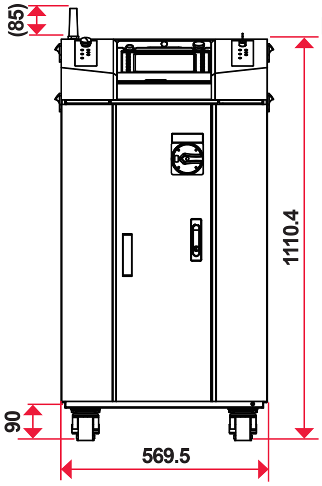
Oscillator	Maximum rated output		1000W (Output from oscillator)
	Max. peak power		1000W (Output from oscillator)
	Pulse width	REPEAT mode	Standard: 0.1 to 500.0ms (0.1ms steps) Setting switching: 0.05 to 50.00ms (0.05ms steps)
		CW mode	Standard: 0.1 to 1000.0s (0.1s steps) Setting switching: 0.01 to 100.00s (0.01s steps) 1 to 10000s (1s step)
	Repeated number of pulse/ modulation		1 to 5000pps
	Modulation function		1 to 5000Hz
	Oscilaltion wavelength		1070 to 1100nm
	Safety shutter		With open/close sensor
	Positioning guide beam		Built-in visible laser (red)
	Output stability		±2% or less @ 10W or more
Power Supply	Power supply	Input power supply	3-phase, 200V to 400V AC (+10%/-15%)
		Frequency	50/60Hz
	Max. input current		43A (200V), 42A (220V), 39A (240V), 28A (380V), 26A (400V)
	Max. apparent power		15kVA
	Power consumption	Maximum	10.3kW
		Standby	1.0kW
	Breaker rated current		75A (200V/220V/240V), 50A (380V/400V)
Cooler	Heat exchange method		Water - Water
	Required city water	Pressure	40psi (294kPa ,3kgf/cm^2) maximum
		Water temperature	41 to78.8°F (5 to 26°C) operable range
		Flow rate	13ℓ/min (22°C of primary cooling water, 27°C of pure water, and 50°C of ambient temperature)
		Differencial pressure	14.7psi to 40psi (98 to 294kPa ,1 to 3kgf/cm^2)
	Inner diameter of hose		φ15mm
	<Note> When chiller is employed, 11.0kW (9440kcal/h) of colling capability is required for the chiller cooler maximum rating.		

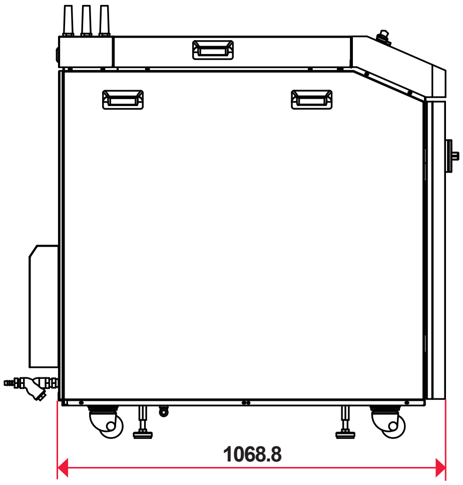
Laser Controller	Number of schedules		256
	Schedule setting	REPEAT mode	Laser output waveform Laser energy for upper/lower limit judgment Number of outputs per second Number of repeated outputs
		CW mode	Laser output waveform Modulation output waveform (when using the modulation function)
	Mesurement function		Laser energy (J), Average power (W)
	Counter		Displays the total number of outputs (9 digits) Displays the number of acceptable outputs (9 digits) Displays the total LD ON time (7 digits) Dispalys the laser output time (7 digits)
	Length of cable		Standard 0.5m cable
Operating Environment	Ambient temperature		41 to 122°F (5 to 50°C)
	Ambient humidity		50% to 85% RH (where there is no sudden moisture) ***<Note>*** For the upper limit of ambient temperature, refer to page 36.
	Temperature during transport or storage		14 to 122°F (-10 to 50°C) with the secondary cooling water drained
	Humidity during transport or storage		20% to 90% RH
	Vibration during transport		$4.9m/s^2$ (0.5G) max.
	Impact during transport		$49m/s^2$ (5G) max.
	Vibration during operations		10 to 60Hz: $0.98m/s^2$ (0.1G) max.
	Intermittent vibration during operations		Less than 2Hz: $4.9m/s^2$ (0.5G) max.
	Oil mist, dust		IP54
Others	Mass		380kg
	Dimensions		1110.4(H)×569.5(W)×1068.8(D) mm

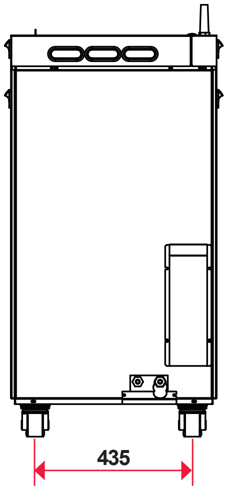
Dimensional Outline Drawings

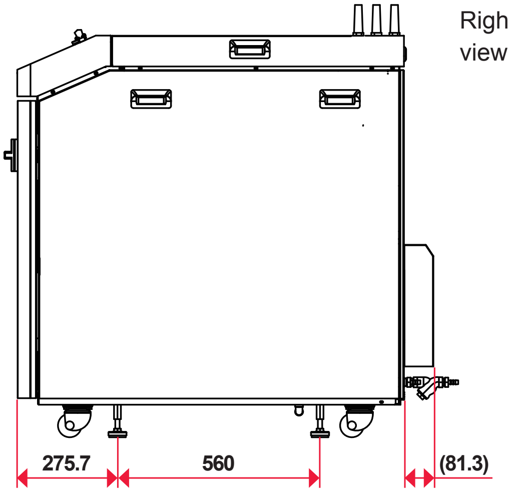
Unit: mm


Top view
(216.8)
(362.6)
(626.7)


Front view
(85)
1110.4
90
569.5


Left side View


Rear view


Right side view
275.7
560
(81.3)

Timing Chart

An example timing chart for the case where the LD is turned on and laser light is output up to a monitor output is shown below. In each timing chart the equipment operation is represented on the vertical axis and the lapse of time is represented on the horizontal axis 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-timesharing
  Operation by external input signals (EXTERNAL CONTROL)
Repeated operation (EXTERNAL CONTROL)
Repeated operation (25 pps or more) (EXTERNAL CONTROL)

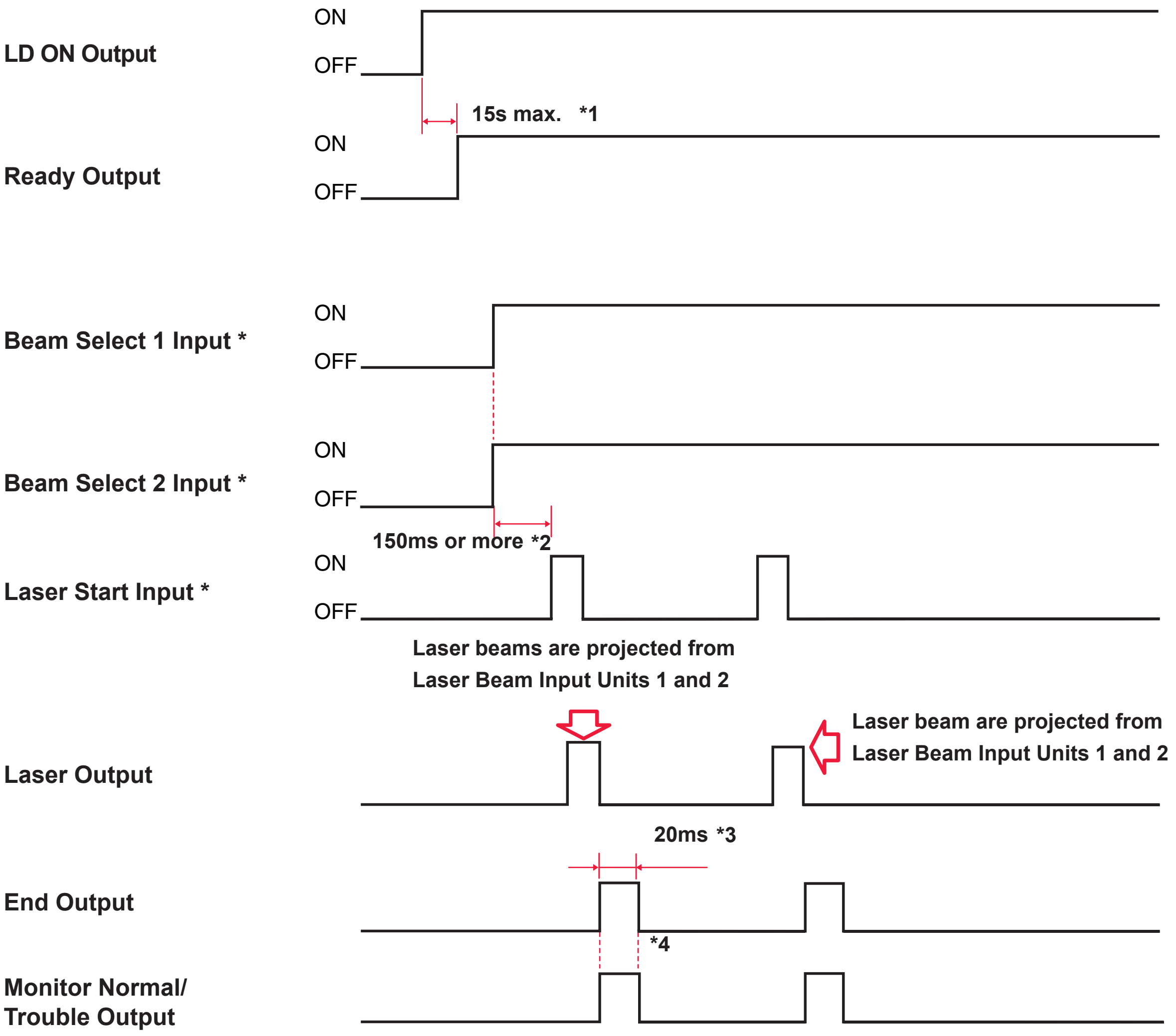
- The control method is switched by putting pin No.25 of the EXT. I/O (1) connector in an open circuit or a closed circuit.
  For PANEL CONTROL in which control is exerted by control panel, put this pin in an open circuit. For EXTERNAL CONTROL in which control is exerted by external input/output signals, 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 pressed this button once again.
  For external input/output signals laser light is output by putting pin No.3 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 the "SHUTTER" button is pressed and "SHUTTER 1" and "SHUTTER 2" are set to ON on the laser controller, and then laser light is simultaneously output from input unit 1 and input unit 2 after the safety shutters are opened.

(*: Operation on the user side)

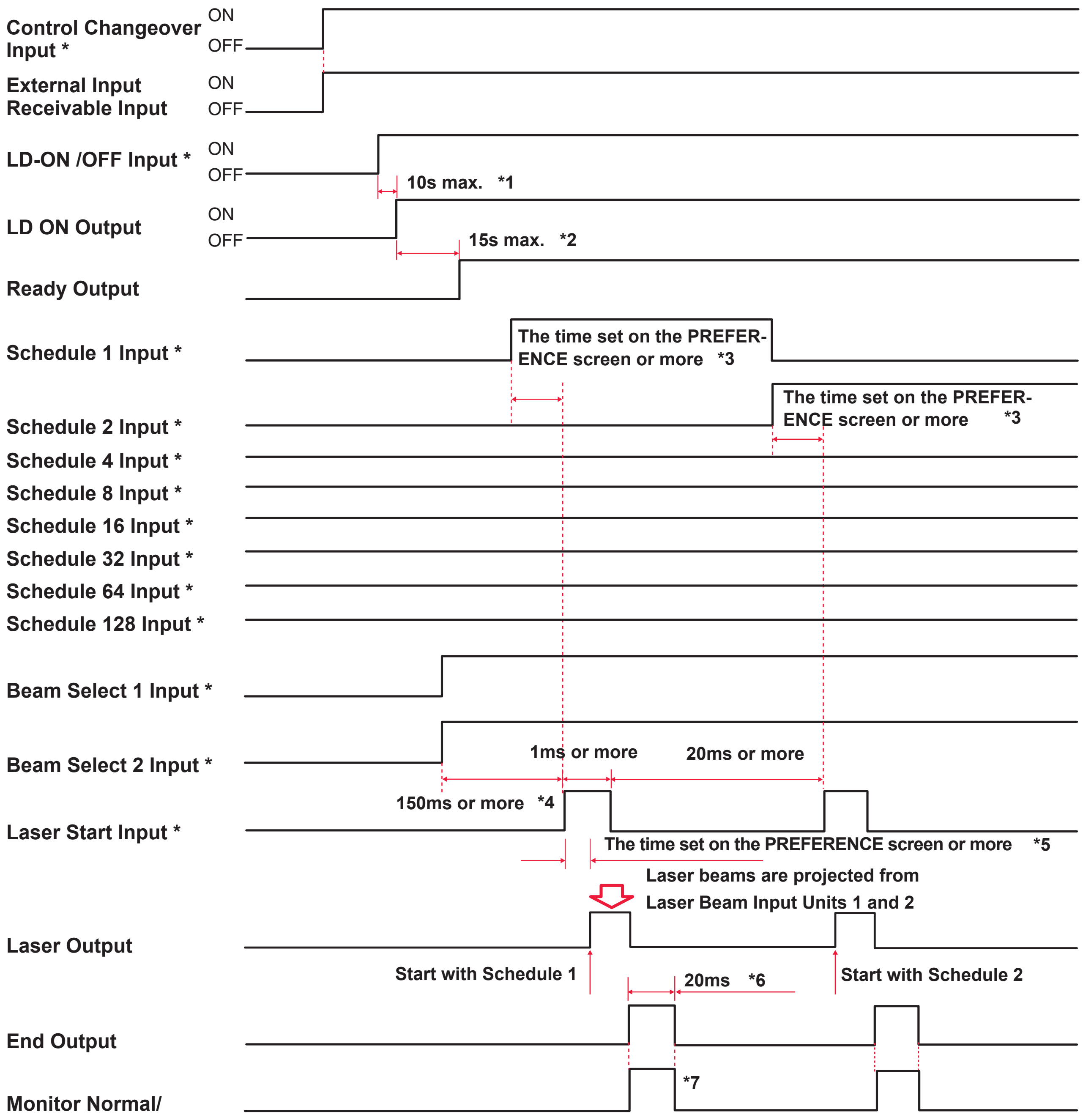

LD ON Output
ON
OFF
15s max. *1
Ready Output
ON
OFF
Beam Select 1 Input *
ON
OFF
Beam Select 2 Input *
ON
OFF
150ms or more *2
Laser Start Input *
ON
OFF
Laser beams are projected from
Laser Beam Input Units 1 and 2
Laser beam are projected from
Laser Beam Input Units 1 and 2
Laser Output
20ms *3
End Output
*4
Monitor Normal/
Trouble Output

*1	15s max.	LD output preparation time. When the LD is turned on for the first time since power-on the self-check of LD is conducted. If the safety shutter is opened when the full-power laser is output internally the shutter is closed regardless of state of the Beam Select signal. After the self-check the safety shutter is returned to the original state.
*2	150ms or more	Shutter operation time. After SHUTTER selection a laser start input signal is input after the lapse of certain time for shutter operation.
*3	20ms	Time required for the end signal to be output after a laser output.
*4	20ms	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.

(*: Operation on the user side)


Control Changeover Input *
ON
OFF
External Input Receivable Input
ON
OFF
LD-ON /OFF Input *
ON
OFF
10s max. *1
LD ON Output
ON
OFF
15s max. *2
Ready Output
Schedule 1 Input *
The time set on the PREFER-ENCE screen or more *3
Schedule 2 Input *
The time set on the PREFER-ENCE screen or more *3
Schedule 4 Input *
Schedule 8 Input *
Schedule 16 Input *
Schedule 32 Input *
Schedule 64 Input *
Schedule 128 Input *
Beam Select 1 Input *
Beam Select 2 Input *
1ms or more
20ms or more
150ms or more *4
Laser Start Input *
The time set on the PREFERENCE screen or more *5
Laser beams are projected from Laser Beam Input Units 1 and 2
Laser Output
Start with Schedule 1
20ms *6
Start with Schedule 2
End Output
*7
Monitor Normal/ Trouble Output

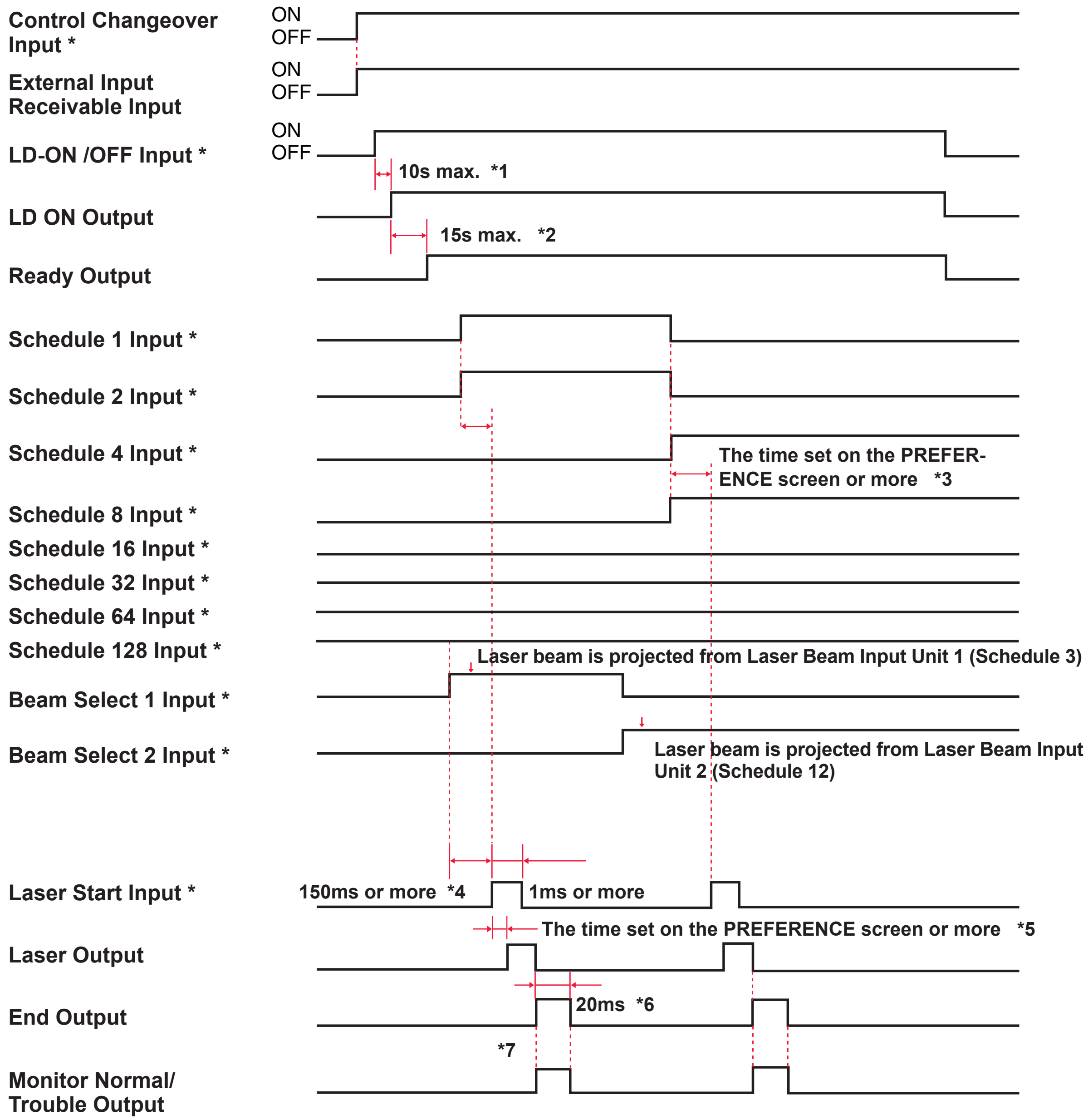
*1	10s ,ax.	LD on time
*2	15s max.	LD output preparation time
*3		Schedule signal acceptance time (time from a schedule signal input till establishment of schedules)
*4	150ms or more	Shutter operation time
*5		Laser start signal acceptance time (time from a signal input till an output)
*6	20ms	Time required for the end signal to be output after a laser output.
*7	20ms	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 *3 and *5, the acceptance time is 16 ms but can be changed to 1.0, 4.0 or 8.0 ms on the PREFERENCE screen.

2-timesharing ... Operation by external input signals (EXTERNAL CONTROL)

The following diagram shows the lapse of time in the case where a schedule signal input, BEAM1 and 2 are selected and laser light is output from input unit 1 and 2 respectively with a time difference.

(*: Operation on the user side)

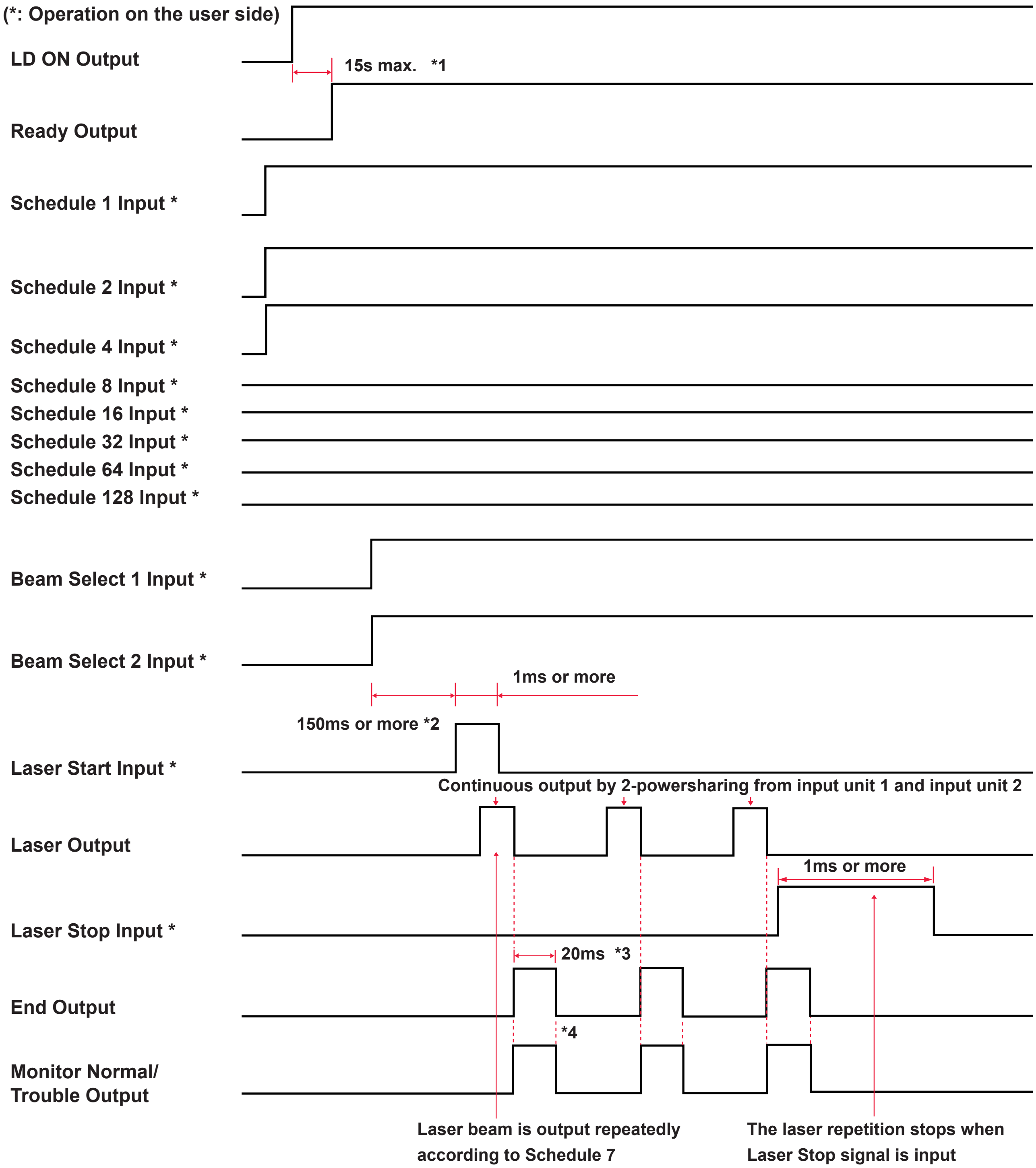

Control Changeover Input *
ON
OFF
External Input Receivable Input
ON
OFF
LD-ON /OFF Input *
ON
OFF
10s max. *1
LD ON Output
15s max. *2
Ready Output
Schedule 1 Input *
Schedule 2 Input *
Schedule 4 Input *
The time set on the PREFER-ENCE screen or more *3
Schedule 8 Input *
Schedule 16 Input *
Schedule 32 Input *
Schedule 64 Input *
Schedule 128 Input *
Laser beam is projected from Laser Beam Input Unit 1 (Schedule 3)
Beam Select 1 Input *
Beam Select 2 Input *
Laser beam is projected from Laser Beam Input Unit 2 (Schedule 12)
Laser Start Input *
150ms or more *4
1ms or more
The time set on the PREFERENCE screen or more *5
Laser Output
End Output
20ms *6
*7
Monitor Normal/ Trouble Output

*1	10s max.	LD on time
*2	15s max.	LD output preparation time
*3		Schedule signal acceptance time (time from a schedule signal input till esta blishment of schedules)
*4	150ms or more	Shutter operation time
*5		Laser start signal acceptance time (time from a signal input till an output)
*6	20ms	Time required for the end signal to be output after a laser output.
*7	20ms	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 *3 and *5, the acceptance time is 16 ms but can be changed to 1.0, 4.0 or 8.0 ms on the PREFERENCE 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.

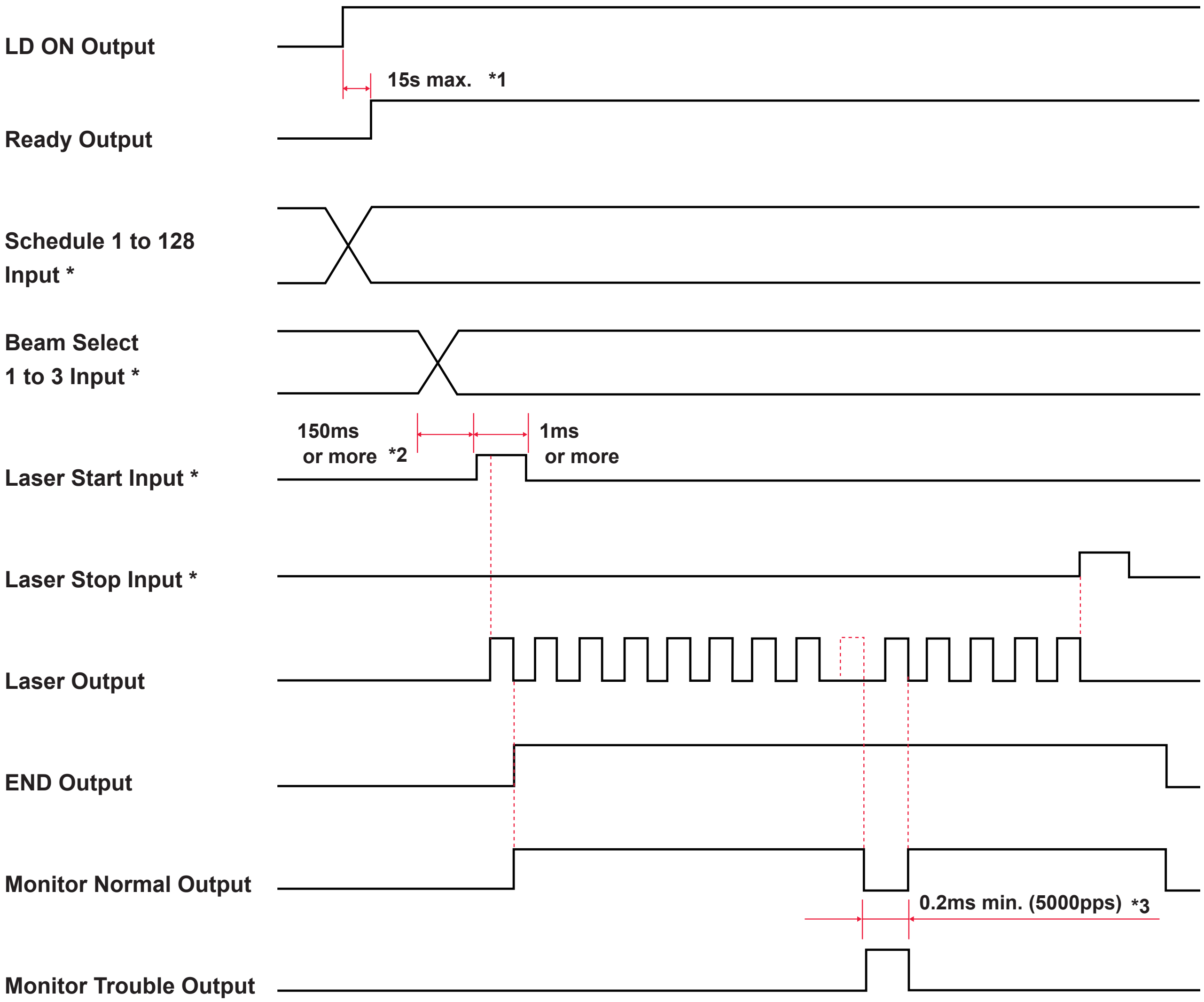

(*: Operation on the user side)
LD ON Output
15s max. *1
Ready Output
Schedule 1 Input *
Schedule 2 Input *
Schedule 4 Input *
Schedule 8 Input *
Schedule 16 Input *
Schedule 32 Input *
Schedule 64 Input *
Schedule 128 Input *
Beam Select 1 Input *
Beam Select 2 Input *
1ms or more
150ms or more *2
Laser Start Input *
Continuous output by 2-powersharing from input unit 1 and input unit 2
Laser Output
1ms or more
Laser Stop Input *
20ms *3
End Output
*4
Monitor Normal/ Trouble Output
Laser beam is output repeatedly according to Schedule 7
The laser repetition stops when Laser Stop signal is input

*1	15s max.	LD output preparation time
*2	150ms or more	Shutter operation time
*3	20ms	Time required for the end signal to be output after a laser output.
*4	20ms	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)


LD ON Output
15s max. *1
Ready Output
Schedule 1 to 128 Input *
Beam Select 1 to 3 Input *
150ms or more *2
1ms or more
Laser Start Input *
Laser Stop Input *
Laser Output
END Output
Monitor Normal Output
0.2ms min. (5000pps) *3
Monitor Trouble Output

*1	15s max.	LD output preparation time
*2	150ms or more	Shutter operation time
*3	0.2ms min.	Monitor error output time. Minimum error output time for 5000 pps.

Definition of Memory Switch

The memory switch definitions are shown below. Display the MEMORY SWITCH screen from the INITIALIZE screen to check the settings. This reference material is intended for Miyachi Unitek service personnel. Incorrect settings may cause laser malfunction or failure.

<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th></tr>
<tr><td>SWITCH 1</td><td>LD ON/OFF at AUTO START (LD AUTO START)
ON: LD OFF
OFF: LD ON</td><td>Laser control by EXT. I/O connector (EXT I-O IN INTER MODE)
ON: Valid
OFF: Invalid</td><td colspan="3">CW setting resolution
(CW TIME RESOL)<table><tr><th></th><th>3</th><th>4</th><th>5</th></tr><tr><td>0.1 s</td><td>OFF</td><td>OFF</td><td>OFF</td></tr><tr><td>1 s</td><td>OFF</td><td>OFF</td><td>ON</td></tr><tr><td>0.01 s</td><td>OFF</td><td>ON</td><td>ON</td></tr></table></td><td>Measurement accuracy of laser energy (POWER MONI RESOL)
ON: 00.000J
OFF: 000.00J</td><td>Setting resolution of pulse width (PULSE WIDTH RESOL)
ON: 0.00ms
OFF: 0.0ms</td><td>Unused</td></tr>
<tr><td>SWITCH 2</td><td>Data bit (DATA BIT)
ON: 7bit
OFF: 8bit</td><td>With or without parity (PARITY)
ON: :Without
OFF: :With</td><td>Parity mode (PARITY MODE)
ON: Odd
OFF: Even</td><td>Stop bit (STOP BIT)
ON: 1bit
OFF: 2bit</td><td colspan="3">Communication speed
(BAUD RATE)<table><tr><th></th><th>5</th><th>6</th><th>7</th></tr><tr><td>9600 bps</td><td>OFF</td><td>OFF</td><td>OFF</td></tr><tr><td>19200 bps</td><td>OFF</td><td>OFF</td><td>ON</td></tr><tr><td>38400 bps</td><td>OFF</td><td>ON</td><td>OFF</td></tr><tr><td>57600 bps</td><td>OFF</td><td>ON</td><td>ON</td></tr><tr><td>115200 bps</td><td>ON</td><td>OFF</td><td>OFF</td></tr></table></td><td>Unused</td></tr>
<tr><td>SWITCH 3</td><td>Unused</td><td colspan="3">Acceptance time of laser start signal and schedule signal
(LASER START DELAY)<table><tr><th></th><th>2</th><th>3</th><th>4</th></tr><tr><td>1 ms</td><td>ON</td><td>ON</td><td>OFF</td></tr><tr><td>4 ms</td><td>OFF</td><td>ON</td><td>OFF</td></tr><tr><td>8 ms</td><td>ON</td><td>OFF</td><td>OFF</td></tr><tr><td>16 ms</td><td>OFF</td><td>OFF</td><td>OFF</td></tr></table></td><td>Unused</td><td>Unused</td><td>Unused</td><td>Unused</td></tr>
<tr><td>SWITCH 4</td><td>Safety shutter 1 (SHUTTER-1)
ON: Enabled
OFF: Disabled</td><td>Safety shutter 2 (SHUTTER-2)
ON: Enabled
OFF: Disabled</td><td>Safety shutter 3 (SHUTTER-3)
ON: Enabled
OFF: Disabled</td><td>Unused</td><td>Unused</td><td>Unused</td><td>Unused</td><td>Unused</td></tr>
<tr><td>SWITCH 5</td><td>Timesharing unit 1 (TIMESHARING UNIT1)
ON: Enabled
OFF: Disabled</td><td>Timesharing unit 2 (TIMESHARING UNIT2)
ON: Enabled
OFF: Disabled</td><td>Unused</td><td>Unused</td><td>Unused</td><td>Unused</td><td>Unused</td><td>Unused</td></tr>
<tr><td>SWITCH 6</td><td>LD deterioration detecting function (LD SELF CHECK)
ON: Valid
OFF: Invalid</td><td>Unused</td><td>Slope monitoring in CW envelope monitoring (CW SLOPE WATCH)
ON: Invalid
OFF: Valid</td><td>Unused</td><td>Unused</td><td>Unused</td><td>Unused</td><td>Unused</td></tr>
</table>

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.142
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.142
Beamsplitter	Mirror to reflect laser light, which is incorporated in the laser oscillator section. → P.101
C	
Class D grounding	Class of grounding that is specified in Article 18 "Interpretation of Technical Standard of Electric Equipment." The grounding work for metal machine/apparatus of a low voltage of 300 V or less is performed in compliance with this specification.
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.
D	
Data bit	Bit to indicate one-character data that is used for asynchronous communication. → P.139
Diode laser	Package that mounts the LD bar in a heat sink.
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, 3 types of DIP switch are mounted on the CPU board. DIP switch is an abbreviation of Dual In-line Package switch. → P.103
Distilled water	Water resulting from boiling and evaporating tap water or ion exchange water and then cooling steam. Deionized water of 1 to 3 MΩ-cm. For cooling water of this laser, ion exchange or distilled water is used.
E	
ETX	Control code that is used for communication between computers. → P.142
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	
FC-LD	Unit that permits diode laser light to be emitted from the fiber by using a special optical system. Abbreviation of Fiber Coupled Laser Diode.
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.77
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.77
FLEX	Flexible waveform of pulse oscillation 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.80
Flexible waveform	Laser light output method of this laser. This is called FLEX or CW. 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.80
Full duplex	Communication system in which data can be send and received simultaneously from both sides in two-way communication. The data transfer system of this laser is an asynchronous full duplex system. → P.139
G	
Grounding	Electrical connection between an electric device and the ground. This is also called earth or ground. For this laser, class D grounding is performed.
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, diode laser for guide light is output. → P.58
H	
High-frequency surge	Transit voltage or current that changes sharply within a short time (3 to 30 MHz). → P.39
I	
Input unit	Unit to transmit laser light to the optical fiber. → P.22 and P.42
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 exchanger	Contains 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.179
Ion exchange water	Water in which an ion ingredient has been removed through the ion exchange resin. For cooling water of this laser, ion exchange water or distilled water is used. → P.41
L	
L	Line terminal. This is a terminal to be connected to a line conductor of the external circuit. Abbreviation of Live. → P.39
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.
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 retuned 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. For the facilities or places where a laser product exceeding Class 3B in JIS C 6802 "Safety Standards for Laser Products", it is necessary to appoint a laser safety supervisor and provide a management area. Since most laser welding equipment comes under class 4 of the highest hazard, the laser safety supervisor must be appointed. → P.10
LD	General term for diode laser and FC-LD.
LD chip	Semiconductor laser device.
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.142
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 welding equipment, 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.44
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.139
PE	Protective earthing terminal. This is a terminal that is provided to ground a device. Abbreviation of Protective Earth. → P.39
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 (FIX/FLEX) or "POWER" value (CW) that is set on the SCHEDULE screen in this laser. → P.55
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.125
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 from multiple optical fibers. → P.100
pps	Number of pulses per second. Abbreviation of pulse per second.
Protective glasses	Protective glasses for safety 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.
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.128
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).
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.138
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.138
RxD	Pin for received data out of signal lines of the communication connector. → P.138
S	
Safety 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.101
SCHEDULE	This word means a laser light output schedule in this laser. 256 types of SCHEDULE can be set and each schedule can be registered with a SCHEDULE number. → P.77
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.
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.139
STX	Control code that is used for communication between computers. → P.142
Super deionized 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 deionized water.
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. To operate this laser, power supply equipment of 3-phase 200 V / 220 V / 240 V (50/60 Hz), 75 A or more, or 380 V / 400 V AC (50/60 Hz), 50 A or more is required.

Timesharing	Laser light delivery specification. When the incorporated timesharing unit is operated, laser light is output from a single optical fiber. This function is provided in the timesharing specification of this laser. → P.100
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.101
TxD	Pin for send data out of signal lines of communication connector. → P.138
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 (Enter No. optionally.)															
↑SLOPE	TIME	000.0 - 499.9	ms																
FLASH1	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
COOL1	TIME	000.0 - 499.9	ms																
FLASH2	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
COOL2	TIME	000.0 - 499.9	ms																
FLASH3	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
↓SLOPE	TIME	000.0 - 499.9	ms																
PEAK POWER:		0010 - 1000	W																
REPEAT		0001 - 5000	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 (Enter No. optionally.)															
↑SLOPE	TIME	000.0 - 499.9	ms																
FLASH1	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
COOL1	TIME	000.0 - 499.9	ms																
FLASH2	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
COOL2	TIME	000.0 - 499.9	ms																
FLASH3	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
↓SLOPE	TIME	000.0 - 499.9	ms																
PEAK POWER		0010 - 1000	W																
REPEAT		0001 - 5000	pps																
SHOT		0001 - 9999																	
ENERGY	HIGH	000.0 - 999.9	J																
	LOW	000.0 - 999.9	J																

NETWORK # ____________________

Output Schedule Data Entry Table [FORM:FLEX (REPEAT)] - 1

ITEM		SETTING RANGE	No. UNIT	SCHEDULE (Enter No. optionally.)															
POINT 01	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 02	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 03	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 04	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 05	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 06	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 07	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 08	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 09	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 10	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 11	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 12	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 13	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 14	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 15	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																

Output Schedule Data Entry Table [FORM:FLEX (REPEAT)] - 2

ITEM		SETTING RANGE	No. UNIT	SCHEDULE (Enter No. optionally.)															
POINT 16	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 17	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 18	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 19	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
POINT 20	TIME	000.0 - 499.9	ms																
	POWER	000.0 - 200.0	%																
PEAK POWER		0010 - 1000	W																
REPEAT		0000 - 5000	pps																
SHOT		0001 - 9999																	
ENERGY	HIGH	000.0 - 999.9	J																
	LOW	000.0 - 999.9	J																

NETWORK # ______________________

Output Schedule Data Entry Table [FORM:FLEX (CW)] - 1

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE (Enter No. optionally.)															
POINT 01	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 02	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 03	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 04	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 05	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 06	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 07	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 08	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 09	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 10	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 11	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 12	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 13	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 14	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 15	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																

Output Schedule Data Entry Table [FORM:FLEX (CW)] - 2

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE (Enter No. optionally.)															
POINT 16	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 17	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 18	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 19	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
POINT 20	TIME	00.0 - 99.9	sec																
	POWER	000.0 - 200.0	%																
PEAK POWER		0010 - 1000	W																
REPEAT		0000 - 5000	pps																
SHOT		0001 - 9999																	
ENERGY	HIGH	000.0 - 999.9	J																
	LOW	000.0 - 999.9	J																

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