Original instructions

FIBER LASER WELDER

MF-C300A-SF/C500A-SF EU

OPERATION MANUAL

AMADA

OM1193140
MF-C300A-SF/C500A-E15-202310

How to Use This Document

ATTENTION
This operation manual is common to both MF-C300A-SF and MF-C500A-SF. The MF-C500A-SF is used in the explanatory drawings unless there is a significant difference.

Thank you for purchasing our product.

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

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

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

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

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

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

Organization of This Document and Its Contents

Introduction Part: Explains the outline and functions of the laser. Regarding the Fiber Laser, this part explains the basic configuration and functional outline of this product including options so that the user can know the configuration of the laser and equipment composition, and also the name and function of each component section.

Installation and Preparation Part: Explains the installation of the laser and preparatory operations such as connections of its respective sections.

Operating Part: Explains how to operate the laser. First, this part explains how to perform each setting and how to operate the laser. Three types of control (Control by the laser controller, control by external input/output signals, and control by external communication control) are explained in the operating method for laser welding.

Maintenance Part: Explains how to perform maintenance and how to handle trouble.

Appendixes: For reference materials, specifications, dimensional outline drawing, timing chart, and list of terminology are available. In the output schedule data entry table, the user can enter registered laser output schedule data for use.

Contents

For Use in Safety

Safety Precautions

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

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

A meaning of a figure sign

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

DANGER

Do not touch the inside of the Laser unnecessarily.
Since source voltage of single-phase 180 V to 240 V AC is applied to the Laser, high voltages are applied to its inside. Do not touch the inside of the Laser unnecessarily with the power turned ON.

Never disassemble, repair or modify the Laser.
These actions can cause electric shock and fire. Do not do anything other than the maintenance described in the operation manual.

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

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

WARNING

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

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

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

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

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

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

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

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

Shield the laser beam.
The laser beam is dangerous to human bodies. Prevent emission through the air by using a light shielding material (a Class 4 laser beam-absorbing material).

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

CAUTION

Do not splash water on the Laser.

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

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

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

Install the Laser on a firm and level surface.

If the Laser falls or drops, injury may result.

Do not place a water container on the Laser.

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

Keep combustible matter away from the Laser.

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

Do not apply the laser beam to combustible materials.

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

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

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

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

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

Protective gear must be worn.

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

Keep a fire extinguisher nearby.

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

Maintain and inspect the Laser periodically.

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

Precautions for Handling

Laser Safety Supervisor

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

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

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

⇒ Install the indicating lamp etc. so that a user can recognize that the Laser is in use from outside the laser operation area.

⇒ When entering a laser operation area for maintenance etc., use the safety interlock.

⇒ When installing the output unit at a place distant from the main unit of the Laser, enable a user to stop the laser even at a distant place.

* For connections of indication lamp, safety interlock, and emergency stop, use two contacts. For details, refer to "E-STOP Connector" on page 124.

Routine Handling

⇒ Perform inspection periodically referring to the Maintenance Part, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection/Replacement" on page 162.

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

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

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

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

⇒ To restart the Laser, ensure that the Laser stops before turning ON the MAIN POWER switch.

⇒ The outer panels and the covers are electrically connected to the main unit by connecting cables. When the panels, covers and connecting cables are removed and installed again, make sure that all these components are put back into place correctly. Also, make sure that the cables do not block the optical path of the oscillator or get caught between the outer panel and the frame.

⇒ To prevent damage, do not bend the optical fiber beyond its minimum bending radius or apply any forms of shock to it (See table below).

Bending radius	Min. 150 mm
Coil radius	Min. 200 mm
Tensile force	Max. 50 N
Torque (torsion)	Max. 0.5 Nm
Torsion	Max. 90° per meter

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

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

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

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

For Transportation

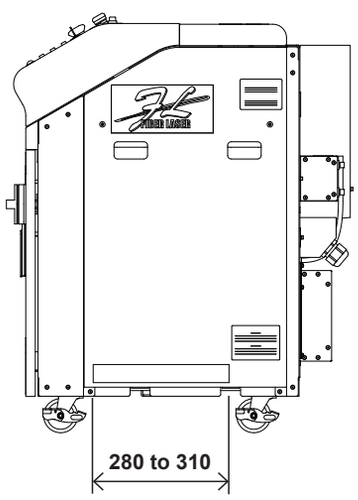
When transporting the laser, observe the following precautions to avoid hazards.

- ⇒ 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 pallet truck of at least 200 kg allowable load.
- ⇒ Do not transport the Laser with its casters. The casters are for fine adjustment.

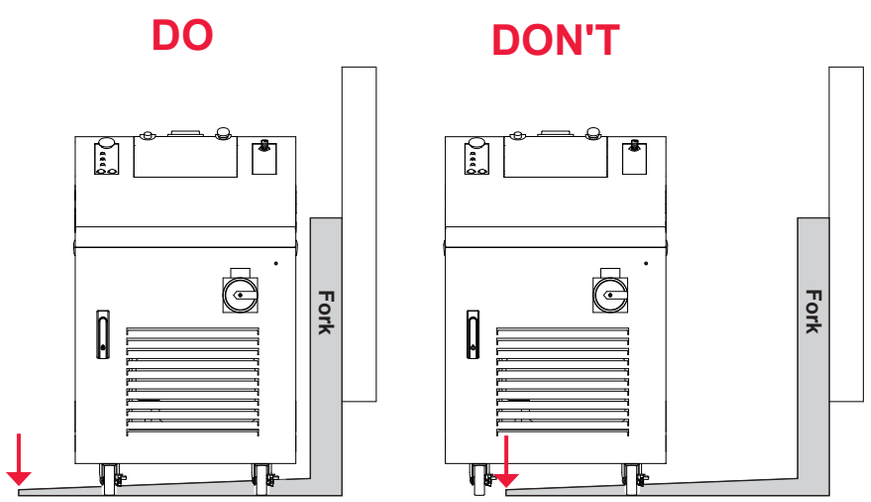
Precautions for using a pallet truck

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 280 to 310 mm, but the fork must not hit the caster.
- ⇒ When transporting, belt the Laser to fix and keep it horizontal.

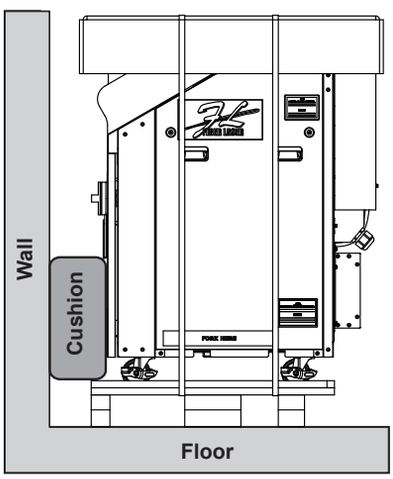


Figures below show example forking; insert the forks fully till the points appear from under the Laser.



Precautions for transportation

- ⇒ Fix it firmly using the dedicated packaging materials to prevent a fall, damage due to vibration.
- ⇒ Fix the caster when freighting the Laser.
- ⇒ Insert a broad and thick cushion between the Laser and wall to provide enough clearance between the wall and the Laser.



For Packaging

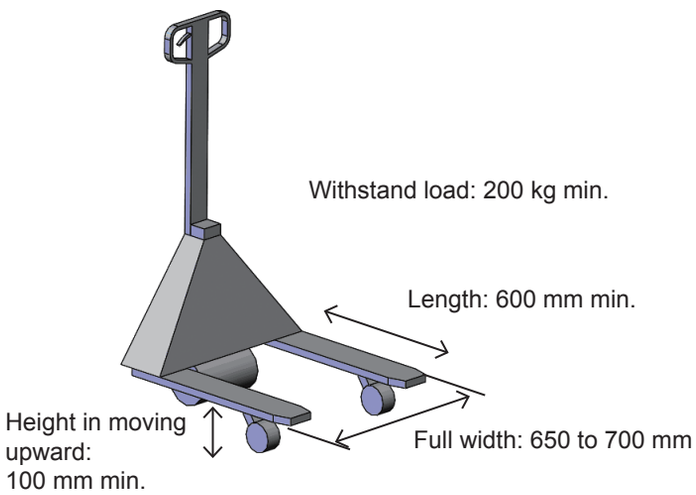
Precautions for packaging

- ⇒ The worker must wear a helmet, safety shoes and gloves for safety. (Leather gloves are recommended.)
- ⇒ Fix the caster when packing the Laser.
- ⇒ Take care that the Laser does not fall or slip.
- ⇒ Fix the skid to prevent slipping or install it on the non-slipping surface.
- ⇒ For overseas transportation, put the Laser on the pallet and cover it with plastic wrap to prevent damage caused by rain.

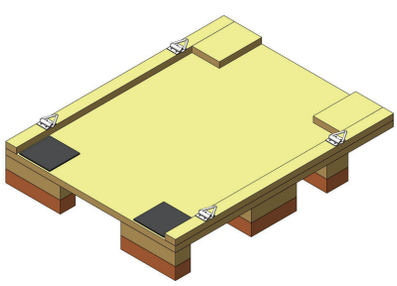
Packaging overview and name of each section

Operating Procedure

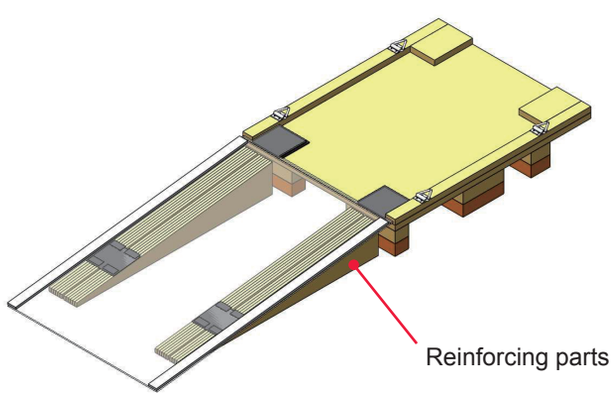
(1) Prepare a pallet truck with the following specifications.



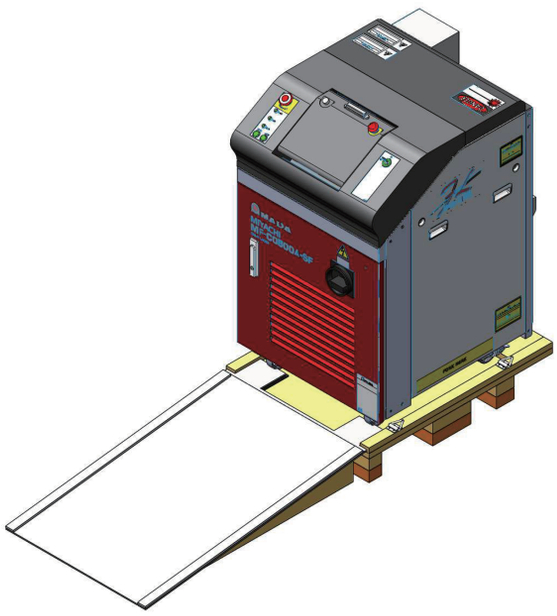
(2) Prepare a vibrationproof skid.



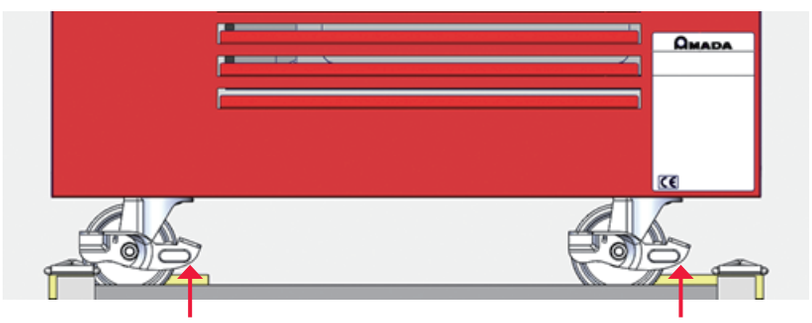
(3) Assemble the slope and attach the reinforcing parts.



(4) Place the Laser on the vibrationproof skid by using the slope.

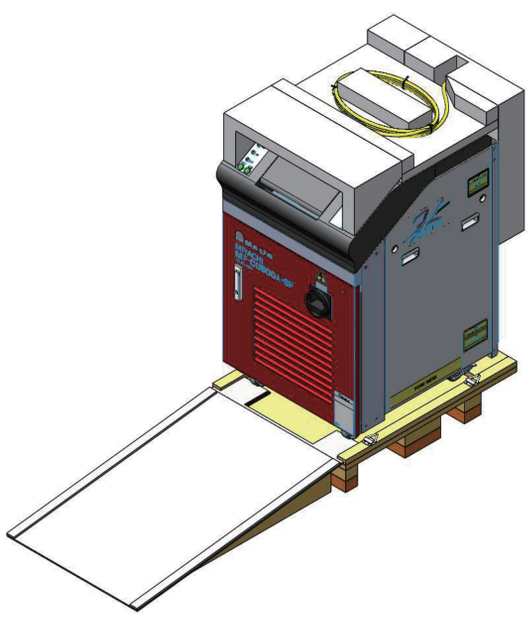


(5) Place the casters sideways to lock them.

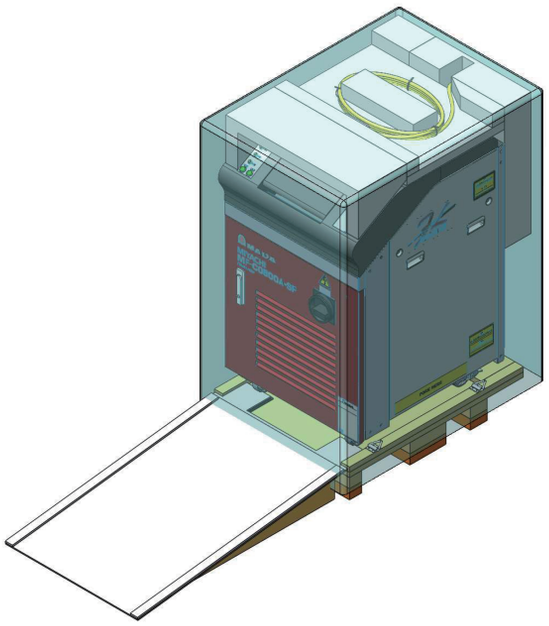


(6) Place the cushioning material on the top of the Laser and then place the optical fiber on it.

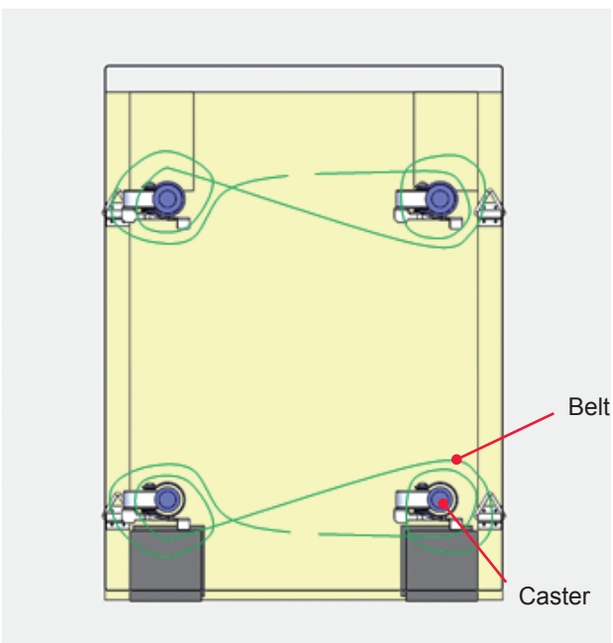
⇒ Fix the optical fiber with insulation locks (three positions).



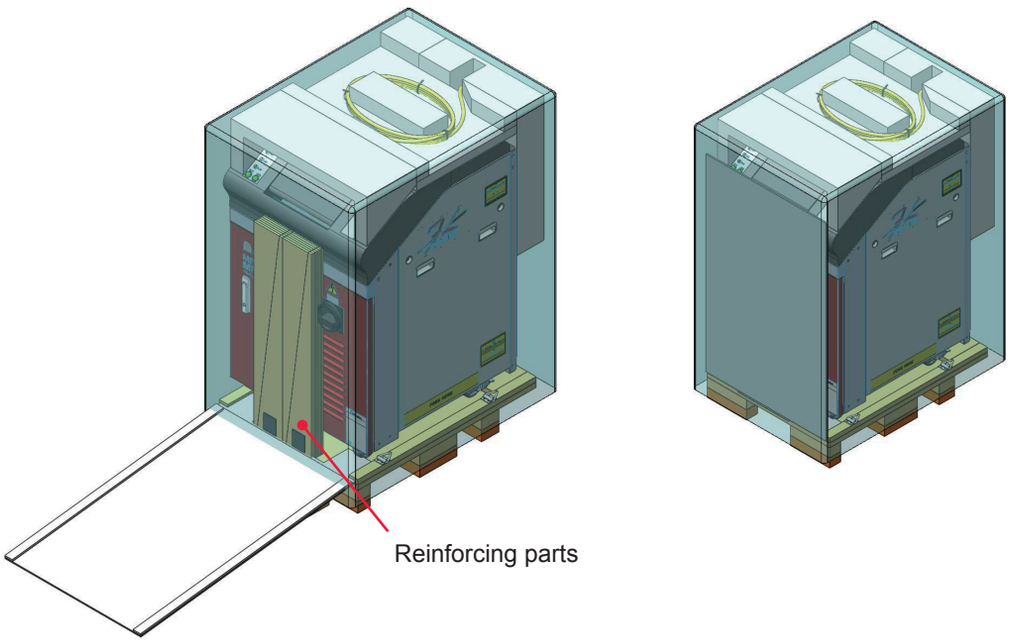
(7) Wrap the Laser separately for each cushioning material with an air cap or packaging wrap.



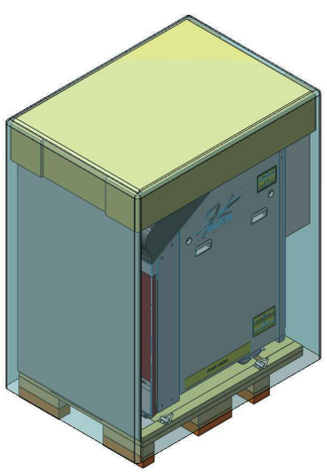
(8) Fix the front and rear casters with the attached belts.



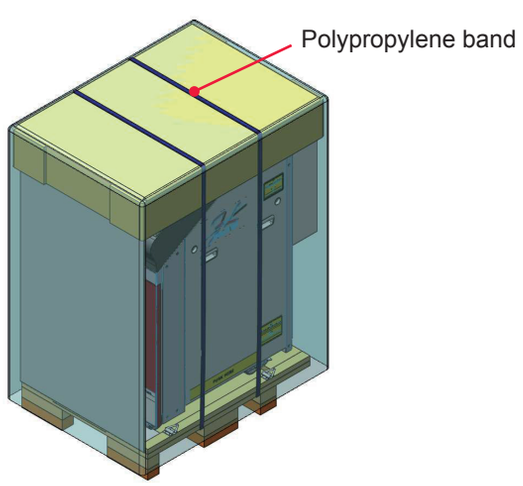
(9) Place the reinforcing parts under the slope as shown below and raise the slope.



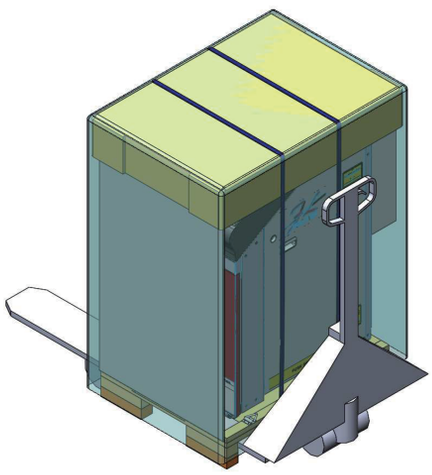
(10) Cover the corrugated cardboard-made top cap on the cushioning material at the top.



(11) Fix them with two polypropylene bands as shown below.



(12) When transporting the Laser, use a pallet truck.

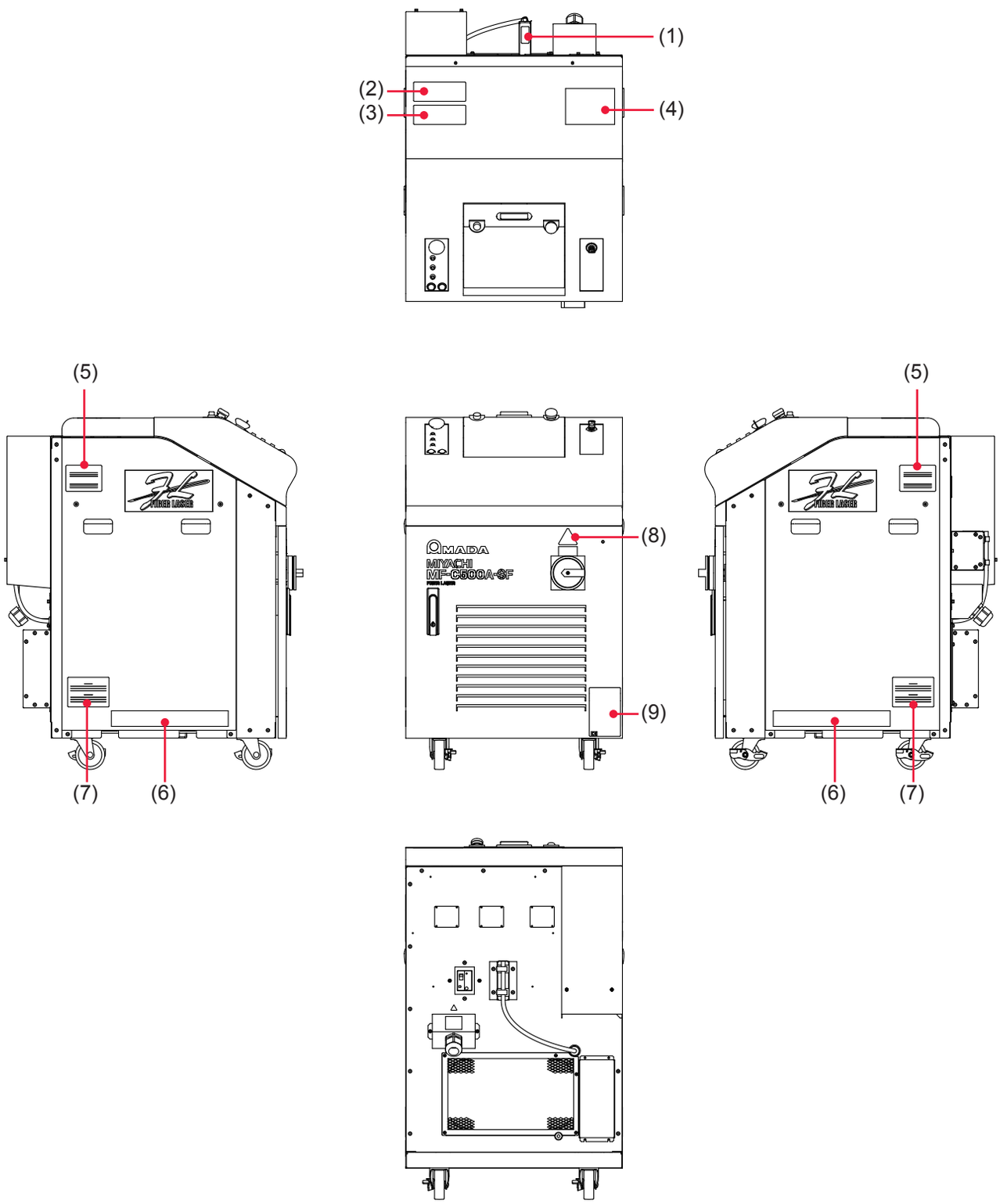


For Disposal

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

Sticking Warning/Danger Labels

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



(1)

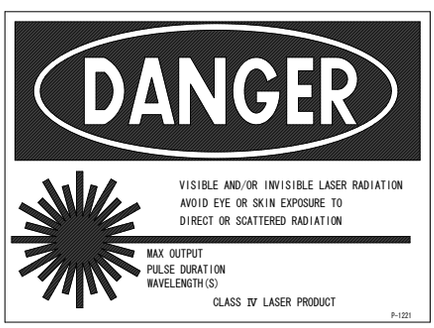
ファイバの曲げ半径は
仕様の範囲内でお取扱下さい
Keep the bend radius of fiber
within the specified range.

(2)

(MAX) MF-C300A-SF: 600W
MF-C500A-SF: 900W

(3)

(4)



(5)

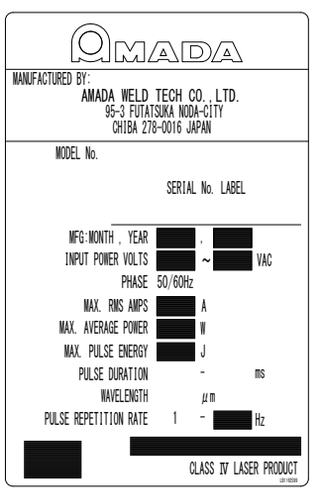
(6)

FORK HERE

(7)

(8)

(9)



Introduction Part

Introduction Part

Chapter 1

Overview of the Fiber Laser Welder

1. Fiber Laser

Laser means the equipment to generate powerful light by amplifying light (electromagnetic wave) or means this light itself. Laser can be classified into various types by light generating material. Among these types, a remarkable type as welding laser in the industrial field is fiber laser for its beam quality. In this laser welder, laser is generated in a fiber doped with Ytterbium (Yb).

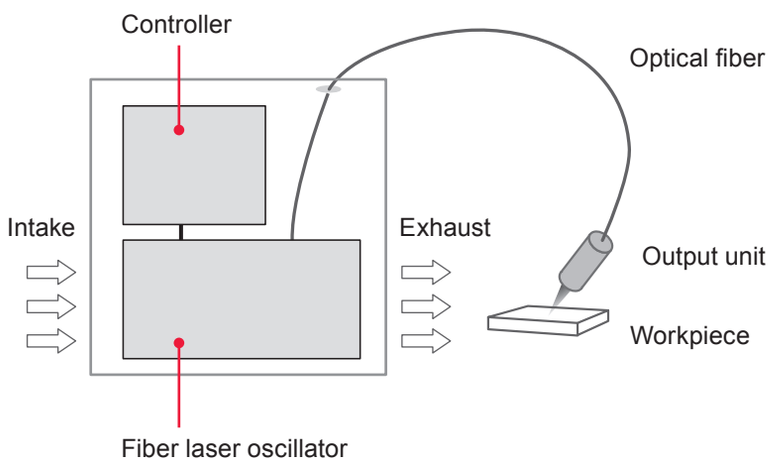
The Yb fiber laser wavelength generated in this laser welder is near infrared rays that are invisible to the human eye. Most of laser equipment for laser welding belongs to class 4 laser that is the most hazardous in the classification of laser products specified in JIS. When the laser light greets the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

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

2. Mechanism of the Fiber Laser

The Fiber Laser for welding consists of a power supply, 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.

Common Fiber Laser Equipment Configuration



3. Functions of the MF-C300A-SF/C500A-SF

⇒ Fiber laser oscillator

- The laser is capable of processing workpieces under a small spot diameter.
- The single laser provides CW and pulse 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.

⇒ Optional waveform control function and schedule setting

- 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 (1000 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.
- 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

- Remote control is available because the Laser Controller is detachable.
- A welding schedule is input from the large-shaped touch panel type color display. Accordingly, operations can be easily and accurately performed.
- Language displayed on the Laser Controller can be switched between Japanese and English.
- A variety of input and output signals allow the Laser to be connected to automatic machines.
- Both the laser energy (J) and its mean power (W) are monitored. If the desired energy range has been preset and the laser energy is out of the range, the trouble signal is output. This function is provided for quality control purposes.
- Optical fiber detection is available to check fiber breakage.
- Using the external communication function permits managing data such as welding schedules and monitor values in centralized form.

⇒ The factory environment can be improved by space saving.

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

⇒ The Laser is in compliance with IEC Standards IEC60825-1 “Safety of laser products Part 1: 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. 1100 (H) × 605 (W) × 835 (D) mm	Approx. 150 kg
Package for accessories	Approx. 580 (H) × 330 (W) × 460 (D) mm	Approx. 10 kg

Checking the Packaged Products

Make sure that all the packaged products are included.

Package for main unit

Product name	Model No.	Q'ty
Fiber Laser Welder	MF-C300A-SF/C500A-SF	1

Package for accessories

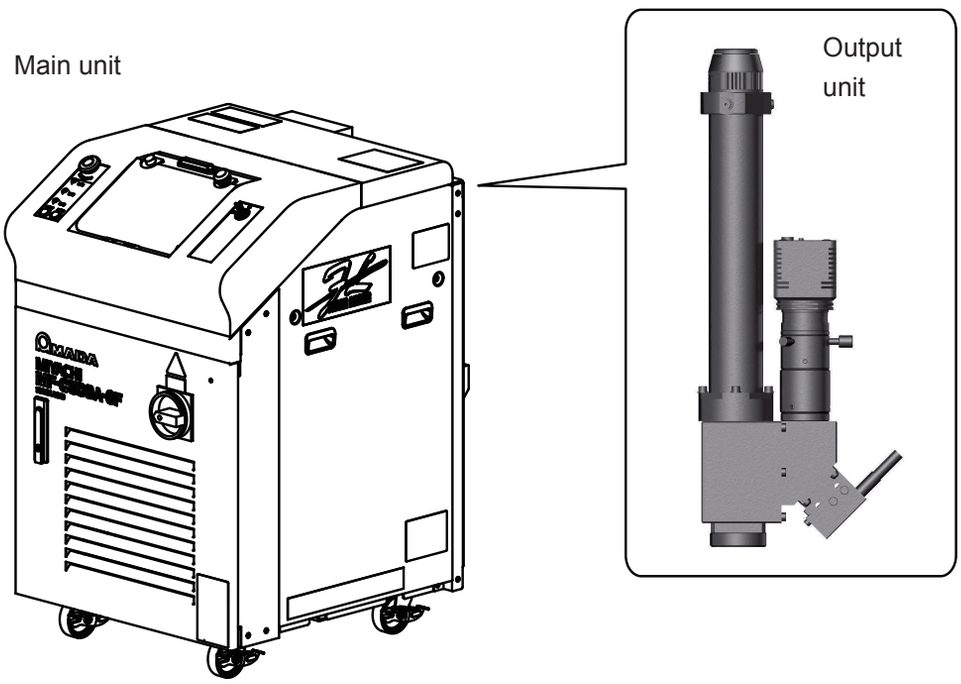
⇒ The model numbers of accessories are subject to change without notice. Depending on the part to be changed, the mounting screw shape may change and a necessary tool may be different. For the latest parts information, contact a nearest sales office.

Product name		Model No.	Q'ty
Power cable (5 m)		AS1192449	1
Operation manual		AS1193137(OM1193139,OM1193140)	1
Caster holder		PA1194174	4
Protective glasses		CE YL-717S	1
Connector	Plug for EXT. I/O (2)	HDCB-37P(05)	1
	Plug for RS-485	116-12A10-5F10.5	2
	Case for EXT. I/O (2)	HDC-CTH(10)	1

Main Unit and Output Unit

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

Main unit x 1	+	Output unit x Number of deliveries



Main unit

Provided with the optical fiber.

Model	Sharing method	Core dia. of optical fiber	Length of optical fiber
MF-C300A-SF-110-00-00	Single delivery	Single mode	10 m
MF-C500A-SF-110-00-00	Single delivery	Single mode	10 m

Output unit

The output unit with the specification that you selected at the time of purchase is connected to the main unit. For details, refer to the Operation Manual or Specification for the output unit (FOCL-25FC series).

Model		Image ratio
FOCL-25FC-	060AS150AS	2.5
	080AS150AS	1.9
	100AS150AS	1.5
	120AS150AS	1.25
	150AS150AS	1

Options

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

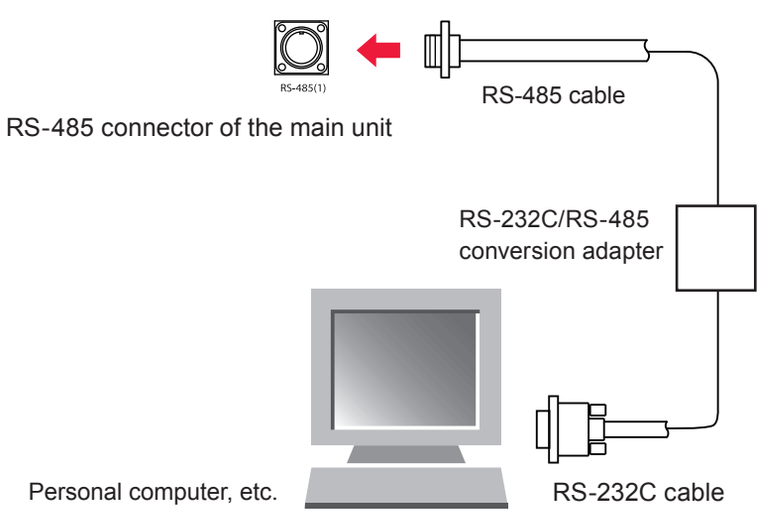
Part name		Model No.
Touch panel extension cable	5 m	AS1162937
	10 m	AS1162938
	15 m	AS1162940
RS-232C/RS-485 conversion adapter		MSC-08S
AC adapter for RS-232C/RS-485 conversion adapter		Exclusively for MSC-08
RS-485 cable	5 m	AS1155931
	10 m	AS1156028
	15 m	AS1156029
RS-232C cable, 0.2 m		KRS-9F25F02K
Basic unit for scanner welding (standard)		GWM-FL
Warning label	Small	P-0211
	Medium	P-0212
	Large	P-0213

⇒ For the basic unit for scanner welding, refer to the Operation Manual or Specification for GWM-FL.

⇒ For the maintenance parts separately sold, refer to the Maintenance Part, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection/Replacement" on page 162.

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.



Introduction Part

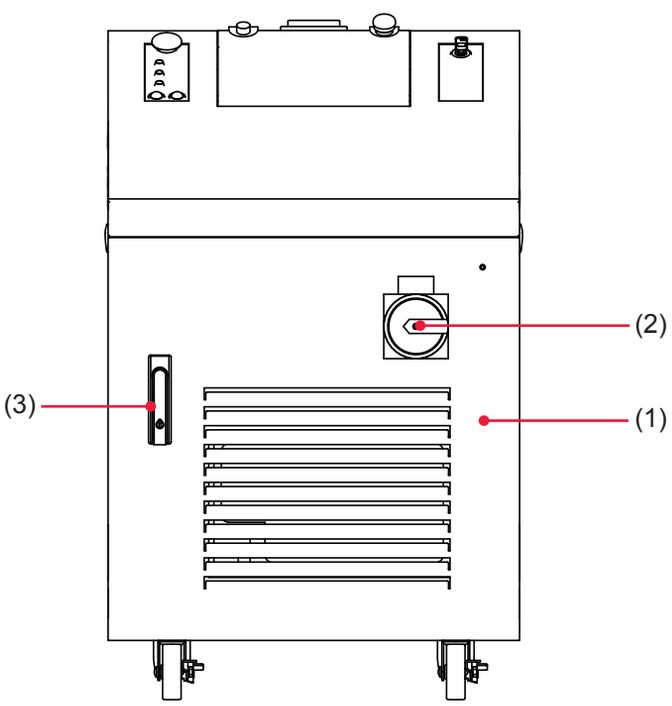
Chapter 2

Name and Functions of Each Section

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

Front Cover Section

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

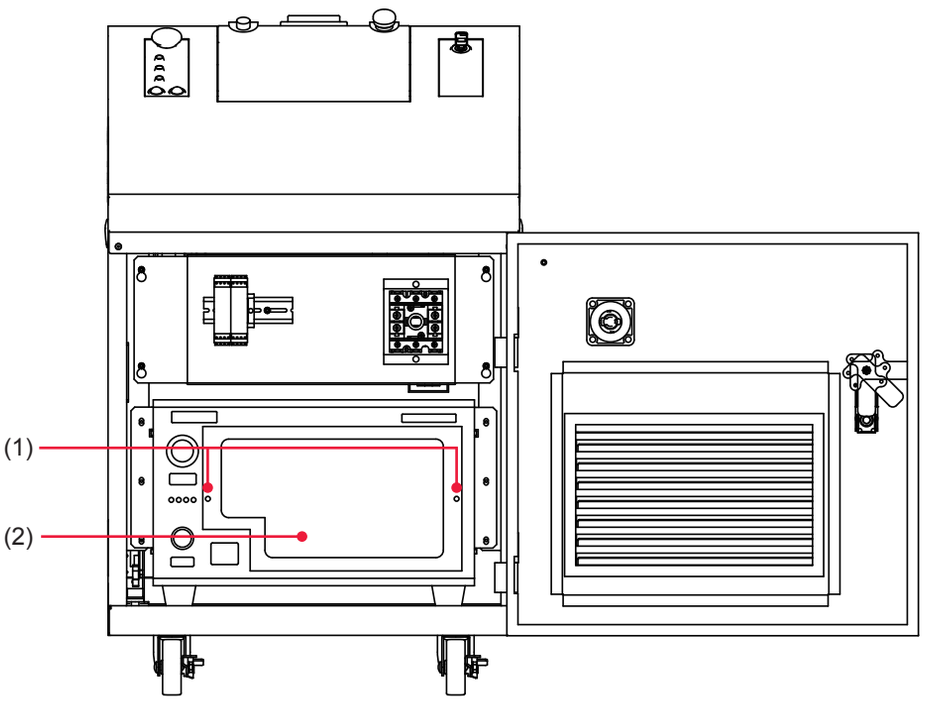


Function of Each Section on the Front Cover

(1) Front Door	This door is opened to perform maintenance of air filter.
(2) MAIN POWER Switch	Turns ON and OFF the power supply.
(3) Front Door Handle	Used to open the front door. Pull out the handle with the MAIN POWER switch OFF and turn it 90 degrees to the right to open the door. After closing the door, put back the handle into place and the door will lock.

Inside of the Front Side

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



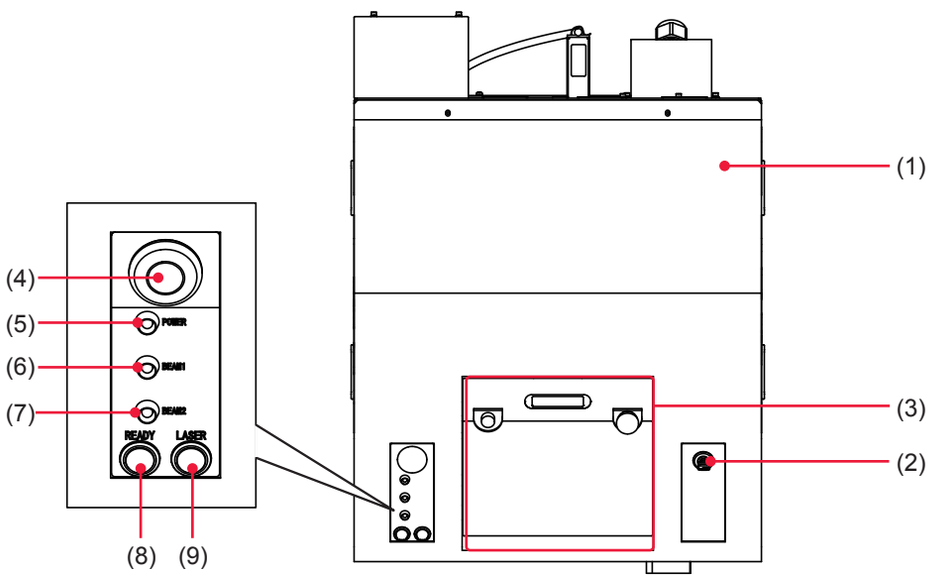
Function of Each Section inside the Front Side

(1) Filter Fixing Screw	Unscrewed to remove the air filter.
(2) Air Filter	At the intake of air. Prevents the Laser from dust and dirt.

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

Top Cover Section

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



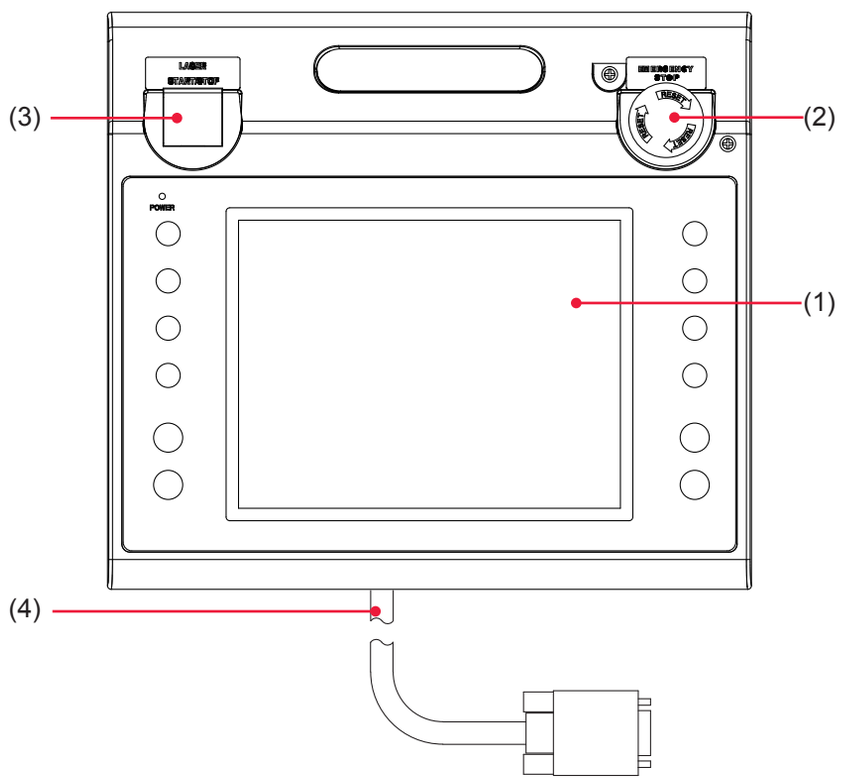
Function of Each Section on the Top Cover

(1) Head Cover	This cover is opened to perform maintenance.
(2) CONTROL Keyswitch	When the CONTROL keyswitch is turned ON with the MAIN POWER switch ON, this keyswitch is operable. When the laser is not used, turn OFF the CONTROL keyswitch and then pull out the key. The laser safety supervisor should take charge of the keyswitch.
(3) 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.
(4) EMERGENCY STOP Button	This is an emergency stop button. With this button pressed, the laser welder operation is stopped and the same state as that provided by turning OFF the CONTROL keyswitch is provided. When the pressed button is turned in the direction of RESET (clockwise), the button is reset to the initial state.
(5) 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.
(6) BEAM1 Lamp	Always turned ON after the CONTROL keyswitch is turned ON and the engine (oscillator) check is complete.
(7) BEAM2 Lamp	Not used.
(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-122A)

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

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



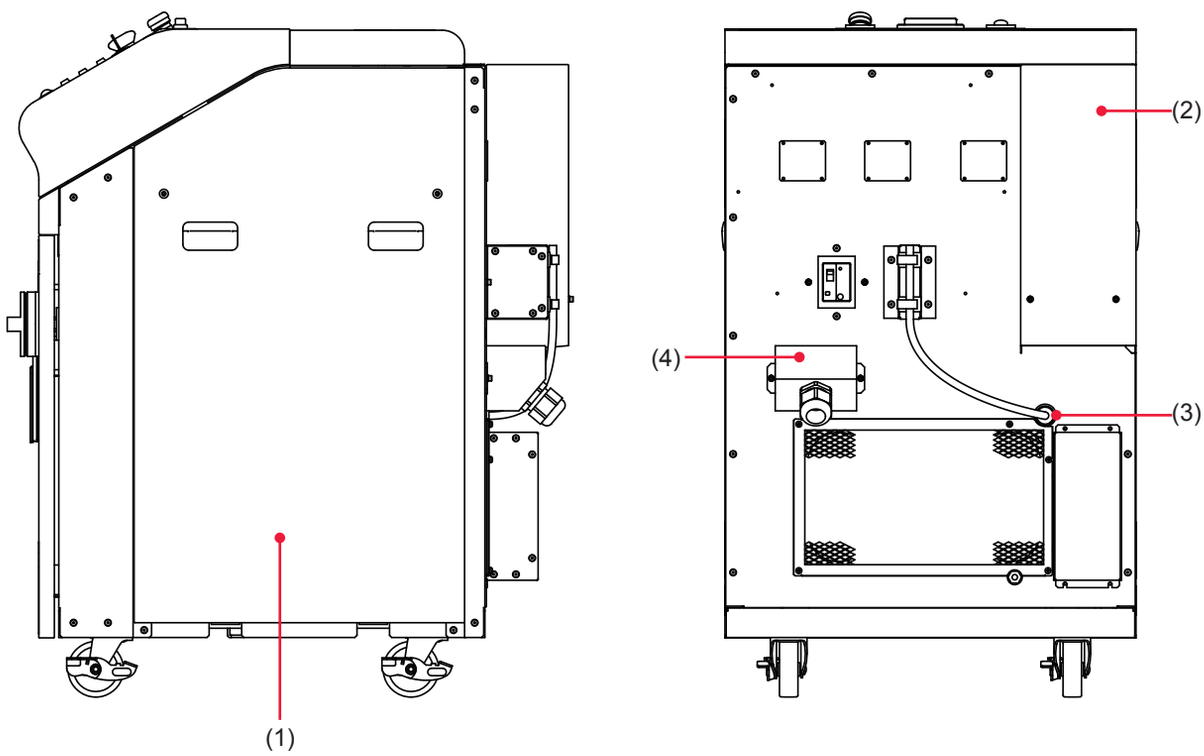
Function of Each Section on the Laser Controller

(1) Liquid Crystal Display	Displays the setting conditions and monitor data.
(2) EMERGENCY STOP (Button)	This is an emergency stop button. With this button pressed, the laser welder operation is stopped. When the pressed button is turned in the direction of RESET (clockwise), the button is reset to the initial state. This button functions in the same way as the EMERGENCY STOP button of the main unit.
(3) LASER START/STOP (Button) **EMISSION (Lamp)**	If you press the button when a laser light output becomes ready, laser light is output. If the button is pressed again while laser light is repeatedly output, the repeated output is stopped. * Pin No.25 (control switching) of the EXT. I/O (1) connector is in an open circuit and the LD is turned on. When the LD is turned on, the EMISSION lamp comes on.
(4) Circuit Cable	Connects the laser controller to the main unit.

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

Lateral Side and Rear Side Cover Section

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

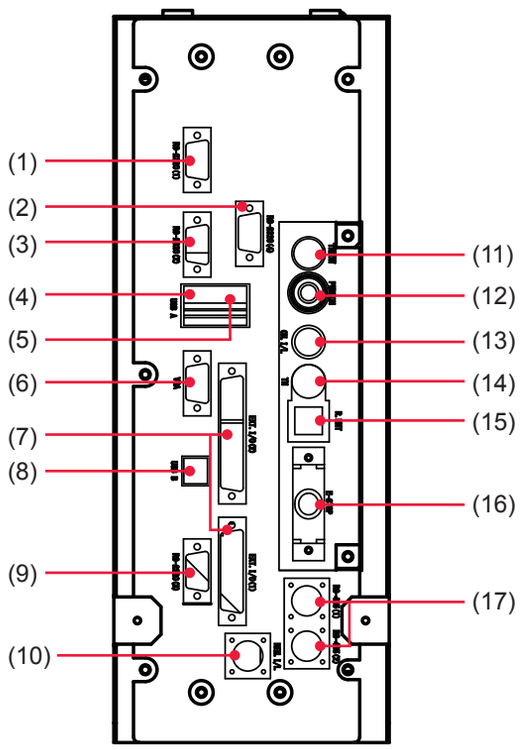


Function of Each Section on the Lateral Side and Rear Side Cover Section

(1) Side Covers	For both sides of the Laser. Power supply, controller and laser oscillator are beyond the cover.
(2) Connector Cover	For the external I/O connectors.
(3) Optical Fiber Outlet	The optical fiber is connected.
(4) Power Supply Terminals	Connects the single-phase power supply of 200 V to 240 V AC (±10%), and the grounding conductor. Remove the cover when connecting the power cable and mount it when using.

Inside of the Connector Cover

This section explains each section inside the connector cover.



Function of Each Section inside the Connector Cover

(1) RS-232C (1) Connector	Used for maintenance only. Do not connect anything.
(2) RS-232C (4) Connector	Used for maintenance only. Do not connect anything.
(3) RS-232C (2) Connector	Used for maintenance only. Do not connect anything.
(4) USB A Connector	Used for maintenance only. Do not connect anything.
(5) LAN Connector	Used to connect GWM-FL.
(6) VGA Connector	Used for maintenance only. Do not connect anything.
(7) 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.
(8) USB B Connector	Used for maintenance only. Do not connect anything.
(9) RS-232C (3) Connector	Used for maintenance only. Do not connect anything.
(10) REM. I/L Connector	Connect it to the Remote Interlock for emergency stop. When this connector is closed, the LD is turned OFF to shut off the laser light output.

(11) THMON Connector	Not used.
(12) PWRMON Connector	BNC connector used to output an analog signal representing the monitor waveform of laser power. When viewing the waveform of laser output, connect to an oscilloscope. The output range is 0 to 5 V (MF-C300A-SF: 300 W = 4 V, MF-C500A-SF: 500 W = 4 V). Set the impedance of the oscilloscope to 1 MΩ.
(13) CH.I/L Connector	Not used.
(14) TH Connector	Not used.
(15) R.MNT Connector	Not used.
(16) E-STOP Connector	Used to connect to the Remote Interlock for emergency stop or input/output Emergency signals.
(17) RS-485 (1), (2) Connectors	Connects a personal computer to use the external communication function.

Installation and Preparation Part

Installation and Preparation Part

Chapter 1

Installation

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

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

1. Installation Place

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

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

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

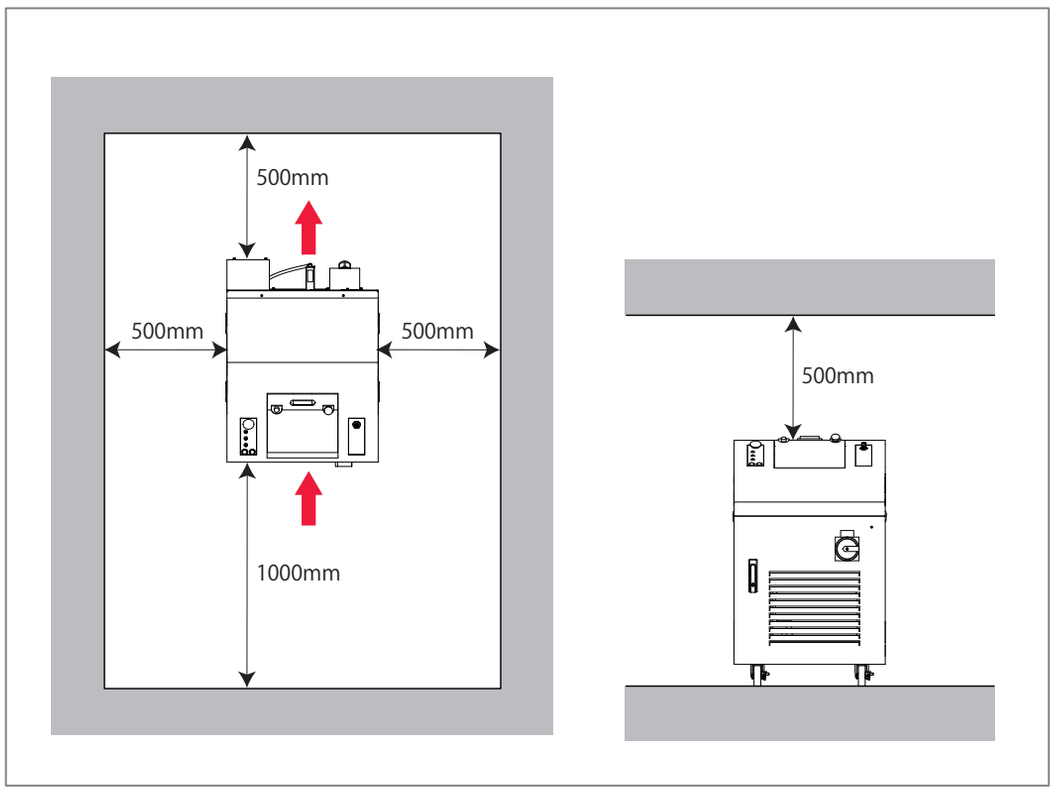
⇒ Perform class D grounding work (Ministry of Economy, Trade and Industry "Technical Standards for Electric Equipment").

Space Required for Installation

In the installation place of this product, at least 1000 mm of space is required in front, and at least 500 mm of space is required in back, right, left and upper sides to cool the internal parts.

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

⇒ Air flows in the direction of the red arrow shown in the following figure. Install the product so as not to interrupt the air flow.



Environment Suitable for Installation and Precautions

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

⇒ Use the product in a place where the ambient temperature is 10 to 35ºC and the ambient humidity is 20 to 85% RH and yet a sudden temperature change does not occur.

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

- Place where there is considerable dirt, dust, or oil mist,
- where the Laser may be subjected to vibration or impact,
- where the Laser may be exposed to chemicals,
- where there is a nearby high noise source,
- where moisture may be condensed on the surface of the Laser,
- where the concentration of CO_2, NOx or SOx is high.

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

⇒ Start operations at least 30 minutes after turning ON the Laser under low-temperature (20°C or lower) environment. Output fluctuation occurs.

2. Fixing the Laser Welder

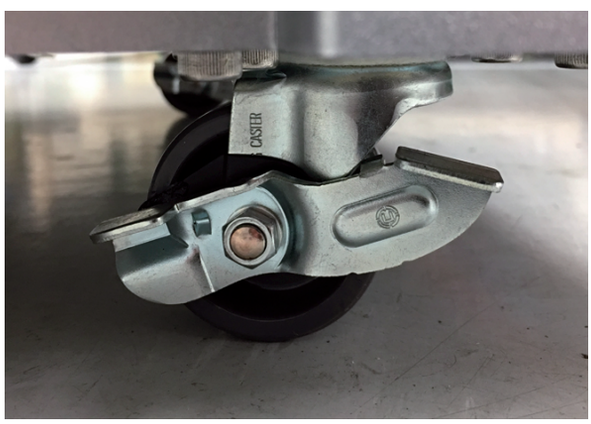
This section explains how to fix the laser welder on the floor.

Item required

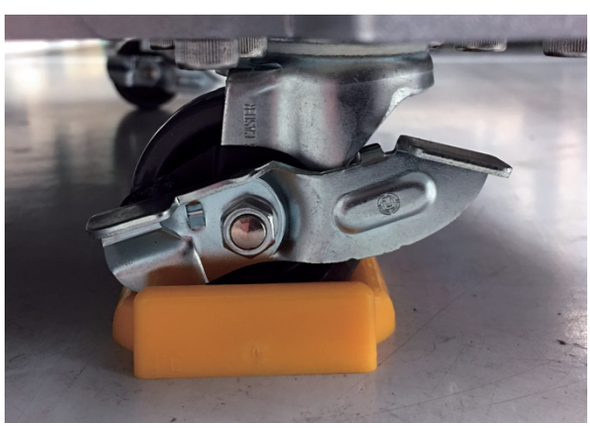
Caster holders

Operating Procedure

(1) Lock the casters provided in 4 positions in the lower part of the main unit.



(2) Fix each caster by using the attached caster holder.



Caster holder

Installation and Preparation Part

Chapter 2

Connections and Preparations of Each Section

1. Connecting the Power Supply

⚠ CAUTION

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

⚠ CAUTION

- **For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 20 A or more, which is applicable to harmonics and surges.**
- **Confirm that the Laser is grounded.**

Item required

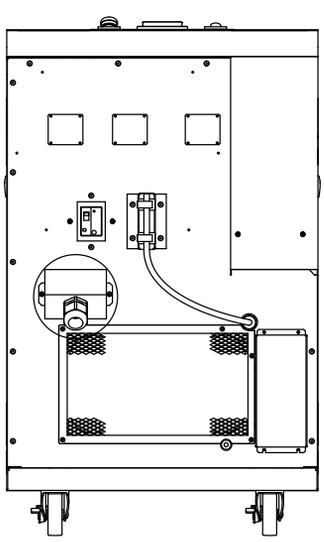
Slotted screwdriver and Phillips screwdriver

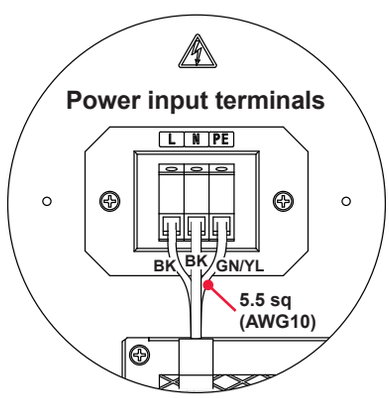
Operating Procedure

(1) Open the terminal cover on the power supply terminals on the rear.

(2) Loosen the cable gland on the terminal cover to pass the power harness.

(3) While confirming the terminal colors of the power harness, connect the power harness to the L (black), N (black), and PE (green/yellow) power input terminals, and secure it with screws with the tightening torque of 1.5 to 1.8 N-m.





(4) Install the terminal cover.

(5) Tighten the cable gland to secure the harness.

2. Connecting the Optical Fiber

This section explains the method of connecting the optical fiber on the laser beam output unit side.

⚠ WARNING

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

⇒ Do not disconnect the optical fiber on the laser beam input unit side. When disconnecting it, contact us for information.

⇒ The work environment with clean room class 10000 or less is required for the optical fiber connection (including the output unit side). If you are not in the clean room environment, prepare a simplified clean booth. Please contact us for details.

Precautions during Operation

⇒ During operation, wear fingerstalls or gloves.

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

Bending radius	Min. 150 mm
Coil radius	Min. 200 mm
Tensile force	Max. 50 N
Torque (torsion)	Max. 0.5 Nm
Torsion	Max. 90° per meter

⇒ Do not tighten the connector section of output unit too firmly; otherwise the incident laser beam may be dislocated. Turn the connector section by hand without using a tool.

Item required

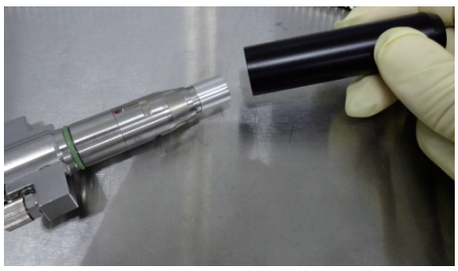
Fingerstalls or gloves, lens cleaning paper, and isopropanol

1 Cleaning the End Face of the Optical Fiber

(1) Remove the cap at the end of the optical fiber and check the end face of the optical fiber.

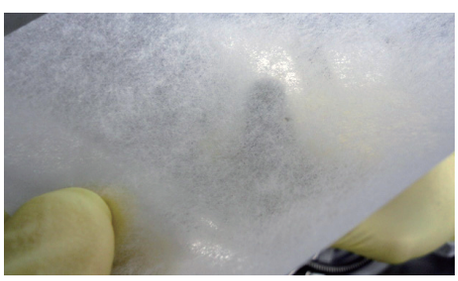
⇒ If it is not stained or dust is not attached, proceed to Step **2**.

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

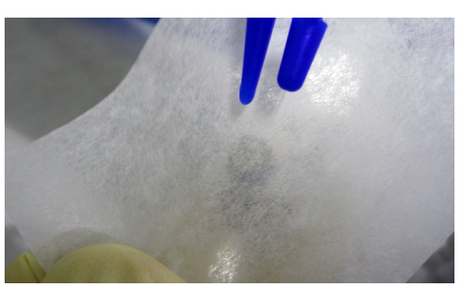


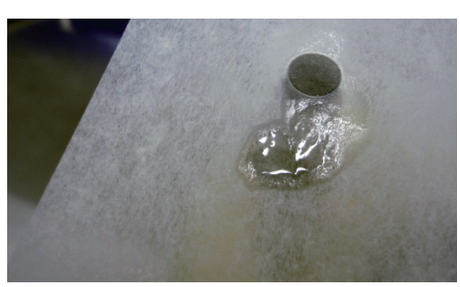
(2) Remove the protective cap at the end of the optical fiber.

(3) Place the cleaning paper on the end of the quartz block.



(4) Place a drop of isopropanol in the quartz block area over the cleaning paper. Wipe the quartz block by pulling the cleaning paper across it.



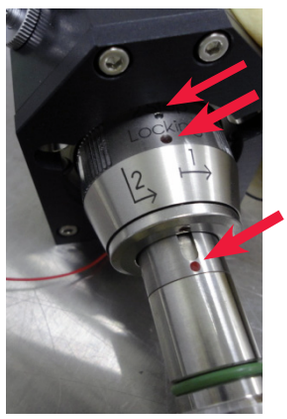
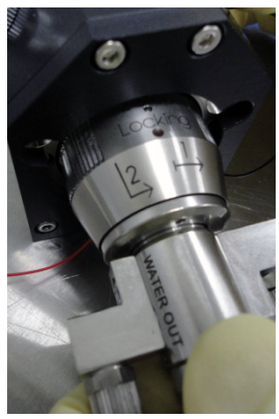


(5) Check that there is no stain, dust and streak on the end of the quartz block and return the protective cap.

2 Connecting the Optical Fiber

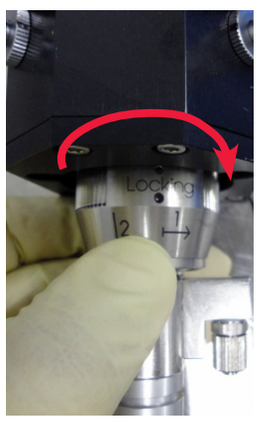
(1) Insert the optical fiber so that a red dot on the optical fiber is in line with the two red dots on the connector section.

⇒ Take care not to fall the O-ring.

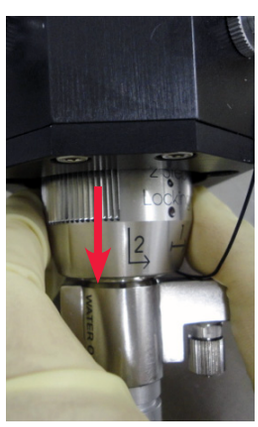
(2) Turn the connector section about 37° in the direction of the arrow 1 indicated on it.

⇒ Turn the connector section by hand without using a tool until it clicks into place.



(3) Pull out the connector section about 2 mm and turn it in the direction of the arrow 2.

⇒ Fix the connector section at the position where it is no longer turned by hand.




3. Removing the Laser Controller

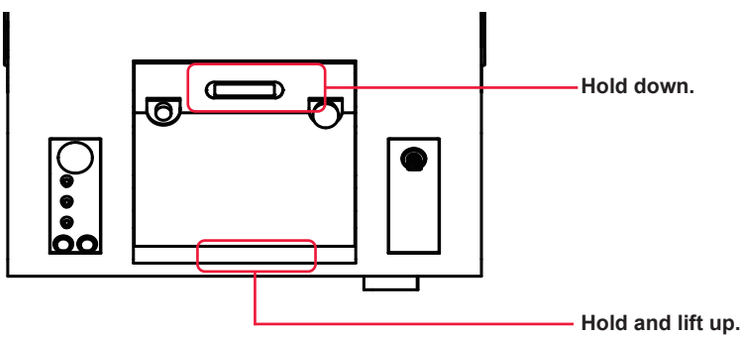
For using the laser welder in the status where the laser controller is separated from the main unit, remove the laser controller from the main unit.

⚠ CAUTION

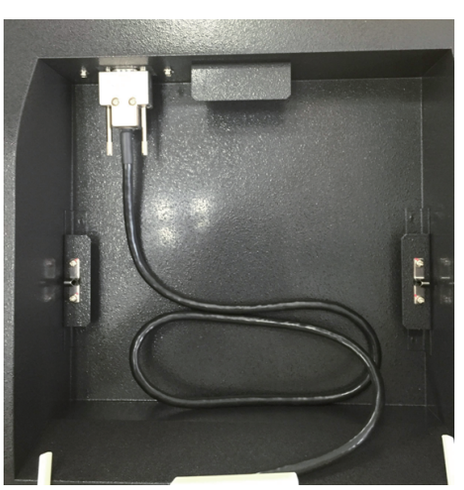
Be sure to turn OFF the power supply before removing the laser controller.

Operating Procedure

(1) Hold the handle located in front of the laser controller and lift it up with holding down its rear portion to remove it.



⇒ When putting the laser controller back in place, wind the cable. Be careful not to stuck the cable, your fingers or hands in the housing.



4. Connecting the External Communication Conversion Adapter (Option)

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

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

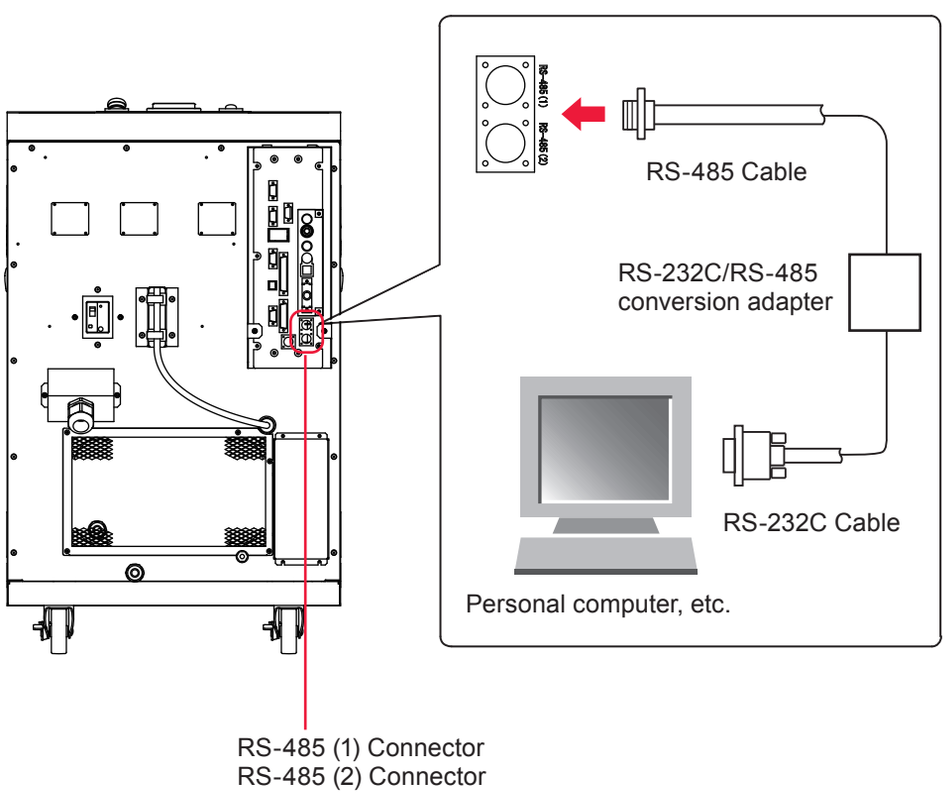
Item required

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

Operating Procedure

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

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



Operating Part

Operating Part

Chapter 1

Control Method, and Start and Stop

1. Control Method

This section explains the control method for the laser.

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

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

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

Switching the Control Method

Control by Laser Controller (PANEL CONTROL)

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

⇒ To switch the control by external input/output signals over to the control by laser controller, turn OFF pin No.25 (control switching) of the EXT. I/O (1) connector.

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

⇒ If the CONTROL keyswitch of the main unit is turned OFF even if another control method is used, it is reset to the control by laser controller. When the CONTROL keyswitch is turned on again, the control method is switched to the control from the laser controller if the external communication control is used, or the control method is set to the control by external input/output signals if the control by external input/output signals is used and Pin No.25 (control switching) of the EXT. I/O (1) connector is ON (closed circuit).

Control by External Input/Output Signals (EXTERNAL CONTROL)

When the PLC or the like is connected to the main unit and pin No.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 processing.

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

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

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

How to Stop the Laser

Operating Procedure

(1) Turn OFF the LD.

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

(3) Turn OFF the MAIN POWER switch.

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

Operating Part

Chapter 2

Various Settings

1. Screen Configuration

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

Transition of Screens

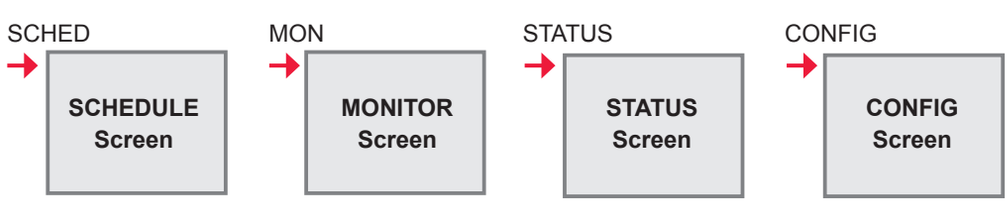
This section explains how to see the SCHEDULE, MONITOR, STATUS, and CONFIG screens to set a processing schedule.

There are 5 types of basic screen as shown below which are displayed on the liquid crystal display of the laser controller. Each screen is selected to perform each setting by the button arranged on the right side of each screen.

Each time the screen selecting button is pressed, each of the SCHEDULE screen, MONITOR screen, STATUS screen, and CONFIG screen appears in sequence from the top.

When laser light is output, the MONITOR screen is automatically displayed so that the output energy can be checked.

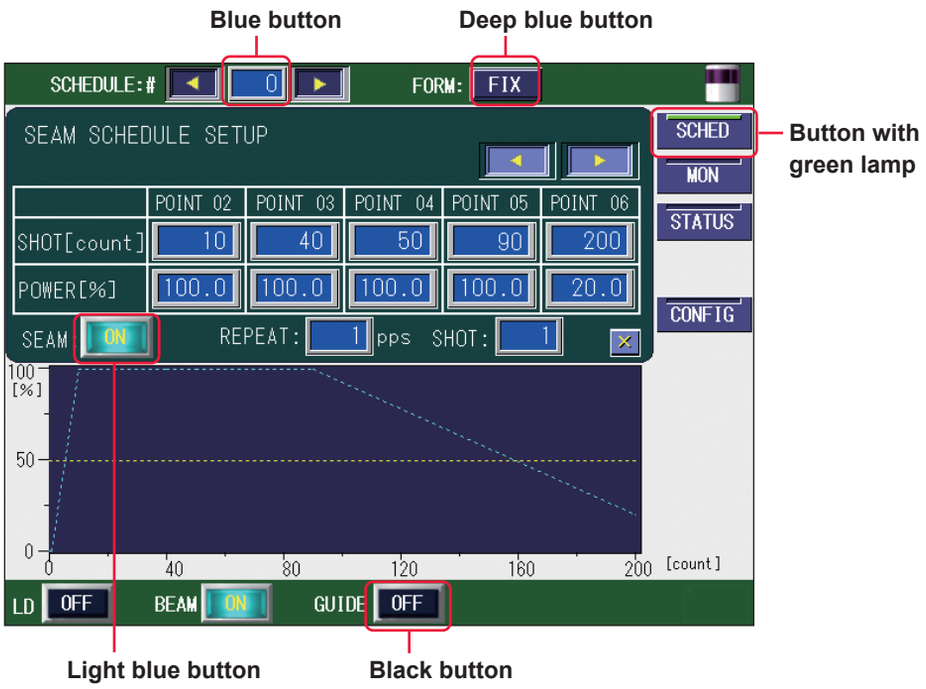
When each of the screen selecting buttons is pressed:



How to Use the Touch Panel

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

The colors of the setting buttons displayed on the basic screens are deep blue, black, light blue, and blue. There is also the button with the green lamp.

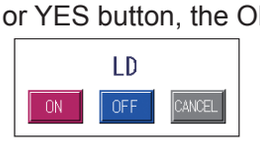


FIX (deep blue) / OFF (black) / ON (light blue) / SCHED (w/ green lamp) button

The deep blue buttons are used to change a screen or display a setting window. The black and light blue buttons are used to change ON/OFF setting.

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

Regarding the ON and OFF buttons, OFF lights out and ON lights up (blinks). When the OFF button is pressed, a check window is displayed. If OFF is switched over to ON by pressing the ON or YES button, the ON setting lights up (blinks).

Example: OFF → 

When pressing ON → ON (blinking)

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

100.0 (blue) button

The blue button is used to set a numeric value.

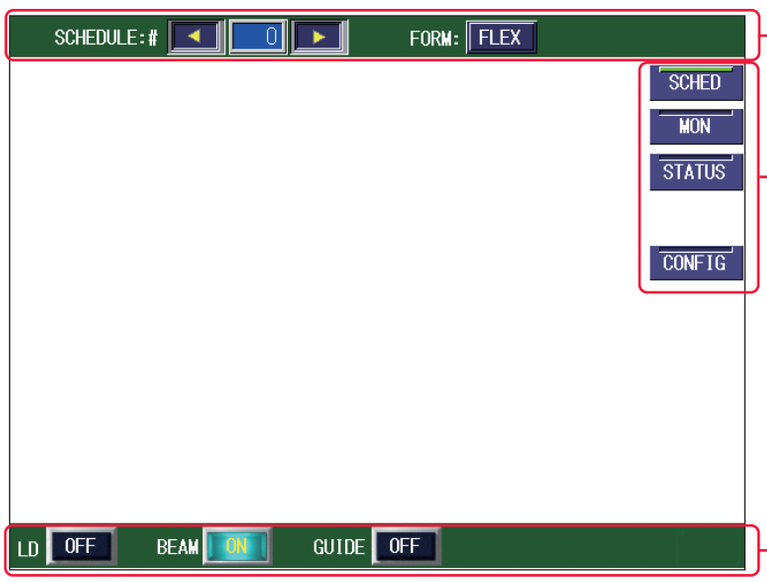
When this button is pressed, a numeric keypad is displayed and then a numeric value can be input. The input value is definitively set by pressing the ENT key.

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 the 4 types of basic screen.



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

: Settable item

SCHEDULE	Sets the SCHEDULE No. of laser light. Output conditions can be registered by setting the 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. You can also carry out the setting by pressing "<" and ">" buttons on right and left sides. The set schedule number is displayed on the button.
FORM	Sets the waveform creating method. When this button is pressed, a window to select "FIX" (fixed waveform), "FLEX" (flexible waveform of pulse oscillation) or "CW" (flexible waveform of CW (continuous) oscillation) is displayed. Select a creating method by pressing an optional button. The set method (FIX, FLEX or CW) is displayed at the button.
LD	Sets the LD to ON/OFF. When this button is pressed, a window to select ON/OFF is displayed. At ON, the LD comes on. At OFF, the LD does not come on and no laser light is output. The set value (ON or OFF) is displayed at the button.
BEAM	Always turned ON since the BEAM1 is always selected.
GUIDE	Sets the guide light output to ON/OFF. When the button is pressed, a window to select ON/OFF is displayed. At ON, guide light is output. At OFF, no guide light is output. The selected result (ON or OFF) is displayed at the button.

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.
MON	When this button is pressed, the MONITOR screen appears. Select this button to check the measured value of laser light.
STATUS	When this button is pressed, the STATUS screen appears. Select this button to check the laser equipment control method or check the operation log and version.
CONFIG	When this button is pressed, the CONFIG screen appears. Select this button to change various settings. On the CONFIG screen, "SCHEDULE" and "FORM" setting buttons are not displayed at the upper part of the screen.

2. Checking the Equipment Status

STATUS Screen

On the STATUS screen, the laser control method, the laser light sharing specification, and the total number of laser light outputs can be checked. In addition, the error log, event log, and software version can be checked.

How to see the displayed items : Settable item

CONTROL DEVICE	Displays the used laser control method. EXTERNAL CONTROL (external control): Control is exerted by the PLC connected to the EXT. I/O connector. PANEL CONTROL (internal control): Control is exerted by laser controller. RS-485 CONTROL (external communication control): Control is exerted by the personal computer connected to the RS-485 (1) or RS-485 (2) connector.
DELIVERY SYSTEM	Displays the laser light sharing method.
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). Pressing the RESET button resets the value to 0.
LD WORK TIME	Displays the LD total time.
FLASH WORK TIME	Displays the laser output time.
Laser Unit Info.	Displays the temperature (CABINET TEMP.) and humidity (CABINET HUM.) inside of the laser unit, and installation environment temperature of the laser main unit (SURROUND TEMP.).
Ext. I/O	Displays the TERMINAL MONITOR screen. Then, the external input/output monitor is displayed.
ERROR LOG	Displays the ERROR LOG screen. Then, the error history is displayed.
EVENT LOG	Displays the EVENT LOG screen. Then, the event history is displayed.

VERSION	Displays the SOFTWARE VERSION screen. Then, the version of each software is displayed.

⇒ For the common items in the upper/lower part of the screen, refer to page 57.

Setting the Output Status

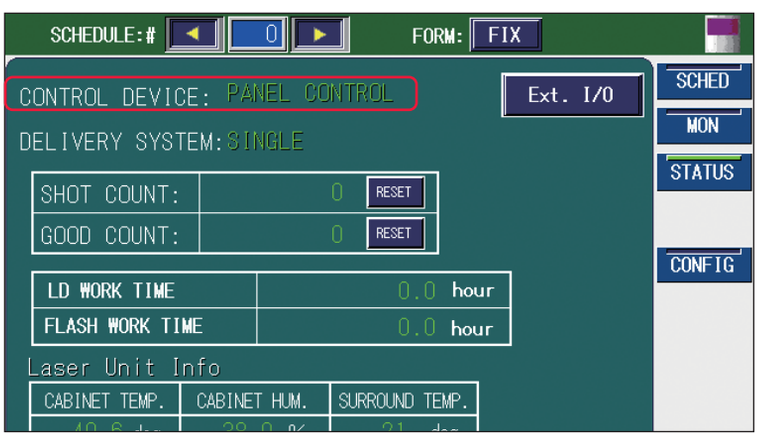
In the following, the method of setting the STATUS screen is explained.

Checking the Control Method

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

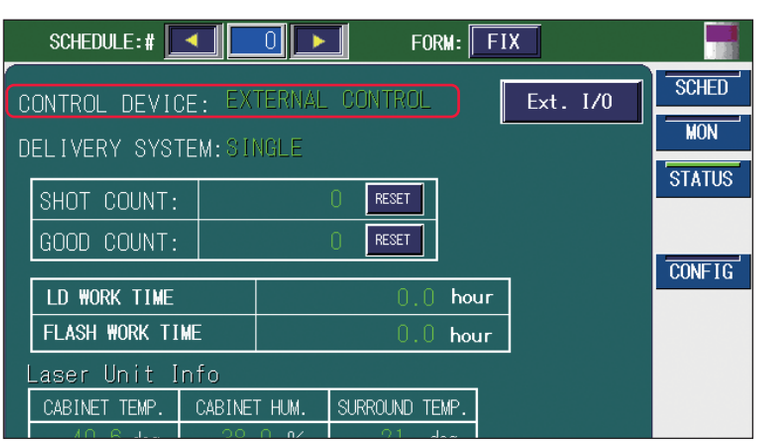
Control by Laser Controller (PANEL CONTROL)

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



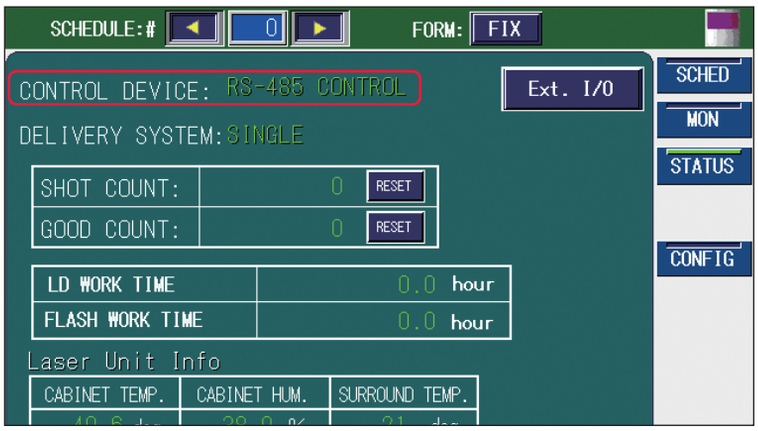
Control by External Input Signal (EXTERNAL CONTROL)

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



Control by External Communication Control (RS-485 CONTROL)

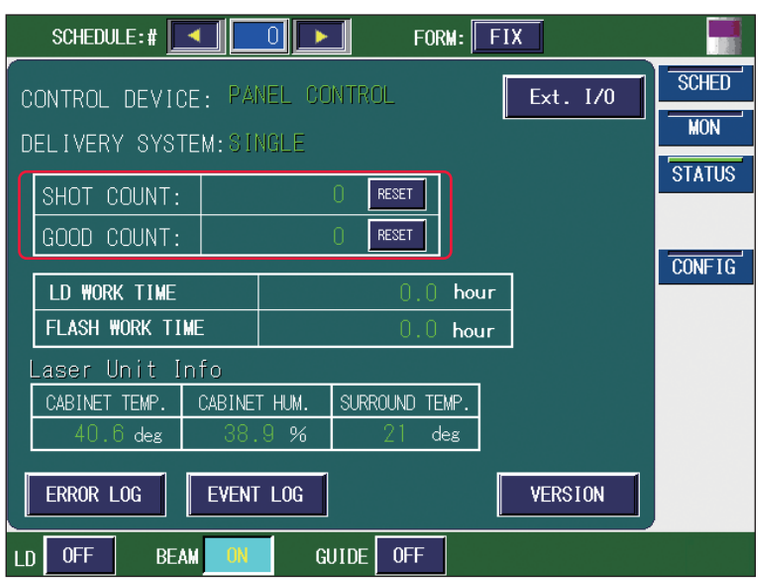
When a command to set a control method is sent from the personal computer connected to the main unit, external communication control is selected and "RS-485 CONTROL" is displayed in "CONTROL DEVICE" on the STATUS screen.



Resetting the Number of Laser Light Outputs

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

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

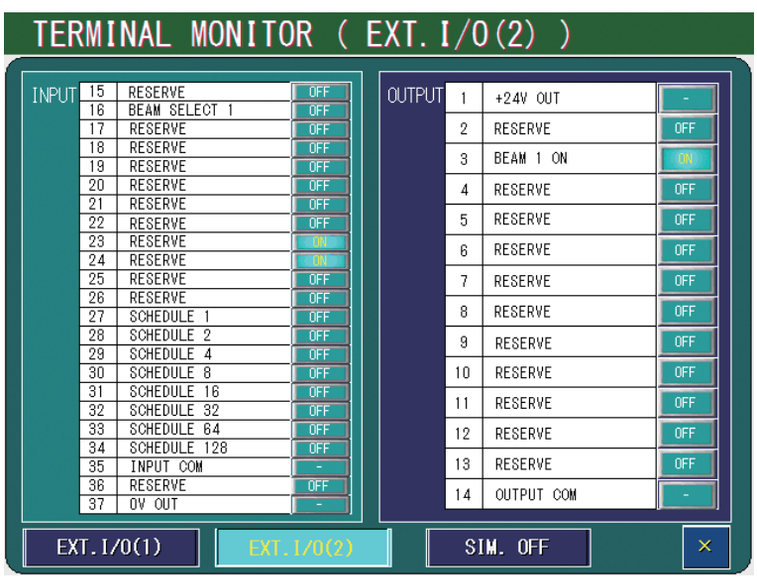


TERMINAL MONITOR Screen

When the Ext.I/O button is pressed on the STATUS screen, the TERMINAL MONITOR screen appears. On this screen, the external input/output is monitored.

EXT. I/O (1)

EXT. I/O (2)



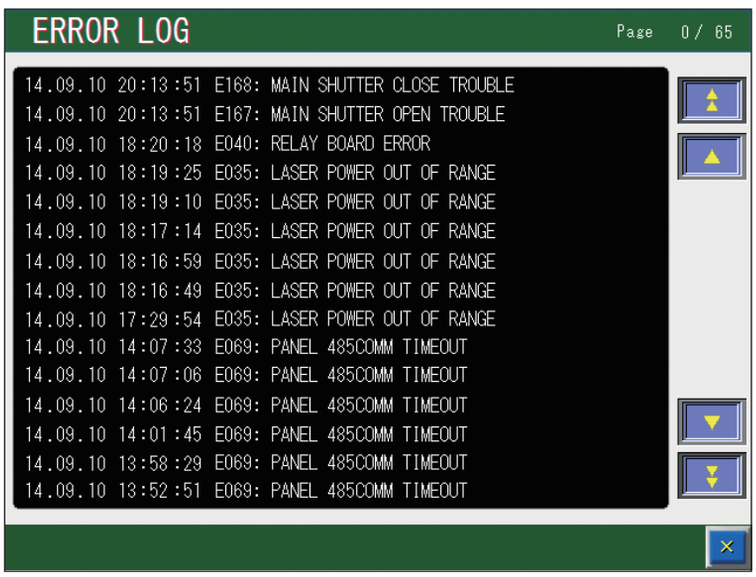
How to see the displayed items

: Settable item

INPUT	Displays the current status of external inputs.
OUTPUT	Displays the current status of external outputs.
EXT.I/O (1)	Moves to the EXT. I/O (1) screen.
EXT.I/O (2)	Moves to the EXT. I/O (2) screen.
SIM.	Sets the external output simulation mode to ON/OFF. This can be turned ON only at PANEL CONTROL.
X	Returns to the STATUS screen. When the SIM. is ON, this cannot be changed.

ERROR LOG Screen

When the ERROR LOG button is pressed on the STATUS screen, the ERROR LOG screen appears. On this screen, up to a thousand error histories are displayed in chronological order. When the number of histories exceeds a thousand, the histories beginning with the chronologically oldest history are overwritten.



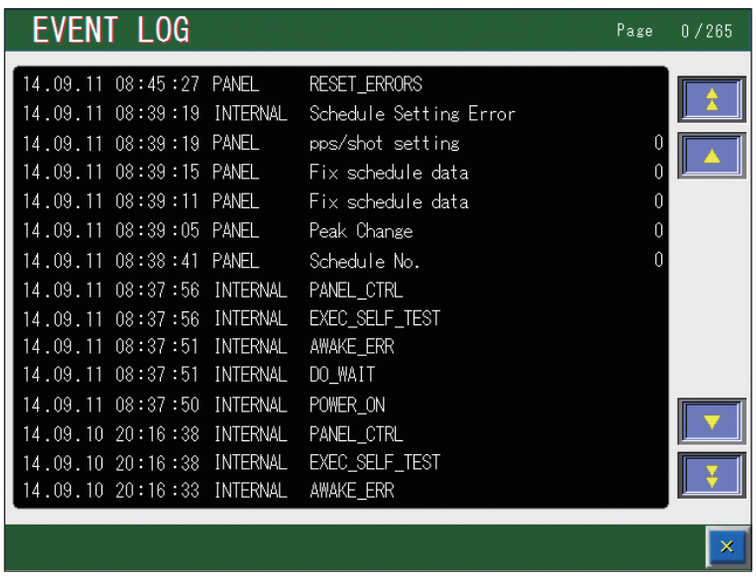
How to see the displayed items

: 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.
Page	Displays currently-displayed page number / total number of pages.
▲ ▼	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.
X	Returns to the STATUS screen.

EVENT LOG Screen

When the EVENT LOG button is pressed on the STATUS screen, the EVENT LOG screen appears. On this screen, up to four thousand operation histories are displayed in chronological order. When the number of histories exceeds four thousand, the histories beginning with the chronologically oldest history are overwritten.



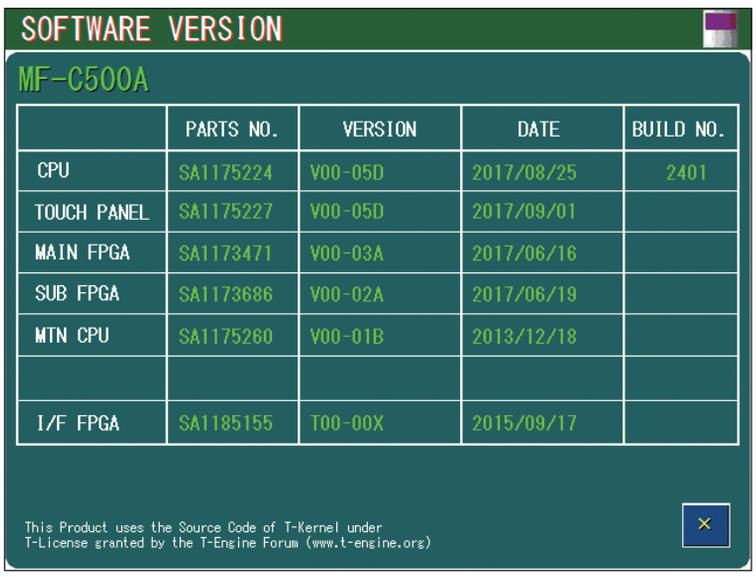
How to see the displayed items

: Settable item

--.--.--	Displays the date when the event occurred.
--:--:--	Displays the time when the event occurred.
Input source	Displays the input source of instruction which causes the event.
Event contents	Displays the contents of equipment operation.
Page	Displays currently-displayed page number / total number of pages.
▲ ▼	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.
X	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.



How to see the displayed items

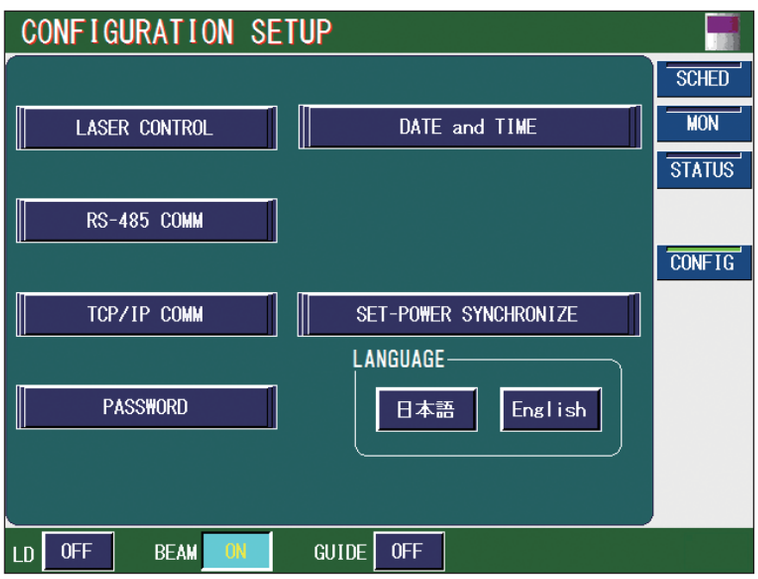
: Settable item

Unit name	Displays the name of unit which uses the software.
PARTS NO.	Displays the parts number of software.
VERSION	Displays the software version.
DATE	Displays the updated date of software.
BUILD NO.	Numbers used for internal management at the time of manufacturing.
X	Returns to the STATUS screen.

3. Changing the Equipment Settings

CONFIG Screen

On the CONFIG screen, the settings for equipment can be configured. The communication settings, password, and displayed language can be changed while the equipment is running.

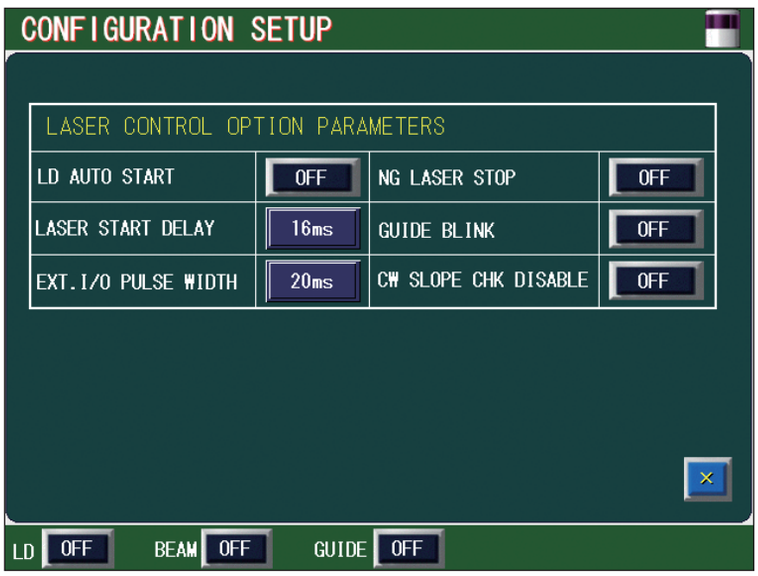


How to see the displayed items

: Settable item

LASER CONTROL	Displays the setting screen for laser control.
RS-485 COMM	Displays the setting screen for RS-485 communication.
TCP/IP COMM	Displays the setting screen for TCP/IP communication.
PASSWORD	Displays the password setting screen.
DATE and TIME	Displays the setting screen for date and time.
SET-POWER SYNCHRONIZE	Displayed when the set power synchronize function is enabled. When this button is pressed, the setting screen for the set power synchronize setting displayed.
LANGUAGE 日本語 **English**	Switches the language displayed on the screen (Japanese or English). The screen appears with the language displayed at the previous completion. The initial setting is English. Switches to the Japanese display. Switches to the English display.

LASER CONTROL OPTION PARAMETERS

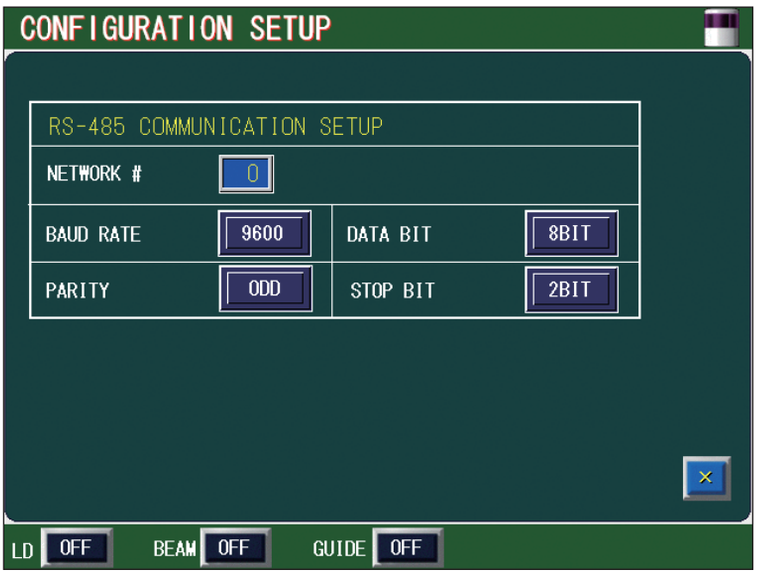


How to see the displayed items

: Settable item

LD AUTO START	Sets the LD to ON or OFF. At ON, a LD becomes ON at AUTO START and the screen is displayed in the status of LD: ON.
NG LASER STOP	At ON, the LD is turned OFF when error No.035/LASER POWER OUT OF RANGE occurs and a laser stops.
LASER START DELAY	Sets the acceptance time for laser start signal and schedule signal from 0.1 ms, 1 ms, 2 ms, 4 ms, 8 ms, or 16 ms.
GUIDE BLINK	Sets the guide light blinking status or continuous lighting to ON or OFF.
EXT-IO PULSE WIDTH	Sets the output time for end signal and monitor normal/trouble signal from 20 ms, 30 ms, or 40 ms.
CW SLOPE CHK DISABLE	Sets the slope portion to be monitored or not in the CW envelope monitoring (monitoring laser in range). At ON, the slope portion is not monitored.
X	Returns to the CONFIG screen.

RS-485 COMMUNICATION SETUP

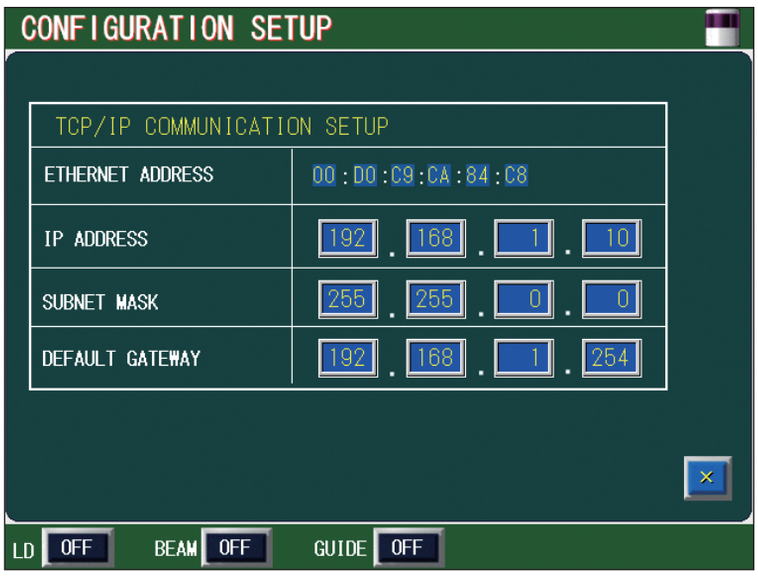


How to see the displayed items

: Settable item

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 mode from NONE, EVEN or ODD.
STOP BIT	Sets the stop bit from 2bit or 1bit.
X	Returns to the CONFIG screen.

TCP/IP COMMUNICATION SETUP



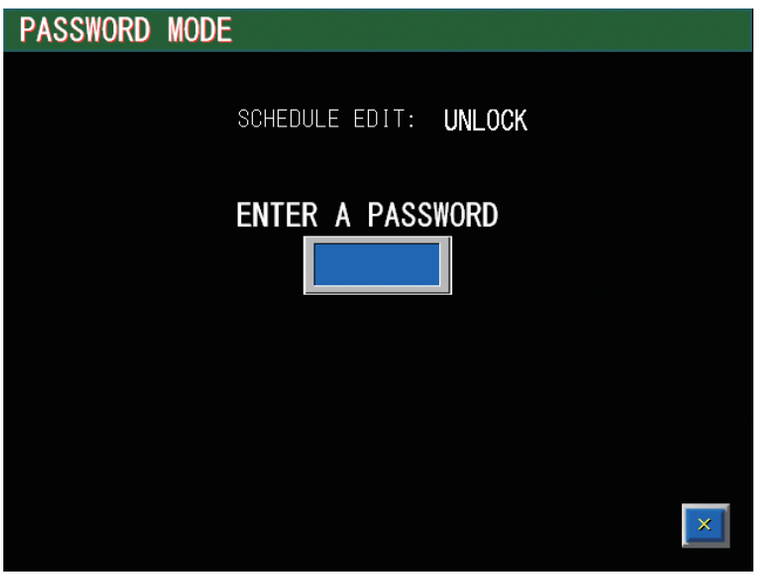
How to see the displayed items

: Settable item

ETHERNET ADDRESS	Displays the Ethernet address.
IP ADDRESS	Sets the IP address.
SUBNET MASK	Sets the subnet mask.
DEFAULT GATEWAY	Sets the default gateway address.
X	Returns to the CONFIG screen.

PASSWORD Screen

On the PASSWORD screen, a password is set to protect the set processing schedule. When the password is set and validated, set values are protected and cannot be changed by any person other than the supervisor.



How to see the displayed items : Settable item

SCHEDULE EDIT	Displays the protection status, UNLOCK or LOCK. At UNLOCK, schedules can be changed. At LOCK, it is impossible to change schedules.
ENTER A PASSWORD	When the input box is pressed, the keyboard is displayed and a password can be entered.
X	Returns to the CONFIG screen.

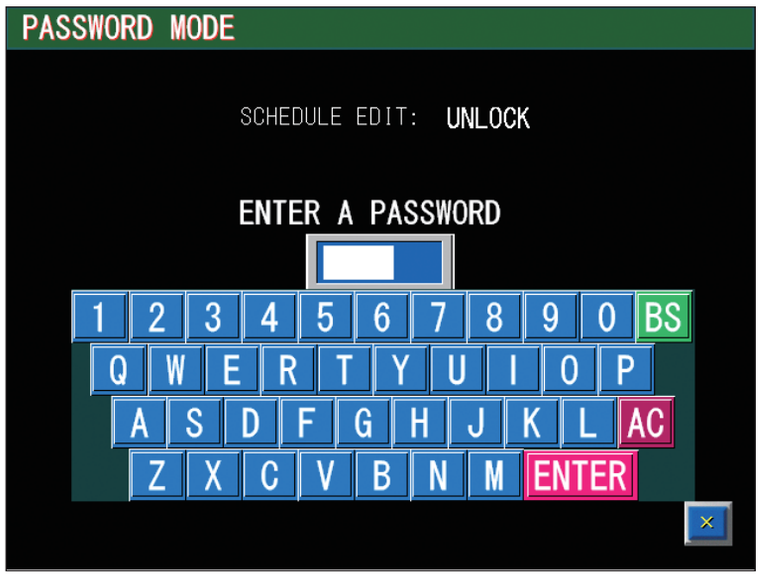
Protecting Set Values

The method of protecting set values by setting the password is explained below.

1 Entering the Present Password

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

(2) Press the password input box.
The keyboard appears.

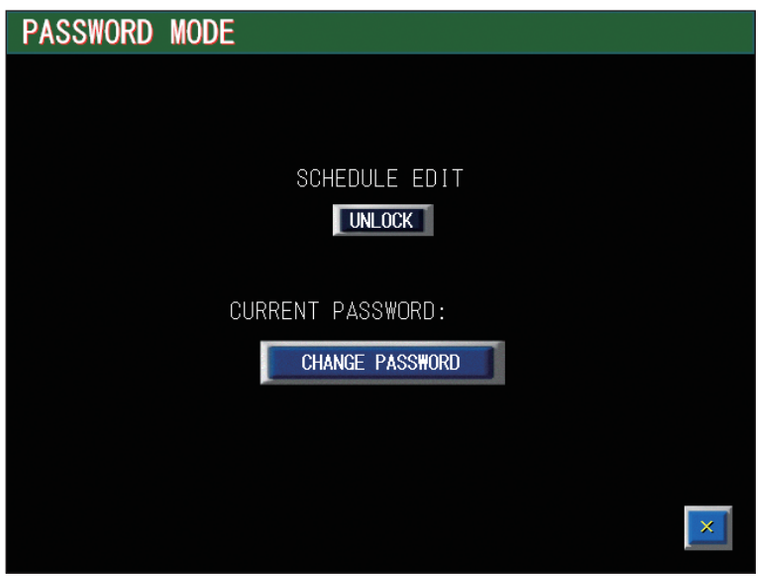


(3) Enter the set password into the password input box.
Press the password by pressing keyboard keys on the screen. The AC key deletes all the entered characters. The BS key deletes a character in front of the cursor one by one. The ENTER key is used to check the entered password for correctness.

⇒ At delivery, a password is not set. Press the ENTER key without inputting characters. Then, set a password.

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

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



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

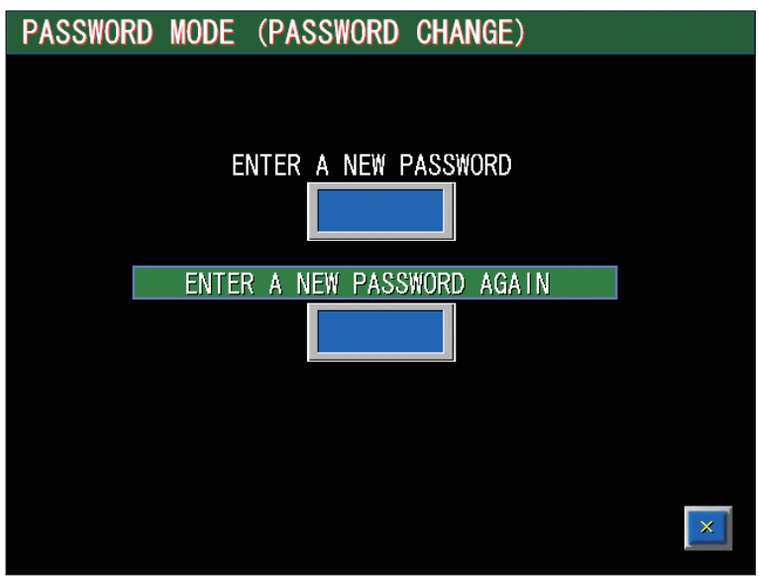
2 Validating the Password

(1) Press the “SCHEDULE EDIT” button.
When “LOCK” is selected on the window, the display on the button changes to “LOCK.” The password is validated and a part of setting items is protected, disabling a change.

⇒ When “UNLOCK” is selected, the display changes to “UNLOCK” and the protection is cancelled, enabling a change.

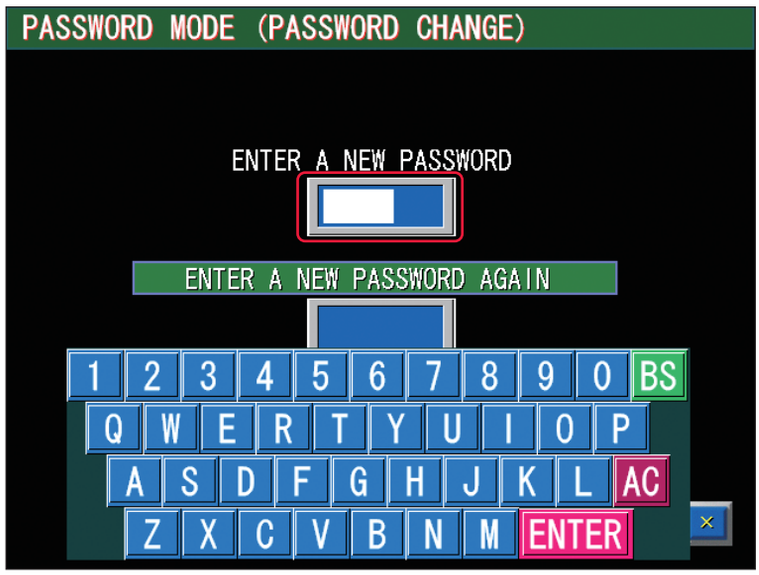
3 Setting a New Password

(1) Press the "CHANGE PASSWORD" button.
The password change screen appears.



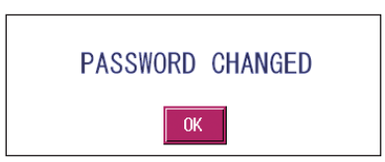
(2) Press the password input box (upper portion).
The keyboard appears.

(3) Enter a new password into the password input box (upper portion).
Enter 4 alphanumerical characters.



(4) Press the ENTER key on the keyboard.
A confirmation screen appears.
⇒ Unless 4 alphanumerical characters are not entered, an error message appears. Enter the password once again.

(5) Enter the same password into the password re-input box (lower portion) and press the ENTER key.
The set password is registered and PASSWORD CHANGED appears.
⇒ Unless the two passwords coincide, the WRONG PASSWORD screen appears. Press the OK button and enter the same password.



(6) Press the OK button.
The PASSWORD screen appears.
⇒ The display of CURRENT PASSWORD changes to the changed password.

The items that can be protected are as follows.

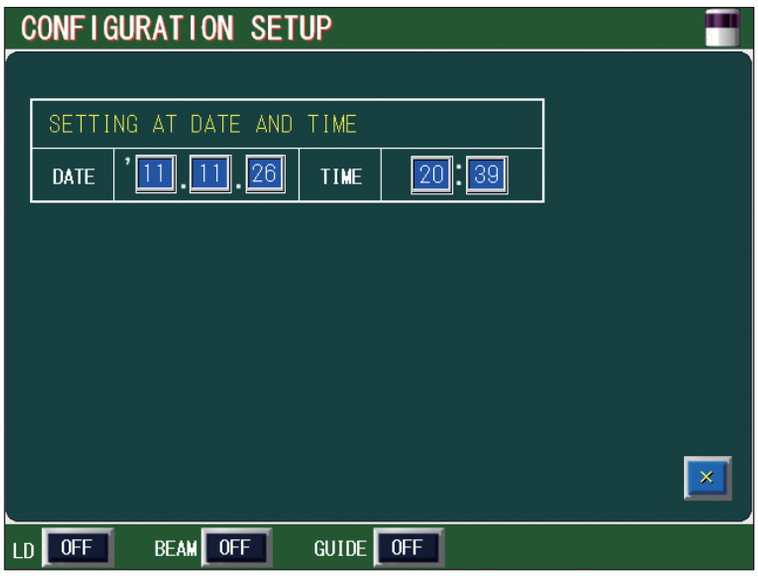
Display Screen	Item
SCHEDULE Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX/CW waveform switching) SET POWER (Laser output set value) RESOL (Input resolution of output time) ↑SLOPE (Time for up-sloping to FLASH1) FLASH1 (Output time and output value of the first laser) COOL1 (Non-laser output time to be inserted between FLASH1 and FLASH2) FLASH2 (Output time and output value of the second laser) COOL2 (Non-laser output time to be inserted between FLASH2 and FLASH3) FLASH3 (Output time and output value of the third laser)

Display Screen	Item
SCHEDULE Screen	↓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) Fn (Schedule editorial assistant function) MODULATION screen: DUTY (Duty ratio) MODULATION (Modulation degree) FREQUENCY (Frequency) MODU (Modulation function ON/OFF) WAVE (Modulation waveform type) SEAM screen: SHOT (Laser light output count of each No. of POINT 01 to 20) POWER (Laser output value % of each No. of POINT 01 to 20) SEAM (Fade function ON/OFF)
MONITOR Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX/CW waveform switching) HIGH (Upper limit value of laser energy to be monitored) LOW (Lower limit value of laser energy to be monitored)
STATUS Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX/CW waveform switching) SHOT COUNT (Resetting the total number of laser light outputs, SHOT COUNT) GOOD COUNT (Resetting the appropriate number of laser light outputs, GOOD COUNT)
CONFIG Screen	LASER CONTROL (Laser control setting) RS-485 COMM (RS-485 communication setting) TCP/IP COMM (TCP/IP communication setting) DATE and TIME (Date and time setting) LANGUAGE 日本語 (Language switching) English (Language switching)

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 set "SCHEDULE EDIT" to UNLOCK.

SETTING AT DATE AND TIME

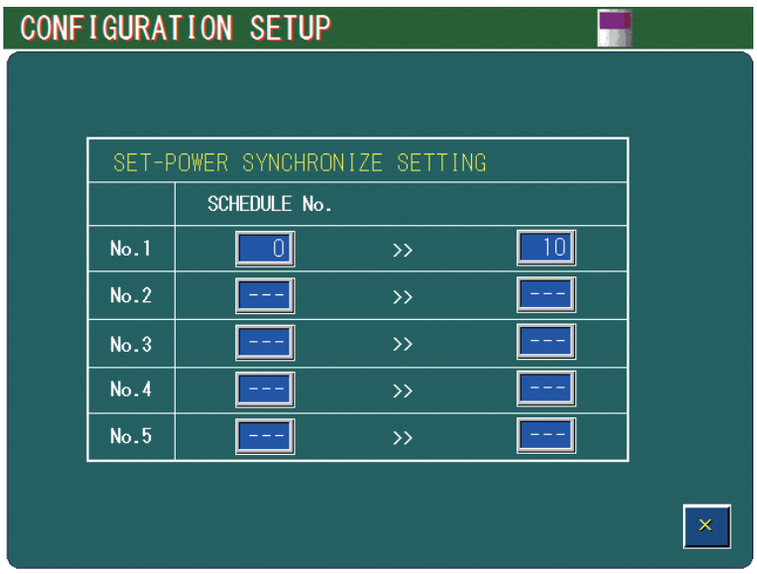


How to see the displayed items

: Settable item

DATE	Sets year (last two digits), month and day.
TIME	Sets time in a 24-hour period.
X	Returns to the CONFIG screen.

SET-POWER SYNCHRONIZE SETTING



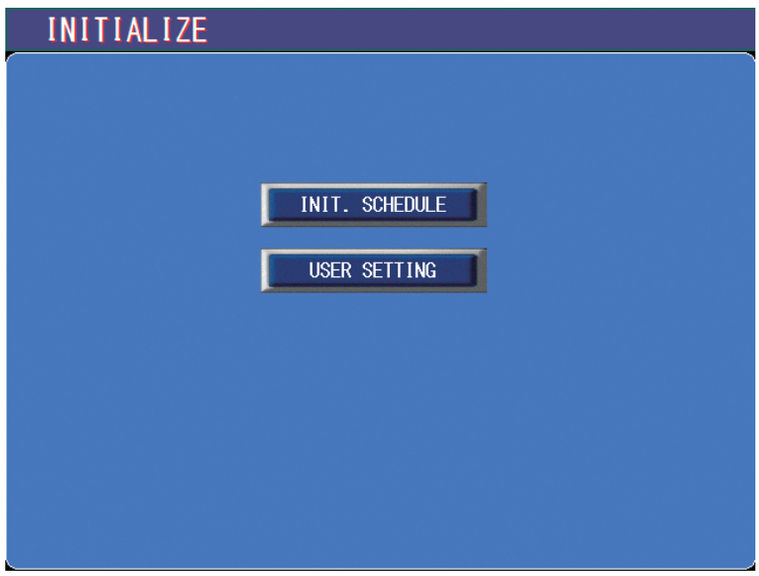
How to see the displayed items

: Settable item

SCHEDULE No.	Up to five sets of schedules to synchronize can be set in No.1 to No.5. In an example of the screen above, laser output set values of SCHEDULEs #0 and #10 are synchronized. When the laser output set value of #0 is changed, that of #10 is also changed into the same value. The laser output set value cannot be changed if the setting error will occur in the synchronous schedule. Also, [LINKED: #] is displayed at the upper right portion of the SCHEDULE screen of the set SCHEDULE number to recognize the synchronous target.
X	Returns to the CONFIG screen.

INITIALIZE Screen

On the INITIALIZE screen, the settings can be initialized, and the screen for setting such as the error output and the LD deterioration check is displayed.

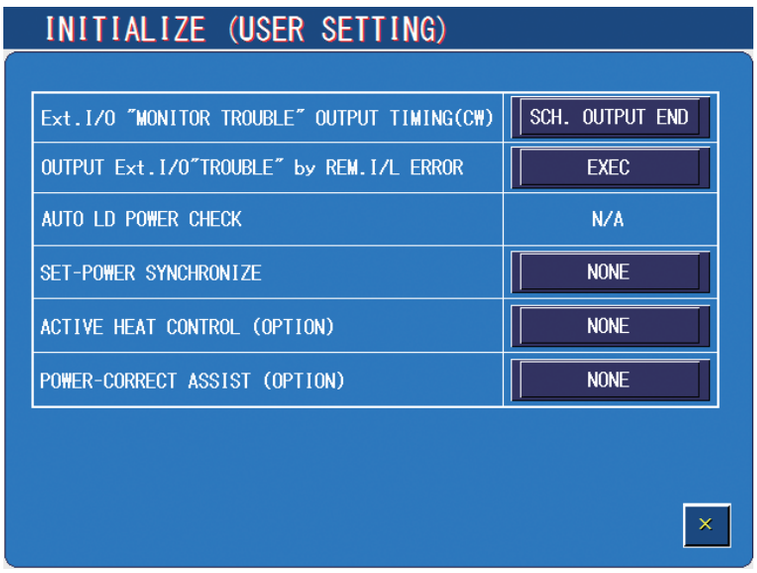


How to see the displayed items

: Settable item

INIT. SCHEDULE	Displays the confirmation window. Press Yes to initialize the set values.
USER SETTING	Displays the USER SETTING screen.

USER SETTING



How to see the displayed items

: Settable item

Ext.I/O "MONITOR TROUBLE" OUTPUT TIMING (CW)	Sets the output timing of the monitor upper/lower limit check error in the CW waveform. SCH. OUTPUT END: Output when output ends (default) MON. TRB. DETECT: Output when the error occurs (The normal output signal is turned ON during output until the error occurs.)
OUTPUT Ext.I/O "TROUBLE" by REM.I/L ERROR	Sets whether to output the error by the external input/output when error No.022/EXTERNAL INTERLOCK OPENED occurs. EXEC: Output (default) NONE: Not output
AUTO LD POWER CHECK	Not used.
SET-POWER SYNCHRONIZE	Sets whether to use the set power synchronize setting. Functions and displays related to the set power synchronize setting are valid only when this is set to USE. NONE: Not use (default) USE: Use
ACTIVE HEAT CONTROL (OPTION)	Not used. Do not change the setting.
POWER-CORRECT ASSIST (OPTION)	Sets whether to use the laser output compensation function. NONE: Not use (default) USE: Use
X	Returns to the INITIALIZE screen.

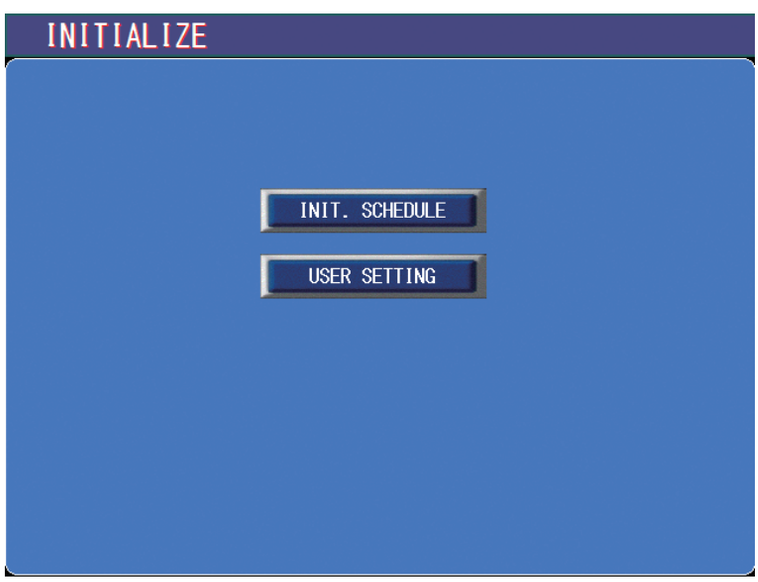
Displaying the INITIALIZE Screen

(1) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch. Power is supplied and the POWER lamp comes on.

(2) While the KEY SWITCH CHECK screen is displayed, press the “INITIALIZE” button, pressing the right button (red portion in the figure below) of the laser controller.

⇒ Unless the CONTROL keyswitch is OFF, the KEY SWITCH CHECK screen does not appear.

The INITIALIZE screen appears.



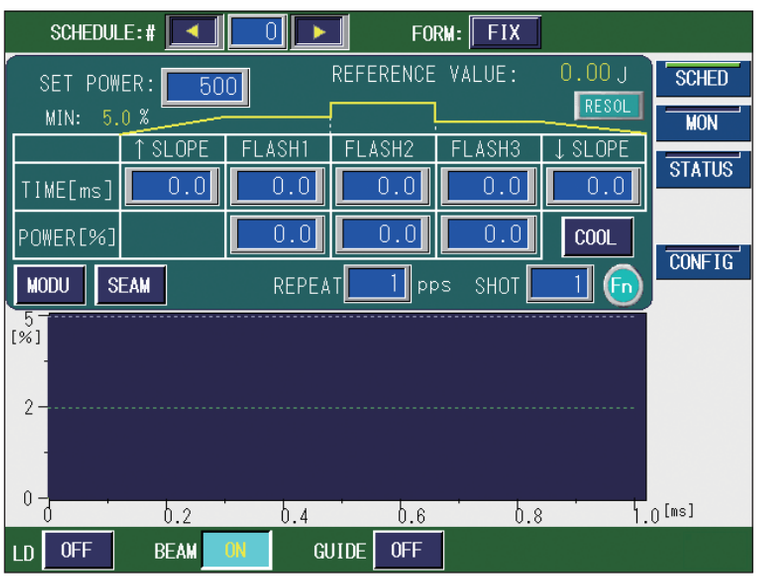
4. Setting the Laser Light Output Schedule

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

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

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

SCHEDULE Screen (Fixed Waveform (FIX))



How to see the displayed items : Settable item

SET POWER	Sets the laser output. Regarding "FLASH1" to "FLASH3", set the ratio (%) supposing that the set value is the reference value (100%). Refer to “REFERENCE VALUE” for the forecast value of laser output. ***<Note>*** The settable value of laser output differs depending on the model. MF-C300A-SF: 30 to 300 / MF-C500A-SF: 50 to 500
MIN	The ratio of the preliminary oscillation output for "SET POWER" is displayed. For the preliminary oscillation, see page 82.
↑SLOPE	Sets the up-sloping (the laser output becomes gradually stronger) time to "FLASH1." After setting "FLASH1", set this time in the range of ↑SLOPE ≤ FLASH1. ***<Note>*** The setting and the slope may be different in a low output range of 0 to 50 W. Check the waveform output on the monitor. To make more detailed settings, use the FLEX mode.

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 "RESOL" is 0.1 ms: 0.0 to 500.0 ms When "RESOL" is 0.05 ms: 0.00 to 99.95 ms (0 or 5 at the hundredths place) Laser output value (POWER [%]): 0.0 to 200% The time of ↑SLOPE is included in the output time of FLASH1. ***<Note>*** To stabilize the laser oscillation, the preliminary oscillation is performed (See the next page).
FLASH2	Sets the laser output time TIME [ms] and laser output value POWER [%] of the second laser in the same range as that for the first laser.
FLASH3	Sets the laser output time TIME [ms] and laser output value POWER [%] of the third laser in the same range as that for the first laser. The time of ↓SLOPE is included in the output time of FLASH3.
↓SLOPE	Sets the down-sloping (the laser output becomes gradually weaker) for the last FLASH. Sets this time in the range of ↓SLOPE ≤ FLASH1, FLASH2, FLASH3. ***<Note>*** The setting and the slope may be different in a low output range of 0 to 50 W. Check the waveform output on the monitor. To make more detailed settings, use the FLEX mode.
REFERENCE VALUE	The forecast value of laser output energy (J) based on the set laser output schedules is displayed. ***<Note>*** There is a little difference between the forecast value of laser output energy and the measured value (actually measured value) depending on the optical and electrical characteristics. Use the forecast value of laser output energy as reference.
RESOL	When this button is pressed, the selected setting resolution can be set from 0.01 ms or 0.05 ms. When the setting resolution is changed, the currently-selected schedule is cleared and the initial value is set.
COOL	Sets the COOL1/COOL2. COOL1: Sets a value other than 0.0 ms to insert the non-laser output time between FLASH1 and FLASH2. COOL2: Sets a value other than 0.0 ms to insert the non-laser output time between FLASH2 and FLASH3. ***<Note>*** When the COOL1/COOL2 is set, the preliminary oscillation is performed during the set time.
MODU	When this button is pressed, the modulation setting screen for the selected schedule number opens. Blinks when the modulation function is enabled. The function can be set on the MODULATION screen.
SEAM	When this button is pressed, the seam setting screen for the selected schedule number opens. Blinks when the fade function for seam processing is enabled. The function can be set on the SEAM screen.
REPEAT	Sets the number of laser light outputs per second in the range of 1 to 1000 pps (pulse per second).
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.

Fn	When this button is pressed, a window to select function is displayed and the following editorial assistant functions can be used. RESET: Initializes the currently-selected schedule. COPY: Copies the currently-selected schedule to a temporary memory buffer. PASTE: Restores data from a temporary memory buffer to the currently-selected schedule.

⇒ For the common items in the upper/lower part of the screen, refer to page 57.

<Notes>

- **The laser output value (%) setting range is 0 to 200%. However, the laser output value cannot be set exceeding the maximum value of "SET POWER" x 100%. If the laser output value is set to 100%, the value set in "SET POWER" is selected.**
- **There are limitations of the total time of the laser output time FLASH1 + COOL1 + FLASH2 + COOL2 + FLASH3 in combination with values of SET POWER and REPEAT. For details, refer to "Limitations of Schedule Setting" on page 99.**
- **Within the range of 10% of the maximum SET POWER, a constant power is output to protect the laser oscillator without reference to waveform input. For details, refer to "Limitations of Schedule Setting" on page 99.**

Preliminary Oscillation

To stabilize the laser oscillation, the minimum power of laser (15 W (MF-C300A-SF) or 25 W (MF-C500A-SF)) is output for 0.5 ms immediately before laser output. The preliminary oscillation is performed during the non-laser output time.

The non-laser output time is any of the following:

- Laser output time (ms) whose laser output value (%) is set to 0%
- Set time of COOL1/COOL2

However, during modulation and AHC control, the output lower limit is limited to the minimum output and does not become 0%.

About REPEAT settings

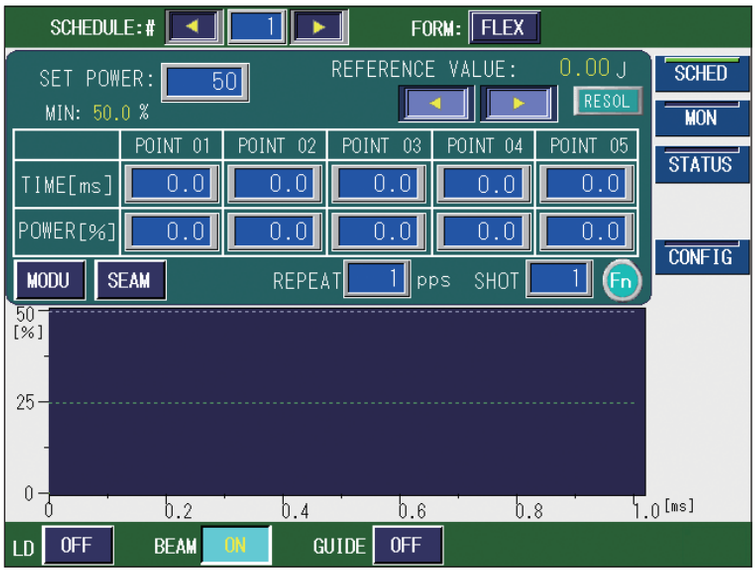
The maximum setting of REPEAT includes Preliminary Oscillation time.

[Set pulse width + Preliminary oscillation 0.5ms + Resolution time*1] xREPEAT number ≦ 1000ms

*1 The set resolution time is 0.1 ms when the resolution is 0.1 ms, and 0.05 ms when the resolution is 0.05 ms.

Example) If the resolution is 0.1ms and the REPEAT number is 1000PPS, the maximum pulse width setting is 0.4ms.

SCHEDULE Screen (Flexible Waveform (FLEX))



How to see the displayed items

: Settable item

SET POWER	Sets the laser output. Regarding “POINT 01” to “POINT 20”, set the ratio (%) supposing that the set value is the reference value (100%). Refer to “REFERENCE VALUE” for the forecast value of laser output. ***<Note>*** The settable value of laser output differs depending on the model. MF-C300A-SF: 30 to 300 / MF-C500A-SF: 50 to 500
MIN	The ratio of the preliminary oscillation output for "SET POWER" is displayed. For the preliminary oscillation, see page 82.
◄ ►	Scrolls the POINT display column of POINT 01 to POINT 20 to the right and left. When a POINT is not displayed, press this button to display it.
POINT 01 to 20	Sets the laser output time and laser output value at each point 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>*** There is a little difference between the forecast value of laser output energy and the measured value (actually measured value) depending on the optical and electrical characteristics. Use the forecast value of laser output energy as reference.
RESOL	When this button is pressed, the selected setting resolution can be set from 0.01 ms or 0.05 ms. When the setting resolution is changed, the currently-selected schedule is cleared and the initial value is set.
MODU	When this button is pressed, the modulation setting screen for the selected schedule number opens. Blinks when the modulation function is enabled. The function can be set on the MODULATION screen.
SEAM	When this button is pressed, the seam setting screen for the selected schedule number opens. Blinks when the fade function for seam processing is enabled. The function can be set on the SEAM screen.

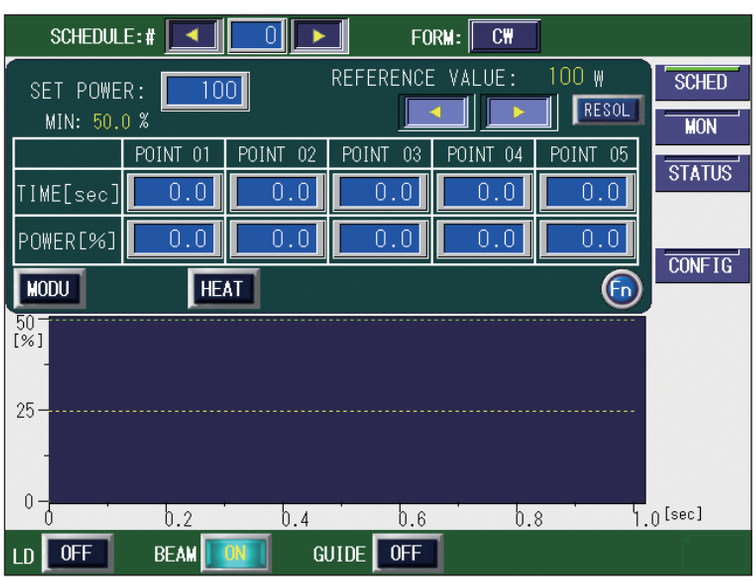
REPEAT	Sets the number of laser light outputs per second in the range of 1 to 1000 pps (pulse per second).
SHOT	Sets the number of laser outputs in the range of 1 to 9999. When the laser output count reaches the set value, the laser output is stopped. When 1 is set, a single-shot output is performed. When 9999 is set, laser light is continuously output until a laser stop signal is input.
Fn	When this button is pressed, a window to select function is displayed and the following editorial assistant functions can be used. RESET: Initializes the currently-selected schedule. COPY: Copies the currently-selected schedule to a temporary memory buffer. PASTE: Restores data from a temporary memory buffer to the currently-selected schedule.

⇒ For the common items in the upper/lower part of the screen, refer to page 57.

<Notes>

- **The laser output value (%) setting range is 0 to 200%. However, the laser output value cannot be set exceeding the maximum value of "SET POWER" x 100%. If the laser output value is set to 100%, the value set in "SET POWER" is selected.**
- **There are limitations of the total time of the laser output time POINT 01 to POINT 20 in combination with values of SET POWER and REPEAT. For details, refer to "Limitations of Schedule Setting" on page 99.**

SCHEDULE Screen (Flexible Waveform (CW))



How to see the displayed items

: Settable item

SET POWER	Sets the laser output. Regarding “POINT 01” to “POINT 20”, set the ratio (%) supposing that the set value is the reference value (100%). Refer to “REFERENCE VALUE” for the forecast value of laser output. ***<Note>*** The settable value of laser output differs depending on the model. MF-C300A-SF: 30 to 300 / MF-C500A-SF: 50 to 500
MIN	The ratio of the preliminary oscillation output for "SET POWER" is displayed. For the preliminary oscillation, see page 82.
◄ ►	Scrolls the POINT display column of POINT 01 to POINT 20 to the right and left. When a POINT is not displayed, press this button to display it.
POINT 01 to 20	Set the laser output time and laser output value at each point of "POINT 01" to "POINT 20."
REFERENCE VALUE	The forecast value of laser output (W) based on 100% POWER with the set laser output schedules is displayed. ***<Note>*** There is a little difference between the forecast value of laser output and the measured value (actually measured value) depending on the optical and electrical characteristics. Use the forecast value of laser output as reference.
RESOL	When this button is pressed, the selected setting resolution can be set from 1 s, 0.1 s, 0.01 s, or 0.001 s. When the setting resolution is changed, the currently-selected schedule is cleared and the initial value is set.
MODU	When this button is pressed, the modulation setting screen for the selected schedule number opens. Blinks when the modulation function is enabled. The function can be set on the MODULATION screen.
Fn	When this button is pressed, a window to select function is displayed and the following editorial assistant functions can be used. RESET: Initializes the currently-selected schedule. COPY: Copies the currently-selected schedule to a temporary memory buffer. PASTE: Restores data from a temporary memory buffer to the currently-selected schedule.

⇒ For the common items in the upper/lower part of the screen, refer to page 57.

Setting Laser Light Output Schedules

This section explains the how to set the SCHEDULE screen (fixed waveform (FIX)).

⇒ 256 types of output schedules can be set and registered with SCHEDULE numbers of #0 to #255. To perform laser processing, enter the registered SCHEDULE numbers and laser processing can be performed in the set output schedules.

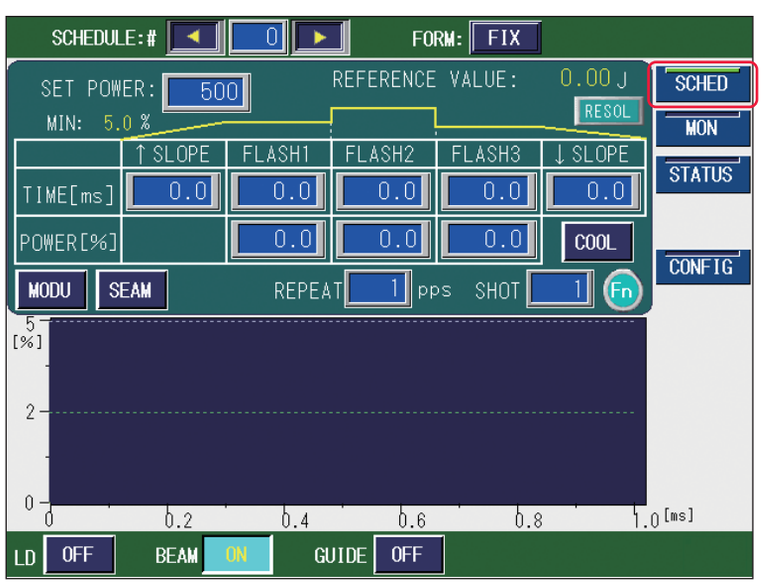
⇒ It is convenient if you enter the set output schedules in the Appendix "Output Schedule Data Entry Table" in advance.

1 Setting Output Schedules by Fixed Waveform (FIX)

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

In the following example, SCHEDULE No.: #0, laser output value: 500, FLASH1: 3.6 ms/100%, COOL1: 0.0 ms, FLASH2: 2.4 ms/80%, COOL2: 0.0 ms, FLASH3: 1.8 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.



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

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

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

<Note>

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

MF-C300A-SF : 30 to 300 / MF-C500A-SF : 50 to 500

(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 500.0 ms. Regarding the laser output value, the ratio (%) based on the case where the set laser output set value is 100% is set.

<Note>

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

FLASH1 + FLASH2 + FLASH3 ≤ 500.0 ms

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

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

<Note>

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

FLASH1 + COOL1 + FLASH2 + COOL2 + FLASH3 ≤ 500.0 ms

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

↑SLOPE ≤ FLASH1

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

↓SLOPE ≤ FLASH1, FLASH2, FLASH3

(10) To output laser light several times for one second, press the "REPEAT" setting button and then set the laser light output count for one second in the range of 1 to 1000 pps (pulse per second) by using the numeric keypad.

(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.

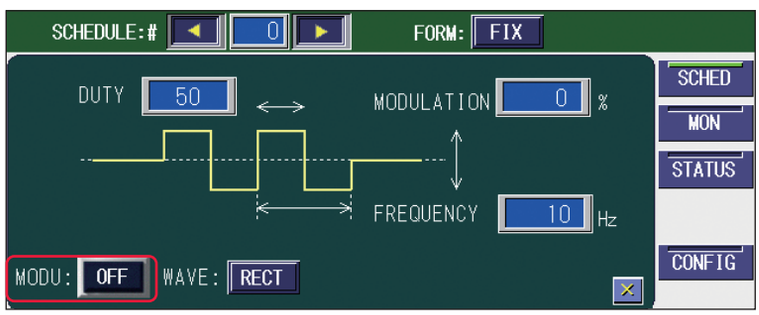
⇒ When 1 is set, a single output is performed.

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.
At 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 95.



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

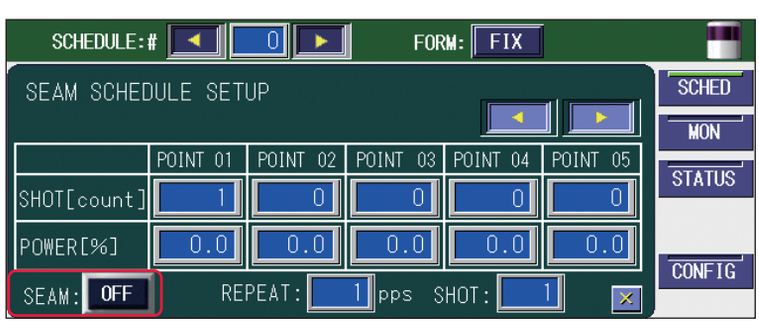
3 Setting ON/OFF for the Output Schedules for Seam Processing

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

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

⇒ For the setting method of the output schedules for seam processing, refer to "Setting the Output schedules for Seam Processing" on page 91.

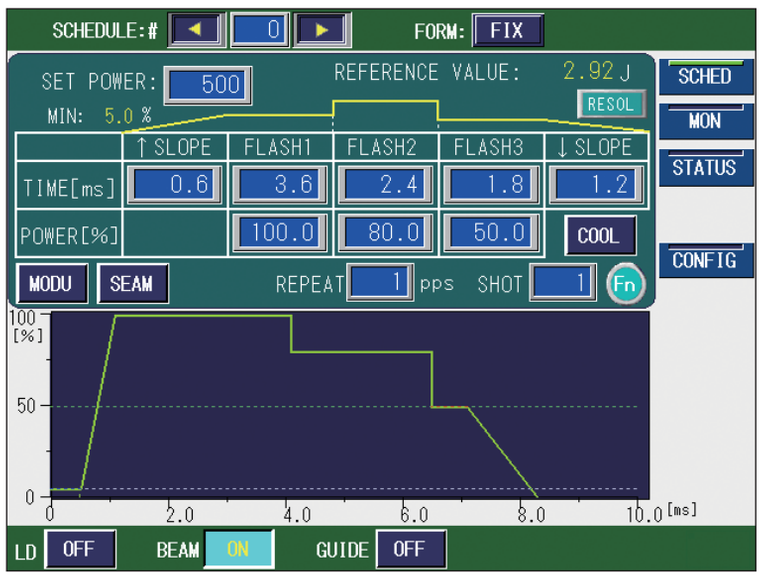
⇒ When the laser light output count is set to 9999 by using the "SHOT" setting button, a laser light is continuously output until the laser stop signal is input and the fade-in/out function becomes disabled.

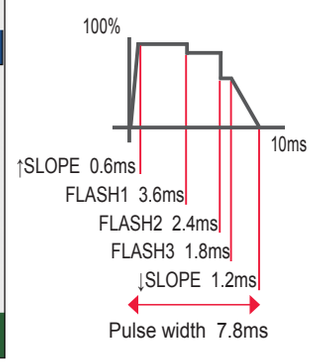


(3) Press the "X" button to display the SCHEDULE screen.

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.





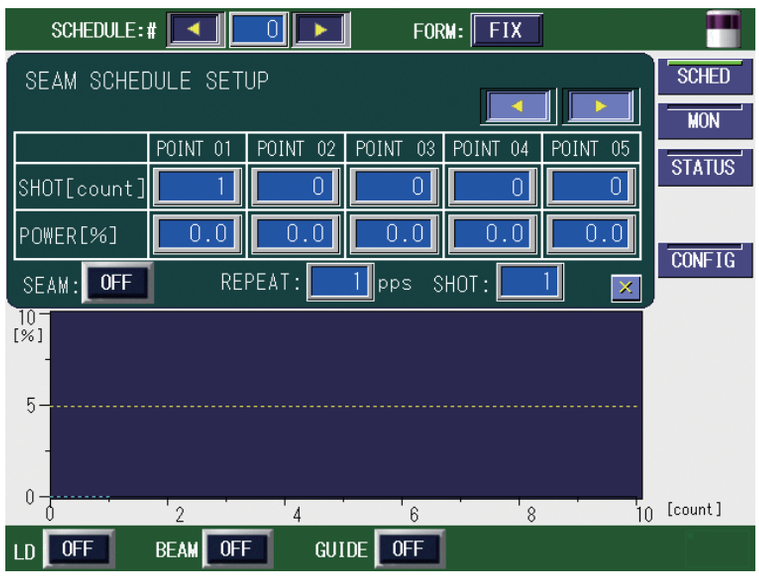
⇒ At the leading edge of waveform, an overshoot (higher form than the set value) may occur. In this case, extend "↑SLOPE" by 0.1 to 1.0 ms.

(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 processing. However, use it as reference.

SEAM Screen

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



How to see the displayed items : Settable item

◄ ►	Scrolls the POINT display column of POINT 01 to POINT 20 to the right and left. When a POINT is not displayed, press this button to display it.
SHOT [count]	Sets the laser light output count of POINT 01 to POINT 20 in the range of 1 to 9999.
POWER [%]	Sets the laser output value of each "SHOT" of POINT 01 to POINT 20 in the range of 0 to 150.0% being the ratio to "SET POWER" set on the SCHEDULE screen.
SEAM	Sets the fade function (*) to ON or OFF. * Laser output value adjusting function. The laser energy is increased decreased slowly to provide a continuous waveform suitable for seam processing. When this item is set to ON, the fade function for seam processing is enabled. When the item is set to OFF, this function is disabled. When this function is not used, set it to OFF.
REPEAT	Sets the number of laser light outputs per second in the range of 1 to 1000 pps (pulse per second). 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. This is not displayed when CW is set in FORM. Common to "SHOT" on the SCHEDULE screen.
X	Returns to the SCHEDULE screen.

⇒ For the common items in the upper/lower part of the screen, refer to page 57.

Setting the Output Schedules for Seam Processing

The method of setting the output waveform for seam processing by using the fade-in/out function after displaying the SEAM screen is explained below.

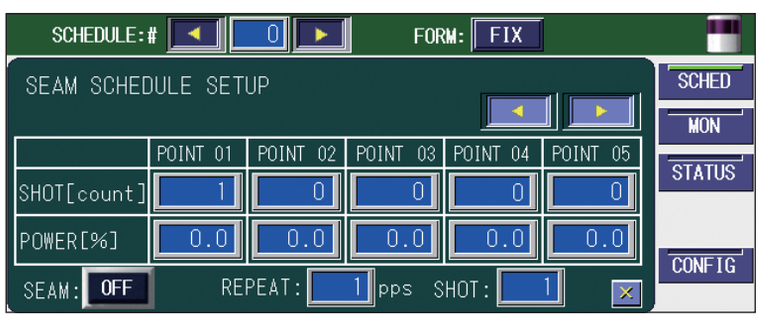
⇒ Only in the FIX or FLEX mode, the waveform for seam processing can be set.

1 Setting the Output Schedules

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

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

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



2 Setting the Fade-in/out Function

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

⇒ 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 "SET POWER" set on the SCHEDULE screen in the range of 0 to 150.0%.

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

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

<Note>

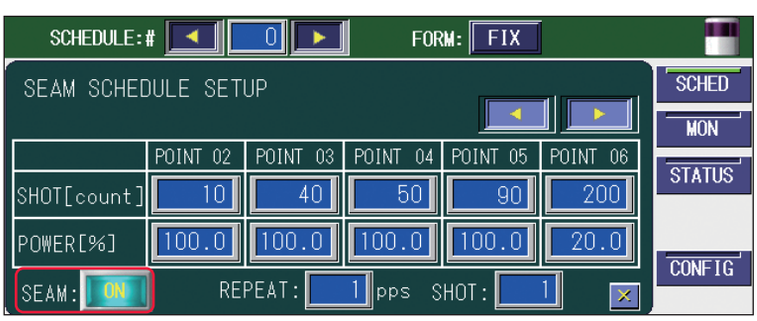
If the output count set in "SHOT" is smaller than that set in "SHOT [count]", any larger output count set in "SHOT [count]" is invalidated.
When the output count set in "SHOT" is larger than that set in "SHOT [count]", the POWER of the final set value in "SHOT [count]" is repeated until the output count reaches the output count set in "SHOT."
For example, supposing that "SHOT" is set to 40, up to 40 shots are also validated for "SHOT [count]." (Up to 40 of POINT 03 on the above screen) When "SHOT" is set to 300, the POWER of the final set value is repeated up to 201 to 300 shots for "SHOT [count]." (In this case, the 20% energy of POINT 06 is repeated up to 201 to 300 shots.)

3 Enabling the Fade Function

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

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

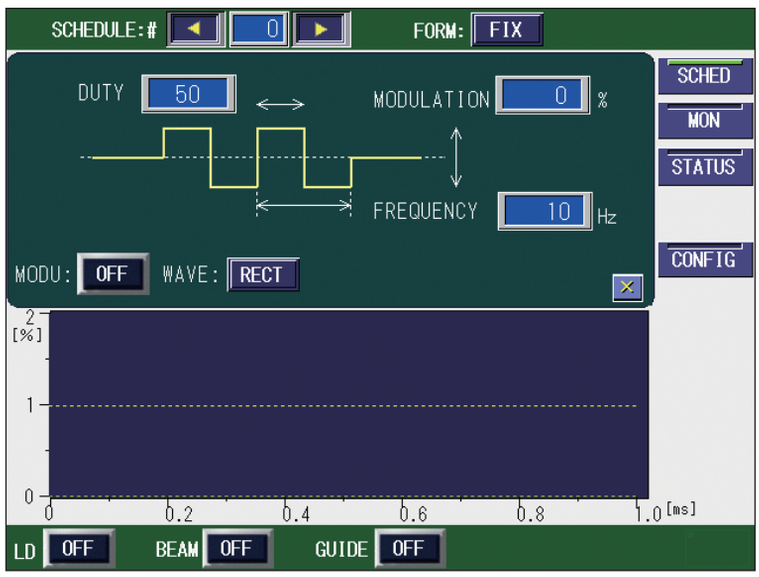
⇒ When the laser light output count is set to 9999 by using the "SHOT" setting button, a laser light is continuously output until the laser stop signal is input and the fade-in/out function becomes disabled.



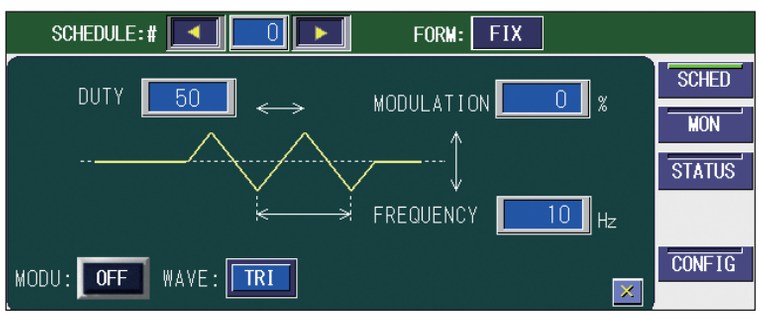
MODULATION Screen

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

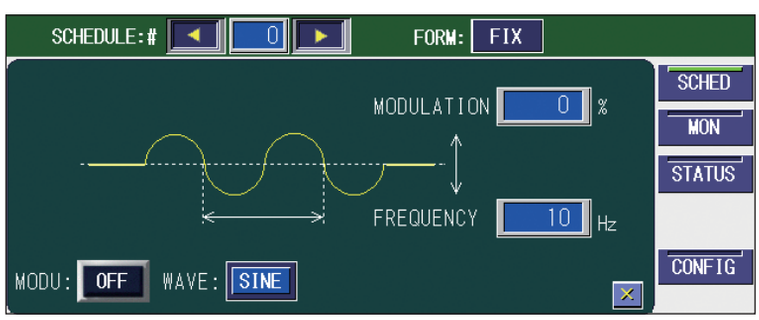
Rectangular wave (RECT)



Triangular wave (TRI)



Sinusoidal wave (SINE)



How to see the displayed items

: Settable item

DUTY	Sets the duty ratio of the laser output value. Sets the ratio of the High period for PEAK in a cycle (%) in the range of 10 to 90.

MODULATION	Outputs the waveform added/subtracted half of the modulation width to/from the set laser waveform. Sets the modulation width in the range of 0 to 100% supposing that the set SET POWER is 100%. ***<Note>*** Set the modulation width so that the waveform after modulation becomes in the range between the minimum of the laser output and the maximum.
FREQUENCY	Sets the frequency of the laser output value. 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).
X	Returns to the SCHEDULE screen.

⇒ For the common items in the upper/lower part of the screen, refer to page 57.

Setting the Modulated Waveform

The method of setting the modulated waveform after displaying the MODULATION screen is explained below.

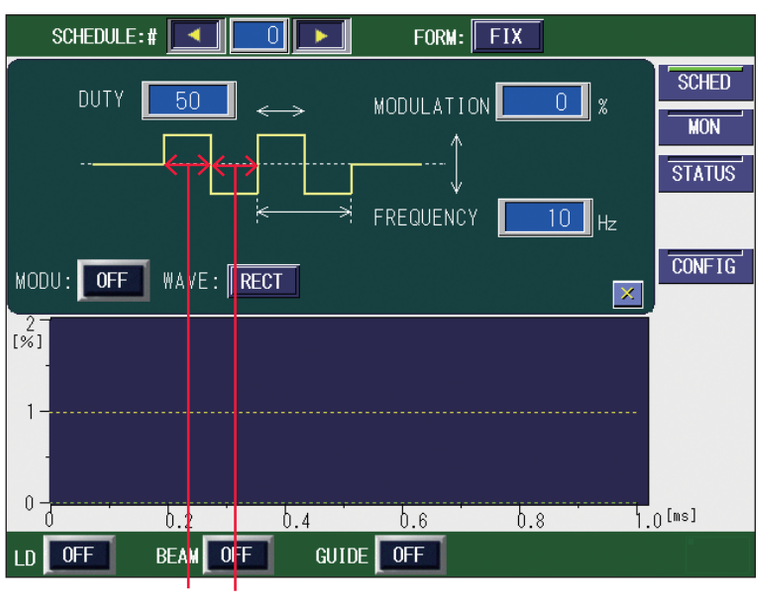
⇒ When using the modulated waveform, normally set the laser output value "POWER [%]" to 100%.

⇒ When the modulated laser is output, the output time may be slightly longer than the setting.

1 Setting the Modulated Waveform

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

⇒ Data for a cycle of modulation wavelength is displayed as a graph on the MODULATION screen. Set the ratio of the period of High in a cycle in "DUTY"; the modulation width in "MODULATION"; and the repetition period (frequency) in "FREQUENCY."



High Low

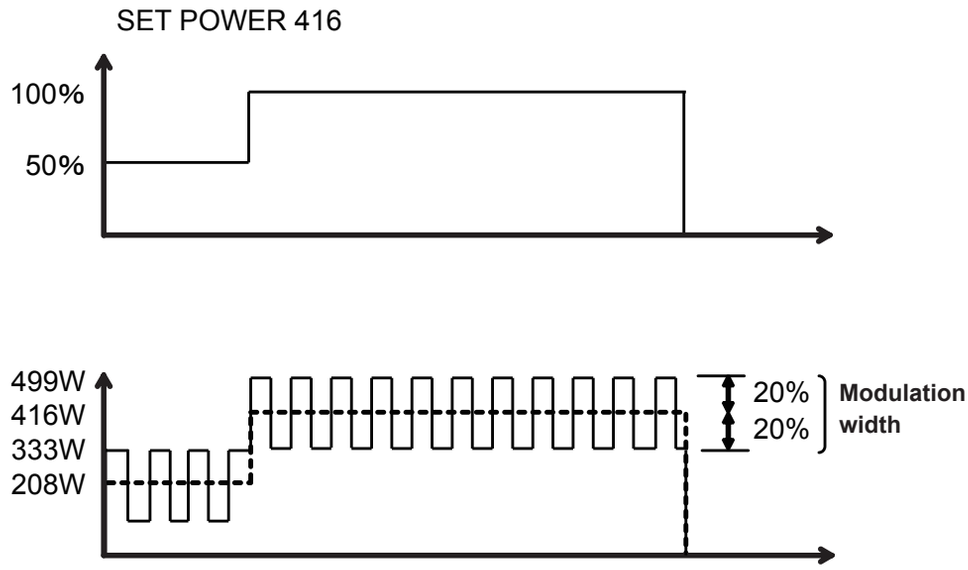
(2) Press the "DUTY" setting button.
Enter the ratio of the High period in a cycle (%) by using the numeric keypad and then press the ENT key.

(3) Press the "MODULATION" setting button.
Enter the modulation width whose center is the laser output set value (SET POWER x POWER [%]) by using the numeric keypad and then press the ENT key.

<Note>

Set the modulation width so that the waveform after modulation becomes in the range between the minimum of the laser output and the maximum.

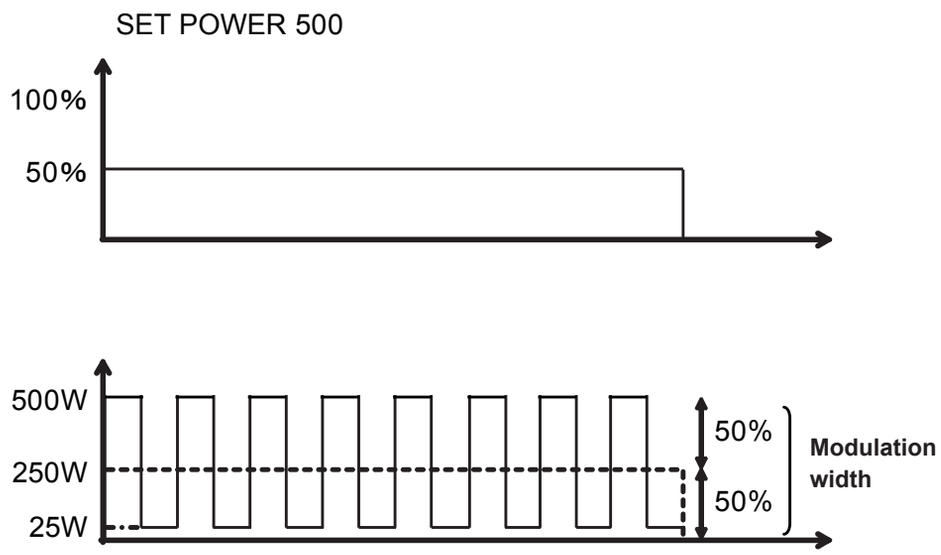
Ex. 1) When setting “SET POWER” to 416 on MF-C500A-SF and making the following waveform



The modulation width is calculated supposing that the set SET POWER is 100%.

Since the maximum set output should be more than SET POWER x POWER [%] x modulation [%], the modulation width becomes up to 40% not exceeding 500 W, the maximum set output.

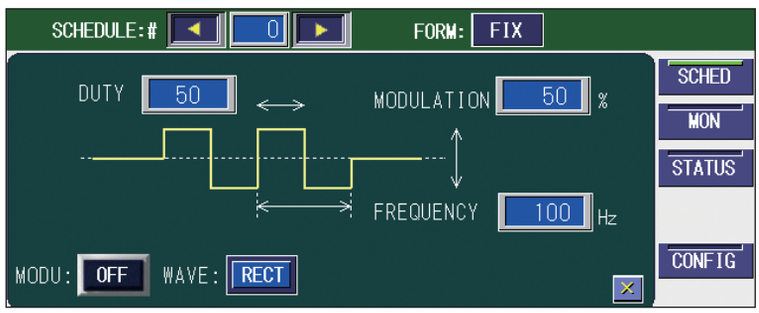
Ex. 2) When performing modulation from the minimum to the maximum on MF-C500A-SF



The modulation width whose center is 250 W can be obtained by setting SET POWER to 500 and POWER to 50%.

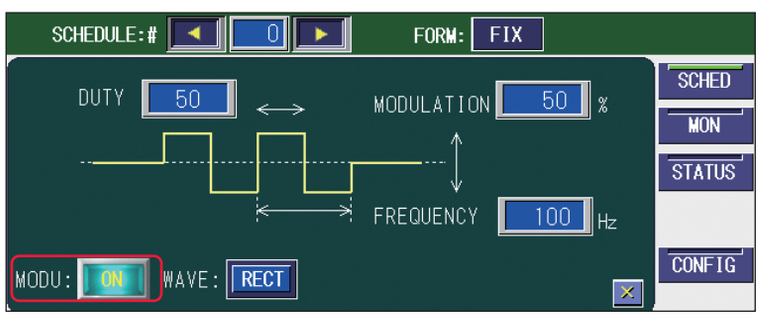
At this time, the minimum output is not 0 W, but 25 W, the preliminary oscillation. Set the modulation width to 100%. The preliminary oscillation is a function for stabilizing the laser oscillation. For details, refer to "Preliminary Oscillation" on page 82.

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



2 Enabling the Modulation Function

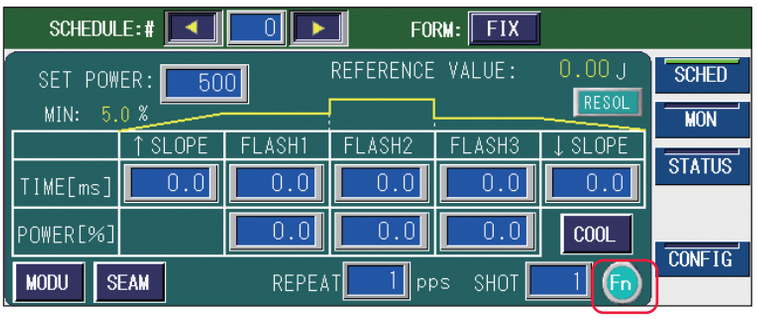
(1) Press the "MODU" setting button to set it to ON.



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

Editorial Assistant Function

When the “Fn” button is pressed on the SCHEDULE screen, a schedule can be initialized (RESET), copied (COPY) or pasted (PASTE).



There is a beffer on a memory for storing a schedule data. With copy and paste functions, you can transfer a schedule data to or from the buffer.

Also, you can move a waveform data to another schedule, appling these functions.

Operating Procedure

(1) Select a schedule number to copy from.

(2) Press the "Fn" button and select "COPY."
The schedule is copied into a memory buffer.

(3) Select a schedule number to copy to.

(4) Press the "Fn" button and select "PASTE."

The data is restored from a memory buffer.

<Note>

With the paste function, the setting of the currently-selected schedule number is overwritten by data in a memory buffer, and the data displayed on the screen before pasting is lost.

Limitations of Schedule Setting

Set schedules so as to satisfy following ranges.

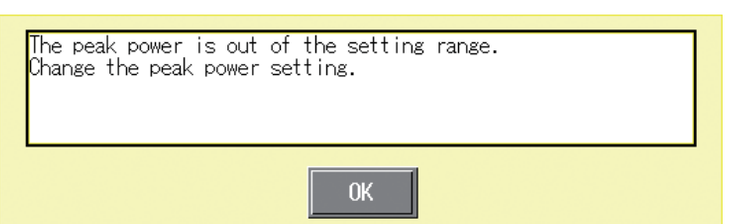
	FIX/FLEX	CW
SET POWER	30 to 300 (MF-C300A-SF), 50 to 500 (MF-C500A-SF)	
REPEAT	1 to 1000 pps	—
SHOT	1 to 9999 (9999 is for endless output.)	—
TIME (FIX: value set in each FLASH) (FLEX/CW: value set in each point)	0.1ms resolution: 0.0 to 500.0 ms 0.05ms resolution: 0 to 99.95 ms (Can be set by a multiple of 0.05 ms. In FIX, set a lower value than FLASH for SLOPE.)	1s resolution: 0 to 9999 sec 0.1s resolution: 0.0 to 999.9 sec 0.01s resolution: 0.00 to 99.99 sec 0.001s resolution: 0.000 to 9.999 sec
POWER	0 to 200.0%	
Modulation setting, FREQUENCY	1 to 5000 Hz	
Modulation setting, MODULATION	0 to 100%	
Modulation setting, DUTY	10 to 90%	
SEAM setting, COUNT	0 to 9999 (Higher value than the previous POINT. POINT 01 is 1.)	—
SEAM setting, POWER	0 to 150.0%	—
Laser output value *1, *2	30 to 300 W (MF-C300A-SF), 50 to 500 W (MF-C500A-SF)	
Total output time (1shot) (FIX: sum of FLASH1 to 3 and COOL1 to 2 TIMEs) (FLEX/CW: sum of all TIMEs)	0.1ms resolution: 0 to 500.0 ms 0.05ms resolution: 0 to 500.00 ms (Can be set by a multiple of 0.05 ms)	1s resolution: 0 to 10000 sec 0.1s resolution: 0.0 to 1000.0 sec 0.01s resolution: 0.00 to 100.00 sec 0.001s resolution: 0.000 to 10.000 sec
REPEAT setting in pulse waveform	Total output time (sec) < 1 / REPEAT	—

*1 The laser output value is as follows:

SET POWER × (POWER + modulation setting MODULATION / 2) × SEAM setting maximum POWER / 100

(Calculated supposing that the MODULATION is 0 when modulation setting is OFF, or the SEAM setting maximum POWER is 0 when the SEAM setting is OFF.)

When the above expression is not satisfied, the following dialogue appears and the schedule setting can not be changed. Review the settings of parameters displayed on the dialogue.



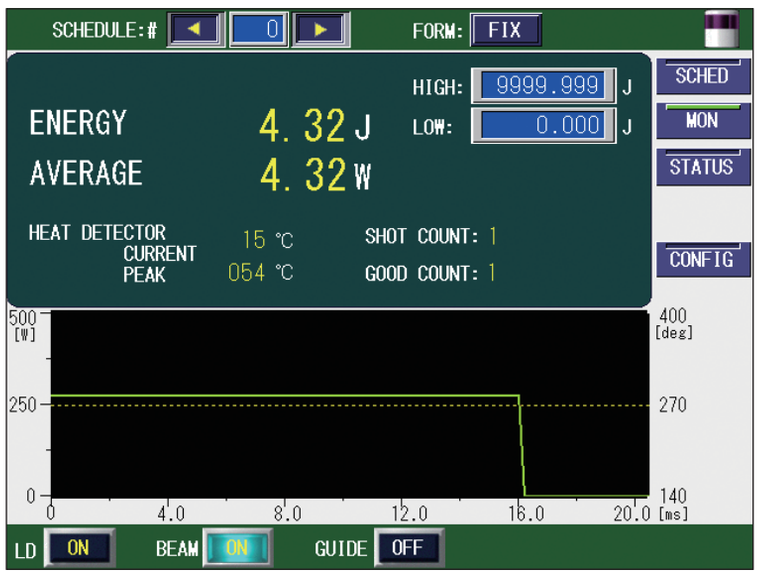
Parameters exceeding a range are displayed in the first line of dialogue, and parameters which needs to be reviewed are displayed in the second line. Review the settings of parameters displayed on the dialogue.

5. Monitoring Output

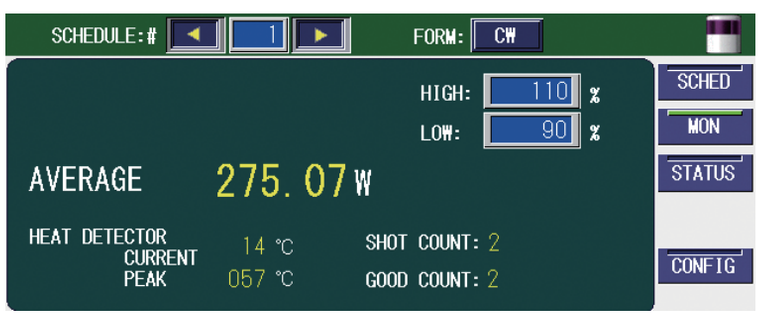
MONITOR Screen

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

FIX / FLEX



CW



How to see the displayed items

: Settable item

ENERGY (FIX / FLEX)	Displays the measured value (J) of laser energy. Each time laser light is output, the laser energy is measured and its value is displayed. In the case of a high-speed repeated output, however, the energy is displayed at certain intervals because the display timing is too quick. Use the displayed value as reference.
AVERAGE	Displays the average power (W) of output laser light. In the FIX/FLEX mode, an upper/lower limit judgment is not performed. Use the displayed value as reference.
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, error No.035/ LASER POWER OUT OF RANGE occurs and a monitor trouble is output. Press the TROUBLE RESET button to clear the trouble. *: Set the ratio of the set output (SET POWER × POWER [%]) in the CW mode. The trouble is not detected in 0.5 s or less. Also, use the value as reference.

SHOT COUNT	Displays the total number of laser light outputs. To reset the display to 0, perform a reset operation on the STATUS screen.
GOOD COUNT	Displays the appropriate number of laser light outputs. The appropriate number of outputs means the laser light output within the allowable energy range set at "HIGH" and "LOW." To reset the display to 0, perform a reset operation on the STATUS screen.

⇒ For the common items in the upper/lower part of the screen, refer to page 57.

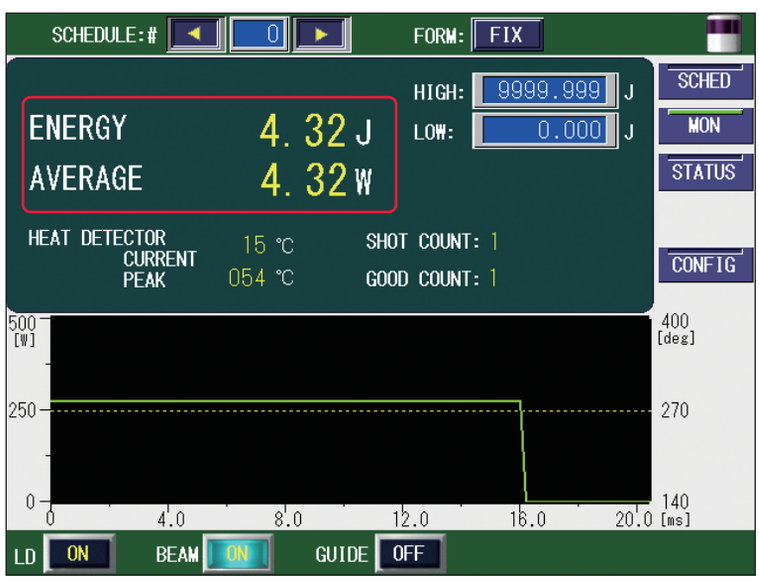
Setting the Output Status Check Screen

In the following, the method of setting the MONITOR screen is explained.

Checking the Measured Energy Value of Laser Light

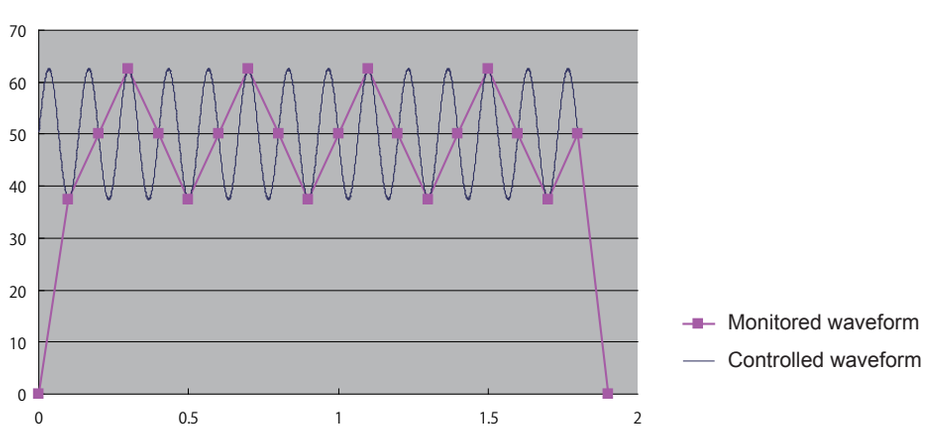
When laser light is output, the MONITOR screen is automatically displayed and a measured energy value is displayed. The measured energy value of the last output laser light can also be checked by the corresponding SCHEDULE number if a registered SCHEDULE number is entered.

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



<Notes>

- **In the CW waveform, the displayed waveform may differ from the actual laser output due to the sampling period of data for displaying a waveform. When the modulation function is set in the CW mode, the average power displayed in "AVERAGE" may also differ from the actual laser output power.**
  Ex.) CW modulation setting: Frequency = 15 Hz, Modulation width = 25%



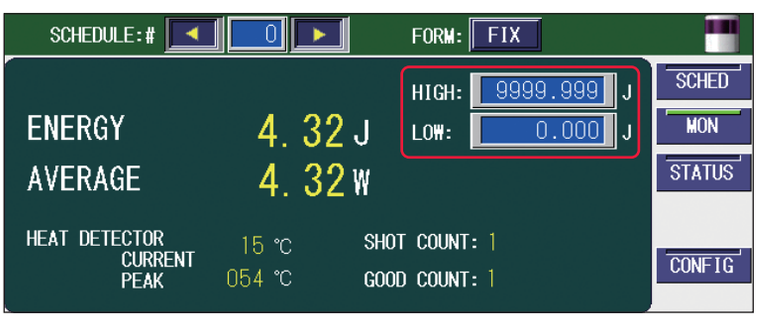
- **When the waveform is set with less than 1 ms of pulse width, the average power displayed in "AVERAGE" may differ from the actual laser output power.**
- **When the set time exceeds 100 seconds in the CW waveform, the waveform shows trends in the past 100 seconds.**

Setting the Laser Energy Range To Be Monitored

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

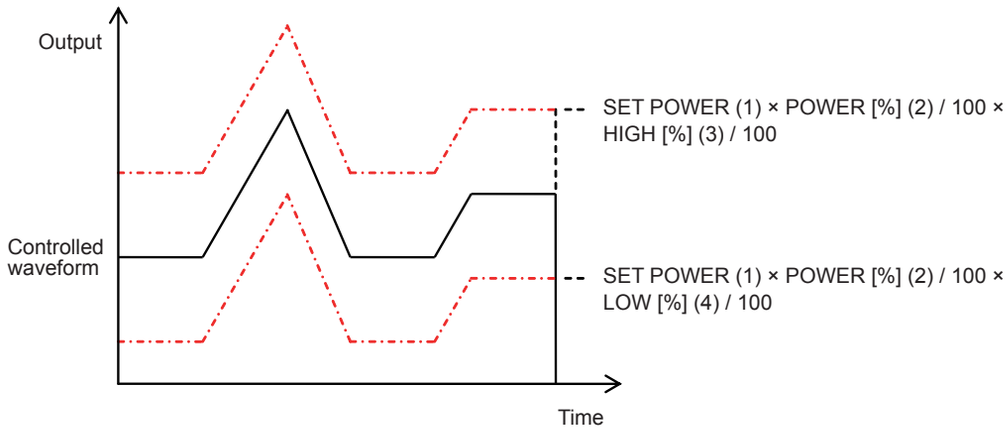
(1) Press the "HIGH" setting button.
Enter the upper limit value by using the numeric keypad and then press the ENT key.
The upper limit value of allowable energy is registered.

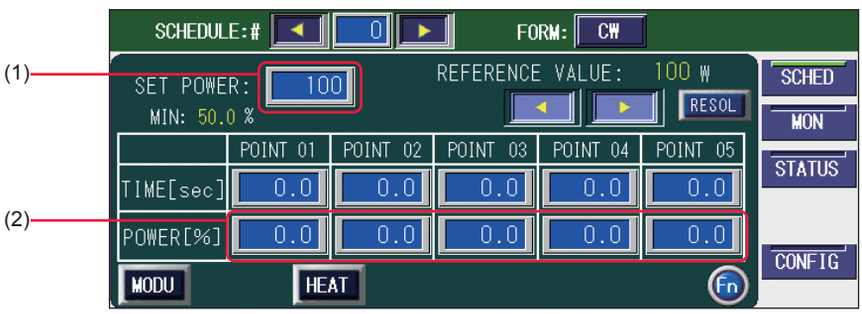
(2) Press the "LOW" setting button.
Enter the lower limit value by using the numeric keypad and then press the ENT key.
The lower limit value of allowable energy is registered.

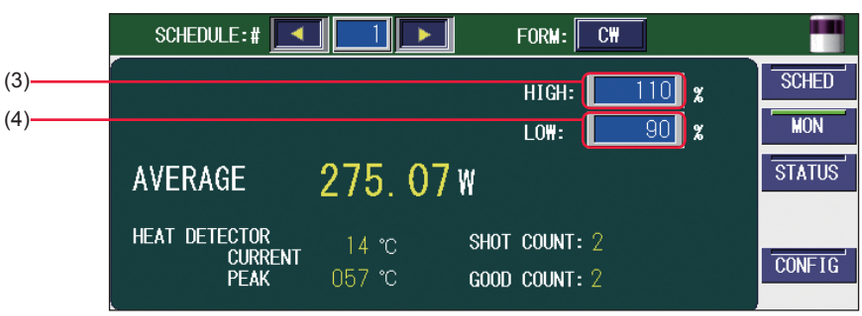


⇒ When laser light is out of the set allowable energy range, error No.035/LASER POWER OUT OF RANGE occurs and a monitor trouble is output. (Pin No.20 of the EXT. I/O (1) connector is closed for the time set on the CONFIG screen after a laser output.) When the total laser output time is 0.5 s or less in the CW mode, however, a monitor trouble does not occur even if laser light is out of the range.

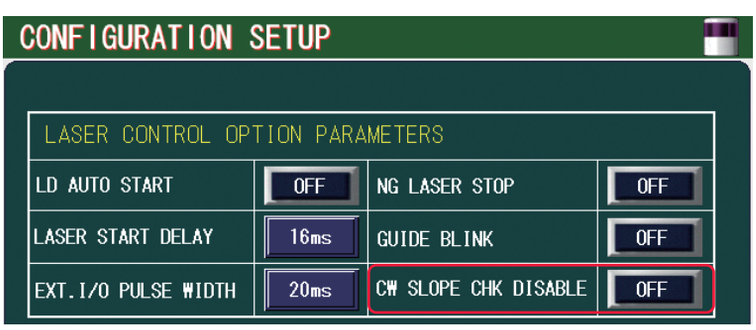
⇒ When the total laser output time is higher than 0.5 s in the CW mode, set “HIGH” and “LOW” at the ratio of output (SET POWER × POWER [%]) set on the SCHEDULE screen. The following formula is given to convert the set value into Watts. POWER [%] is also increased or decreased according to the output increase/decrease between each POINTs. When the measured value of the monitored laser light is out of the range shown by red lines below, error No.035/ LASER POWER OUT OF RANGE occurs.



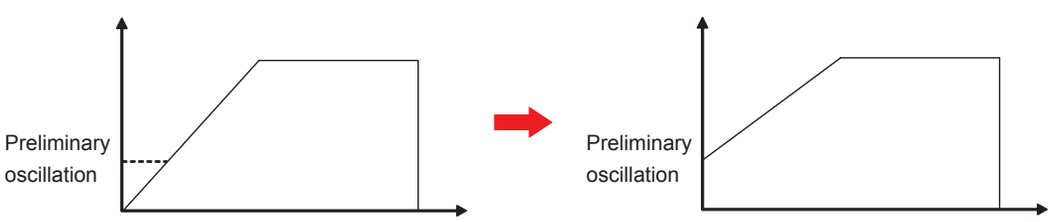




⇒ When not using the slope judgment in the CW mode, select the LASER CONTROL on the CONFIG screen and set the CW SLOPE CHK DISABLE to ON.



Also, set the slope to the value higher than the preliminary oscillation output.



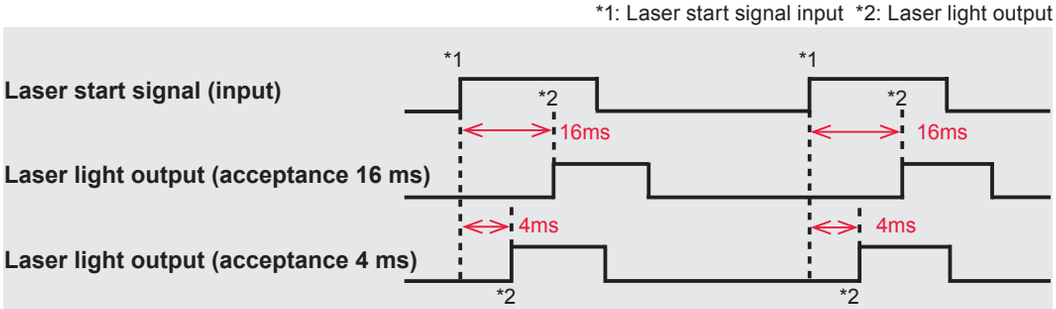
6. Changing the Acceptance Time for Laser Start Signal/ Schedule Signal (CONFIG Screen)

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 by setting the CONFIG screen when EXTERNAL CONTROL is exerted by external input/output signals.

The laser start signal acceptance time means the time required until laser light is actually output after the laser start signal is input. The schedule signal acceptance time means the time required until this laser establishes schedules after a schedule signal 1, 2, 4, 8, 16, 32, 64, or 128 to select a SCHEDULE number is input.

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

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



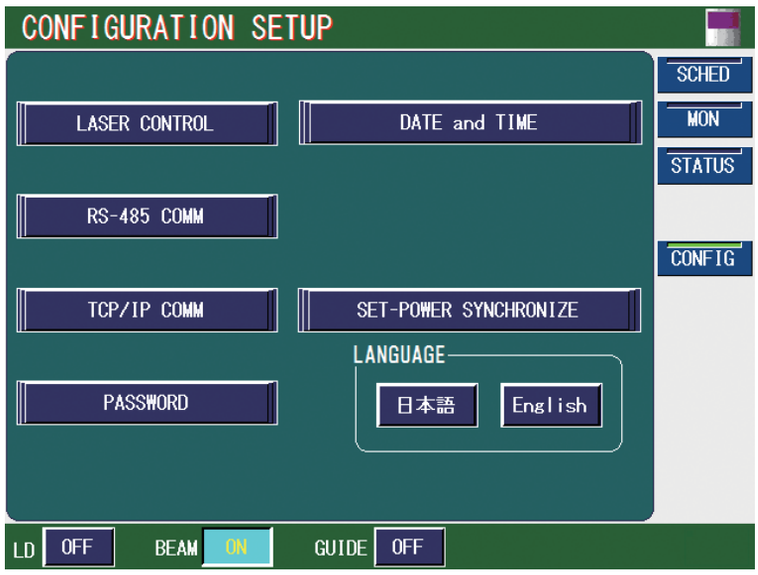
⇒ The laser start signal acceptance time and the schedule signal acceptance time are common. A different value cannot be set for the respective time.

As the acceptance time for laser start signal, the 6 types of 0.1 ms, 1 ms, 2 ms, 4 ms, 8 ms, and 16 ms are available. At delivery, the acceptance time is set to 4 ms.

Usually, the acceptance time for laser start signal is 4 ms but can be changed as required. To change this setting, switch the setting of "LASER START DELAY" on the CONFIG screen as shown below.

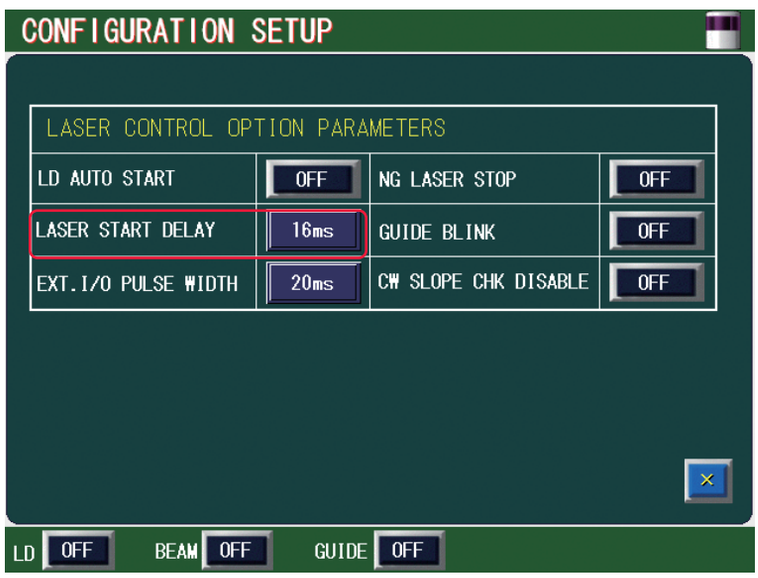
1 Displaying the CONFIG Screen

(1) Press the "LASER CONTROL" button on the CONFIG screen.
The page of LASER CONTROL OPTION PARAMETERS is displayed.



2 Changing the Acceptance Time

(1) Set the "LASER START DELAY."



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

Operating Part

Chapter 3

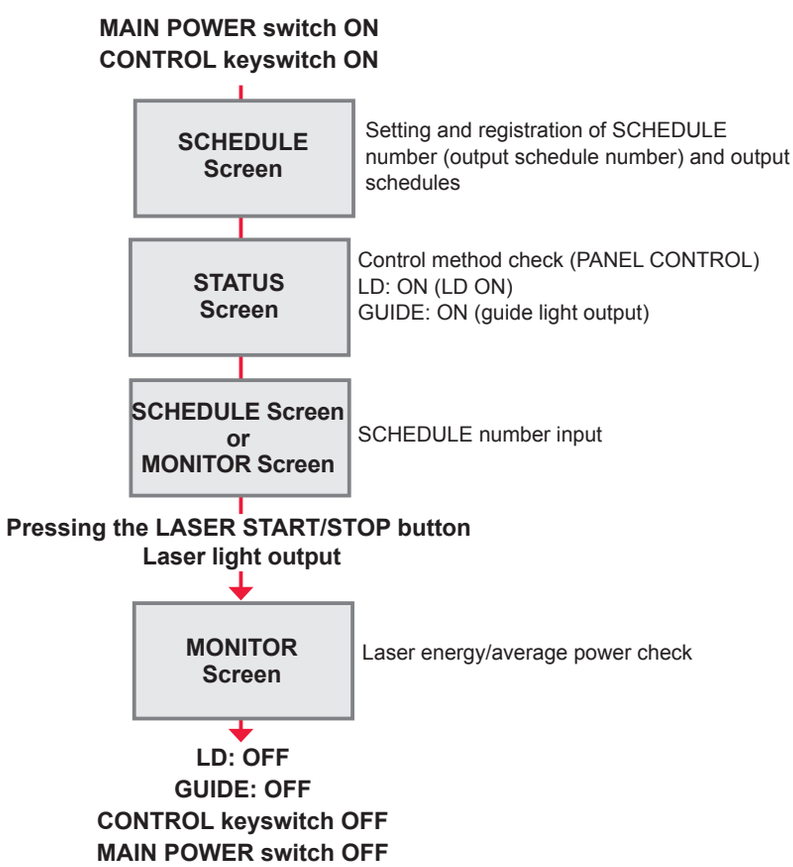
Laser Processing by Laser Controller (PANEL CONTROL)

1. Operation Flow

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

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

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

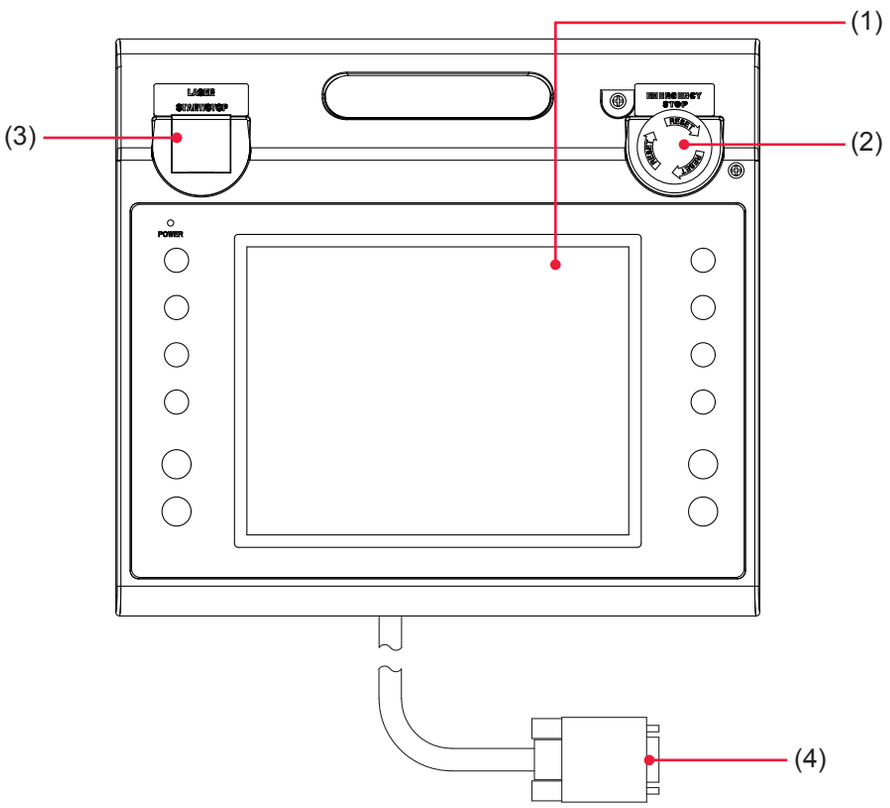


2. Laser Controller Functions

This section explains the functions of the laser controller.

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

⇒ It is possible to perform laser processing operations in a remote place from the laser equipment 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 windows and keyboard required for settings.
(2) EMERGENCY STOP (Button)	This is an emergency stop button. With this button pressed, the laser equipment 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) **EMISSION (Lamp)**	If you press the button when a laser light output becomes ready, laser light is output. If the button is pressed again while laser light is repeatedly output, the repeated output is stopped. * Pin No.25 (control switching) of the EXT. I/O (1) connector is in a closed circuit and the LD is turned on. When the LD is turned on, the EMISSION lamp comes on.
(4) Circuit Cable	Connects the laser controller to the main unit.

3. Operating Procedure

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

⇒ For the details of processing schedule settings, refer to Chapter 2, "4. Setting the Laser Light Output Schedule" on page 80. For connector functions, refer to Chapter 4, "3. Connector Functions" on page 117.

⇒ Before turning on the power supply, put pin No.25 (control switching) of the EXT. I/O (1) connector to an open circuit to invalidate external input signals. As a result, the control by external input signals (EXTERNAL CONTROL) is invalidated and "PANEL CONTROL" is displayed in "CONTROL DEVICE" on the STATUS screen.

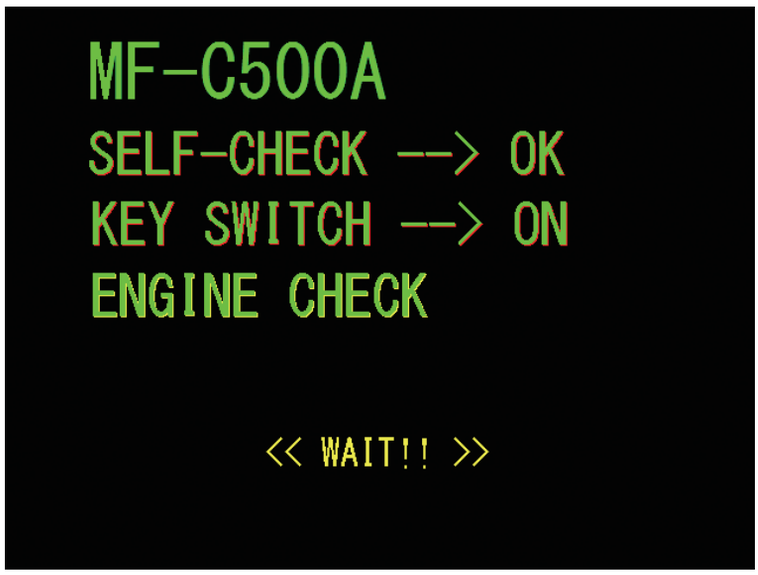
1 Starting the Laser

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

The power supply is turned ON and the POWER lamp comes on.

The memory and power supply unit are automatically checked. When no error is found, the KEY SWITCH CHECK screen is displayed.

(2) Turn ON the CONTROL keyswitch.
The engine (oscillator) is automatically checked.



The SCHEDULE screen appears.

2 Setting Output Schedules

As an example, the procedure for setting SCHEDULE No.5, laser output set value 500, FLASH1 laser output time 30 ms/output value 50%, and up-slope 10 ms is explained below.

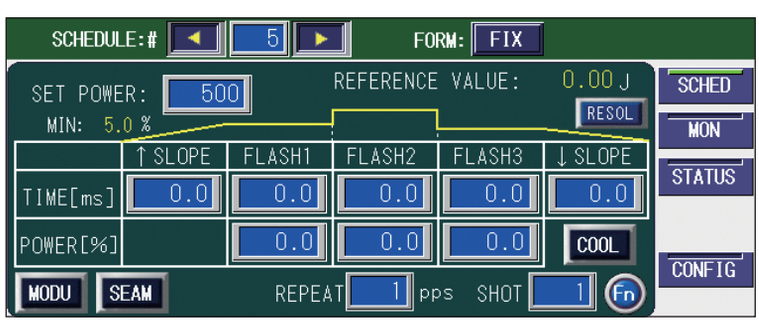
(1) Press the "SCHED" button to display the SCHEDULE screen.

(2) Press the "SCHEDULE" setting button.
Enter the SCHEDULE number by using by using the "<" and ">" buttons or numeric keypad and then press the ENT key
In this example, set #5.

⇒ As the SCHEDULE number, it is possible to set 255 schedules of #000 to #254. In "FORM", the fixed waveform "FIX", flexible waveform of pulse oscillation "FLEX", or flexible waveform of CW (continuous) oscillation "CW" can be specified.

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

(3) Press the "SET POWER" setting button.
Enter the laser output set value by using the numeric keypad and then press the ENT key.
In this example, set 500.



<Note>

The settable laser output set value differs depending on the model. For the laser output value setting (% of FLASH), set the value within the setting range of each model.

MF-C300A-SF: 30 to 300	**MF-C500A-SF: 50 to 500**

(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 30.0 ms in "FLASH1."

<Note>

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

"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 10.0 ms.

<Note>

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

↑SLOPE ≤ FLASH1

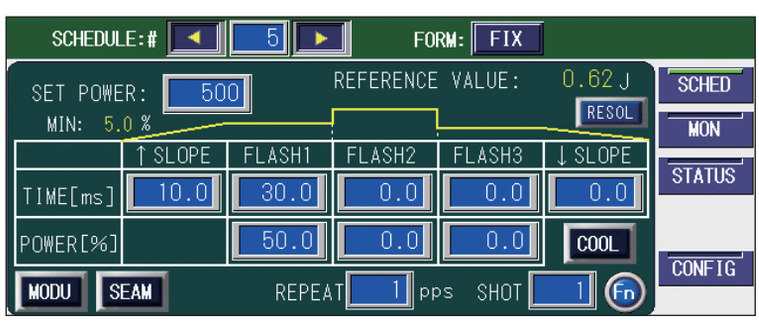
When setting "FLASH2" or "FLASH3", set the time required for laser light to down-slow (the laser output is gradually weaker) to FLASH. Set "↓SLOPE" so as to result in the following value.

↓SLOPE ≤ FLASH1, FLASH2, FLASH3

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

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

In this example, set 50.0% in "FLASH1."



⇒ For the laser output value, set the ratio (%) supposing that the set laser output set value is 100%. In this example, this set value is 50% of "SET POWER=500", so that the actual laser output value is 250 W. In this case, even if "SET POWER=250" and "FLASH1 100 ms 100%" are set, the actual laser output value is the same.

⇒ For setting the number of continuous laser light outputs, set the number of outputs per second in "REPEAT" in the range of 1 to 1000 pps (pulse per second).

⇒ For setting the number of laser light outputs, set it in "SHOT" in the range of 1 to 9999. When 1 is set, a single output is performed.

3 Outputting Laser Light

⚠ WARNING

Be sure to put on specified protective glasses during laser light output operation. Even if you wear them, you may lose your sight if the laser beam enters your eyes directly through protective glasses.

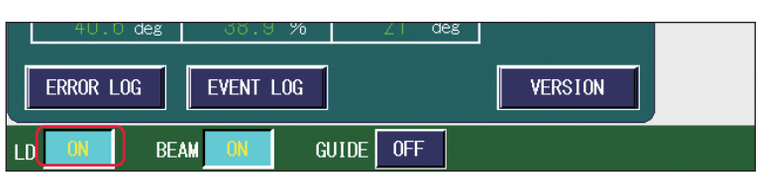
(1) Press the "STATUS" button to display the STATUS screen.

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."

(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 "LD" setting button.

The LD lights up.



(4) Press the “GUIDE” setting button to set it to ON to output guide light.

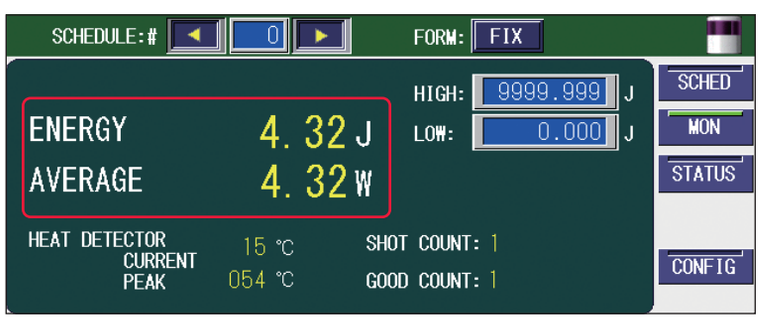
The “GUIDE” setting button is set to ON and a red dot of guide light appears at the laser light injecting position. Laser light is injected to the red-dot position.

(5) Check the laser light irradiation position.
If the point to be worked deviates from the red point of guide light, adjust the position by moving the output unit or workpiece.

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

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

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



4 Stopping Laser Processing

CAUTION

During a laser light output or for 5 seconds immediately after a laser light output, do not turn OFF the MAIN POWER switch.

(1) Press the "LD" and "GUIDE" setting buttons on each screen to set them to OFF.

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

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

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

Operating Part

Chapter 4

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

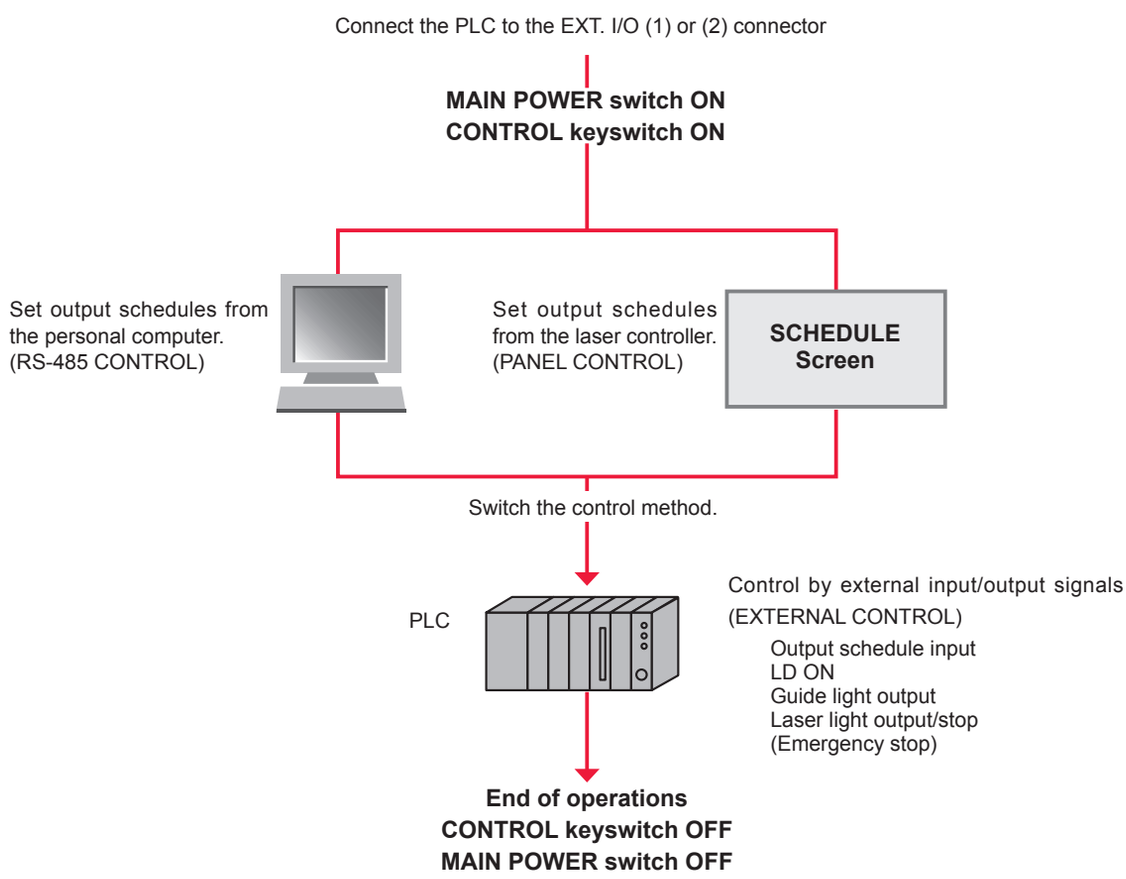
1. Operation Flow

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

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

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

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

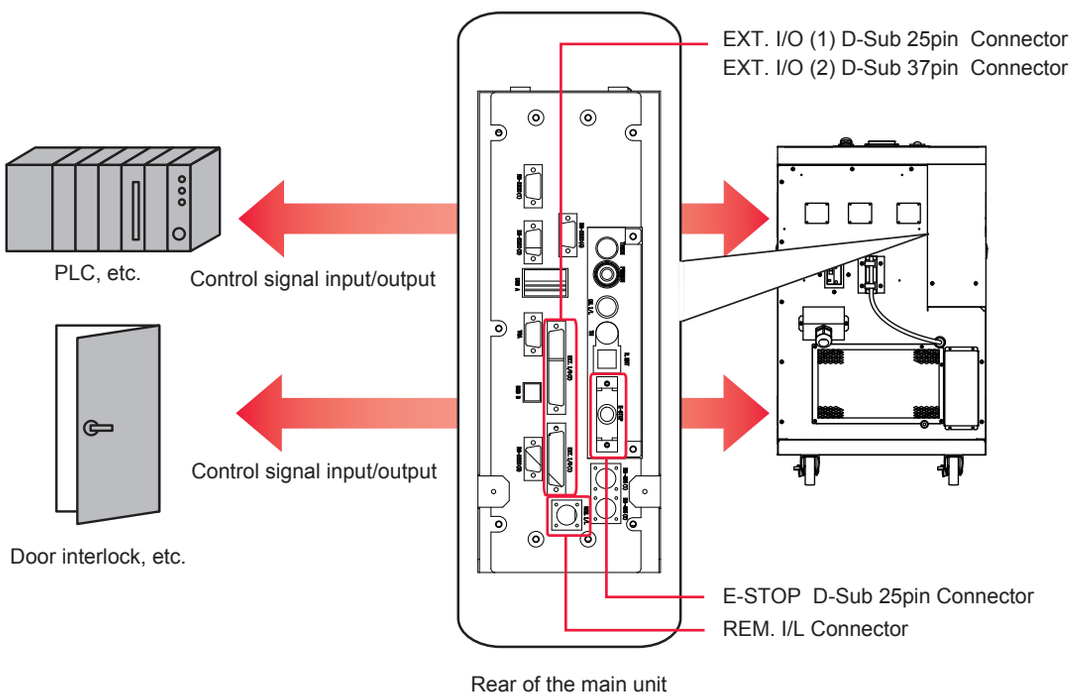


2. Preparations for Operations

This section explains the devices and connectors required for laser processing by 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 by executing the program from the outside.

Also, for preventing hazards, a remote interlock must be connected as a matter of duty. The E-STOP connector (the REM. I/L connector when replacing our old products) is connected to the interlock of the door of the chamber or room for laser processing. If the door is suddenly opened, the LD is turned off.



The plug, socket and case models of connectors are as follows.

Connector	Plug / Socket	Case	Manufacturer
EXT. I/O (1)	HDBB-25P(05)	HDB-CTH(10)	HIROSE ELECTRIC CO., LTD.
EXT. I/O (2)	HDCB-37P(05)	HDC-CTH(10)	
REM. I/L	116-12A10-2AF10.5		TAJIMI ELECTRONICS CO., LTD.
E-STOP	HDBB-25S(05)	HDB-CTH(10)	HIROSE ELECTRIC CO., LTD.

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

⇒ It is recommended to use the shielded cable for inputting and outputting the control signal.

⇒ To exhibit the shield effect, it is recommended to connect the shield of a cable to the shield of a connector case or FG (flame ground), but it may be better not to connect to a ground in some cases. Perform evaluation and connection to match the operation of the overall system.

⇒ When there is influence of noise, attach a ferrite core as close to the equipment as possible. A ferrite core has an effect in reducing external noise.

⇒ Do not connect the shield of a cable to SG (signal ground).

3. Connector Functions

Pin Arrangement and Functions

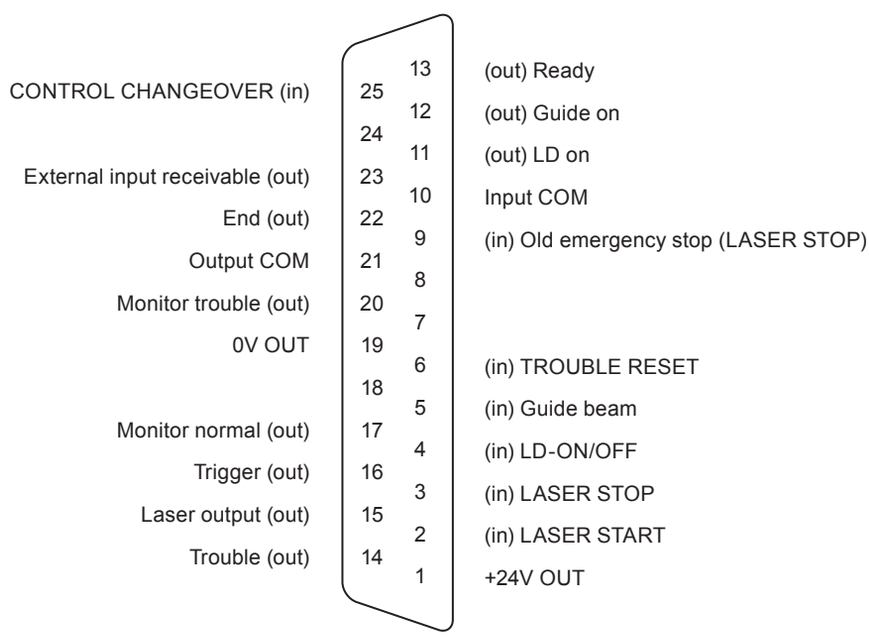
There are 4 connectors to be connected for the control by external input/output. This section explains the arrangement and functions of the respective pins.

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

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

⇒ Use the following product out of the attached connectors.

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



Input Pins of EXT. I/O (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 the MF-C300A-SF/C500A-SF. Do not use it for any other purpose.
2	LASER START When Pin 3 is closed, the laser beam is output. Make sure that the circuit is left closed for at least the time set on the CONFIG screen.

Pin No.	Description
3	LASER STOP When outputting the laser using Pin 2, close this pin. The laser output is stopped by closing the pin during a laser output. 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 canceled.
7	Unused Do not connect anything.
8	Unused Do not connect anything.
9	Old emergency stop (LASER STOP) When this pin is opened, the equipment is brought to an emergency stop, which is in the same state as the CONTROL keyswitch is OFF. ***<Note>*** This pin can be used only when replacing our old products. Use the E-STOP connector for the emergency stop signal in accordance with machine safety standards.
10	Input COM
19	0 V OUT Power supply for external input signals. This pin is exclusively used for the MF-C300A-SF/C500A-SF. Do not use it for any other purpose.
24	Unused Do not connect anything.
25	CONTROL CHANGEOVER While this pin is closed, the external input signals are effective.

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

Pin No.	Description
11	LD ON While the LD power supply is on, this pin is closed internally.
12	Guide ON While the guide beam is turned on, this pin is closed internally.
13	Ready When the laser can be output and a valid schedule is selected, this pin is closed internally.
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	Trigger This pin is dedicated to the laser weld monitor. Do not connect to other pins.

Pin No.	Description
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	Unused Do not connect anything.
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. At the same time, error No.035/ LASER POWER OUT OF RANGE occurs.
21	Output COM
22	End After the laser is output, 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 closed. In the open circuit status, an external input signal is not acceptable if it is input.

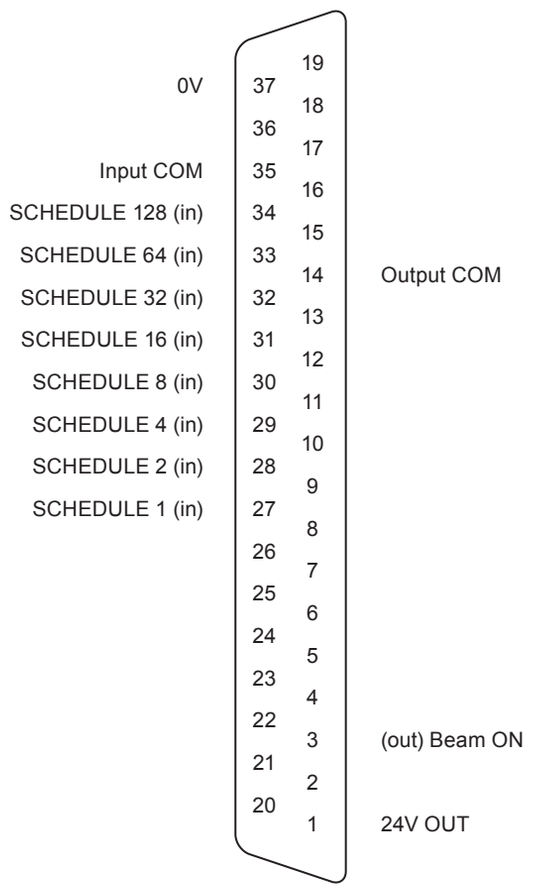
Type of output: Photo MOS relay output
Rating of output: 24 V DC, 20 mA max.

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

The EXT. I/O (2) connector inputs processing schedules.

⇒ Use the following product out of the attached connectors.

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



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

Pin No.	Description
15	Unused Do not connect anything.
16	Unused Do not connect anything.
17	Unused Do not connect anything.
18	Unused Do not connect anything.
19	Unused Do not connect anything.
20	Unused Do not connect anything.
21	Unused Do not connect anything.
22	Unused Do not connect anything.

Pin No.	Description	
23	Unused Do not connect anything.	
24	Unused Do not connect anything.	
25	Unused Do not connect anything.	
26	Unused Do not connect anything.	
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	Unused Do not connect anything.	
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	Unused Do not connect anything.
3	Beam ON While BEAM is ON, this pin is closed internally.
4	Unused Do not connect anything.
5	Unused Do not connect anything.
6	Unused Do not connect anything.
7	Unused Do not connect anything.
8	Unused Do not connect anything.
9	Unused Do not connect anything.
10	Unused Do not connect anything.
11	Unused Do not connect anything.

Pin No.	Description
12	Unused Do not connect anything.
13	Unused Do not connect anything.
14	Output COM

REM. I/L Connector

The REM. I/L connector connects the interlock to turn off the LD in an emergency.

⚠ CAUTION

This connector can be used only when replacing our old products. Use the E-STOP connector for the emergency stop signal in accordance with machine safety standards.

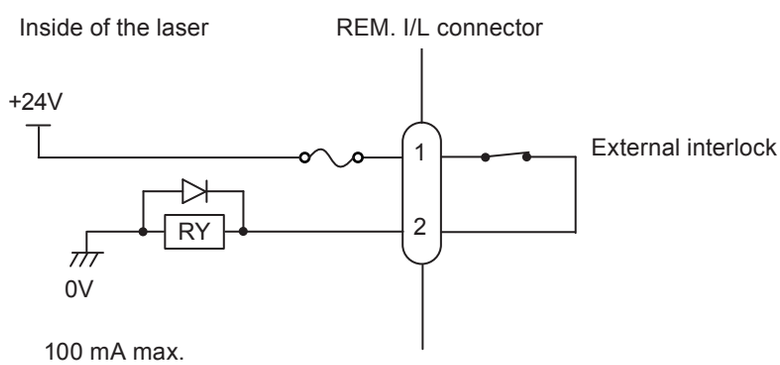
⇒ Use the following attached connector.

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

Pin No.	Description
1	When the section between pin No.1 and pin No.2 is put an open circuit, the LD is turned off.
2	

⇒ When the section between 2 pins of this connector is opened by operating the external interlock, 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.

⇒ To release the interlock, put the section between pin No.1 and pin No.2 a closed circuit and press the TROUBLE RESET button displayed on the laser controller.

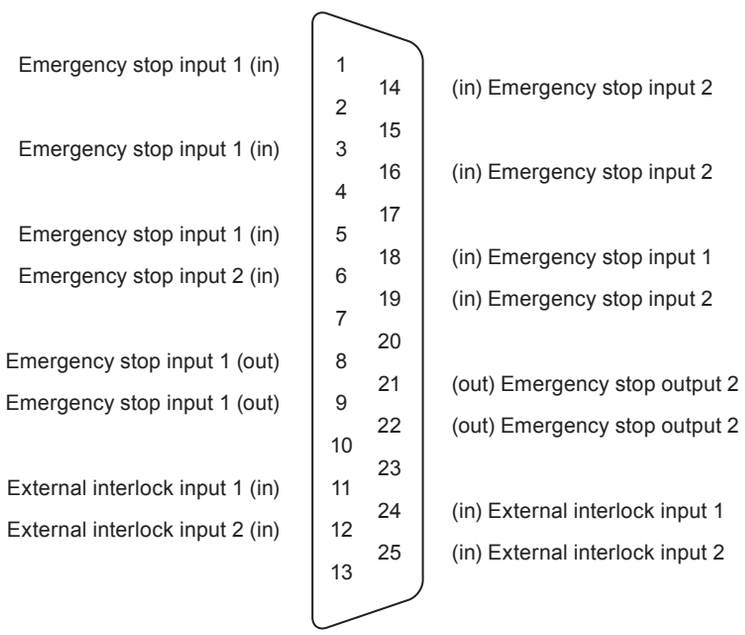


E-STOP Connector (D-Sub 25 pin)

The E-STOP connector inputs and outputs an emergency stop signal for the laser and inputs an external interlock signal.

⇒ Use the following product out of the attached connectors.

Socket	Case	Manufacturer
HDB-25S(05)	HDB-CTH(10)	HIROSE ELECTRIC CO., LTD.



Input Pins of E-STOP Connector

Pin No.	Description
1 3 5 18	Emergency stop input 1 When the section between pin No.1 and pin No.18 or the section between pin No.3 and pin No.5 is put in an open circuit, an emergency stop is activated, and the LD is turned off. To cancel it, put the sections between pin No.1 and pin No.18, between pin No.14 and pin No.19, between pin No.3 and pin No.5, and between pin No.6 and pin No.16 in closed circuits and then input the trouble reset signal.
6 14 16 19	Emergency stop input 2 When the section between pin No.14 and pin No.19 or the section between pin No.6 and pin No.16 is put in an open circuit, an emergency stop is activated, and the LD is turned off. To cancel it, put the sections between pin No.1 and pin No.18, between pin No.14 and pin No.19, between pin No.3 and pin No.5, and between pin No.6 and pin No.16 in closed circuits and then input the trouble reset signal.
11 24	External interlock input 1 When the section between pin No.11 and pin No.24 is put in an open circuit, the LD is turned off. To cancel it, put the section between pin No.11 and pin No.24 and the section between pin No.12 and pin No.25 in closed circuits and then input the trouble reset signal.
12 25	External interlock input 2 When the section between pin No.12 and pin No.25 is put in an open circuit, the LD is turned off. To cancel it, put the section between pin No.11 and pin No.24 and the section between pin No.12 and pin No.25 in closed circuits and then input the trouble reset signal.

⇒ For simple systems, do not connect anything to pins not described above.

Output Pins of E-STOP Connector

Pin No.	Description
8	Emergency stop output 1 When the laser is put in an emergency stop, the section between pin No.8 and pin No.9 is put in an open circuit.
9	
21	Emergency stop output 2 When the laser is put in an emergency stop, the section between pin No.21 and pin No.22 is put in an open circuit.
22	

⇒ For simple systems, do not connect anything to pins not described above.

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

⚠ CAUTION

ALL CONNECTIONS ARE POTENTIAL FREE DRY CONTACT CLOSURE ONLY.
Do not apply any voltage or current or you will damage the system.
Do not connect to the power supply on the EXT. I/O (1) and (2) connectors.

Interlocks

The interlocks cut off laser light in an emergency.

⚠ CAUTION

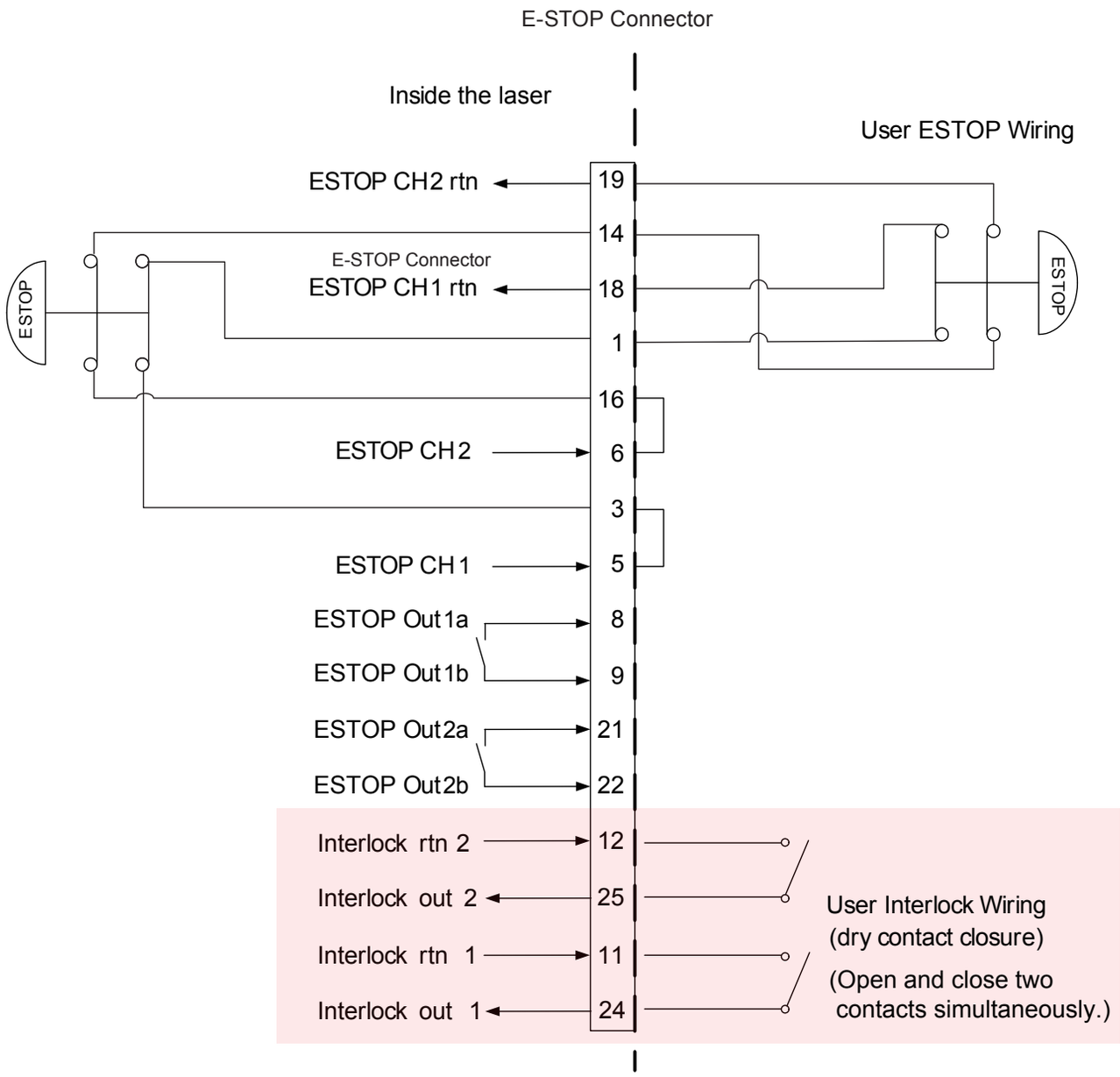
The emergency stop and interlock are made up of two dry contact inputs. These must be made to open and close simultaneously. After the interlock has opened and closed, reset is activated and interlock is canceled.

Emergency Stop for Simple Systems

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

The Laser can be interfaced to a simple system including an enclosure and one or more external emergency stop buttons. In this situation the Laser would not be connected to any larger automation system or control any other equipment. The dual channel output relays can be monitored to verify the status of the emergency stop circuit but no external equipment other than that outlined above should be included. Reset can be performed via the EXT. I/O (1) connector.

Also, dual channel relay outputs are available.



Emergency Stop for Complicated Systems

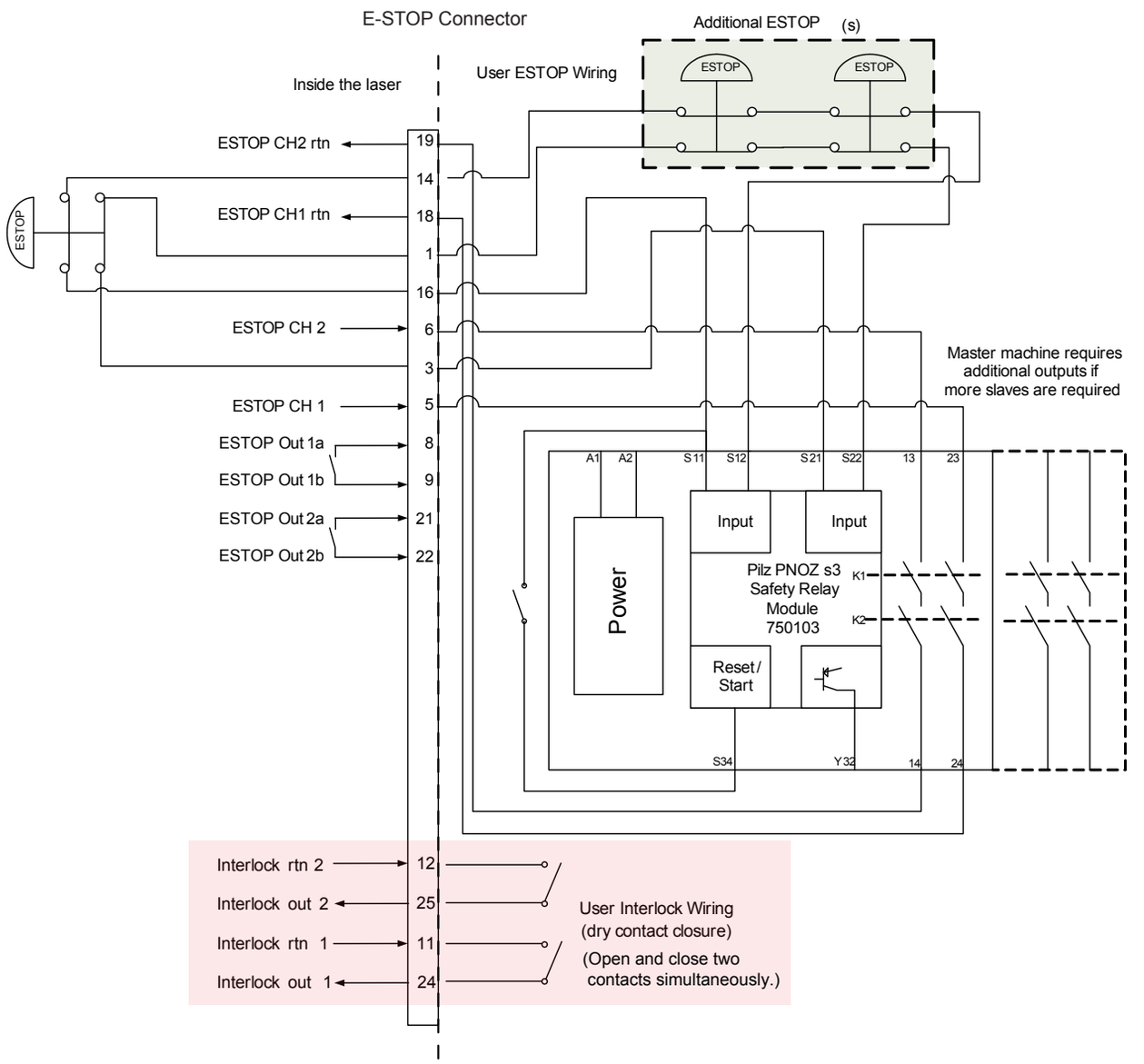
Interfacing with External Emergency Stop Circuitry

User Supplied Safety Relay Module(s) Required

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

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

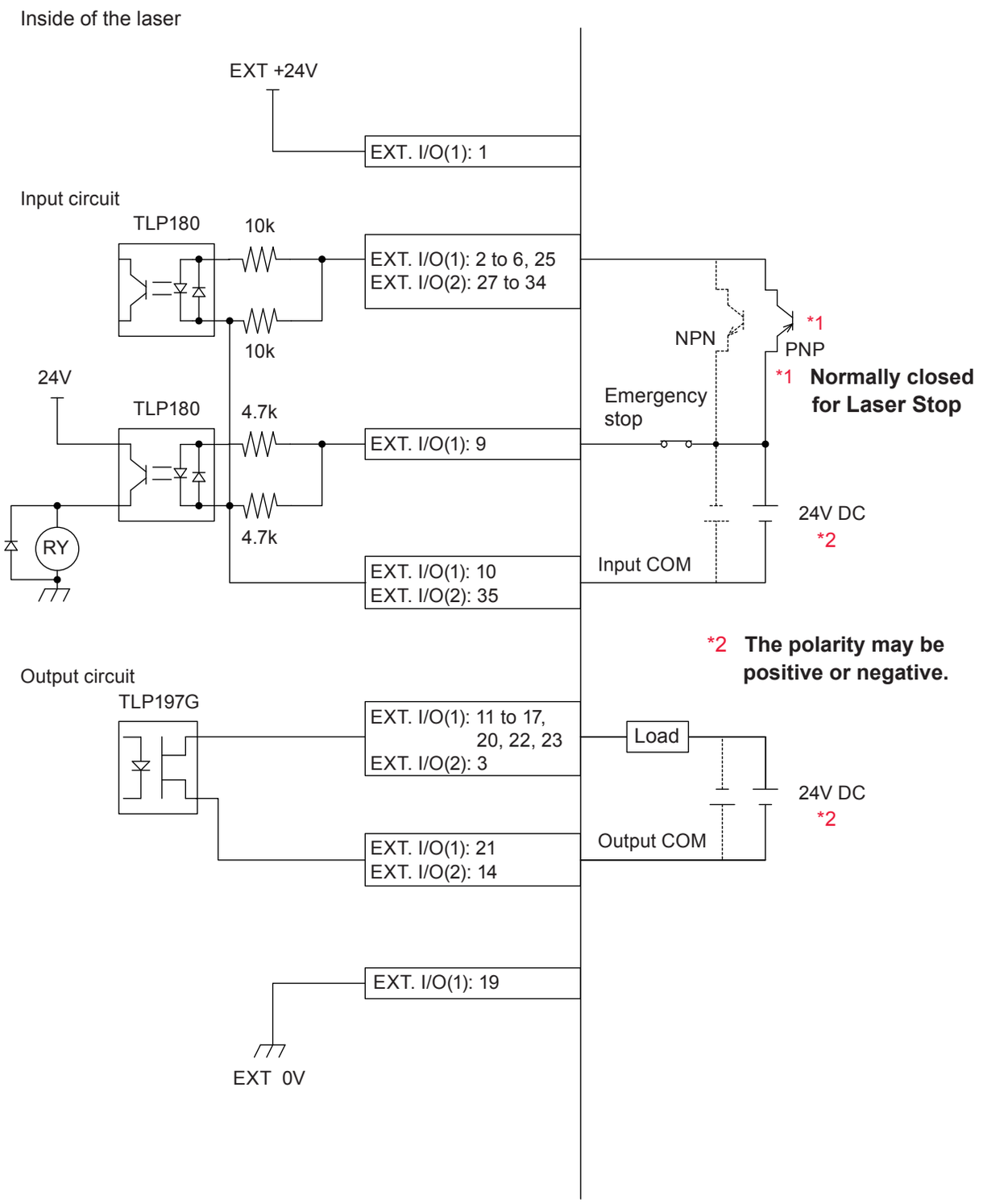
In this wiring example a Pilz PNOZ family safety relay module controls the Laser and interfaces two external emergency stop buttons. In this example the Pilz device would also control additional emergency stop functions outside of the Laser using expansion contacts. The more devices which must be implemented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



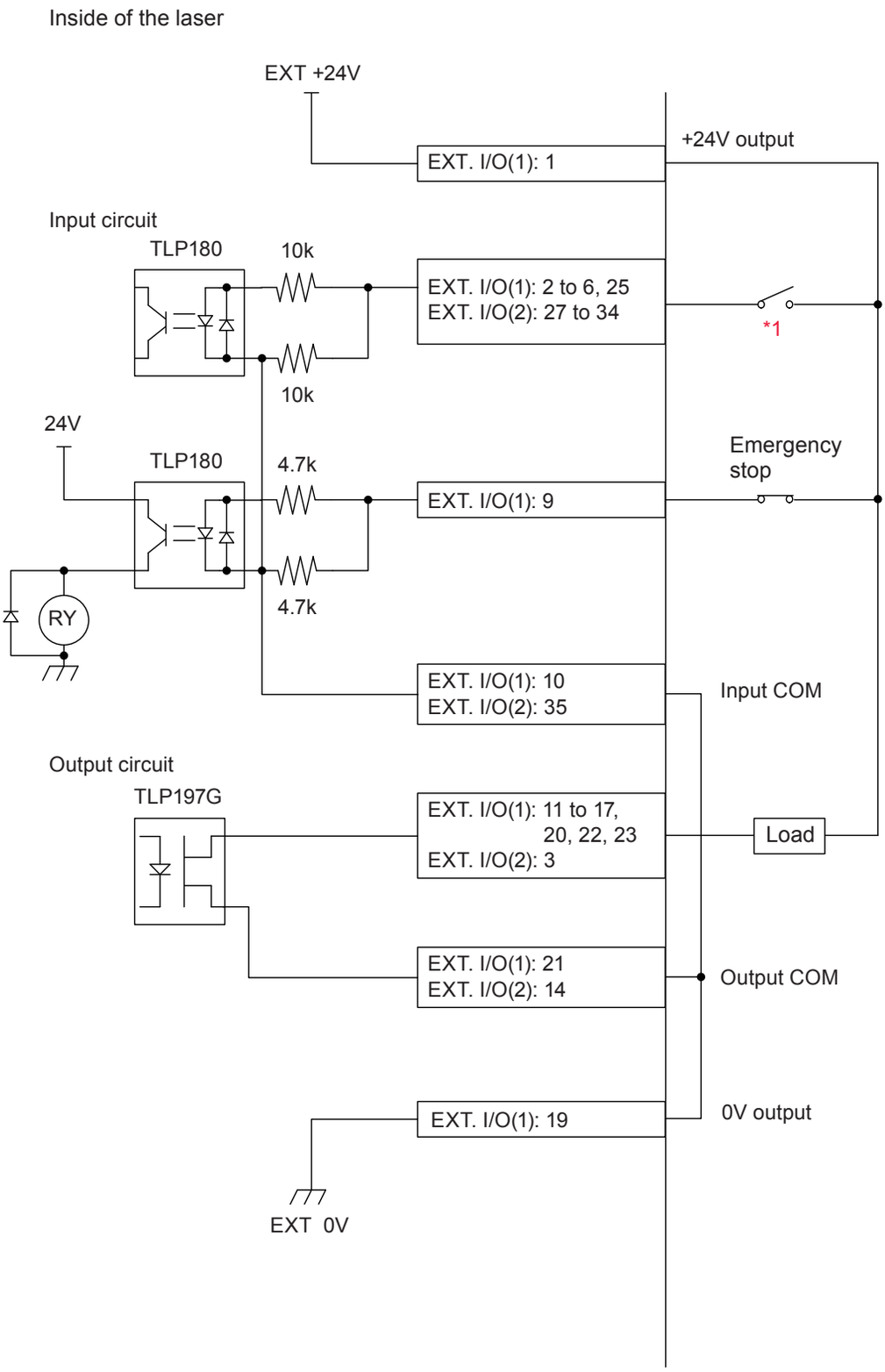
Example Connections of External Input/Output Signals

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

When Connected to an External Power Source



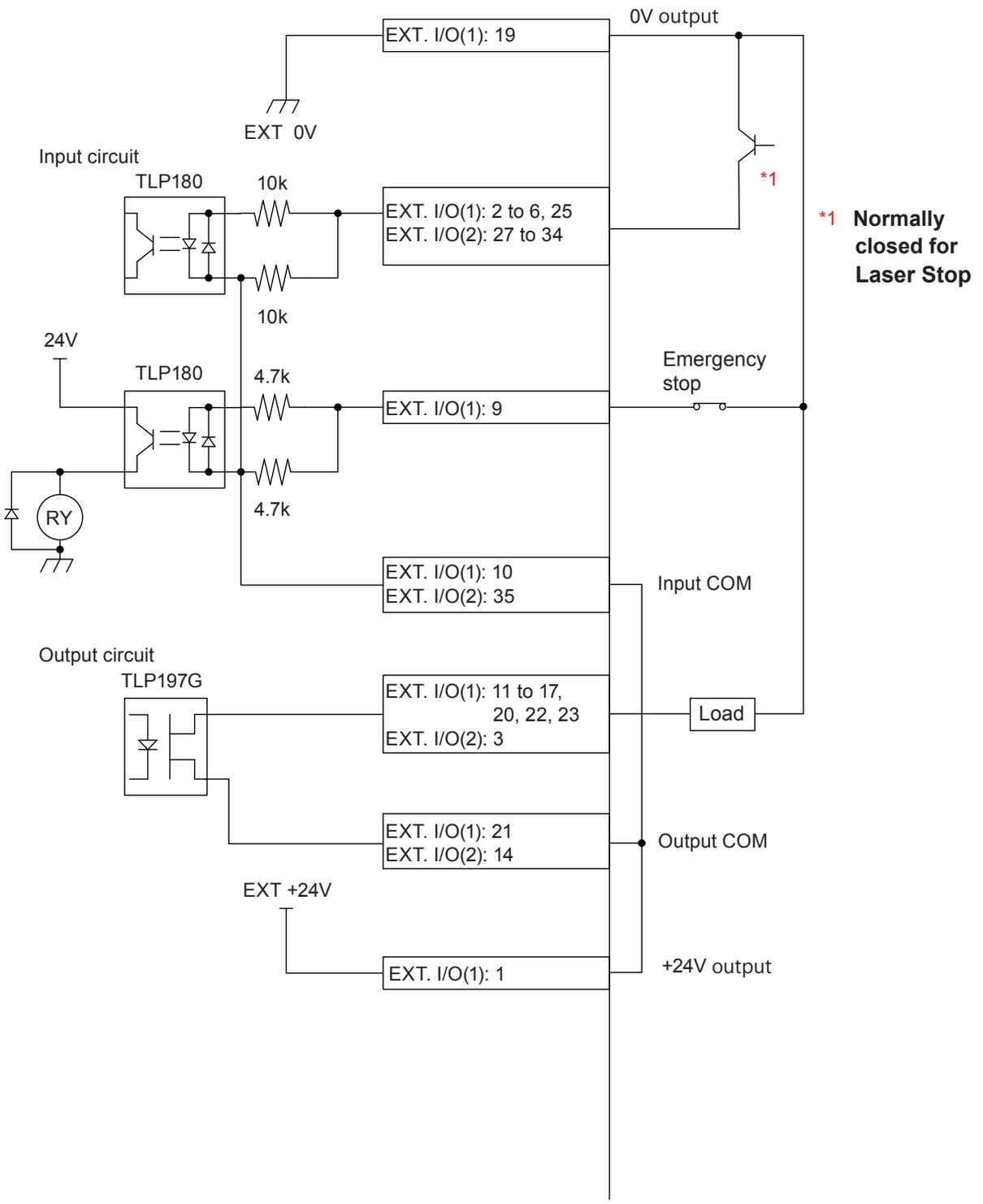
When Using a Contact Signal



*1 **Normally closed for Laser Stop**

When Using an Open-Collector Signal

Inside of the laser



*1 **Normally closed for Laser Stop**

4. Programming

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

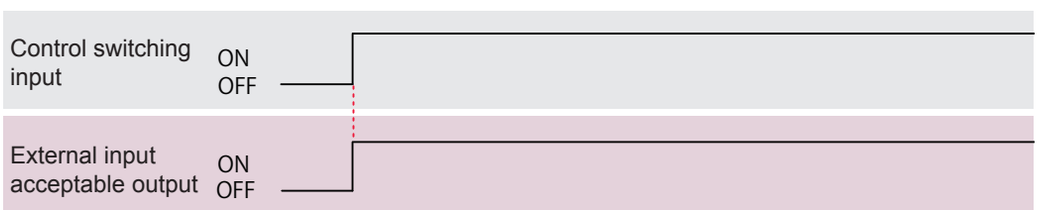
The timing chart of the appendix shows the input signal length and input waiting time required to correctly operate the laser. Perform actual programming referring to this timing chart.

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

1 Switching the Control Method

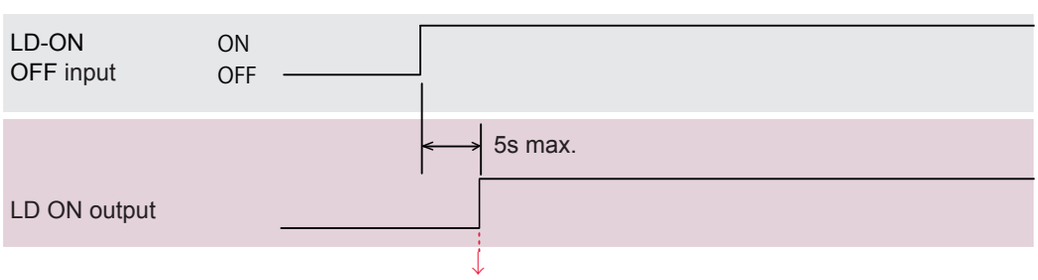
(1) Put pin No.25 (control switching) of the EXT. I/O (1) connector in a closed circuit.
Pin No.23 of the EXT. I/O (1) connector is put in a closed circuit and the signal (external input acceptable) is returned from the laser.

⇒ 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 Power Supply

(1) Put pin No.4 of the EXT. I/O (1) connector in a closed circuit to turn ON the LD power supply.
Pin No.11 of the EXT. I/O (1) connector is put in a closed circuit after 5 seconds maximum and the signal (LD ON) is returned from the laser.

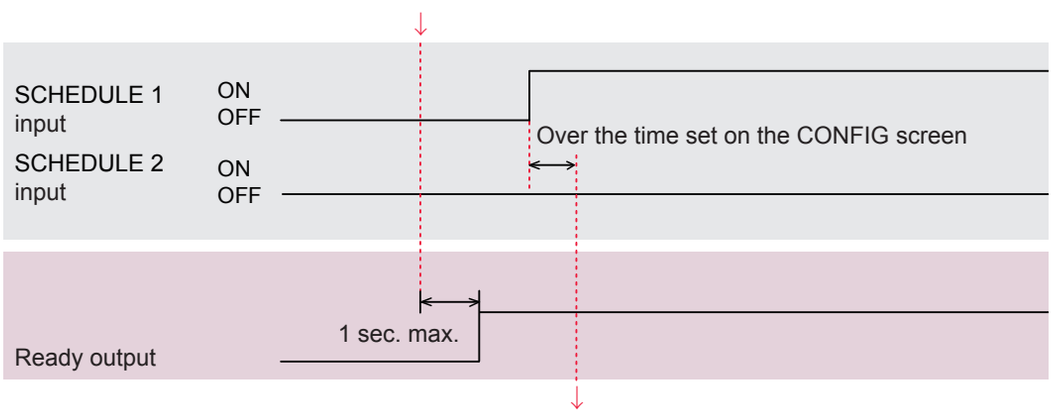


3 Setting Output Schedules (SCH.#01)

(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 4 ms or more to set SCH.#01.

⇒ At delivery, the signal acceptance time (time from a signal input till establishment of schedules) of processing schedules is set to 4 ms. Set the close circuit time referring to this value. As the signal acceptance time, 0.1 ms, 1 ms, 2 ms, 4 ms, 8 ms, or 16 ms can be selected by displaying the CONFIG screen. For details, refer to Chapter 2 "6. Changing the Acceptance Time for Laser Start Signal/ Schedule Signal".

When the laser can be output and a valid schedule is selected, 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 1 seconds maximum.

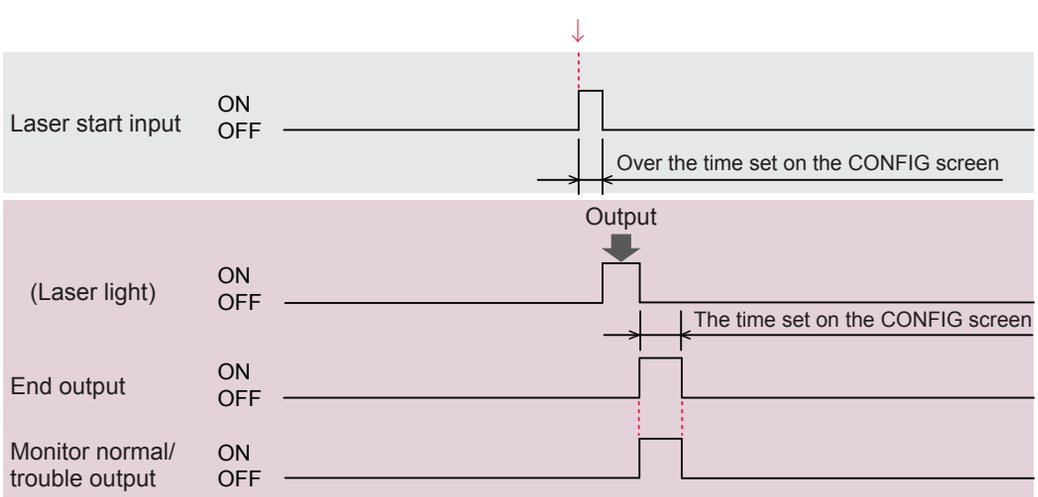


4 Outputting Laser Light

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

Laser light is output from the optical fiber.

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.



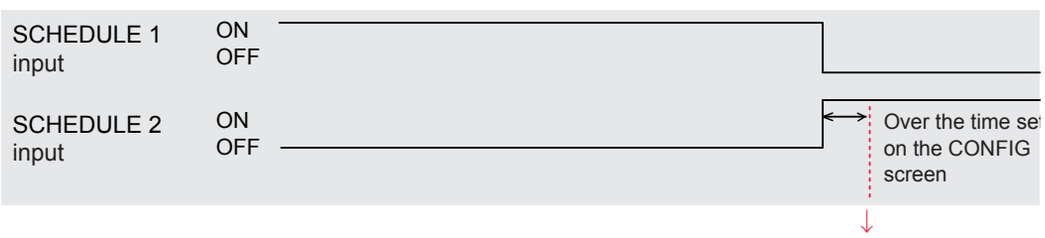
⇒ In more than the time set on the CONFIG screen after the setting of processing conditions, close the LASER START pin.

⇒ At delivery, the laser start acceptance time (time from a signal input till an actual output of laser light) is set to 4 ms. Set the close circuit time referring to this value. As the laser start acceptance time, 0.1 ms, 1 ms, 2 ms, 4 ms, 8 ms, or 16 ms can be selected by displaying the CONFIG screen. For details, refer to Chapter 2, "6. Changing the Acceptance Time for Laser Start Signal/Schedule Signal".

⇒ At delivery, the output time for the end signal and the monitor normal/trouble signal is set to 20 ms. 20 ms, 30 ms, or 40 ms can be selected by displaying the CONFIG screen.

5. Setting Output Schedules (SCH.#02)

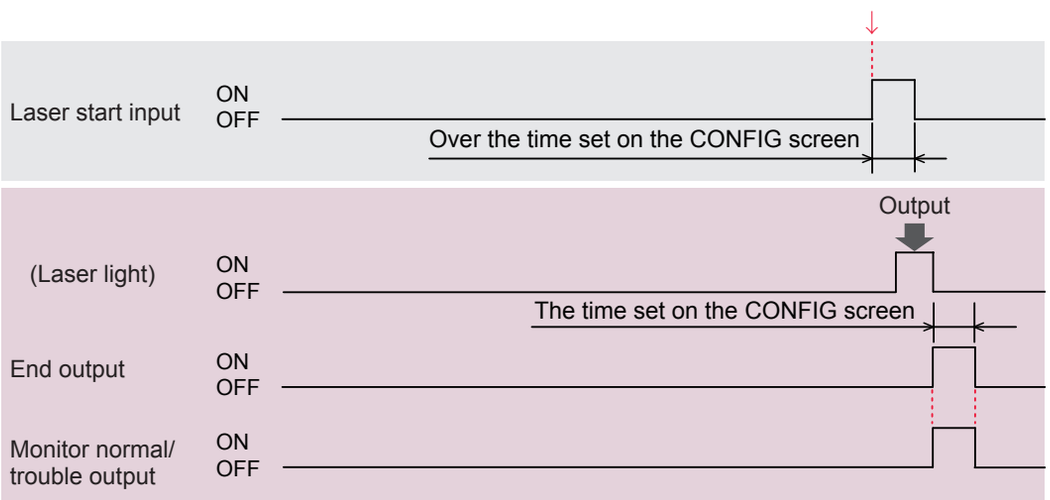
(1) Set the SCHEDULE number by combining pin No.27 to pin No.34 of the EXT. I/O (2) connector. In this example, put pin No.27 of the EXT. I/O (2) connector to an open circuit to turn OFF SCH.#01, and put pin No.28 in a closed circuit to turn on SCH.#02.



6. 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 from the optical fiber.

⇒ The details are the same as Step 5.



7 Stopping the Operation

(1) Put pin No.4 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) connector in an open circuit to invalidate external input signals.

Making a Position Adjustment by Guide Light

Make a position adjustment by guide light before processing 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.
Guide light can be seen as a red point. Laser light is irradiated to this red point position.

(3) Check the laser light irradiation position.
If the processing point deviates from the red point of guide light, move the output unit or workpiece to adjust the position.

Operating Part

Chapter 5

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

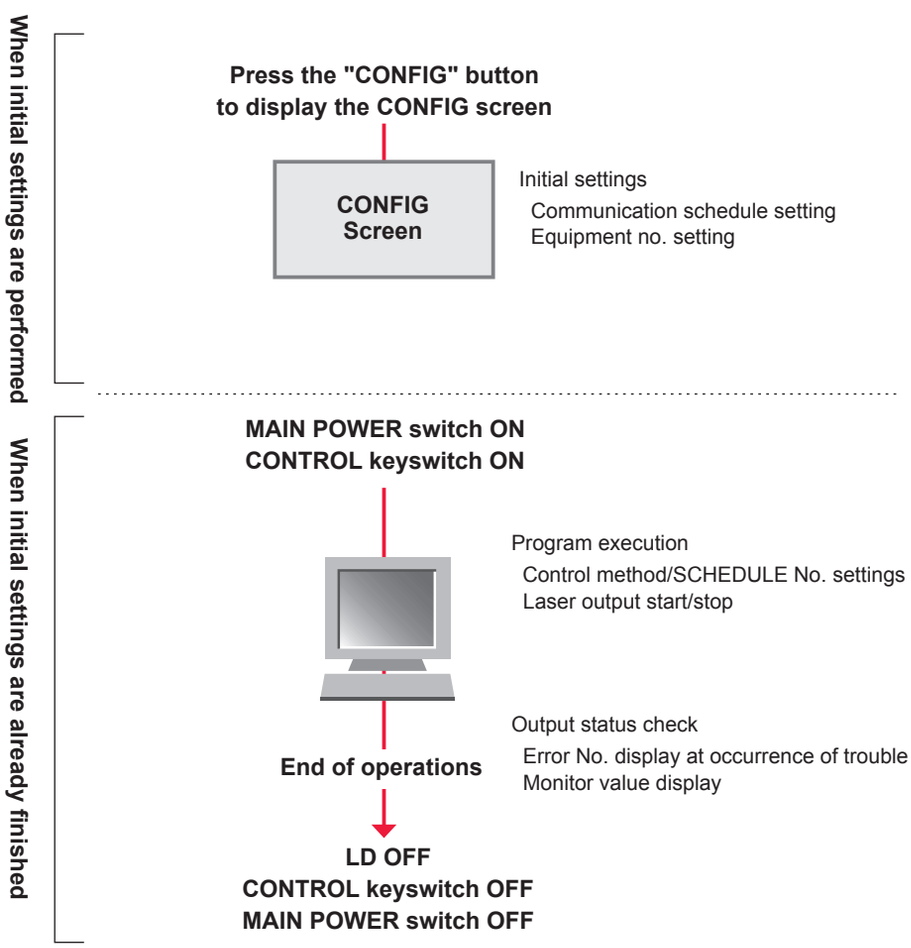
1. Operation Flow

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

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

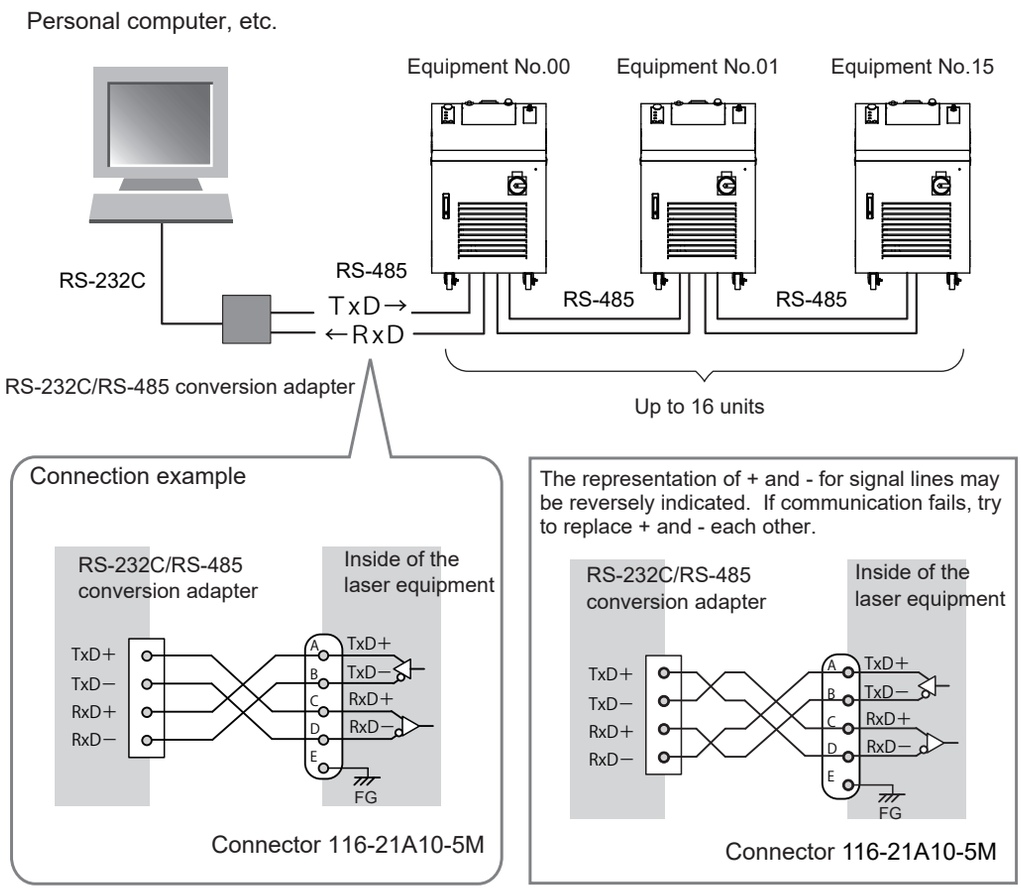
At the control by external communication (RS-485 CONTROL), the original customer-developed program is executed on the personal computer to set laser output schedules and read monitor data and various types of status.

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



2. Preparations for Operations

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



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

⇒ The RS-232C/RS-485 conversion adapter is an option separately sold. Purchase it as required. For details, refer to the Introduction Part, Chapter 1 "Options" on page 28.

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

⇒ It is recommended to use the shielded cable. To exhibit the shield effect, connect the shield of a cable to FG (frame ground) inside the laser equipment. Do not use it as SG (signal ground).

3. Initial Settings

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

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 RS-485 COMMUNICATION SETUP from the CONFIG screen by the laser controller of each equipment that is connected to the personal computer, etc.

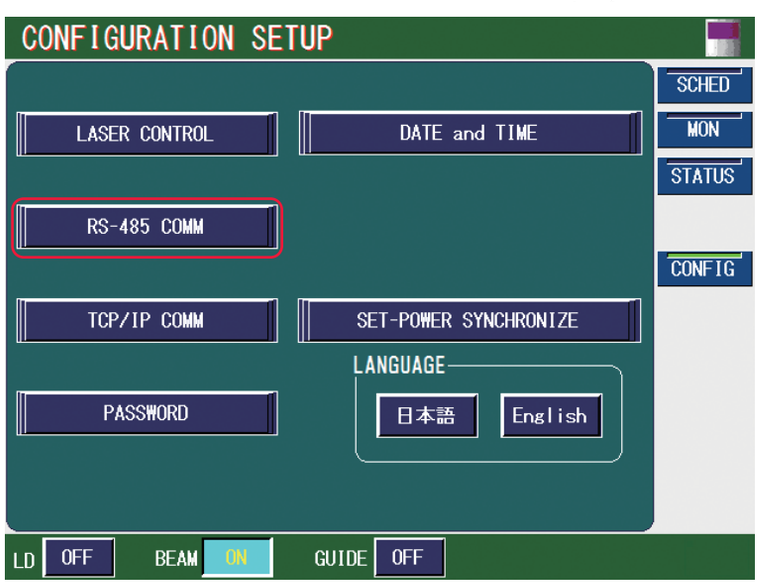
Setting Communication Schedules and Equipment No.

Set the communication schedules and equipment No. by displaying the RS-485 COMMUNICATION SETUP from the CONFIG screen by the laser controller of the equipment.

1 Displaying the CONFIG Screen

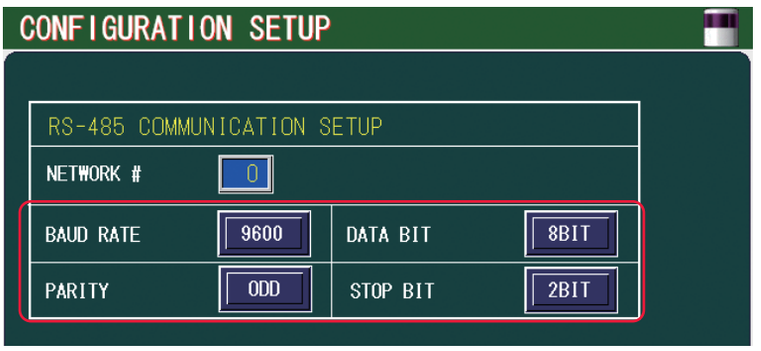
(1) Press the "CONFIG" button to display the CONFIG screen.

(2) Press the "RS-485 COMM" button.
The RS-485 COMMUNICATION SETUP is displayed.



2 Specifying Communication Schedules

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

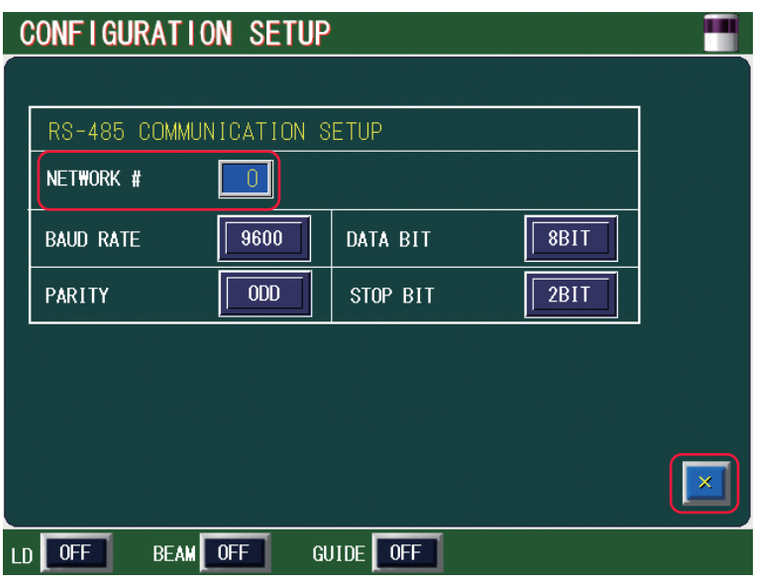


3 Specifying Equipment No.

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

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

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



(2) Press the "X" button.

Returns to the CONFIG screen.

4. Commands

This section explains the commands that are used to control laser processing 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 141 to "Reading the Equipment Name" on page 158.

Control Codes (Hexadecimal Codes)

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

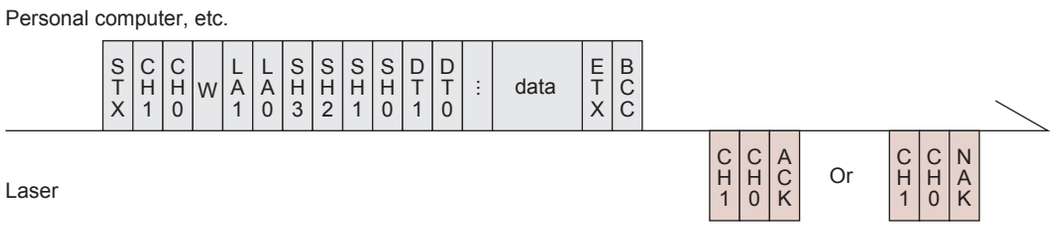
BCC (block check code) ... 1-byte horizontal even parity up to ETX excluding STX

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., 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.							
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., 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
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.							

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

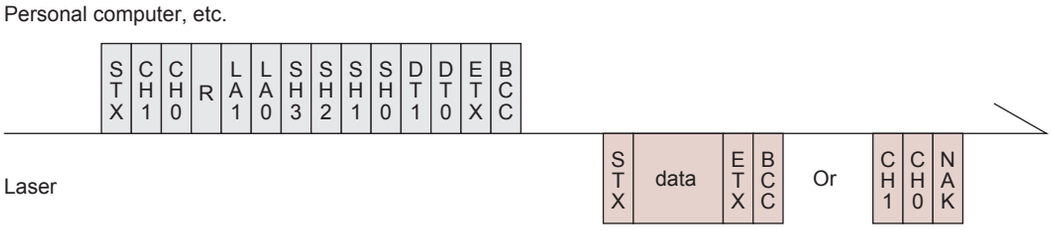
The command (code: W) to set processing schedules by specifying equipment No. and schedule No. is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
LA1/LA0	Classification No. of the setting (LA1 = tens digit, LA0 = units digit) 84 Schedule settings for FIX, FLEX and CW 85 Schedule settings for FIX 86 Schedule settings for FLEX, TIME 01 to 10 87 Schedule settings for FLEX, TIME 11 to 20 88 Schedule settings for FLEX, POWER 01 to 10 89 Schedule settings for FLEX, POWER 11 to 20 66 Schedule settings for CW, TIME 01 to 10 67 Schedule settings for CW, TIME 11 to 20 68 Schedule settings for CW, POWER 01 to 10 69 Schedule settings for 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 143. • 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 (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 processing 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) 84 Schedule settings for FIX, FLEX and CW 85 Schedule settings for FIX 86 Schedule settings for FLEX, TIME 01 to 10 87 Schedule settings for FLEX, TIME 11 to 20 88 Schedule settings for FLEX, POWER 01 to 10 89 Schedule settings for FLEX, POWER 11 to 20 66 Schedule settings for CW, TIME 01 to 10 67 Schedule settings for CW, TIME 11 to 20 68 Schedule settings for CW, POWER 01 to 10 69 Schedule settings for 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 51 Laser output total time 40 Backup memory settings 95 Laser power monitor — Shot count, Good count, average 00 Laser power monitor — Energy, number of waveform data, etc. 01 Laser power monitor — Waveform data 000 to 004 : : 20 Laser power monitor — Waveform data 095 to 099
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 143. • If “99” is entered, data is read in a batch. data: (Data No.1), (Data No.2), (Data No.3), … (the last Data No.) Insert [,] between individual data.
ACK or NAK	The Laser returns a [NAK] if the classification No., schedule No., or data No. falls outside the specified range.

Set Value/Monitor Value Table

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

⇒ The value in ( ) indicates the unit.

⇒ The unit of time setting depends on the setting of "RESOL" on the SCHEDULE screen. When setting to 0.05 ms, set the values in increment of 5.

84 Schedule Settings for FIX, FLEX and CW

Data No.	Item	Data Range
01	[FORM] on the [SCHEDULE] screen Selection of waveform setting method 0: FIX 1: FLEX 2: CW	0 – 2
02	Turning ON/OFF the graph display on the [SCHEDULE] screen 0: OFF 1: ON	Fixed to 1
03	[SET POWER] on the [SCHEDULE] screen Laser output set value	MF-C300A-SF: 00030 – 00300 MF-C500A-SF: 00050 – 00500
04	[REPEAT] on the [SCHEDULE] screen Pulse repetition rate	FIX/FLEX : 00001 – 01000 (Cannot be set in the CW mode.)
05	[SHOT] on the [SCHEDULE] screen Number of consecutive shots	FIX/FLEX : 0001 – 9999 (Cannot be set in the CW mode.)
06	[HIGH] on the [MONITOR] screen Energy monitor upper limit setting	FIX/FLEX : 000000 – 999999 (×0.1J/×0.01J) CW : 000000 – 000999 (×1%)
07	[LOW] on the [MONITOR] screen Energy monitor lower limit setting	FIX/FLEX : 000000 – 999999 (×0.1J/×0.01J) CW : 000000 – 000999 (×1%)
08	Turning ON/OFF the graph display on the [MONITOR] screen 0: OFF 1: ON	Fixed to 1
09	Unused	Fixed to 100

85 Schedule Settings for FIX

Data No.	Item	Data Range
01	[↑SLOPE] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
02	[FLASH 1] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
03	[FLASH 2] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
04	[FLASH 3] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
05	[↓SLOPE] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
06	Unused	Fixed to 0000
07	[FLASH 1] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)

Data No.	Item	Data Range
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	000000 – 999999 (×0.01J)
12	[COOL 1] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
13	[COOL 2] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)

86 Schedule Settings for FLEX — TIME 01 to 10

Data No.	Item	Data Range
01	[POINT 01] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
02	[POINT 02] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
03	[POINT 03] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
04	[POINT 04] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
05	[POINT 05] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
06	[POINT 06] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
07	[POINT 07] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
08	[POINT 08] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
09	[POINT 09] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
10	[POINT 10] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)

87 Schedule Settings for FLEX — TIME 11 to 20

Data No.	Item	Data Range
01	[POINT 11] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
02	[POINT 12] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
03	[POINT 13] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
04	[POINT 14] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
05	[POINT 15] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)

Data No.	Item	Data Range
06	[POINT 16] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
07	[POINT 17] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
08	[POINT 18] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
09	[POINT 19] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)
10	[POINT 20] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms) 0000 – 9995 (×0.01ms)

88 Schedule Settings for FLEX — POWER 01 to 10

Data No.	Item	Data Range
01	[POINT 01] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
02	[POINT 02] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
03	[POINT 03] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
04	[POINT 04] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
05	[POINT 05] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
06	[POINT 06] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
07	[POINT 07] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
08	[POINT 08] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
09	[POINT 09] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
10	[POINT 10] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)

89 Schedule Settings for FLEX — POWER 11 to 20

Data No.	Item	Data Range
01	[POINT 11] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
02	[POINT 12] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
03	[POINT 13] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
04	[POINT 14] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
05	[POINT 15] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
06	[POINT 16] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
07	[POINT 17] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
08	[POINT 18] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
09	[POINT 19] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
10	[POINT 20] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)

66 Schedule Settings for 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/×0.001s)
02	[POINT 02] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
03	[POINT 03] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
04	[POINT 04] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
05	[POINT 05] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
06	[POINT 06] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
07	[POINT 07] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
08	[POINT 08] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
09	[POINT 09] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
10	[POINT 10] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)

67 Schedule Settings for 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/×0.001s)
02	[POINT 12] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
03	[POINT 13] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
04	[POINT 14] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
05	[POINT 15] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
06	[POINT 16] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
07	[POINT 17] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
08	[POINT 18] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
09	[POINT 19] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
10	[POINT 20] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)

68 Schedule Settings for 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 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%)
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

Data No.	Item	Data Range
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 modulation 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 01 and 20.	Fixed to 100
05*	Flash pulse width	0000 – 5000 (×0.1ms)

01 Laser Power Monitor — Waveform data 000 to 004

: :

20 Laser Power Monitor — Waveform data 095 to 099

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 100 or less by extending the measurement interval.
(Example)

Pulse width	Measurement interval
0.05 to 0.45 ms	0.005 ms
0.50 to 0.90 ms	0.01 ms
0.95 to 1.80 ms	0.02 ms
1.85 to 4.50 ms	0.05 ms
4.55 to 9.00 ms	0.1 ms
9.05 to 18.00 ms	0.2 ms
18.05 to 45.00 ms	0.5 ms
45.05 to 90.00 ms	1.0 ms
90.05 to 180.00 ms	2.0 ms
180.05 to 450.00 ms	5.0 ms
450.05 to 900.00 ms	10.0 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.

51 LD Output Total Time

Data No.	Item	Data Range
01*	[FLASH WORK TIME] on the [STATUS] screen	0000000 – 9999999 (×0.1H)

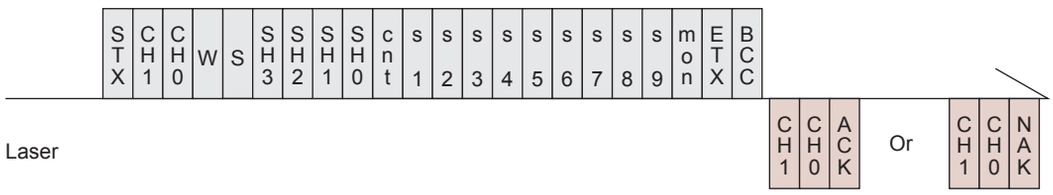
40 Backup Memory Settings

Data No.	Item	Data Range
01*	[NETWORK #] on the [CONFIG] screen	00 – 15
02*	[IP ADDRESS] on the [CONFIG] screen	000000000000 – 999999999999
03*	[SUBNET MASK] on the [CONFIG] screen	000000000000 – 999999999999
04*	[DEFAULT GATEWAY] on the [CONFIG] screen	000000000000 – 999999999999
05*	Unused	Fixed to 00
06*	Unused	Fixed to 000
07*	Unused	Fixed to 0
08*	Unused	Fixed to 00000000
09*	Unused	Fixed to 00000000
10*	Unused	Fixed to 00000000
11*	Unused	Fixed to 00000000
12*	Unused	Fixed to 00000000
13*	Unused	Fixed to 00000000

Setting the Control Method, SCHEDULE No., etc.

The command (code: WS) to set the control method, SCHEDULE No., 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.

Personal computer, etc.



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) 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.
cnt	Control method 0: Control by laser controller 1: Control by external input/output signals (Output schedules are set on the laser controller.) 2: Control by external communication control 3: Maintenance mode 4: (Missing number) 5: Control by external input/output signals (Output schedules are set on the personal computer.) * The cnt value that can be set from the personal computer is "0" and "2." If another value or □ (space) is set, the control method cannot be changed. It is impossible to set "Control by external input/output signals" or "Maintenance mode." * The maintenance mode is used for our engineer to perform maintenance. Usually, this mode is not used by customer. In the maintenance mode, the control method cannot be changed. * When the CONTROL keyswitch is turned OFF, the control method is returned to "0: Control by laser controller" (when the control by external input/output signals is OFF). * To change the control method, blank all the other items. **When the control by external input/output signals (EXTERNAL CONTROL) is ON** The control by external input/output signals has priority over the other control methods. When "0" or "2" is entered from the personal computer, the control method is as shown in the following table. The order of setting does not matter.

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

	* When the external input/output control is turned OFF at "1: Control by external input/output signals (Output schedules are set on the laser controller)", the control method is changed to "0: Control by laser controller." * When the external input/output control is turned OFF at "5: Control by external input/output signals (Output schedules are set on the personal computer)", the control method is changed to "2: Control by external communication control."
s1	LD (0: OFF 1: ON □: Current status kept)
s2	Guide light (0: OFF 1: ON □: Current status kept)
s3	Unused (fixed to □)
s4	Unused (fixed to □)
s5	Unused (fixed to □)
s6	Unused (fixed to □)
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 laser is output, "00 Laser Power Monitor-Energy, number of waveform data, etc." on page 149 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 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

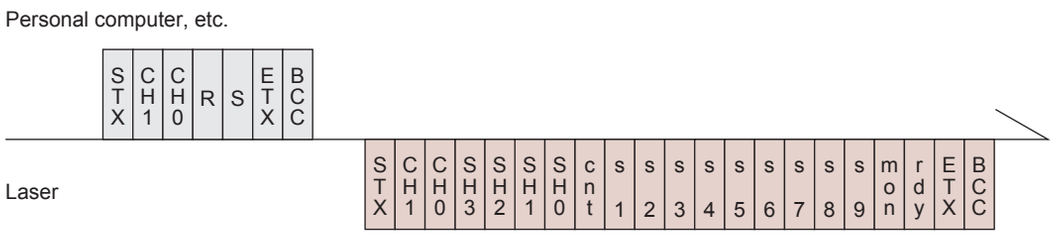
CH1	CH0	NAK

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., etc.

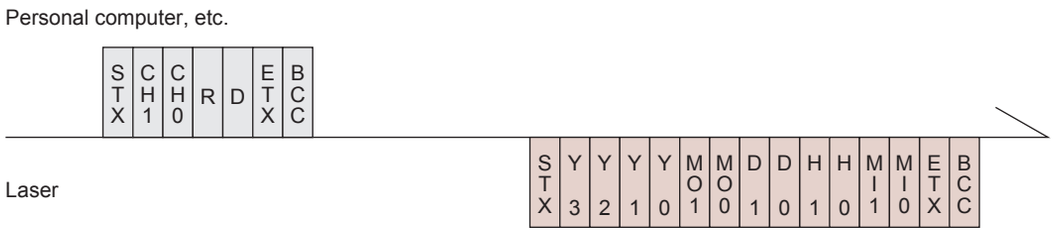
The command (code: RS) to read the control method, SCHEDULE No., LD ON/OFF status, guide light ON/OFF status, automatic laser power value transmission ON/OFF status, etc. is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
SH3/SH2/SH1/SH0	Schedule No. (SH3 = thousands digit, SH2 = hundreds digit, SH1 = tens digit, SH0 = units digit)
cnt	Control method 0: Control by laser controller 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	Unused (fixed to 0)
s5	Unused (fixed to 0)
s6	Unused (fixed to 0)
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 laser is output, "00 Laser Power Monitor-Energy, number of waveform data, etc." on page 149 is sent.
rdy	READY status (0: Laser start disabled 1: Laser start enabled)

Reading the System Date and Time

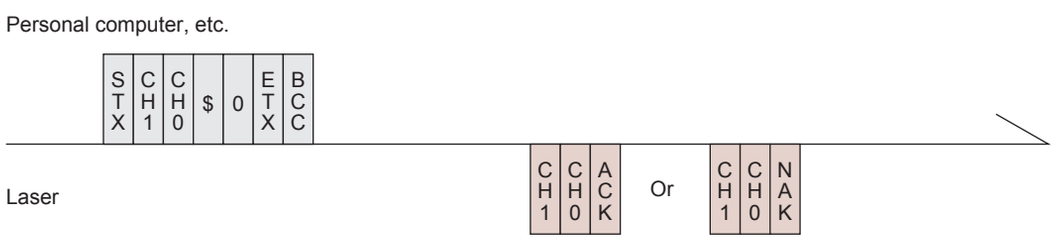
The command (code: RD) to read the system date and time is explained below.



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

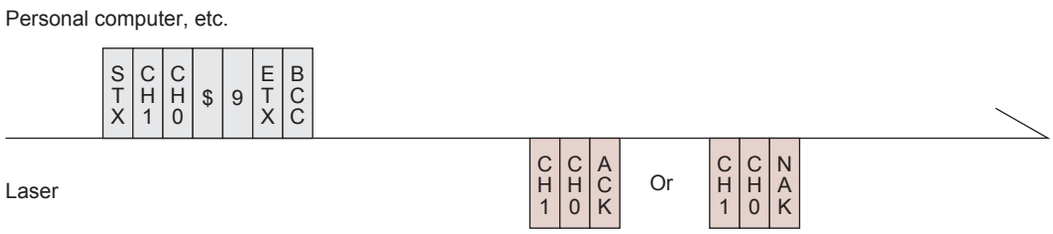
The command (code: $0) to start a laser light output is explained below.



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

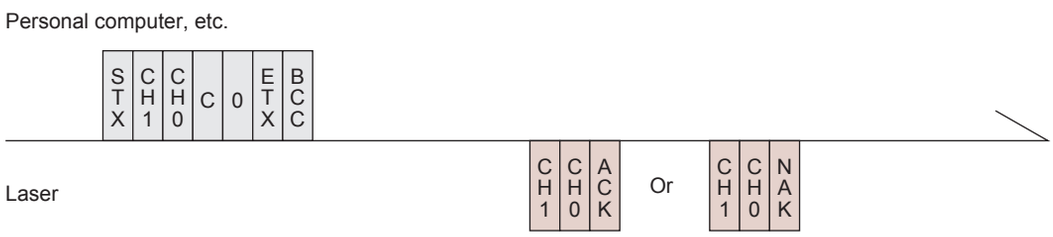
The command (code: $9) to stop a laser light output is explained below.



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

Stopping an Error Signal Output

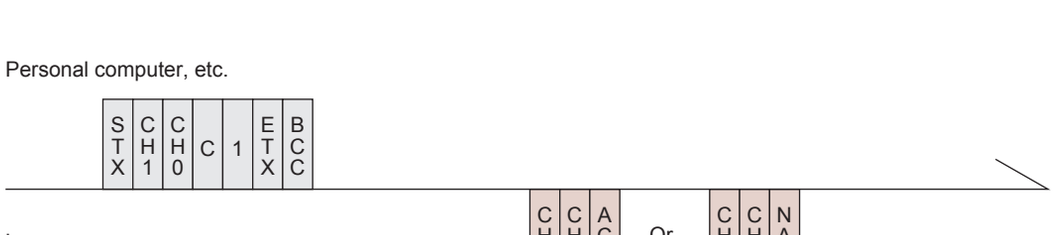
The command (code: C0) to stop an error signal output is explained below.



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

Resetting the Total Number of Outputs

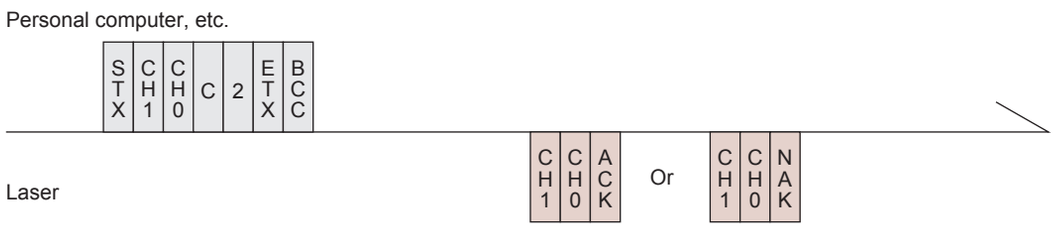
The command (code: C1) to reset the total number of outputs (SHOT COUNT) is explained below.



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

Resetting the Appropriate Number of Outputs

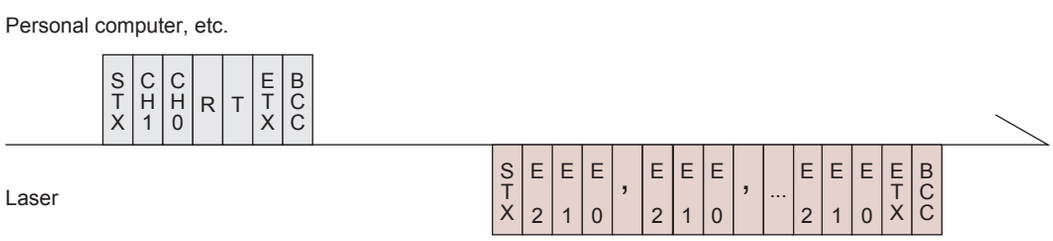
The command (code: C2) to reset the appropriate number of outputs (GOOD COUNT) is explained below.



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

Reading Error No. at Occurrence of Trouble

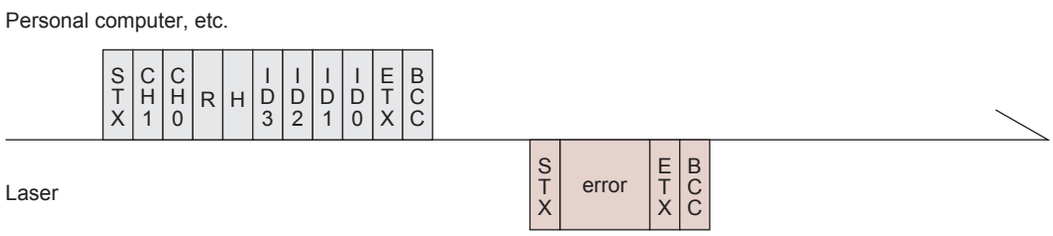
The command (code: RT) to read error No. at occurrence of trouble is explained below.



CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
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 171.

Reading the Error History

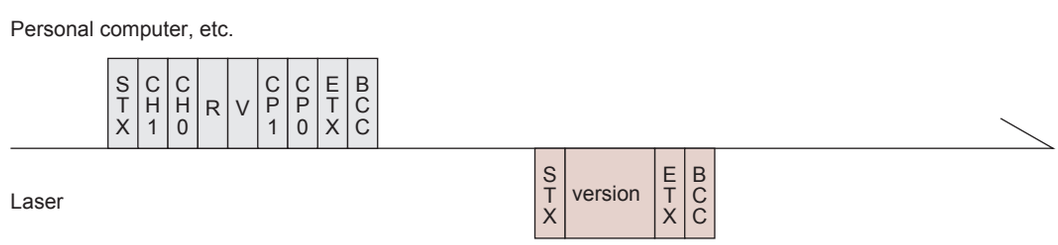
The command (code: RH) to read the error history is explained below.



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.

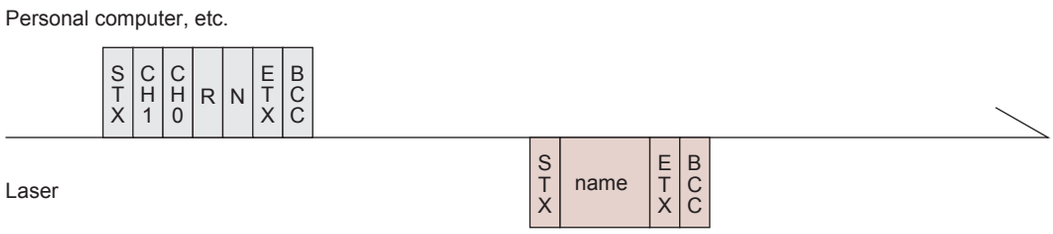


CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
CP1/CP0	CPU No. (CP1 = tens digit, CP0 = units digit) 00: CPU 01: MAIN FPGA 02: SUB FPGA • If “99” is entered, data is read in a batch.

version	Version information (nnnnnnnnnnnnnnnsssssssssssvvvvvvvvyyyymmddhhmm) nnnnnnnnnnnnnn Software name sssssssss 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 Part

Chapter 1

How to Perform Maintenance

NOTE

Simple user maintenance tasks are described in this chapter. For optimal performance, we recommend regular inspections. Contact us for further details.

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

⚠ WARNING

- **Before starting maintenance operations, be sure to turn OFF the power supply.**
- **Turning ON the power supply for an operation check during maintenance puts the laser in oscillation. Take extreme care about it.**
- **The operator and those who may receive laser light during maintenance must put on protective glasses.**

⚠ CAUTION

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

1. Maintenance Parts and Standard Intervals of Inspection/Replacement

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

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

Part name		Model No.	Operation interval (standard) (*1)	Contents of operation (*2)
Lithium battery (*3)		CR 2450	3 years	Replace
MAIN POWER switch		P3-63/V/SVB-SW	5 years	Replace
Switching power supply		PLA300F-24	5 years	Repair or Replace
Oscillator unit (*4)	MF-C300A-SF	AS1194550	4 years	Replace
	MF-C500A-SF	AS1194173		
Air filter		PC1194553 or PC1212902 (*6)	Every month	Clean
			1 year	Replace
Protective glass		Specified glass for output unit	Every day	Clean
			Every month	Replace (*5)

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

*1: The operation interval means the maintenance time or expected life of the part, and is different from the 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: The oscillator unit is the laser oscillator including the excitation LD. If the laser output drops down and the processing conditions cannot be restored despite setting the maximum output, it is determined as the end of its useful life. The warranty is valid for a period of two years. However, usage out of specifications, for example, failing to perform cleaning when connecting the optical fiber described in the Installation and Preparation Part, Chapter 2 “4. Connecting the Optical Fiber” on page 45 or keep the bending radius of the optical fiber, is not covered by the warranty.

*5: We do not specify a degree of parallelism of our standard protective glass. Therefore, the condensing position may be shifted before and after replacing the protective glass due to individual differences. The protective glass having a very small positional deviation is also available. Contact us as needed.

*6: The model number of the air filter differs depending on the manufacturing date of the equipment. Contact a nearest sales office.

2. Maintenance of the Laser Oscillator

Inspecting the Laser Output

Measure and inspect the laser output before and after operation.

It is recommended that the installation space for the laser power meter is secured so that the laser output from the output unit can be measured.

⚠ WARNING

Wear protective glasses. Shield the scattered light because it is also hazardous.

Item required

Laser power meter (FL500A-LP1 manufactured by Ophir is recommended) and protective glasses

⚠ CAUTION

Calibrate the laser power meter every year.

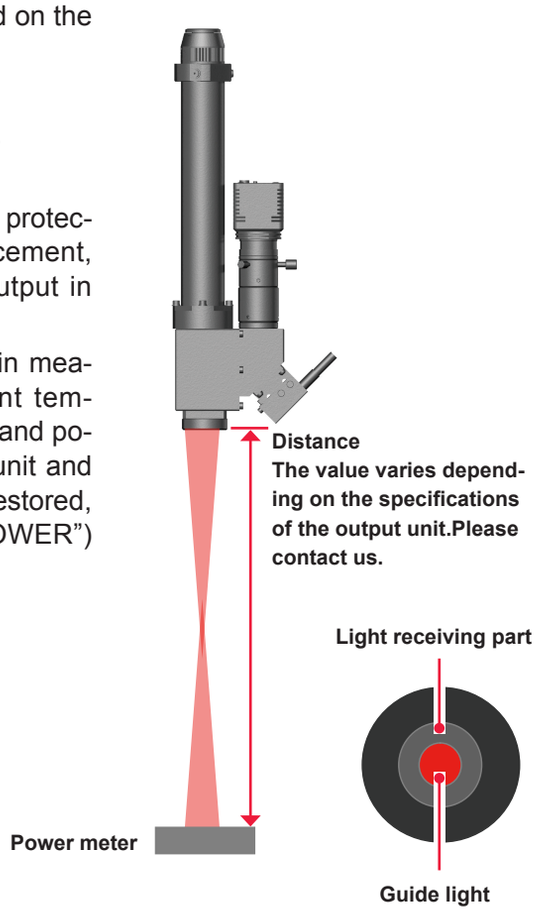
Operating Procedure

(1) Turn on the guide light and adjust the position so that the guide light is centered on the power meter.

(2) Output the laser light and measure it.

If the output is low, clean or replace the protective glass of the output unit. For replacement, refer to the operation manual for the output in use.

Also check whether there is no change in measurement environment such as ambient temperature, cooling fan of the power meter, and positional relationship between the output unit and the power meter.When the output is not restored, set the laser output set value ("SET POWER") again.



Correcting the Laser Power

This section explains how to correct the lowering of output caused by deterioration of the optical module.

Perform the following procedure when the rated output cannot obtained even if "SET POWER" on the SCHEDULE screen is set to the maximum value.

1 Validating the Laser Power Correction Function

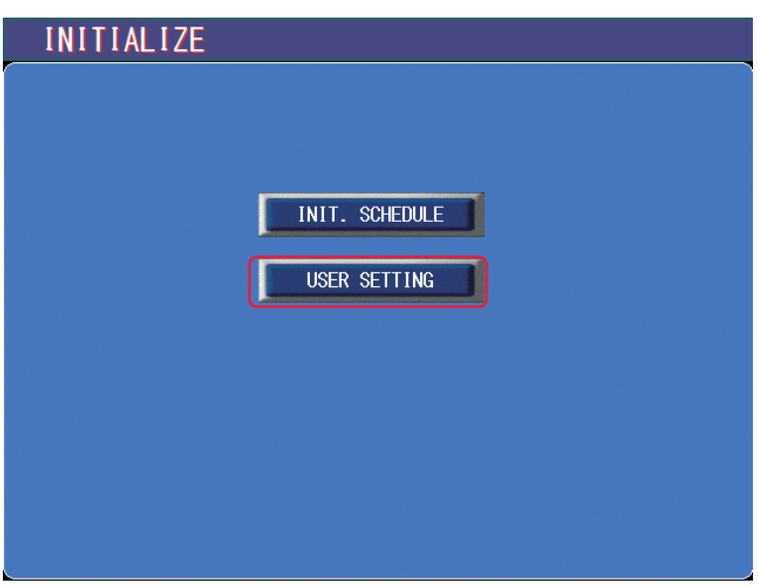
(1) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch.
Power is supplied and the POWER lamp comes on.

(2) While the KEY SWITCH CHECK screen is displayed, press the “INITIALIZE” button, pressing the right button (red portion in the figure below) of the laser controller.

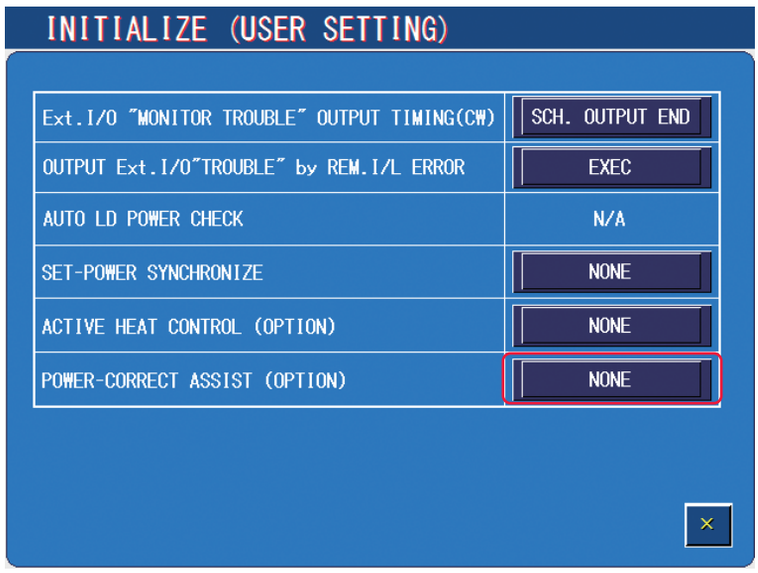
⇒ Unless the CONTROL keyswitch is OFF, the KEY SWITCH CHECK screen does not appear.

The INITIALIZE screen appears.

(3) Press the “USER SETTING” button.
The USER SETTING screen is displayed.

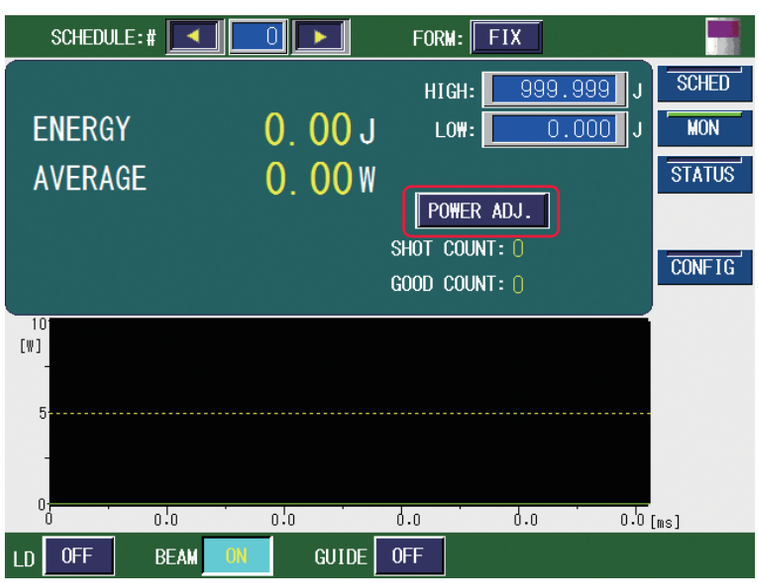


(4) Press the “POWER-CORRECT ASSIST (OPTION)” setting button and set to USE to restart the equipment.



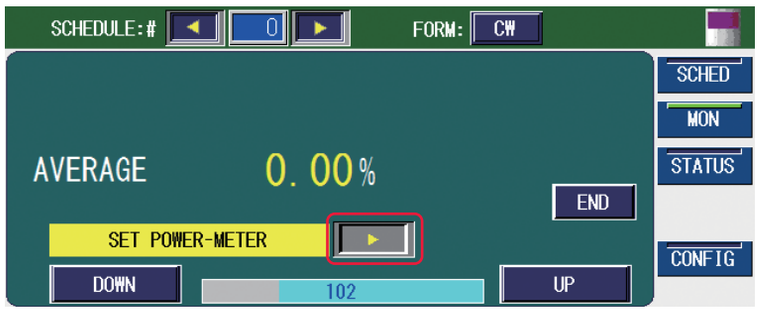
2 Correcting the Laser Output

(1) Display the MONITOR screen and depress the “POWER ADJ.” button for about 1 second.

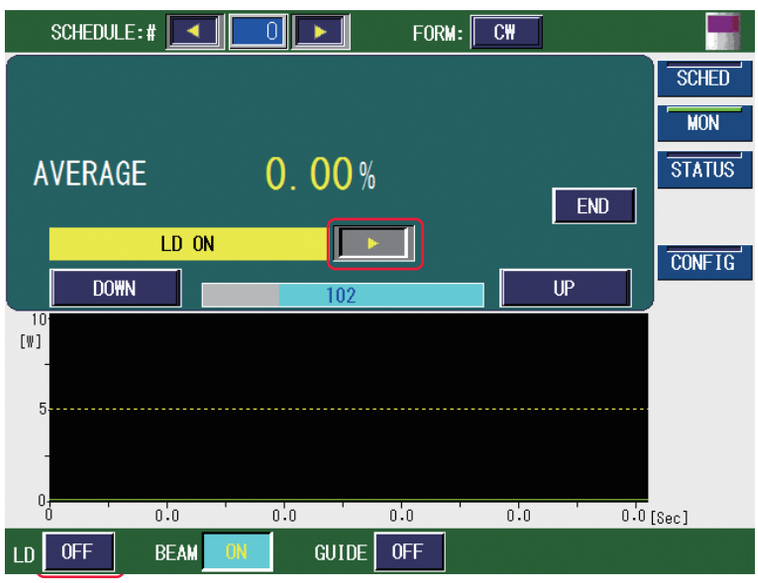


(2) Set up the power meter. (Operate according to the display of the yellow line.)

Confirm that the power meter is placed at the proper position. After wearing protective glasses and confirming that the safety against the scattered light is ensured, press ▶ button.

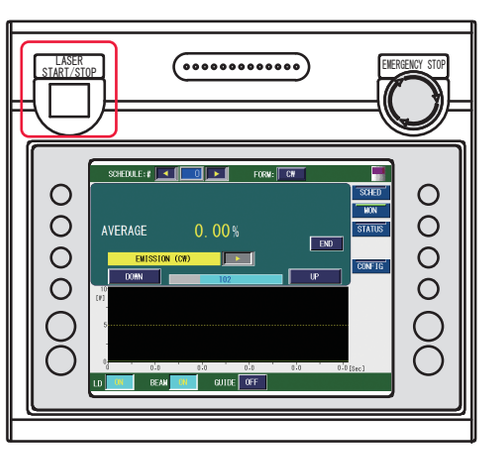


(3) Press the “LD” setting button to set it to ON.
Confirm that the LD is turned ON and press the ▶ button.



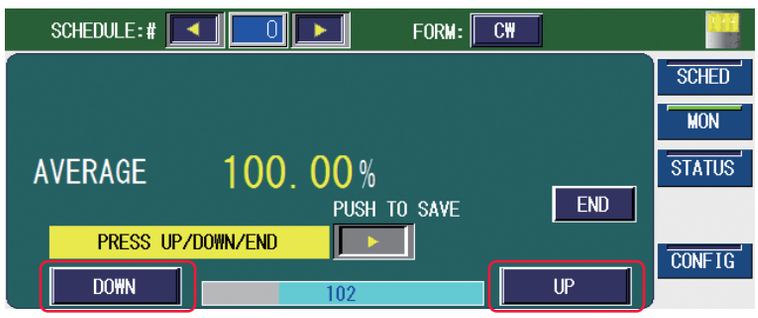
(4) Press the LASER START/STOP button of the laser controller.
Check the display on the power meter and confirm that the laser is emitted. The laser is emitted with the rated output setting.

⇒ Due to characteristics of the power meter, it takes 30 to 60 seconds until the measurement value is stabilized after emission.



(5) Depress the “UP” button to increase the output and the “DOWN” button to decrease it for about 1 second.

Adjust it within the range of gauge. One-clicking button adjusts the output approx. 1% to 3%. The rising rate may be not constant according to the individual difference. Check the output with the power meter.



⇒ The UP/DOWN adjustment is effective only when “PRESS UP/DOWN/END” is displayed. When UP is clicked beyond the rated output, error No.221/OUTPUT POWER HIGH (A10) occurs. Confirm that the measurement of the power meter is proper.

⇒ Make the UP/DOWN adjustment within the range of gauge (100 to 110).

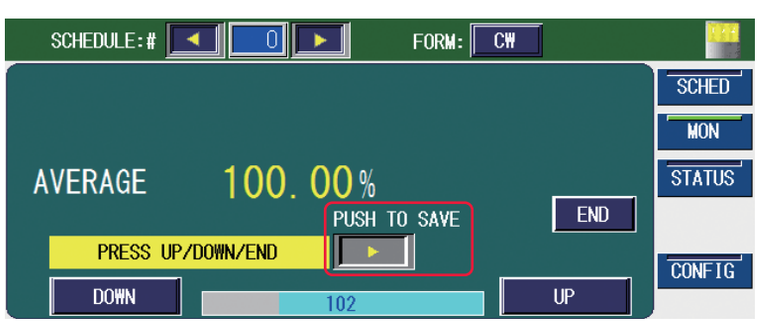
⇒ Since the adjustment range (100 to 110) is displayed by an integer, the displayed numeral value may not change even if the buttons are pressed, but it actually changes. Check the output with the power meter.

⇒ The laser power correction function is to correct with the maximum rated current. After correction, also check the output on the SCHEDULE screen.

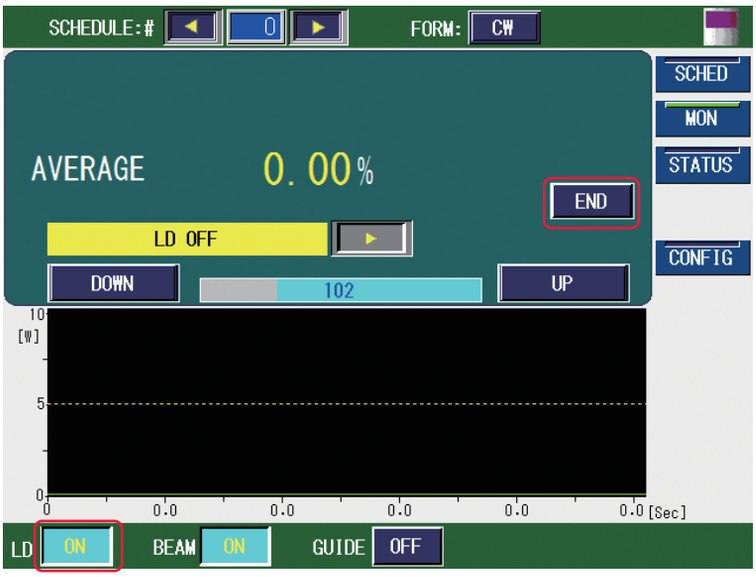
⚠ CAUTION

The laser power correction function is for restoring the lowered output. Make sure not to exceed the rated output. It will not coverd by the warranty even if it is still within the warranty period since it causes a high load and the product lifetime is shortened.

(6) After the UP/DOWN adjustment, press the ▶ button with a message of “PUSH TO SAVE” to save the setting.



(7) Press the “LD” setting button to set it to OFF and press the “END” button.



When a further adjustment is necessary, repeat Step **2**.

Cleaning and Replacing the Protective Glass

Clean the protective glass every day and replace it every month. For how to clean and replace the protective glass, refer to the operation manual for the output unit in use.

⚠ CAUTION

Using a dirty protective glass may make the laser beam attenuation large.

Item required

Operation manual for the output unit, protective glass, and cleaning paper

3. Maintenance of the Power Supply Section

Cleaning the Air Filter

An air filter is provided at the air inlet beyond the door on the front face of the main unit. Perform cleaning every month.

<Note>

Not performing cleaning of the air filters decreases the cooling capacity, increases the internal temperature, and affects the service life of parts. To give normal performance of the laser welder, perform cleaning periodically.

Item required

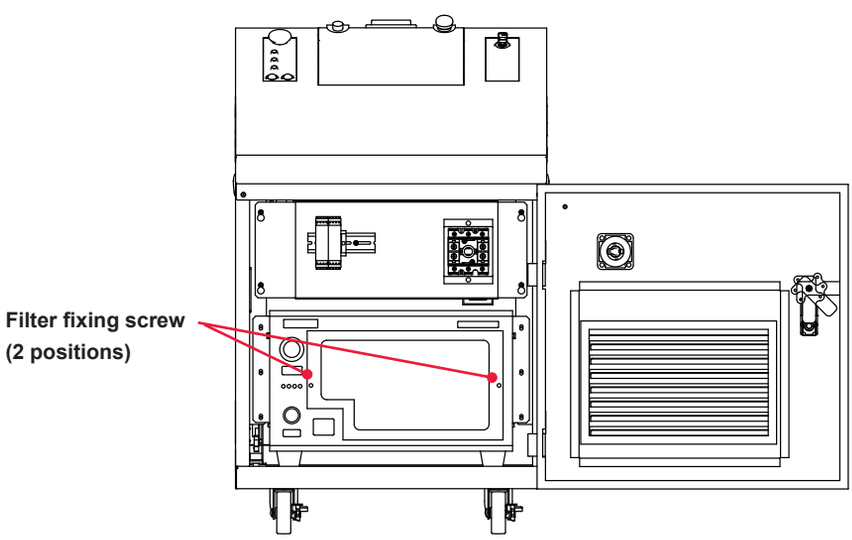
Hexagon wrench (2 mm) or Phillips screwdriver

⇒ The item required differs depending on the manufacturing date of the equipment.

Operating Procedure

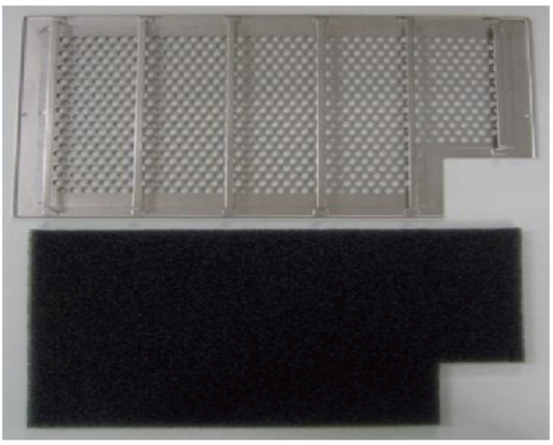
(1) Open the front door.

(2) Remove two filter fixing screws by turning them with a hexagon wrench or Phillips screwdriver.



(3) Take out the air filter and wash it in tap water. Then, dry the air filter completely.

⇒ When the air filter is very dirty, use a neutral cleaner.



(4) Install the air filter and tighten the bezel with the filter fixing screws.

Maintenance Part

Chapter 2

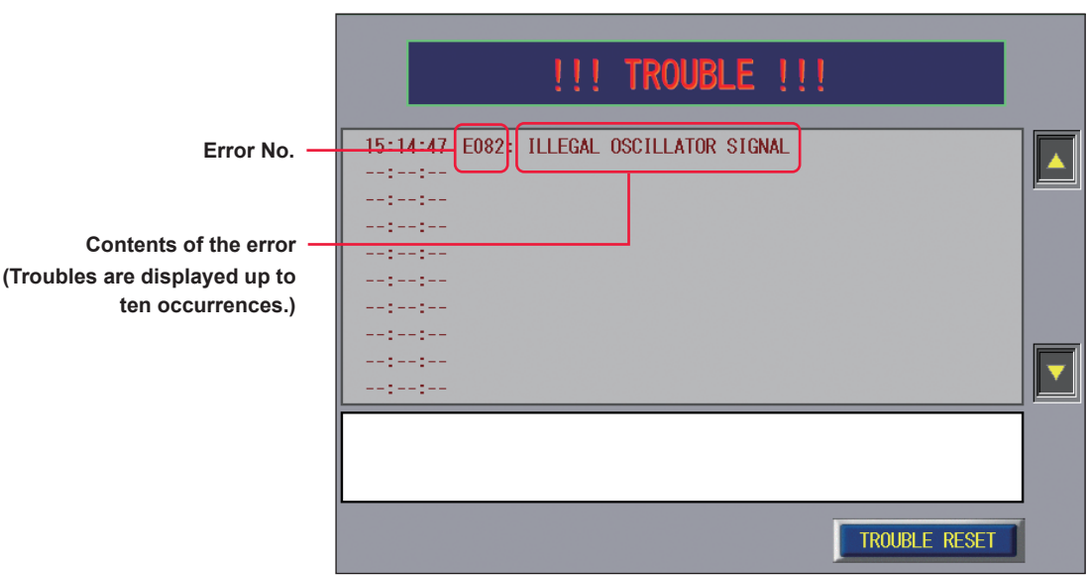
Inspection and Measure To Be Taken at Occurrence of an Error

1. Error Display and How to Take a Measure

When an error occurs in the laser, the contents of the error are displayed on the laser controller screen as shown below. In the following, how to take a measure is explained in the order of Error No. At occurrence of an error, read this chapter carefully and perform inspection of the laser and take a proper measure.

* If you have any unclear point, contact the distributor or us for information.

⇒ When there is any related page in this Operation Manual, the reference page is shown.



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.	Contents of error	LD	Alarm output	Measures
000	COMMUNICATION LINE ERROR	OFF	ON	The communication line between the laser equipment and the touch panel is abnormal. If there is any noise generation source nearby, separate it as far as possible or take a preventive measure for occurrence of noise.

No.	Contents of error	LD	Alarm output	Measures
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	INTERNAL COMM. ERROR(IO2)	OFF	ON	An error has occurred with the wiring in the main unit. Consult us.
012 014 015	CONTROL BOARD ERROR	OFF	ON	An error has occurred with the controller unit. Consult us.
016	BOARD SETTING ERROR	OFF	ON	A setting error has occurred with the main unit interior. Consult us.
020	COVER OPENED	OFF	ON	The cover is removed. Mount them.
022	EXTERNAL INTERLOCK OPENED	OFF	ON	An external interlock signal is input. → P.78 Close Pin No.11 and Pin No.24, and Pin No.12 and Pin No.25 of the E-STOP connector.
023	EMERGENCY STOP	OFF	ON	An emergency stop signal is input. Close Pin No.1 and Pin No.18, and Pin No.14 and Pin No.19 of the E-STOP connector. Reset the EMERGENCY STOP buttons provided at the front surface of the main unit and of the laser controller.
024	E.INDICATOR TROUBLE (PROGRAM CONT.)	OFF	ON	Emission lamp fault on laser controller. Consult us.
025	LASER STOP	OFF	ON	The LASER STOP signal is input. Close Pin 1 and Pin 9 of the EXT. I/O (1) connector.
027	AC POWER DOWN(PDI)	OFF	ON	A temporary blackout of AC power supply was detected. Check the power supply environment.
028	INTERLOCK SIGNAL ERROR	OFF	ON	An error of unknown cause has occurred with the interlock. If it has not been better by resetting, consult us.
035	LASER POWER OUT OF RANGE	-	-	The monitor value of laser energy is out of the range of "HIGH" and "LOW" set on the MONITOR screen. → P.67, P.100, P.103, and P.119 Check "HIGH" and "LOW" settings. If monitored value is abnormal, consult us.
037	VIBRATION DETECTED	OFF	ON	Shock and vibration has been detected. Check around any other trouble. After checking that nothing is damaged, press the RESET button.
046	FIBER ERROR1	OFF	ON	Breakage of an optical fiber has been detected. Check that the optical fiber is connected

No.	Contents of error	LD	Alarm output	Measures
060	POWER FPGA ERROR1	OFF	ON	An error has occurred with the controller unit. Consult us.
061	POWER FPGA CALC. ERROR	OFF	ON	An error has occurred with the controller unit. Consult us.
063 064	POWER FPGA ERROR 2 POWER FPGA ERROR 3	OFF	ON	An error has occurred with the controller unit. Consult us.
067	INTERNAL RS-232C ERROR	OFF	ON	The communication line in the main unit 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.
068	INTERNAL RS-232C TIMEOUT	OFF	ON	The communication line in the main unit 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.
069	PANEL 485COMM TIMEOUT	OFF	ON	The communication line in the main unit 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.
070	BCMD ERROR IN LASER UNIT	OFF	ON	The laser unit could not execute the command. Consult us.
078	LD-ON TIMEOUT	-	-	A timeout occurred in Oscillator reply “LD ON.” Check the KEY-SWITCH on attached to the oscillator. If the KEY-SWITCH is on, consult us.
079	LASER ERROR SIGNAL ERROR	OFF	ON	An oscillator error signal of unknown cause has been detected. Consult us.
080	OSCILLATOR NOT READY	OFF	ON	The oscillator has not started normally. Consult us.
082	ILLEGAL OSCILLATOR SIGNAL	OFF	ON	A signal from the oscillator is abnormal. Consult us.
163	ILLEGAL WARNING SIGNAL	-	-	An oscillator warning signal of unknown cause has been detected. Consult us.
164	LASER STOP2	OFF	ON	The REM. I/L connector circuit is opened. Eliminate the cause of trouble and close the pin.
165	LD POWER SUPPLY ERROR	OFF	ON	An error has occurred with the LD power supply. Consult us.
166	LD CURRENT OVERLOAD	OFF	ON	Overcurrent of the LD. Consult us.
205 206	THERMAL 1 ERROR THERMAL 2 ERROR	OFF	ON	Abnormal temperature of the internal unit. After waiting for several minutes, press the TROUBLE RESET button.

No.	Contents of error	LD	Alarm output	Measures
207	LDPS MONITOR VOLTAGE HIGH	OFF	ON	Abnormal voltage of the LD unit. Consult us.
210	INTERNAL UNIT TEMP WARNING (W01)	-	-	Temperature inside the equipment is high. Secure spaces for air intake at the front and exhaust at the rear. If the air filter is dirty, clean it.
211	BACK REFLECTION HIGH (W03)	-	-	It's too strong back reflection. Adjust the power setting to reduce back reflection.
212	LD POWER SUPPLY WARNING (W05)	OFF	ON	Abnormal voltage of the LD unit. If it has not been better by restarting, consult us.
214	BACK REFLECTION HIGH ERROR (A01)	OFF	ON	It's too strong back reflection. Adjust the power setting to reduce back reflection.
215	INTERNAL UNIT TEMP ERROR (A02)	OFF	ON	Temperature inside the equipment is high. Secure spaces for air intake at the front and exhaust at the rear. If the air filter is dirty, clean it. Installation temperature may be high. Place LASER in an atmosphere under the specification.
216	LD CURRENT HIGH (A03)	OFF	ON	Restart the LASER. If this error happens often, consult us.
217	OUTPUT POWER LOW(A04)	OFF	ON	The optical circuit is wrong. Consult us.
218	ILLEGAL USE (A05)	-	-	Invalid operation in self-checking at warming-up. Restart in accordance with the operation manual.
219	FIBER OUTPUT UNIT ERROR (A06)	OFF	ON	Check the feed fiber broken. Check that the optical fiber is connected correctly. If you can't reset this error, consult us.
220	ENGINE ERROR (A08)	OFF	ON	The communication error occurs between internal units. If this error happens often by restarting, consult us.
221	OUTPUT POWER HIGH (A10)	OFF	ON	The power output is too high. → P.167 Adjust the power setting to reduce back reflection.
222	INTERNAL UNIT OPEN (A14)	OFF	ON	The cover of inner unit is opened. Consult us.
226	CABINET TEMP. HIGH ERROR	OFF	ON	The temperature in the cabinet is too high. If it has not been better by lowering the temperature of installation environment, consult us.
230	SURROUNDING TEMP WARNING (W02)	-	-	Check the air intake-and-exhaust system or installation environment. If this error happens often by restarting, consult us.
231	INTERNAL UNIT COOLING-FAN WARNING (W09)	-	-	Turn off the power and clean the fan at the rear of the main unit. The fan may come to the end of its service life. Consult us.

No.	Contents of error	LD	Alarm output	Measures
232	LD-PS COOLING-FAN WARNING (W10)	-	-	Turn off the power and clean the fan at the rear of the main unit. The fan may come to the end of its service life. Consult us.
235	EMERGENCY STOP ERROR (A07)	OFF	ON	“EMERGENCY STOP” or “EXTERNAL I/L” signal has been detected. If you can’t reset by checking the signal, consult us.
236	LD POWER VOLTAGE ALARM (A11)	OFF	ON	A voltage error has occurred with the LD power supply. If this error happens often by restarting, consult us.
237	LD ALARM (A21)	OFF	ON	An error has occurred with the LD. If this error happens often by restarting, consult us.

2. Troubles not Displaying Fault Code

States of Laser	Measures
Laser output increases though monitor displays normal value. (When processing spot is not clean or spatter increases.)	Adjust SET POWER and output time. If the laser does not improve though the setting is adjusted, optical axis of resonator may have been dislocated. For adjusting the axis, consult us.
Laser output decreases though monitor displays normal value. (When processing is not performed or weld strength is not enough.)	

Appendixes

Specifications

Item			MF-C300A-SF	MF-C500A-SF
Oscillator	Maximum rated output		300 W	500 W
	Minimum setting output		30 W	50 W
	Pulse width *1	REPEAT mode	Standard: 0.1–500.0 ms (0.1ms steps) Setting switching: 0.05–500.00 ms (0.05ms steps)	
		CW mode	Standard: 0.1–1000.0 s (0.1s steps) Setting switching: 0.001–10.000 s (0.001s steps) 0.01–100.00 s (0.01s steps) 1–10000 s (1s step)	
	Repeated number of pulse/ modulation		1 to 1000 pps	
	Modulation function		1 to 5000 Hz (rectangular wave, triangular wave, sinusoidal wave)	
	Oscillation wavelength		1070 ± 10 nm	
	Class		4	
	Positioning guide beam		Wavelength: 650 nm (red) Class: 2	
	Output stability		±3% max. (less than 100 W), ±2% max. (100 W or more) Ambient temperature: ±5°C max. Laser emission time: 8 hours max.	
	Mode field diameter		0.022 mm	
	Beam quality	BPP	0.48 mm-mrad max. (calculated value)	
		M^2	1.4 max.	
	Cooling system		Air cooling	
Power Supply	Power supply	Input power supply	Single-phase, 200 V to 240 V AC (±10%)	
		Frequency	50/60 Hz	
	Max. input current		12 A	18 A
	Max. apparent power		2.1 kVA	3.4 kVA
	Power consumption	Maximum (including LD deterioration)	2.0 kW	3.3 kW
		Maximum (when shipped)	1.5 kW	2.5 kW
		Standby	0.5 kW	
	Breaker rated current (to be supplied by customers)		For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 20 A or more, which is applicable to harmonics and surges.	
	Ground		Class D (ground resistance: 100 Ω max.)	

Item			MF-C300A-SF	MF-C500A-SF
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 Modulation output waveform (when using the modulation function)	
	Schedule setting	CW mode	Laser output waveform Modulation output waveform (when using the modulation function)	
	Measurement 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) Displays the laser output time (7 digits)	
	Cable length		Standard 1 m	
	Display language		Japanese and English (switchable)	
Operating Environment	Ambient temperature		10 to 35°C	
	Ambient humidity		20% to 85% RH (non-condesning)	
	Temperature during transport or storage		-10 to 50°C	
	Humidity during transport or storage		20% to 85% RH	
	Vibration during transport		4.9 m/s^2 (0.5 G) max.	
	Impact during transport		49 m/s^2 (5 G) max.	
	Vibration during operations		10 to 60 Hz: 0.98 m/s^2 (0.1 G) max.	
	Intermittent vibration during operations		Less than 2 Hz : 4.9 m/s^2 (0.5 G) max.	
	Pollution degree *2		2	
	Altitude		2000 m or less	
Others	Mass		150 kg or less	
	Dimensions		Approx. 902 (H) × 556 (W) × 744 (D) mm	
	Noise level	A; Weighted equivalent continuous sound pressure level	75 dB (A) max.	
		C; Sound pressure level	0.3 Pa max.	
	Overvoltage category		2	

*1 There are limitations of the total time of the laser output time in combination with values of SET POWER and REPEAT. For details, refer to “Limitations of Schedule Setting” on page 99.

*2 This index indicates the degree to which conductive pollution is generated in the environment where the equipment is used. In pollution degree 2, only non-conductive pollution occurs but temporary conductivity may be produced due to condensation.

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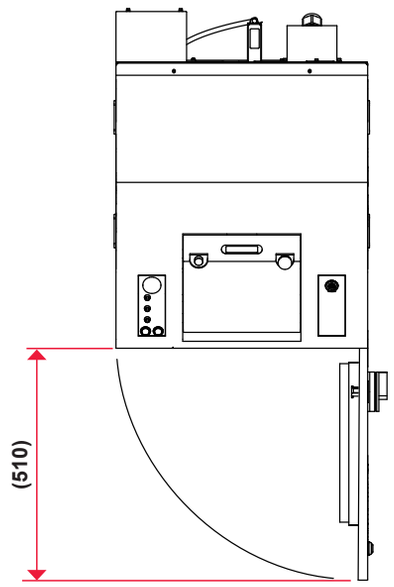
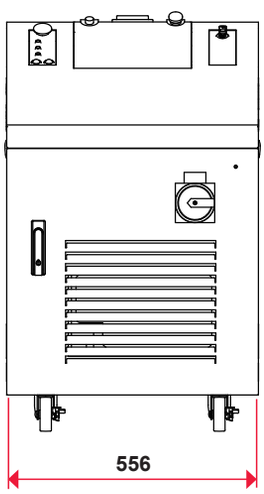
Dimensional Outline Drawings

Unit: mm

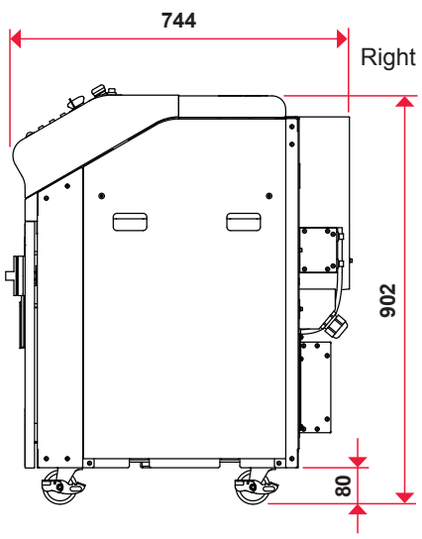
Top view



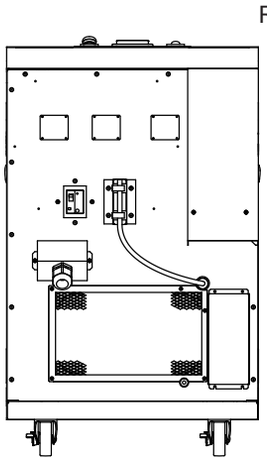
Front view



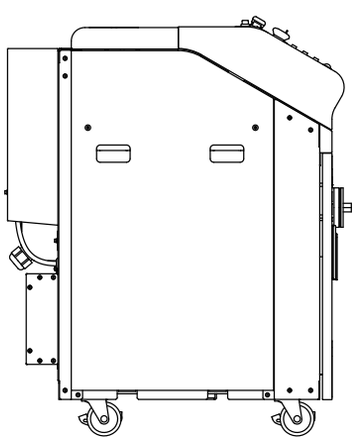
Right side view



Rear view

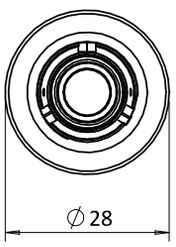


Left side view

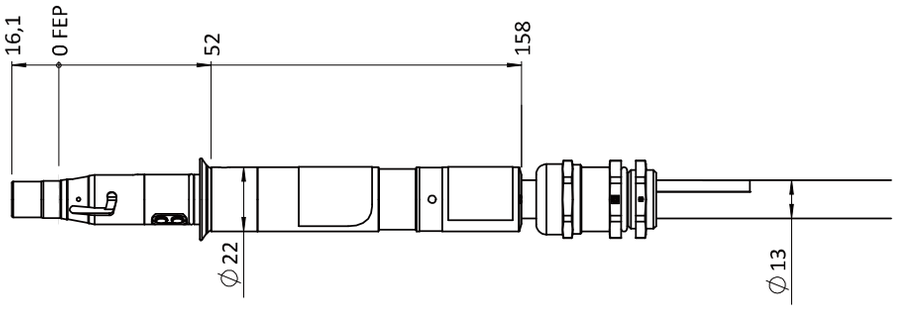


Fiber Connector

Unit: mm



**Max diameter incl.
the removable gaiter**



Timing Chart

An example of 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 axis of ordinates and the lapse of time is represented on the axis of abscissas to show the change status based on changes with the lapse of time at each operation and the time required for a certain operation.

The following 4 types of timing chart are mentioned for your reference.

Single

Operation by laser controller (PANEL CONTROL)

Operation by external input signals (EXTERNAL CONTROL)

Repeated operation (EXTERNAL CONTROL)

Repeated operation (50 pps or more) (EXTERNAL CONTROL)

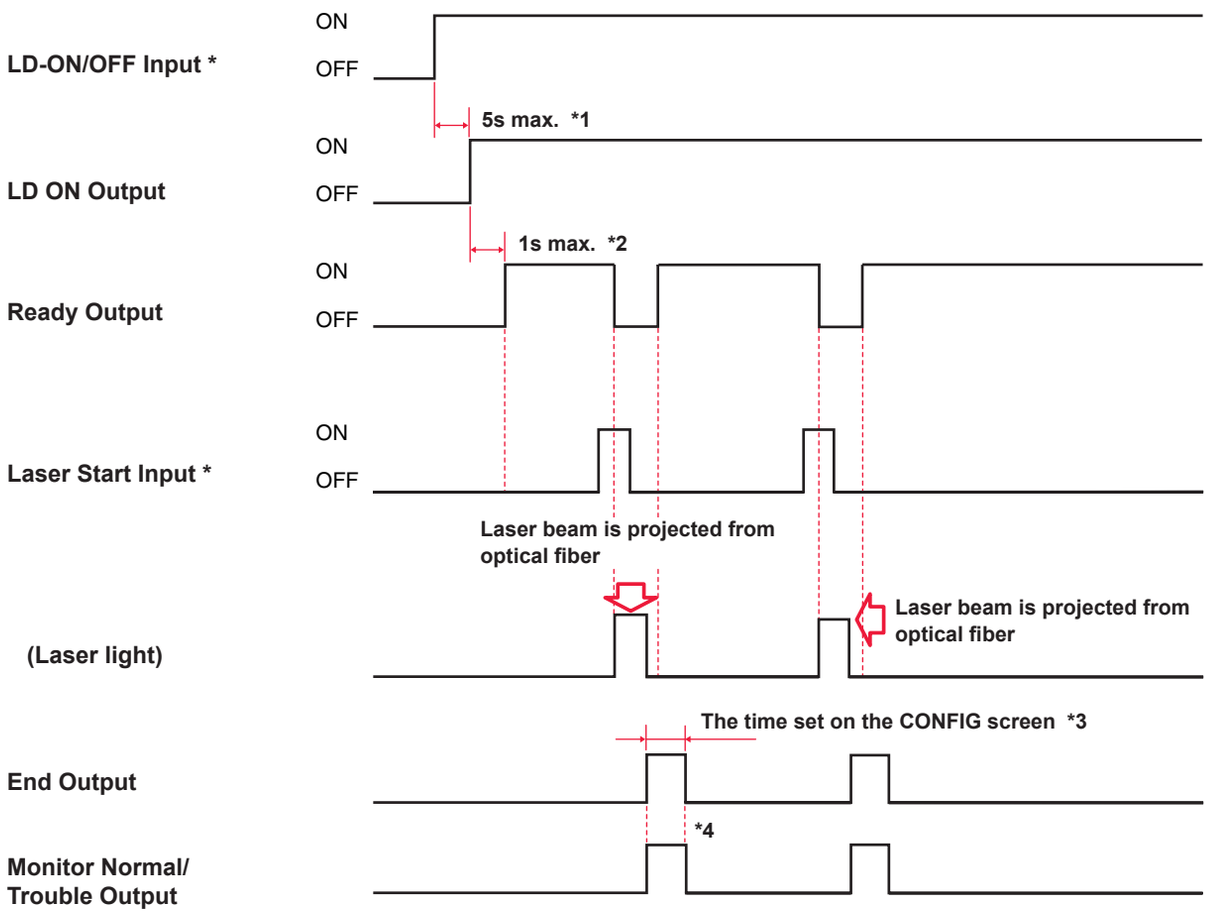
⇒ The control method is switched by putting pin No.25 of the EXT. I/O (1) connector in an open circuit or a closed circuit.
For PANEL CONTROL in which control is exerted by laser controller, put this pin in an open circuit. For EXTERNAL CONTROL in which control is exerted by external input/output signals, put this pin in a closed circuit.

⇒ For the laser controller, laser light is output by pressing the LASER START/STOP button and stopped by pressing this button once again.
For external input/output signals, laser light is output by putting pin No.2 (Laser start) of the EXT. I/O (1) connector in a closed circuit when pin No.3 (Laser stop) is put in a closed circuit and stopped by putting pin No.3 in an open circuit. Confirm that pin No.13 (Ready) is put in a closed circuit before putting pin No.2 in a closed circuit.

Single ... Operation by laser controller (PANEL CONTROL)

The following diagram shows the lapse of time in the case where the laser light is output from optical fiber using the laser controller.

(*: Operation on the user side)



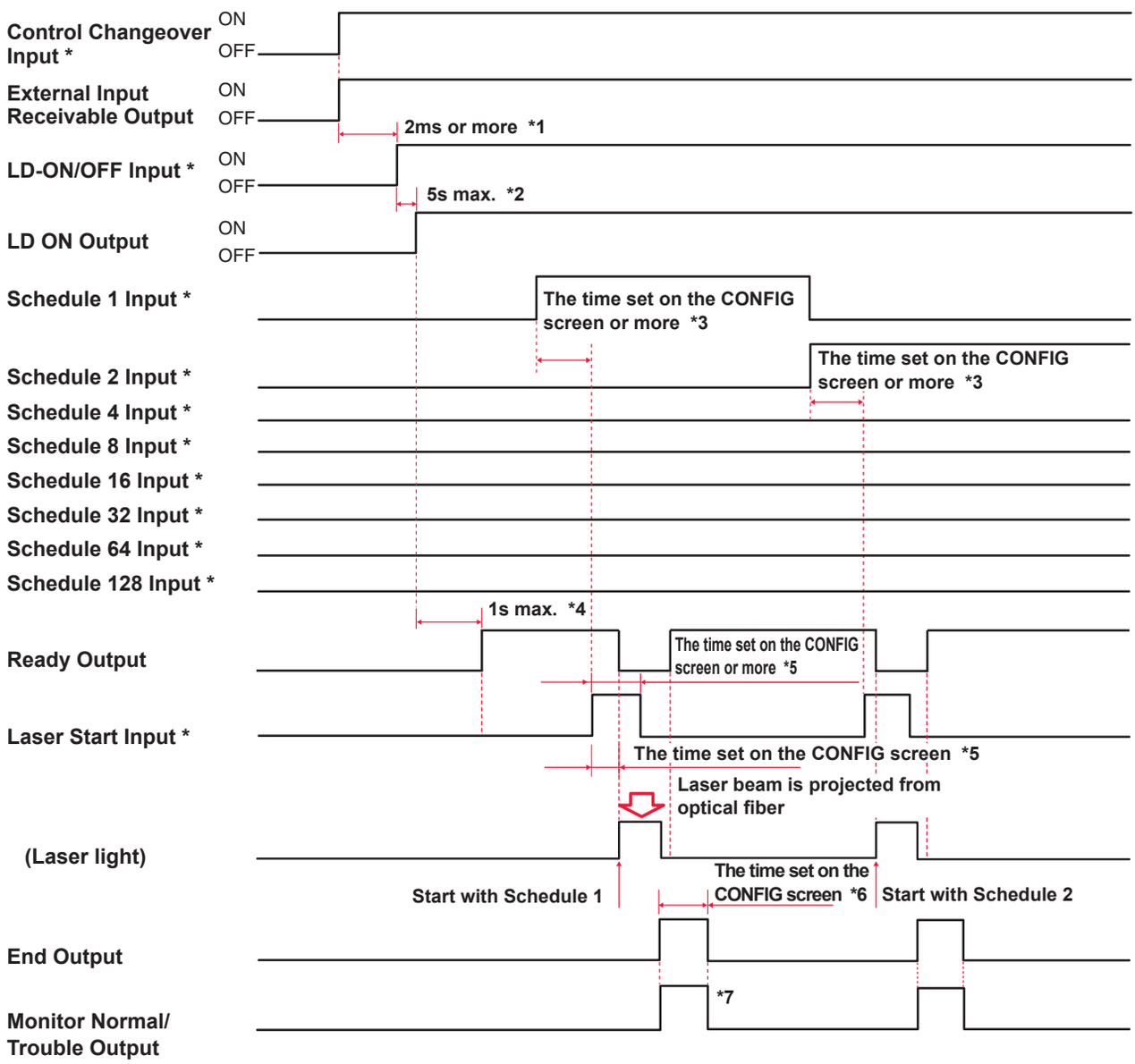
*1	5s max.	LD on time.
*2	1s max.	LD output preparation time. In the REPEAT mode, the signal is kept turned off for certain time after laser output to keep the average power below the maximum rated output. The signal is not output until a valid schedule is selected.
*3		Time required for the end signal to be output after a laser output
*4		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 *4, the output time is 20 ms but can be changed to 30 or 40 ms on the CONFIG screen.

Single ... 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, and then laser light is output from optical fiber.

(*: Operation on the user side)



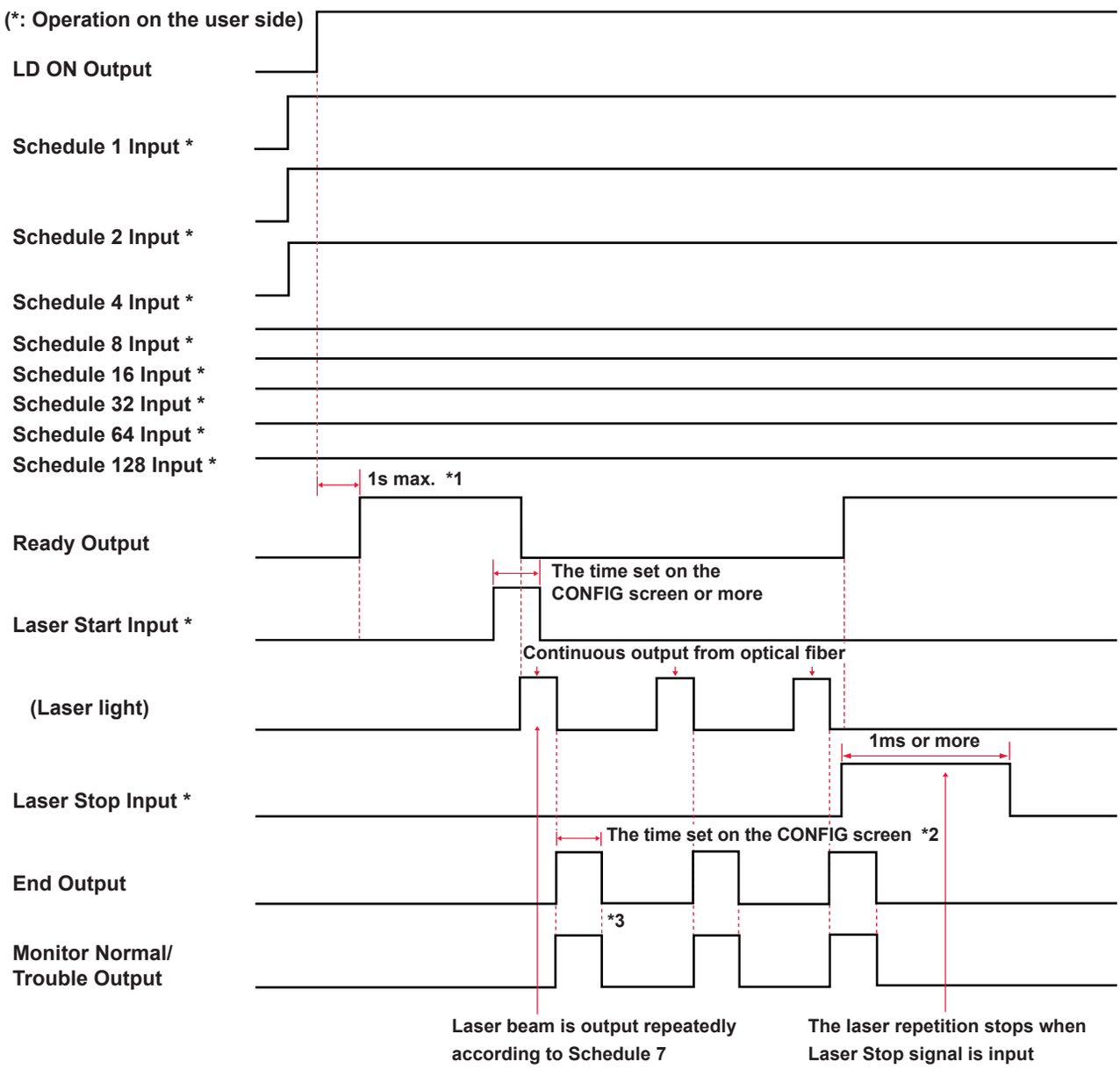
*1	2ms or more	Control changeover time
*2	5s max.	LD on time
*3		Schedule signal acceptance time (time from a schedule signal input till establishment of schedules)
*4	1s max.	LD output preparation time
*5		Laser start signal acceptance time (time from a signal input till an output). Time from the laser start signal till the preliminary oscillation is 50 to 100 µs after the time set on the CONFIG screen. Further, the set laser waveform is output in 0.5 ms after the preliminary oscillation.
*6		Time required for the end signal to be output after a laser output
*7		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 4 ms but can be changed to 0.1, 1, 2, 8 or 16 ms on the CONFIG screen.

In *6 and *7, the output time is 20 ms but can be changed to 30 or 40 ms on the CONFIG 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, and then laser light is output from optical fiber.



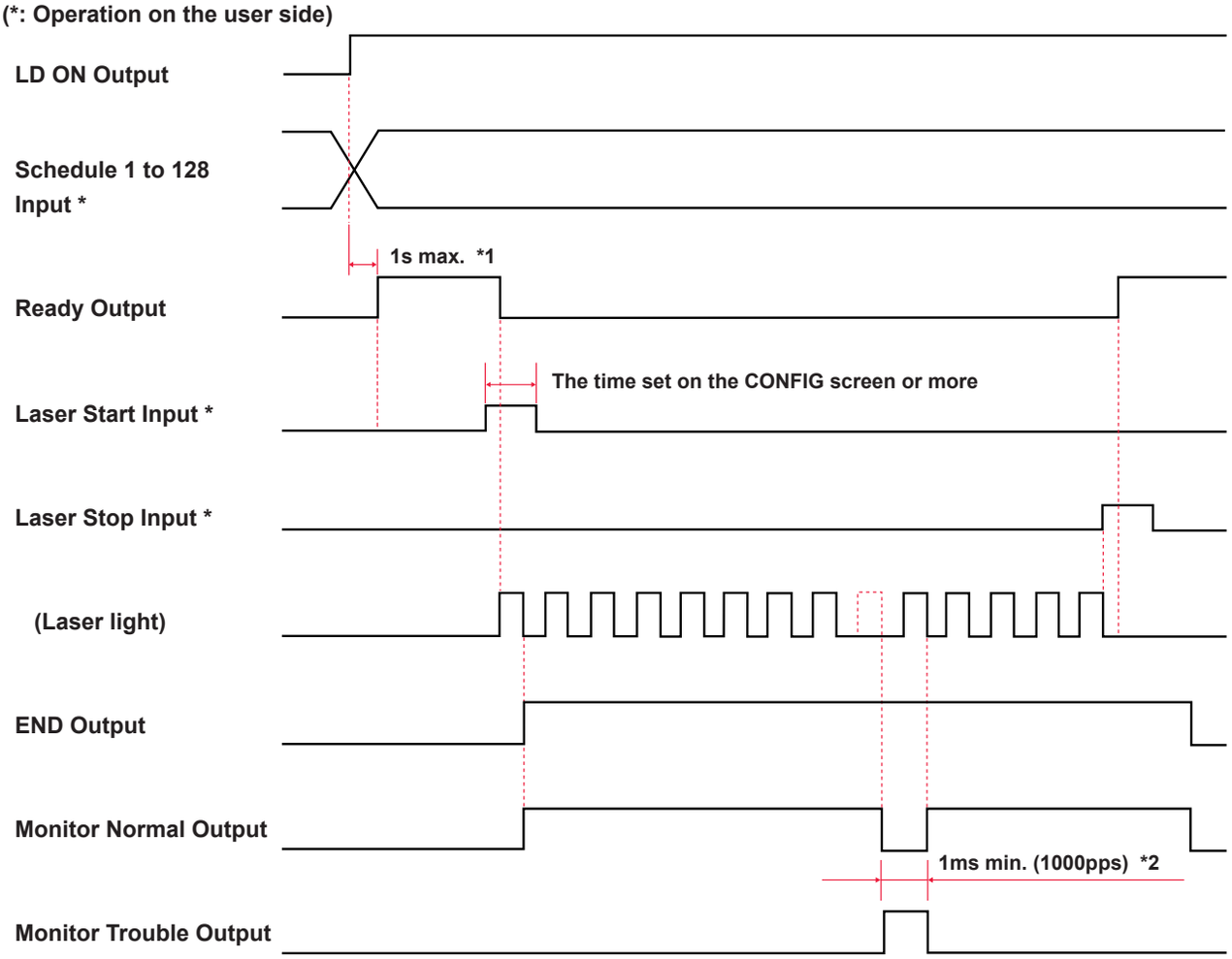
*1	1s max.	LD output preparation time
*2		Time required for the end signal to be output after a laser output
*3		Time required for outputting a signal to indicate whether the laser energy is within the set upper limit value (HIGH) and lower limit value (LOW) of monitor output

In *2 and *3, the output time is 20 ms but can be changed to 30 or 40 ms on the CONFIG screen.

Repeated operation (50 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 50 pps or more.

(*: Operation on the user side)



*1	1s max.	LD output preparation time
*2	1ms min.	Monitor error output time. Minimum error output time for 1000 pps.

Explanation of Terminology

The following table explains the terminology related to laser welding. General terms and the terms peculiar to this laser are included. When there is any related page in this Operation Manual, the reference page is shown.

A	
ACK	Control code that is used for communication between computers. Affirmative response that is sent from the computer of transmission destination to the transmission source. Abbreviation of acknowledgement (affirmative response). → P.139
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.139
C	
COM (Common)	Common line. This means a connecting point where the multiple points are connected to the same common point. The electric circuit includes an A contact, B contact, and Common. The common contact is connected to the A contact and B contact commonly. Abbreviation of Common.
Common	Common line. This means a connecting point where multiple points are commonly connected to the same point in the circuit or wiring. The electric circuit includes an A contact, B contact, and Common. The common contact is connected to the A contact and B contact commonly. This is abbreviated as COM.
CW	Flexible waveform of CW (continuous) 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.84
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.
E	
ETX	Control code that is used for communication between computers. → P.139
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 Coupling 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.80

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.80
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.83
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.83
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.
Grounding work	Specified in Article 18 "Interpretation of Technical Standard of Electric Equipment." The grounding work for device connected to a low-voltage circuit of 300 V or less is performed in compliance with class D, and that of more than 300 V is performed in compliance with class C. → P.39
Guide light	Auxiliary light to check the laser light irradiating position and make a positional adjustment. Light with a wavelength of 380 nm to 780 nm that can be seen by man. This is also called visible laser. In this laser, diode laser for guide light is output. → P.57
H	
Harmonic	Waveform having 3 to 40 times of frequency of the basic frequency (50/60 Hz). → P.43
I	
Input unit	Unit to transmit laser light to the optical fiber. → P.24
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.
L	
L	Line terminal. This is a terminal to be connected to a line conductor of the external circuit. Abbreviation of Live. → P.43
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 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 welder comes under class 4 of the highest hazard, the laser safety supervisor must be appointed. → P.9
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.139
O	
Optical fiber	Cable to transmit light that is made of quarts glass or thin plastic fiber. This cable consists of a core of the center and a clad covering the surroundings, and light is propagated in the core. The mode is classified into 2 types, namely, multi mode and single mode by the number of light propagation modes, and the multi-mode optical fiber is divided into step index (SI) and graded index (GI) by refractive index distribution of the core.
Oscillator	In the laser welder, the oscillator means a unit to amplify and oscillate laser light. This unit consists of a laser medium, excitation source, amplifier, etc. Laser is amplified and oscillated when the laser medium is excited by excitation source.
Output unit	Unit to output the laser light transmitted by optical fiber to the workpiece. The optical fiber connected to the input unit is connected. → P.24 and P.45
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.43
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.119
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.
pps	Number of pulses per second. Abbreviation of pulse per second.
Protective glasses	Protective glasses that the operator puts on to protect the eyes from laser light. The protective glasses are divided into some types by wavelength of laser light.
Pulse width	Time during which laser light is irradiated.
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 E-STOP connector (the REM. I/L connector when replacing our old products) is connected to the door of the room so that laser light may be shut off when the door is opened. → P.123 and P.124
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.136
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.136
RxD	Pin for received data out of signal lines of the communication connector. → P.136
S	
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.90
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.
Single phase	Electric current whose magnitude and direction change periodically, having the same phase. This single phase is used as a 100 V power supply for electric lamps and plug sockets.
sq (square)	Unit that represents a sectional area of cable. Square millimeter. → P.43
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.139
Surge	Abnormal overvoltage or overcurrent applied momentarily to the electric circuit. → P.43
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.
TxD	Pin for send data out of signal lines of communication connector. → P.136
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	00.0 - 50.0	ms																
FLASH1	TIME	00.2 - 50.0	ms																
	POWER	000.0 - 200.0	%																
COOL1	TIME	00.0 - 50.0	ms																
FLASH2	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
COOL2	TIME	00.0 - 50.0	ms																
FLASH3	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
↓SLOPE	TIME	00.0 - 50.0	ms																
SET POWER **MF-C300A-SF:** **MF-C500A-SF:**		 30 - 300 50 - 500																	
REPEAT		0001 - 1000	pps																
SHOT		0001 - 9999																	
ENERGY	HIGH	00.000 - 99.999	J																
	LOW	00.000 - 99.999	J																

NETWORK # _____

Output Schedule Data Entry Table [FORM:FIX] - 2

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE (Enter No. optionally.)															
↑SLOPE	TIME	00.0 - 50.0	ms																
FLASH1	TIME	00.2 - 50.0	ms																
	POWER	000.0 - 200.0	%																
COOL1	TIME	00.0 - 50.0	ms																
FLASH2	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
COOL2	TIME	00.0 - 50.0	ms																
FLASH3	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
↓SLOPE	TIME	00.0 - 50.0	ms																
SET POWER **MF-C300A-SF:** **MF-C500A-SF:**		 30 - 300 50 - 500																	
REPEAT		0001 - 1000	pps																
SHOT		0001 - 9999																	
ENERGY	HIGH	00.000 - 99.999	J																
	LOW	00.000 - 99.999	J																

NETWORK # _____

Output Schedule Data Entry Table [FORM:FLEX] - 1

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE (Enter No. optionally.)															
POINT 01	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 02	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 03	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 04	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 05	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 06	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 07	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 08	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 09	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 10	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 11	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 12	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 13	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 14	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 15	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																

Output Schedule Data Entry Table [FORM:FLEX] - 2

ITEM		SETTING RANGE	No. / UNIT	SCHEDULE (Enter No. optionally.)															
POINT 16	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 17	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 18	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 19	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
POINT 20	TIME	00.0 - 50.0	ms																
	POWER	000.0 - 200.0	%																
SET POWER **MF-C300A-SF:** **MF-C500A-SF:**		30 - 300 50 - 500																	
REPEAT		0000 - 1000	pps																
SHOT		0001 - 9999																	
ENERGY	HIGH	00.000 - 99.999	J																
	LOW	00.000 - 99.999	J																

NETWORK # _____

Output Schedule Data Entry Table [FORM: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: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	%																
SET POWER **MF-C300A-SF:** **MF-C500A-SF:**		30 - 300 50 - 500																	
AVERAGE	HIGH	000 - 999	%																
	LOW	000 - 999	%																

NETWORK # _____

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