FIBER LASER WELDER

MF-C2000A Series

OPERATION MANUAL



How to Use This Document

ATTENTION

This operation manual is common to MF-C2000A-M, MF-C2000A-MC, MF-C2000A-S, and MF-C2000A-SC. The MF-C2000A-S 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.

Refer to the manual for SWDraw3 for instructions for welding control using the SWDraw3 application. Be sure to read the user's manuals for any equipment used in conjunction with the system (e.g., documentation for computer systems).

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 Explains the Preparation Part: Such as cor

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. Four types of control (Control by the laser controller, control by external input/output signals, control by external communication control, and control in the CL-E mode) 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.

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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.
00	Denote actions which operators must take.
A	Denotes that the content gives notice of DANGER, WARNING or CAUTION to the operator.

DANGER



Do not touch the inside of the Laser unnecessarily.

Since source voltage of 3-phase 200 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.

$\hat{\ }$

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.

Routine Handling

- ⇒ Perform inspection periodically referring to the Maintenance Part, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection/Replacement" on page 216.
- ⇒ 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.

^{*} For connections of indication lamp, safety interlock, and emergency stop, use two contacts. For details, refer to "E-STOP Connector" on page 160.

⇒ 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.

Japanese Industrial Standards JIS C 6802 "Safety of Laser Products" Notification by the Ministry of Health, Labor and Welfare No. 0325002 "Laser Damage Prevention Measures"

For Transportation

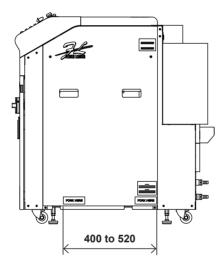
When transporting the laser, observe the following precautions to avoid hazards.

- ⇒ 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 300 kg allowable load.
- ⇒ Do not transport the Laser with its casters. The casters are for fine adjustment.
- ⇒ Retract the level adjuster fully when transporting the Laser.

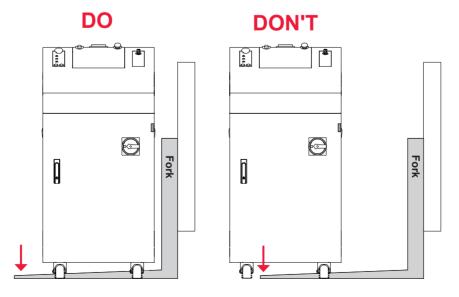
Precautions for using a pallet truck

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 400 to 520 mm, but the fork must not hit the level adjuster.
- ⇒ When transporting, belt the Laser to fix and keep it horizontal.

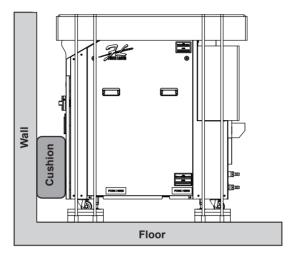


Figures below show example forking; insert the forks fully till the points appear from under the Laser.



Precautions for transportation

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



For Packaging

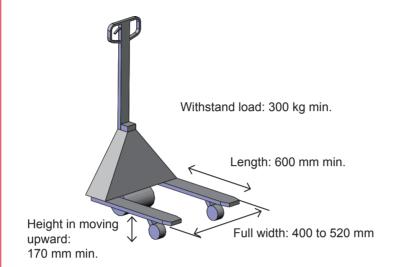
Precautions for packaging

- ⇒ The worker must wear a helmet, safety shoes and gloves for safety. (Leather gloves are recommended.)
- ⇒ Retract the level adjuster fully 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.

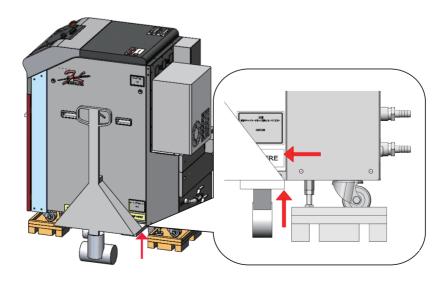


(2) Prepare two vibrationproof skids and make polypropylene bands (approx. 4 m x 4) go through grooves as shown below.

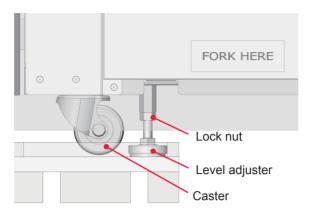


(3) Lift up the Laser with the pallet truck and place it on the vibrationproof skids.

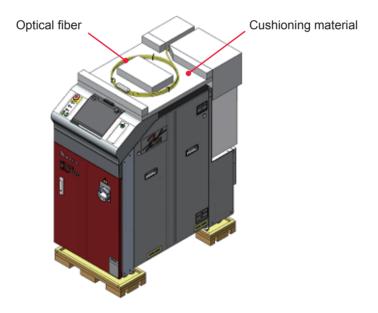
Align the positions of "FORK HERE" and the forks and insert the forks vertically to lift up the Laser.



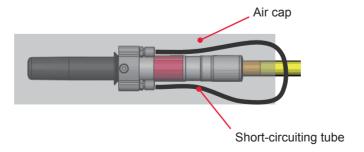
(4) Lower level adjusters (four positions) below the caster and fix them with lock nuts.



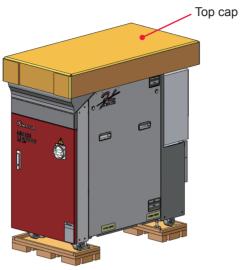
- (5) Place the cushioning material on the top of the Laser and then place the optical fiber on it.
- ⇒ Keep the minimum bending radius 200 mm or more and fix it with insulation locks (three positions).



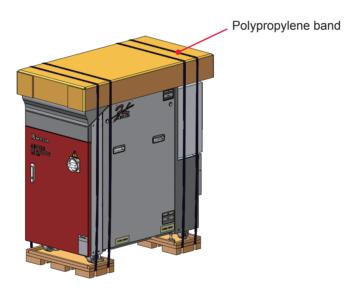
- (6) Wrap the connector section of the optical fiber with an air cap to protect it.
- ⇒ Confirm that the water-cooling connector is shorted.



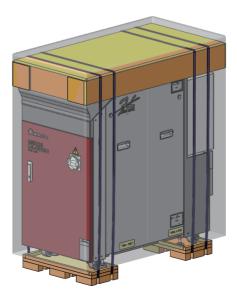
(7) Cover the corrugated cardboard-made top cap on the cushioning material at the top.



(8) Fix them with four polypropylene bands as shown below.



(9) Protect the Laser with an air cap or packaging wrap.

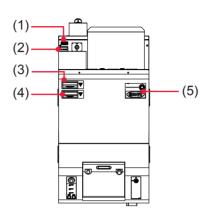


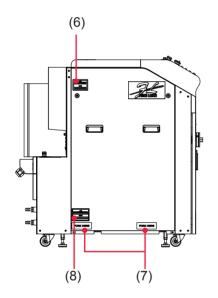
For Disposal

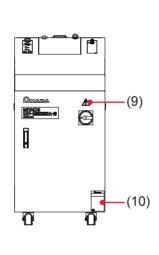
This product incorporates parts containing gallium arsenide (GaAs). At the time of disposal, separate it from general industrial waste or domestic waste and carry out the disposal in accordance with applicable laws and regulations.

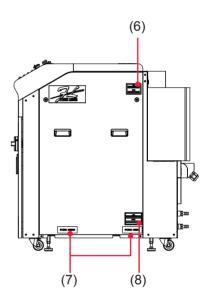
Sticking Warning/Danger Labels

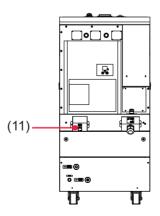
Warning/danger labels are struck on the laser. Read the precautions provided on each label for correct use. The numbers correspond to the label figure numbers on the next page.











(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.

AVOID EXPOSURE
INVISIBLE LASER RADIATION
IS EMITTED FROM THIS APERTURE
不可視レザ光 出口
注意 ここから
不可視レザ光が出ます。

TOT視レーザ放射
INVISIBLE LASER RADIATION

ビームや放射外の目又は皮膚への砂ばくを遅けること。
AVIOLE PEC OR SIGN EXPROSURE TO DIRECT OR SCATTERED RADIATION

最大出力 / MAX . 3000W

バルス特検時間/ PRLSE DURATION : 0.05ms~CII

波 長 / MAYE LENGTH : 0.90~1.20 µm

クラス4レーザ製品 CLASS 4 LASER PRODUCT (E000025-1:2014

VISIBLE AND/OR INVISIBLE LASER RADIATION
AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION
MAX OUTPUT
PULSE DURATION
MAYELENGIN(S)
CLASS BY LASER PRODUCT
F-1221

FORK HERE

注意

| 注意
| 接置のキャスターを使って運搬しないでください。
| 接置の運搬には、許容荷重300kg以上のフォークリフト
| 又はハンドリフトなどを使用してください。
| CAUTION |
| DO NOT TRANSPORT THE LASER WITH ITS CASTERS. |
| WHEN TRANSPORTING THE LASER WER A LIFT TRUCK. PALLET TRUCK, ETC., OF AT LEAST 300KG ALLOWABLE LOAD.

(9)

(10)Qm<u>ada</u> MANUFACTURED BY AMADA WELD TECH CO., LTD. 95-3 FUTATSUKA NODA-CITY CHIBA 278-0016 JAPAN MODEL No SERIAL No. LABEL MFG:MONTH , YEAR INPUT POWER VOLTS PHASE 50/60Hz MAX. RMS AMPS MAX. AVERAGE POWER MAX. PULSE ENERGY PULSE DURATION WAVELENGTH PULSE REPETITION RATE CLASS 4 LASER PRODUCT

(8)

CAUTION 注意 HOT! DO NOT TOUCH TO AVOID HAVING YOUR SKIN BURNT. 高温注意 触れるな やけどの恐れあり

Cautions for Export

The product described in this Operation Manual falls into a controlled item specified in the Foreign Exchange and Foreign Trade Law.

When exporting the product from Japan, you need approval based on the said law. For details, please visit the Security Export Control's website or contact the Security Export Licensing Division, Ministry of Economy, Trade and Industry directly.

Security Export Control's website of Ministry of Economy, Trade and Industry http://www.meti.go.jp/policy/anpo/index.html

Security Export Licensing Division, Ministry of Economy, Trade and Industry Phone: +81-3-3501-2801

Introduction Part

Introduction Part

Chapter 1



1. Fiber Laser

Laser means the equipment to generate powerful light by amplifying light (electro-magnetic 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, cooler, oscillator, optical fiber, output unit, etc. Laser light can be transferred to a place remote from the main unit by optical fiber, so that only the optical fiber and output unit can be mounted in the manufacturing line for welding.

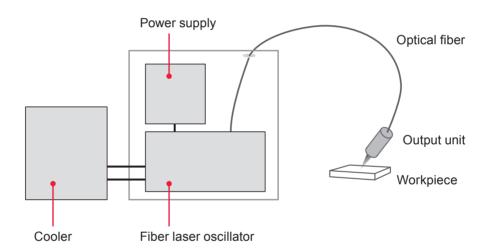
Single Delivery

This is a sharing method of outputting a laser beam to a single optical fiber from the oscillator.

Timesharing

This is a sharing method of outputting a laser beam from the selected optical fiber by operating the beamsplitter built in the laser equipment. Up to 2 optical fibers can be connected with an oscillator for this laser equipment. This is called "2-timesharing."

Common Fiber Laser Equipment Configuration



3. Functions of the MF-C2000A Series

- ⇒ 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.
 - 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. (MF-C2000A-MC/SC only)
 - 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. (*)
 - * There are some limitations for MF-C2000A-MC/SC.
- → Active heat control function (option)
 - This function varies the laser output while detecting the temperature of the processing part coaxially with the laser light to control heat input.
- → 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 conforms to "JIS C 6802" and "Notification by the Ministry of Health, Labor and Welfare No. 0325002."
- ⇒ Cooperation with the scanner head unit (MF-C2000A-MC/SC only)
 - The scanner head unit realizes a high-speed welding at an arbitrary position and wobbling.
 - Multi-parameter spot welding for different materials and thicknesses within the same workpiece is facilitated.
- ⇒ EtherNet/IP function* (option) (MF-C2000A-MC/SC only)
 - The laser optionally supports EtherNet/IP and can participate in the EtherNet/

IP network as an adapter (server).

- By connecting to a scanner (client) device such as PLC and EtherNet/IP network, you can obtain data from the laser and change settings.
- * The laser supports EtherNet/IP by using Anybus CompactCom 40 EtherNet/IP of HMS Industrial Networks AB. For detail specifications of EtherNet/IP, refer to the information issued by ODVA, Inc.

Trademark

- EtherNet/IP™ is a trademark of ODVA, Inc.
- Anybus® is a registered trademark of HMS Industrial Network AB.

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. 1153 (H) × 656 (W) × 1083 (D) mm	Approx. 250 kg
Package for accessories	Approx. 580 (H) × 330 (W) × 460 (D) mm	Approx. 30 kg

Checking the Packaged Products

Make sure that all the packaged products are included.

Package for main unit

Product name	Model No. or specification	Q'ty
Fiber Laser Welder	MF-C2000A Series	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.

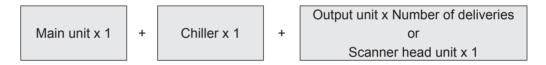
Product name		Model No. or specification	Q'ty
Power cable (5 m)		AS1187143	1
Operation ma	anual	AS1209210(OM1209212+OM1209213)	1
Filter cartridg	je	CW-50-R	1
Cooling water	er (Purified water, 10L)	L-05115-001	1
Adjuster pres	ssure plate	KC-1275C-3	4
Protective glasses		YL-717 Fiber Laser	1
Braided hose (10 m)		φ15 x φ22	1
Hose clip		SGT-W4/9 16-25	4
Water feed h	and pump	TP-0002	1
Gloves		Emboss L	2
NFH tightening spanner		PA1173184	1
Campadan	Plug for EXT. I/O (2) (*1)	HDCB-37P(05)	1
Connector	Plug for RS-485	116-12A10-5F10.5	2

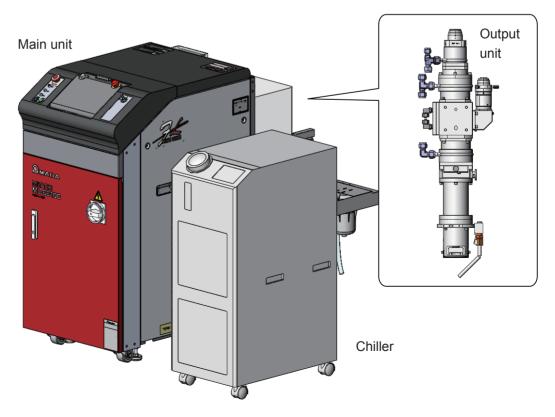
	Product name	Model No. or specification	Q'ty
Connector	Case for EXT. I/O (2) (*1)	HDC-CTH(10)	1
PC software S	SWDraw3 (*2)	AS1206506	1
Operation ma	nual for SWDraw3 (*2)	AS1206501(OM1206503,OM1206504)	1
68-core connector harness (*2)		HDRA68N3C300	1
LAN cable (*2)		Compliant with CAT5e IEEE802.3ab 1000BASE-T	1
Scanner control connecting cable (10 m) (*2)		AS1204916	1
Scanner power cable (10 m) (*2)		AS1209058 or AS1209059 (*3)	1
LASER IF (2) short-circuit connector (*2)		AS1209055	1
EXT. I/O (1) short-circuit connector (*2)		AS1172045	1

^{*1:} Only for MF-C2000A-M/S

Main Unit, Chiller, and Output Unit or Scanner Head Unit

This product is used in combination with the chiller and output unit or scanner head unit as shown below.





^{*2:} Only for MF-C2000A-MC/SC

^{*3:} Either one is attached depending on the specification of the scanner connected.

Main unitProvided with the optical fiber.

Model		Sharing method	Core dia. of optical fiber	Length of optical fiber	Active heat control
	110-00-01	Single delivery	φ0.05 mm	10 m	N/A
	110-00-11	Single delivery	φ0.05 mm	10 m	Available
MF-C2000A-M-	010-00-01	Single delivery (beam coupler)	φ0.1 mm min.	Selected from table below	N/A
	010-00-11	Single delivery (beam coupler)	φ0.1 mm min.	Selected from table below	Available
	002-00-01	2-timesharing	φ0.1 mm min.	Selected from table below	N/A
	110-00-21	Single delivery	φ0.05 mm	10 m	N/A
	110-00-31	Single delivery	φ0.05 mm	10 m	N/A
	110-00-41	Single delivery	φ0.05 mm	10 m	Available
	110-00-51	Single delivery	φ0.05 mm	10 m	Available
MF-C2000A-MC-	010-00-21	Single delivery (beam coupler)	φ0.1 mm min.	Selected from table below	N/A
	010-00-31	Single delivery (beam coupler)	φ0.1 mm min.	Selected from table below	N/A
	010-00-41	Single delivery (beam coupler)	φ0.1 mm min.	Selected from table below	Available
	010-00-51	Single delivery (beam coupler)	φ0.1 mm min.	Selected from table below	Available
ME C2000A S	110-00-00	Single delivery	Single mode	10 m	N/A
MF-C2000A-S-	110-00-10	Single delivery	Single mode	10 m	Available
MF-C2000A-SC-	110-00-20	Single delivery	Single mode	10 m	N/A
	110-00-30	Single delivery	Single mode	10 m	N/A
WII -02000A-30-	110-00-40	Single delivery	Single mode	10 m	Available
	110-00-50	Single delivery	Single mode	10 m	Available

Optical fiber

	Model No.	Core dia.	Length
For MF-C2000A-M/MC	4-9521x01		5 m
	4-9521x02		10 m
	4-9521x03	φ0.1 mm	15 m
	4-9521x04		20 m
	4-9725x02	□0.1 mm	10 m

Chiller

Please use the specified chiller.

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.

	Model		Image ratio	Active heat control
For MF-C2000A-M/S	FOCL-50C-	50300	6	N/A
		80300	3.75	N/A
		100300	3	N/A
		150300	2	N/A
		200300	1.5	N/A
		200200	1	N/A

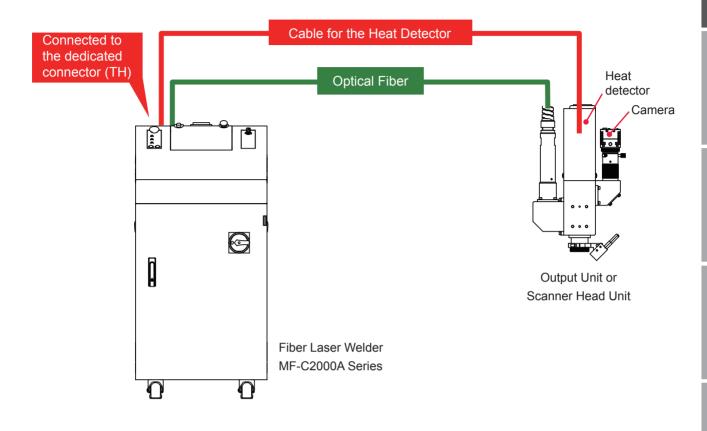
Scanner head unit

The scanner head 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 CL-H201A or CL-H601A.

	Model	Collimator lens	f	fθ lens	f	Active heat control
	01 110044 00 00		60	AS1206953	163	N/A
				AS1206954	306	N/A
	CL-H201A-00-00			AS1206955	420	N/A
For MF-C2000A-MC		LP1206949	80	AS1206955	420	N/A
	CL-H601A-01-00	LP1206948	60	AS1206957	306	N/A
		LP1206949	80			N/A
	CL-H201A-00-00	LP1206948	60	AS1206953 163 AS1206954 306 AS1206955 420	306	N/A
		LP1206949	80			N/A
5 M5 00000 00		LP1206950	100			N/A
		LP1206951	120			N/A
		LP1206952	150			N/A
For MF-C2000A-SC	CL-H601A-01-00	LP1206948	60	AS1206957	306	N/A
		LP1206949	80			N/A
		LP1206950	100			N/A
		LP1206951	120			N/A
		LP1206952	150			N/A

→ Mechanism of the Active Heat Control

This function controls the laser output while detecting the temperature of the processing part coaxially with the laser light to keep heat input constant.



Options

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

Part name		Model No. or specificatio	
	5 m	AS1162937	
Touch panel extension cable	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	
	5 m	AS1155931	
RS-485 cable	10 m	AS1156028	
	15 m	AS1156029	
RS-232C cable, 0.2 m		KRS-9F25F02K	
I/O conversion harness for FL-PL welder (*1)		AS1172103	
Scanner head unit		CL-H201A-00-00	
		CL-H601A-01-00	

Part name		Model No. or specification
	Small	P-0211
Warning label	Medium	P-0212
	Large	P-0213
Dry air unit		LP1209321
EtherNet/IP		LP1209314
Personal computer (*2)		PA1708952
Laser weld monitor		MM-L300A

^{*1:} Cable for converting the external I/O's pin assignment of the fiber laser welder into that of the YAG laser welder.

PC specifications

CPU	Intel Celeron 3867U or better, Intel Core i5-7442EQ or better (when using the camera unit *1)
Memory	2 GB or more, 16 GB or more (when using the camera unit *1)
Hard disk space	5 GB or more
Display resolution	1024 x 768 dots or more, 1366 x 768 dots or more (when using the camera unit *1)
Optical drive	DVD-ROM drive
Interface	Keyboard / mouse / LAN (10/100M) / LAN (1000M) for connecting the camera ×1 *2 (when using the camera unit *1)
os	Windows 10 Pro, 64 bit*3

^{*1:} The camera unit is an option for the scanner head unit.

- ⇒ For the I/O conversion harness for FL-PL welder and scanner head unit, refer to the Operation Manual or Specification for each of them.
- ⇒ For the maintenance parts separately sold, refer to the Maintenance Part, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection/Replacement" on page 216.

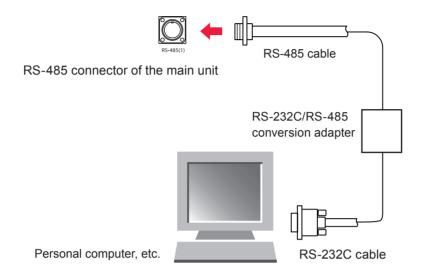
^{*2:} A personal computer is required to set conditions of MF-C2000A-MC/SC. It can be also prepared by customers. For the PC specifications, refer to the table below.

^{*2:} Jumbo packet 9 Kbyte or more.

^{*3:} For recommended specifications of operating system other than Windows 10, contact us.

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.



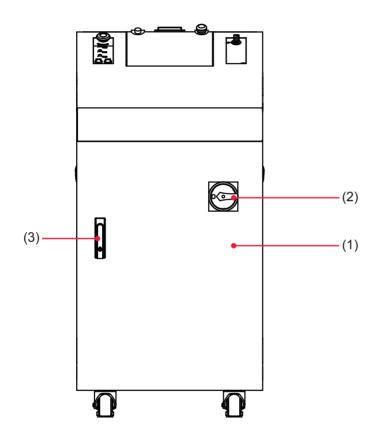
Introduction Part

Chapter 2

Name and Functions of Each Section

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

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



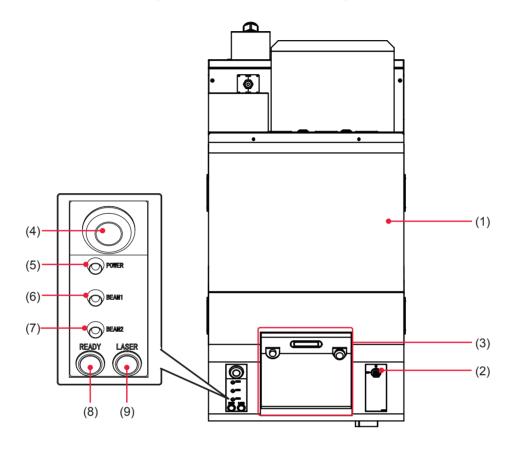
Function of Each Section on the Front Side

(1) Front Door	This door is opened to perform maintenance including cable connections.	
(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.	

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

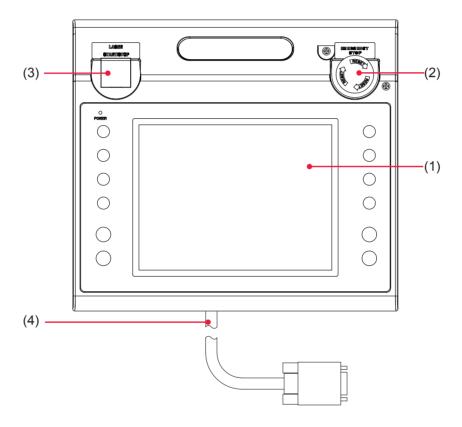
(1) Head Cover	This cover is opened to perform maintenance.
(2) CONTROL Keyswitch	When the CONTROL keyswitch is turned ON with the MAIN POWER switch ON, this keyswitch is operable. When the laser is not used, turn OFF the CONTROL keyswitch and then pull out the key. The laser safety supervisor should 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	In the single delivery, always turned ON after the CONTROL keyswitch is turned ON and the engine (oscillator) check is complete. In the timesharing delivery, turned ON when the branch 1 is selected.
(7) BEAM2 Lamp	In the timesharing delivery, turned ON when the branch 2 is selected. Not used in the single delivery.

(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.



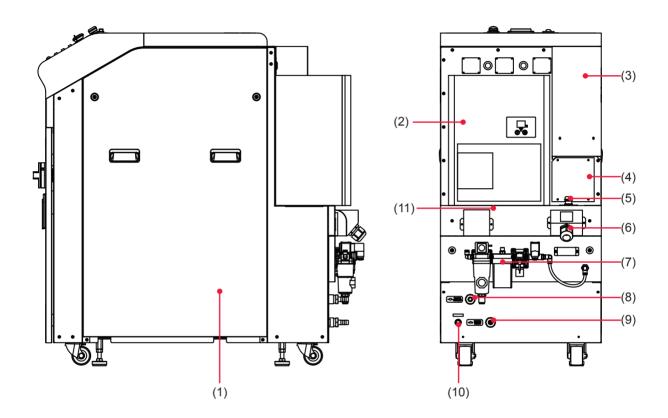
Function of Each Section on the Laser Controller

(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.



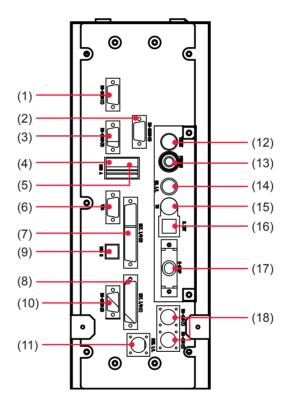
Function of Each Section on the Lateral Side and Rear Side Cover Section

(1)	Side Covers	For both sides of the Laser. Power supply, controller and laser oscillator are beyond the cover.	
(2)	FA Cooler	For preventing the inside of housing from condensation.	
(3)	Connector Cover	For the external I/O connectors.	
(4)	Connector Panel 2	For MF-C2000A-MC/SC, various connectors are mounted.	
(5)	Optical Fiber Outlet	The optical fiber is connected.	
(6)	Power Supply Terminals	Connects the 3-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.	
(7)	Dry Air Unit (Option)	Supplies dry air inside of the main unit to prevent dew condensation.	
(8)	Cooling Water Outlet	Outlet for the cooling water.	

(9) Cooling Water Inlet	Inlet for the cooling water.	
(10)Drain Outlet	Since the cooling water may be discharged in the occurrence of water leakage in the beam coupler or timesharing specification, connect the hose to discharge water to a drain ditch. (Coupling: Rc3/8)	
(11)Drain Port	Drain water within the FA cooler is drained from the drainage pipe who the Laser is used under high-humidity environment. Be sure to connect the attached drain hose to carry out drain piping.	

Inside of the Connector Cover

This section explains each section inside the connector cover.



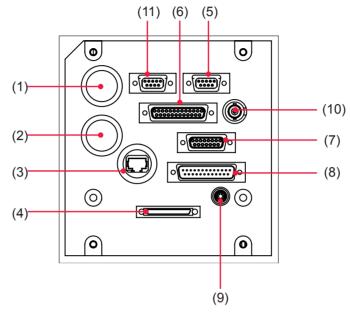
Function of Each Section inside the Connector Cover

(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 for maintenance only. Do not connect anything.
(6) VGA Connector	Used for maintenance only. Do not connect anything.

(7) EXT. I/O (1) Connector	For MF-C2000A-M/S, used to output signals, e.g., alarm signals and monitor judgment signals; and to input signals, e.g., start signal and schedule signals. For MF-C2000A-MC/SC, short-circuited with the LASER IF (1) connector. Do not remove this connector.		
(8) EXT. I/O (2) Connector	For MF-C2000A-M/S, used to output signals, e.g., alarm signals and monitor judgment signals; and to input signals, e.g., start signal and schedule signals. For MF-C2000A-MC/SC, this does not function. To prevent malfunction, do not connect anything.		
(9) USB B Connector	Used for maintenance only. Do not connect anything.		
(10)RS-232C (3) Connector	Used for maintenance only. Do not connect anything.		
(11)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.		
(12)THMON Con- nector	BNC connector used to output an analog signal input to the TH connector between 0 to 5 V (option).		
(13)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 10 V (2000 W = 8 V). Set the impedance of the oscilloscope to 1 M Ω .		
(14)CH.I/L Connector	Used to connect to the chiller. Detects the chiller operation. When the chiller is stopped, error No. 200/ CHILLER TROUBLE occurs. When the dry air unit (option) is equipped, this performs control of the chiller.		
(15)TH Connector	Connects the cable for the heat detector (option).		
(16)R.MNT Connector	Used for maintenance only. Do not connect anything.		
(17)E-STOP Connector	Used to connect to the Remote Interlock for emergency stop or input/output Emergency signals.		
(18)RS-485 (1), (2) Connectors	Connects a personal computer to use the external communication function.		

Inside of the Connector Panel 2 Section (MF-C2000A-MC/SC Only)

This section explains each section inside the connector panel 2.



Function of Each Section inside the Connector Panel 2

Terminal for external network. Used when the optional EtherNet/IP is used.
Terminal for external network. Used when the optional EtherNet/IP is used.
Used to connect to the personal computer with the attached LAN cable. The LAN standard is compatible with 100BASE-TX.
Connector for input and output with the external device (PLC, etc.).
Short-circuited with the dedicated cable. When the scanner head unit is not used on MF-C2000A-MC/SC, connect the dedicated short-circuit connector.
The dedicated cable is connected. Do not remove it.
Power supply connector for the scanner head unit.
For connection to the scanner head unit using the scanner control connecting cable. (XY2-100, 16 bits)
Connects to the optional MM-L300A and outputs the external trigger.
Connector used to output a reflected light. The output range is 0 to 10 V.
A connector for using the external communication function.

Installation and Preparation Part



Chapter 1



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.

Regarding the requirements of the power supply equipment, refer to the table below.

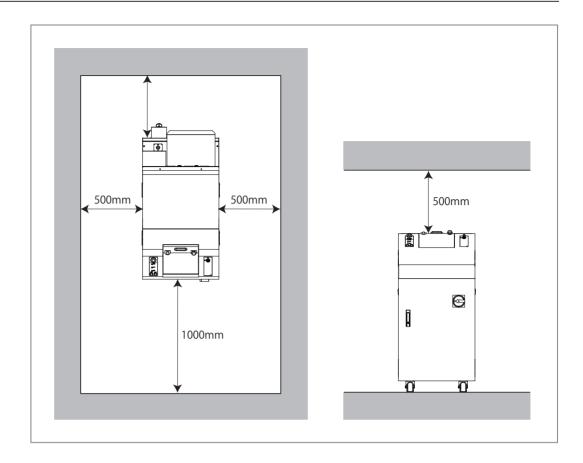
	Input power supply	Current capacity
Main unit (MF-C2000A Series)	3-phase 200 V/220 V/240 V AC (50/60 Hz)	40 A or more
Chiller (specified one)	Single-phase 200 V to 230 V AC (50/60 Hz)	20 A or more

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.

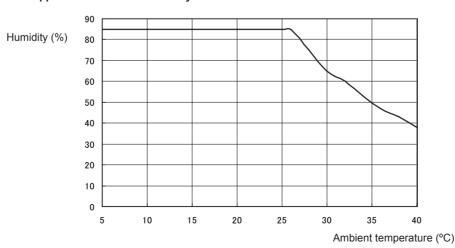
Install the product in a place remote from the wall as shown in the figure on the next page.



Environment Suitable for Installation and Precautions

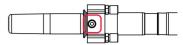
- ⇒ In laser processing, dust and fumes are generated from workpiece. Depending on the kind of workpiece, they may adversely affect a human body. Also, dust and fumes from workpiece may cause staining and burning of optical parts and lower the laser output. Furthermore, if conductive dust enters the laser equipment, a short circuit accident may occur to cause malfunction. Therefore, in laser processing, be sure to install an exhaust device such as dust collector and blower in a proper position to keep a clean environment.
- ⇒ Use the product in a place where the ambient temperature is 5 to 40°C and the ambient humidity is 20 to 85% RH and yet a sudden temperature change does not occur. If the humidity is higher than values shown below, condensation may occur.

Upper limit of ambient humidity



When condensation occurs, water may be drained from the drain port at the bottom of the FA cooler. For piping, refer to the Installation and Preparation Part, Chapter 2 "4. Piping the Drain Water" on page 57.

Also, condensation may occur on the cooling part of the fiber connector. Perform dehumidification for preventing condensation.



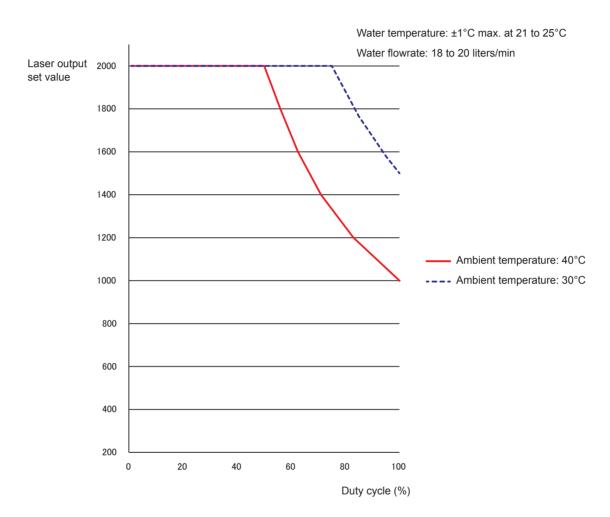
- ⇒ Avoid operating the product in the following places because a failure may occur.
 - Place where there is considerable dirt, dust, or oil mist,
 - where the Laser may be subjected to vibration or impact,
 - where the Laser may be exposed to chemicals,
 - where there is a nearby high noise source,
 - where moisture may be condensed on the surface of the Laser,
 - where the concentration of CO₂, NOx or SOx is high.
- ⇒ If the temperature falls below 0°C in winter, the cooling water will be frozen and the Laser may be broken. Particularly in cold districts, take care that the temperature of the Laser does not fall below 0°C. When the product is not operated for 2 weeks or longer or the temperature is 0°C or less, bleed the equipment of cooling water completely. For bleeding, refer to the Maintenance Part, Chapter 1 "3. Maintenance of the Chiller" on page 228.
- ⇒ 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.
- ⇒ Use the Laser under conditions of operating environment to avoid a sudden temperature / flow rate change of the cooling water.
- ⇒ Start operations at least 30 minutes after turning ON the Laser and the chiller under low-temperature (10°C or lower) or high-temperature (35°C or higher) environment. Dew condensation or output fluctuation occurs by the difference between the room temperature and the cooling water temperature.

Allowable Duty Cycle Graph

The allowable duty cycle graph for each ambient temperature is shown below. Refer to this graph to use the laser output set value within a range inside the curve. If it is out of range, the temperature in the equipment rises, error No.256/OUT OF TEMPERATURE-RANGE occurs, and the product lifetime may be shortened.

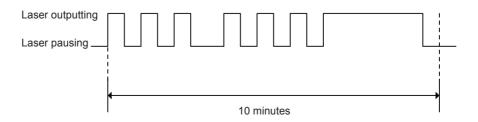
The duty cycle is the ratio (in percent) of load time for the total time.

Duty cycle =
$$\frac{\text{Laser output time}}{\text{Laser output time} + \text{Laser pause time}} \times 100$$



Example)

When the laser output set value is 1600 and the duty cycle is 60%, output 1600 W of laser for 6 minutes and pause it for 4 minutes in for 10 minutes. (40°C environment)



2. Fixing the Laser Welder

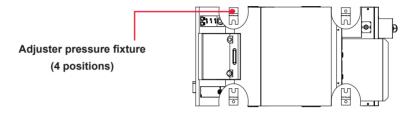
This section explains how to fix the laser welder on the floor.

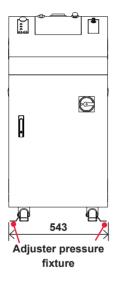
Item required

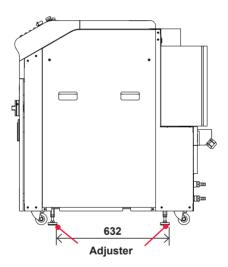
Phillips screwdriver, adjuster pressure fixture, and anchor, etc.

Operating Procedure

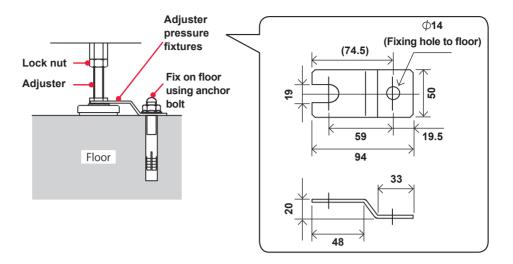
(1) Install the attached adjusters pressure fixtures on the adjusters provided in 4 positions in the lower part of the main unit.







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



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



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

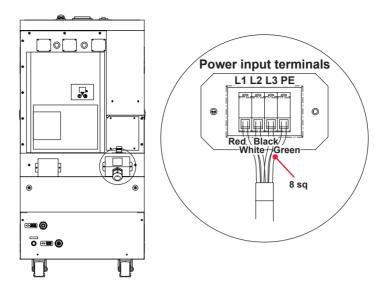
- For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 40 A or more, which is applicable to harmonics and surges.
- Confirm that the Laser is grounded.

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 L1 (red), L2 (white), L3 (black), and PE (green) 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 Chiller

A CAUTION

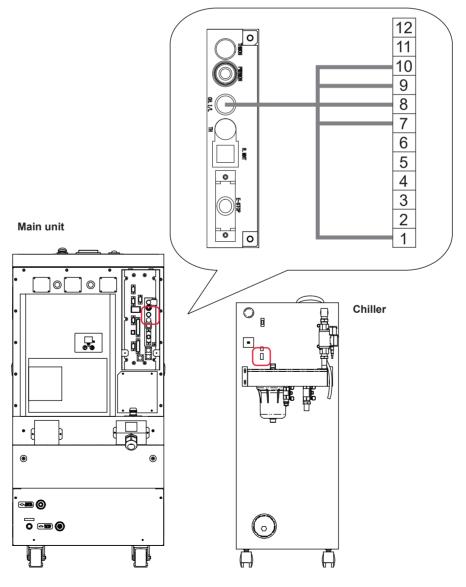
- For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 20 A or more, which is applicable to harmonics and surges.
- Confirm that the Laser is grounded.

Item required

Phillips screwdriver

Operating Procedure

- (1) Connect the power cable attached to the chiller.
- (2) Connect the alarm detecting cable connected to the chiller to the CH.I/L connector on the rear surface of the main unit.



3. Connecting the Hose for Cooling Water

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

Item required

Braided hose (Inner diameter: ϕ 15 mm), hose clip, slotted screwdriver, tube (ϕ 8 and ϕ 6) (attached to the chiller), coupling (attached to the chiller), and spanner (14 mm)

Operating Procedure

- (1) Connect the attached braided hoses to the cooling water inlet and the cooling water outlet on the rear surface of the main unit, and fix them with hose clips. Connect each end of the hoses to the water discharge port and the water outlet and inlet of the chiller.
- ⇒ Be careful about INLET and OUTLET.
- (2) Connect the attached ϕ 8 tubes to the chiller connector, and fix them with hose clips.
- (3) Connect the φ 8 tubes connected to the chiller to the pipes of the fiber connector after being relayed by the φ 6 tubes with couplings.
- ⇒ It is recommended that the length of the φ 6 tube be 100 mm or shorter on each side of IN/OUT. When the length is longer than 100 mm, the pressure loss becomes greater and a flow rate error may occur.
- ⇒ Refer to the Appendixes, "Dimensional Outline Drawings" for the shape of the fiber connector.
- ⇒ Refer to the next page for how to connect the coupling.

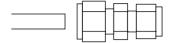
Main unit Chiller Fiber connector Coupling ### Couplin

Coupling

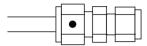
⇒ Be sure to insert the insert material (SKITK8 or SKITK6) before connection.

Connection method

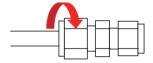
Without removing the nut, insert the tube into the coupling and push the end of the tube all the way in.



Tighten the nut with a hand until it stops moving. Put a mark in this position.



Rotate the nut 450 degrees clockwise with a spanner, keeping the coupling body with another spanner from moving.

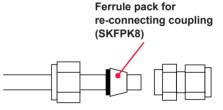


Reconnection method

Before loosening the nut, check its position. (This position is used as a reference later.)

Remove the nut.

Check again that the front ferrule is mounted at the proper position.



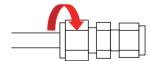
Check that no foreign matter is attached to the body.

Insert the front ferrule until it attaches firmly to the body and tighten the nut with a hand.

⇒ Take care not to scratch the body with the end of the tube.



Tighten the nut with a spanner until it goes slightly over the position before loosened (15 to 30 degrees).



Preparing the Cooling Water

This section explains how to supply the cooling water.

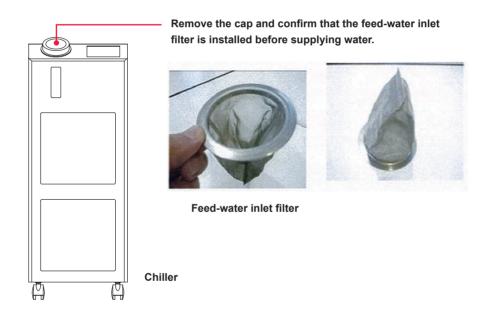
Item required

Cooling water (10 liters) and water feed pump



Use our specified cooling water. Tap water, industrial water, or ground water may cause corrosion or clogging, resulting in fault of the equipment.

- ⇒ When the chiller is operated for the first time after water feeding, the water level lowers. If it is lower than the lower limit, replenish cooling water again.
- ⇒ Be sure to confirm that the feed-water inlet filter is installed before supply the water. Otherwise, the pump may fail due to contamination of foreign substances.



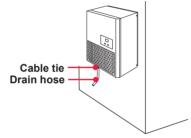
4. Piping the Drain Water

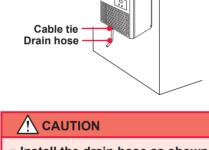
This section explains the method of connecting the drain hose to the drain port at the bottom of the FA cooler.

- Outside air is sucked towards the side of the circulation path of the FA cooler and devices in the control panel or devices located near the circulation path of the FA cooler may malfunction. Do not connect the drain hose in an environment of remarkably floating dirt and oil mist. In addition, do not extremely shorten the drain hose and secure a certain length (at least 2 m).
- ⇒ Use a container exclusively for receiving the drain water.
- ⇒ If the drain water is not drained normally, drainage is performed from the suction port on the heat radiation side.

Operating Procedure

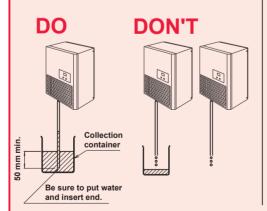
- (1) Attach the drain hose to the drain port at the bottom of the FA cooler.
- (2) Remove the front panel and install a cable tie. Fix the drain hose surely with a cable tie.





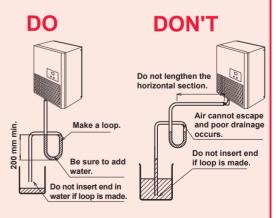


When soaking the hose end in water



If there is no water around the hose end or the hose end comes out of the water surface, air will be vacuumed through the hose. This may cause poor drainage or result in water leak blowing from the outlet.

When opening the hose end



If a loop is made, air may be collected between a container and a loop when the hose end is soaked in water. This may cause poor drainage.

5. 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

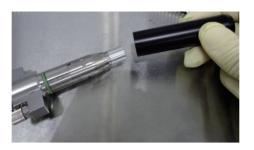
⇒ Do not tighten the connector section of output unit too firmly; otherwise the incident laser beam may be dislocated. Turn the connector section by hand without using a tool.

Item required

Fingerstalls or gloves, lens cleaning paper, and isopropanol

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.



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





- (4) Install the water cooling tube. Be careful about IN and OUT.
- ⇒ For connection and cooling water, refer to the Operation Manual for the output unit.



OUT

6. Removing the Laser Controller

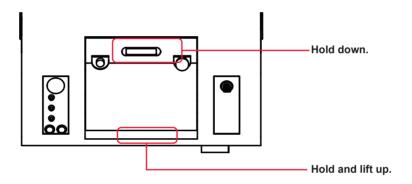
For using the laser welder in the status where the laser controller is separated from the main unit, remove the laser controller from the main unit.



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.



7. 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.

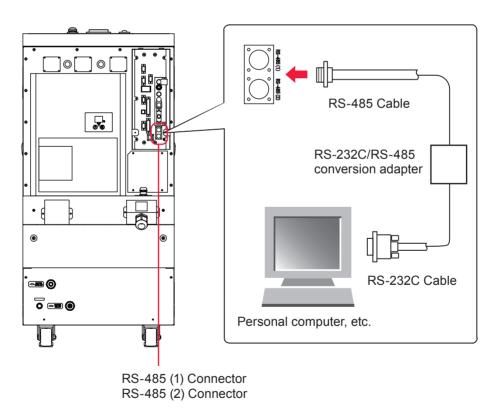
⇒ For making a connection to a PLC provided with RS-485, the conversion adapter for external communication is not required.

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."



8. Connecting the Cable for the Heat Detector (Option)

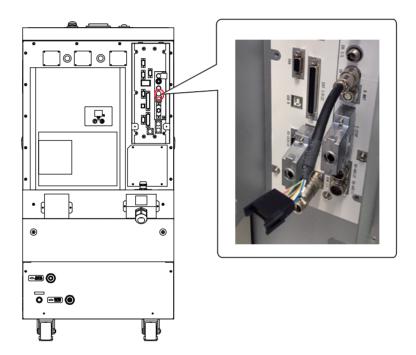
To use the output unit corresponding to the active heat control, connect the cable for the heat detector attached to the output unit.

Item required

Cable for the heat detector

Operating Procedure

- (1) Confirm that the MAIN POWER switch is turned OFF.
- (2) Open the connector cover on the rear to connect the cable for the heat detector to the TH connector.



- (3) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch. Power is supplied and the POWER lamp comes on.
- (4) 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.

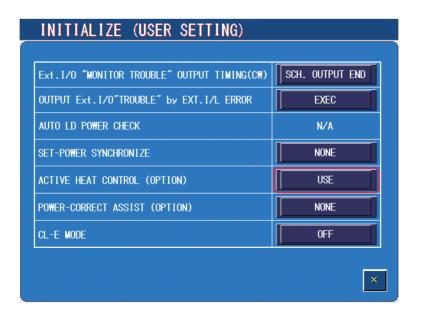


The INITIALIZE screen appears.

(5) Press the "USER SETTING" button. The USER SETTING screen is displayed.



- (6) To enable the active heat control function after connecting the cable for the heat detector, press the "ACTIVE HEAT CONTROL (OPTION)" setting button and set it to USE. When the active heat control function is not used, set the button to NONE.
- ⇒ When USE is set with the cable disconnected, error No.043/HEAT DETECTOR ERROR occurs.



9. Connecting the Scanner Head Unit (MF-C2000A-MC/SC Only)

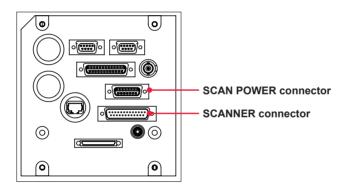
This section explains how to connect the scanner head unit.

Item required

Phillips screwdriver

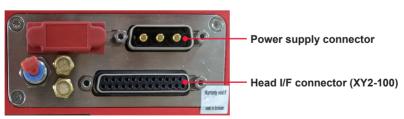
Operating Procedure

- (1) Confirm that the MAIN POWER switch is turned OFF.
- (2) Connect the scanner power cable to the SCAN POWER connector on the connector panel 2.
- (3) Connect the scanner control connecting cable to the SCANNER connector on the connector panel 2.

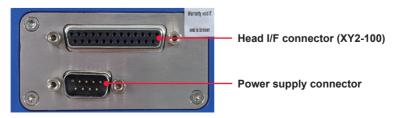


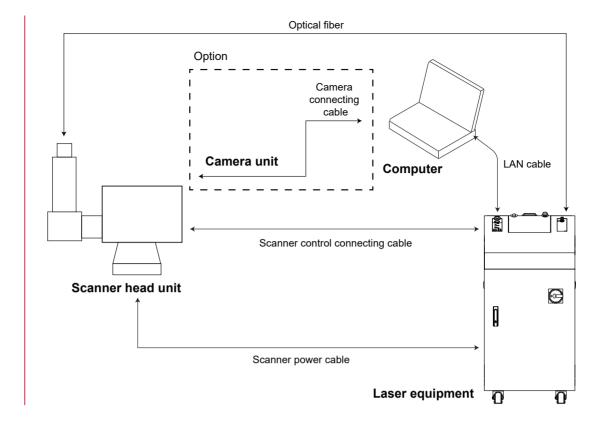
- (4) Connect the scanner power cable to the power supply connector on the scanner head unit.
- (5) Connect the scanner control connecting cable to the head I/F connector (XY2-100) on the scanner head unit.

CL-H601A



CL-H201A





10. When Not Using the Scanner Head Unit (MF-C2000A-MC/SC Only)

The scanner head unit is controlled by CL-E100A built in MF-C2000A-MC/SC.

When replacing the scanner head unit with the output unit and operating the laser equipment alone, it is necessary to separate connection between MF-C2000A-MC/SC and CL-E100A.

Disconnection is performed by the following procedure. They can be reconnected by reversing the procedure.

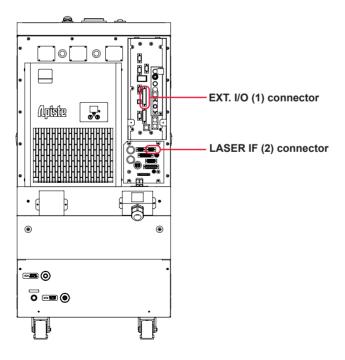
⇒ When changing availability of the scanner head, the output correction may be required. For the output correction, contact us.

Item required

Phillips screwdriver, EXT.I/O (1) short-circuit connector, and LASER IF (2) short-circuit connector

Operating Procedure

- (1) Turn OFF the MAIN POWER switch and open the connector cover on the rear.
- (2) Disconnect the cable connected to the EXT.I/O (1) connector and connect the attached EXT.I/O (1) short-circuit connector.
- (3) Disconnect the cable connected to the LASER IF (2) connector on the connector panel 2 and connect the attached LASER IF (2) short-circuit connector.



- (4) Close the connector cover on the rear.
- (5) Turn OFF the CONTROL keyswitch and turn ON the MAIN POWER switch. Power is supplied and the POWER lamp comes on.
- (6) 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.

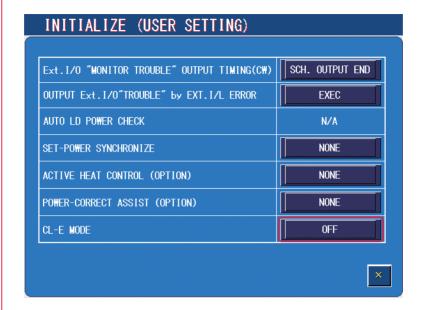


The INITIALIZE screen appears.

(7) Press the "USER SETTING" button. The USER SETTING screen is displayed.



(8) Press the "CL-E MODE" setting button and set it to OFF.



<Note>

When the CL-E mode is switched from ON to OFF, all welding schedules are initialized.

- (9) Turn OFF/ON the MAIN POWER switch again.
- ⇒ When the CL-E mode is set to ON or OFF, the model name on the startup screen changes.

MF-C2000A-SC

OFF

MF-C2000A-S

11. Connecting the Dry Air Unit (Option)

The dry air unit (option) supplies dry air inside of the equipment and dehumidify the interior.

It can be installed at the time of purchase or later. When it is installed later, our engineer makes wiring and internal air piping connection, enables the option setting, and changes the chiller parameters.

The work performed by customers after the dry air unit is installed is as follows.

Item required

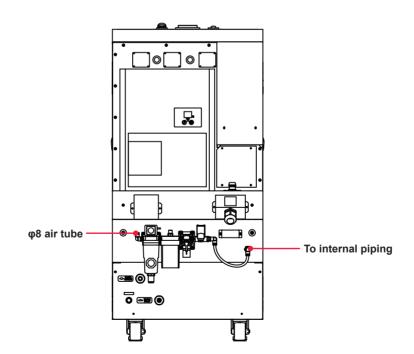
Spanner (6 mm), tube for dry air (φ8)*1 and recommended dry air*2

- *1 The destination coupling is MCLPTK8-1 (MISUMI) or equivalent.
- *2 The recommended dry air is as follows. The non-recommended dry air may adversely affect the filter effect and durability.

Temperature	20 to 35°C
Air pressure	0.5 to 0.7 MPa
Flow rate	30 NL/min. or more (filter inflow end)
Compressed air quality class	Equivalent to 7,9,4 or lower (ISO8573-1:2010 (JIS B8392-1:2012))

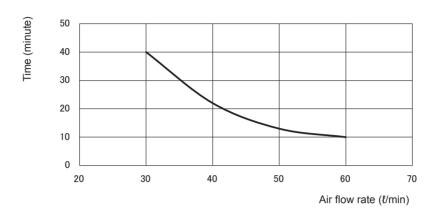
Operating Procedure

(1) Insert the air tube from the dry air supply source.



Dehumidification Function

Shown below is the time reference value until the humidity decreases from 80% to 40% by the air flow rate.



⇒ Even for the equipment with the dry air unit, condensation may occur on the cooling part of the fiber connector or the cooling pipings on the outside of the equipment. To prevent condensation, perform dehumidification of the installation environment.

Operating Part

Operating Part

Chapter 1

Control Method, and Start and Stop

1. Control Method

This section explains the control method for MF-C2000A-M/S.

→ MF-C2000A-MC/SC is controlled by SWDraw3 or the external input/output signals or External communication control (RS-232C). For details refer to the Operating Part, Chapter 6.

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.

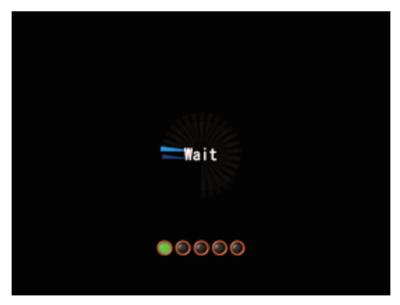
2. Start and Stop

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

How to Start the Laser

Operating Procedure

- Turn ON the MAIN POWER switch.
 The following screen is displayed during a startup.
- ⇒ In the beam coupler specification or the timesharing specification, the guide light automatically turns on during a startup and turns off after a startup is completed.



- (2) Turn ON the CONTROL keyswitch.
- ⇒ For the details of operating procedure, refer to Chapter 3, "3. Operating Procedure" on page 145.

- (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.



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

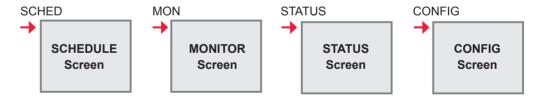
This section explains how to see the SCHEDULE, MONITOR, STATUS, and CONFIG screens to set a processing schedule.

There are 4 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.

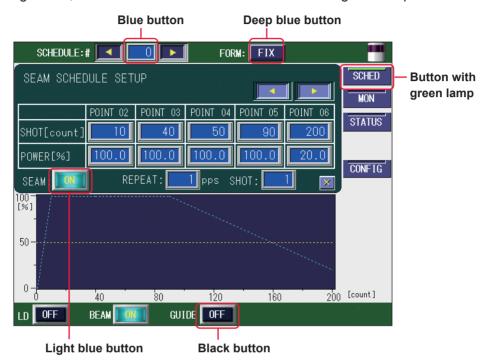
When each of the screen selecting buttons is pressed:



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.



(deep blue) / OFF (black) / (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).



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

100.0 (blue) button

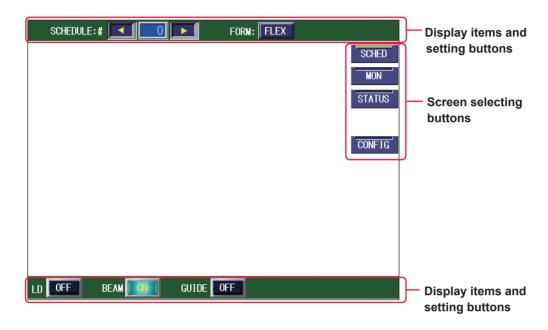
The blue button is used to set a numeric value.

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 key.



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	In the timesharing delivery, a window to set the beamsplitter is displayed with this button pressed to set the BEAM1 and BEAM2 to ON/OFF. In the single delivery, this is 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.), humidity (CABINET HUM.), and water temperature (WATER TEMP.) inside of the laser unit.
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 soft-
	ware is displayed.	

⇒ For the common items in the upper/lower part of the screen, refer to page 81.

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.

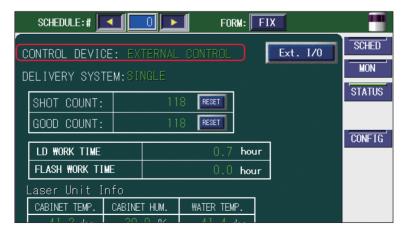
Control by Laser Controller (PANEL CONTROL)

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.



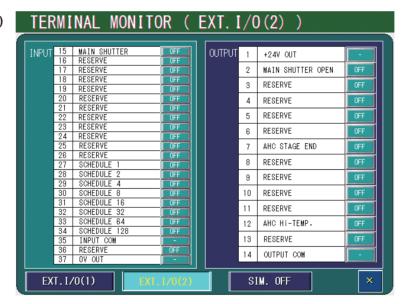
TERMINAL MONITOR Screen

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.

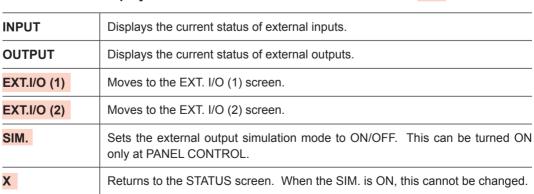
EXT. I/O (1)



EXT. I/O (2)



How to see the displayed items

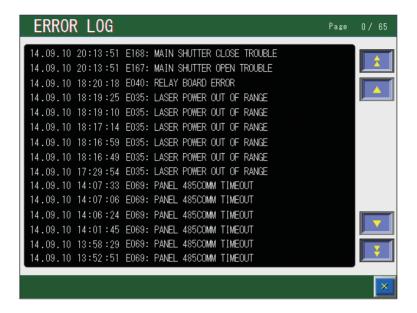


: Settable item

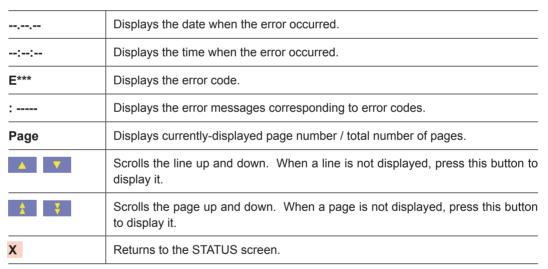
: Settable item

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.

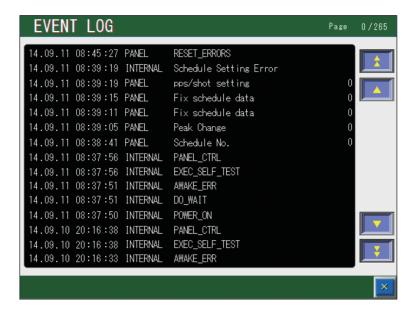


How to see the displayed items

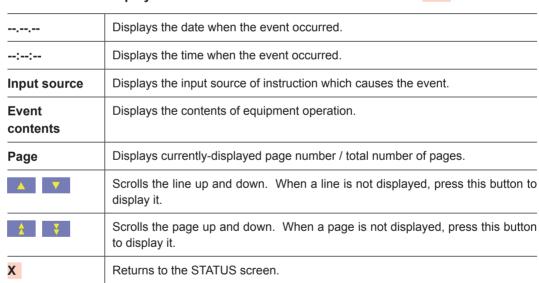


EVENT LOG Screen

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

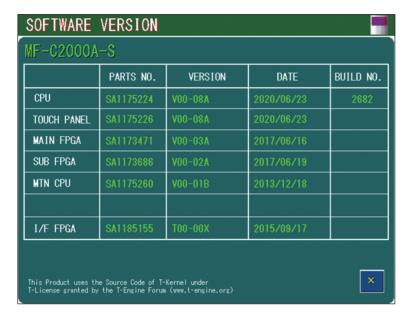


: Settable item

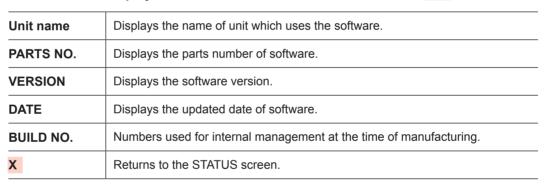
: Settable item

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.



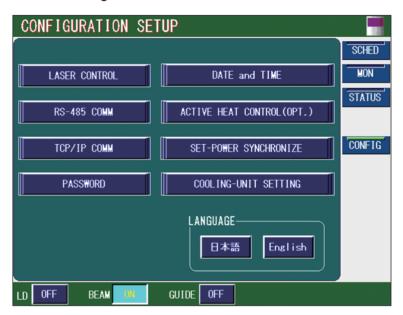
How to see the displayed items



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

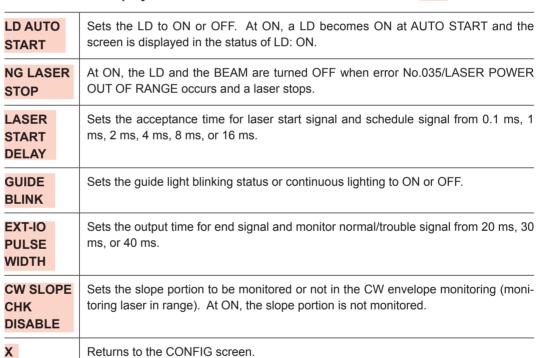
: Settable item **LASER** Displays the setting screen for laser control. CONTROL RS-485 COMM Displays the setting screen for RS-485 communication. TCP/IP COMM Displays the setting screen for TCP/IP communication. **PASSWORD** Displays the password setting screen. **DATE and TIME** Displays the setting screen for date and time. **ACTIVE HEAT** Displayed when the active heat control function (option) is enabled. When this button is pressed, the setting screen for the upper limit value of CONTROL (OPT.) temperature indication is displayed. **SET-POWER** Displayed when the set power synchronize function is enabled. When this button is pressed, the setting screen for the set power synchronize SYNCHRONIZE setting displayed. **COOLING-UNIT** Displays the setting screen for the cooling unit. SETTING **LANGUAGE** 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. 日本語 Switches to the English display. **English**

: Settable item

LASER CONTROL OPTION PARAMETERS



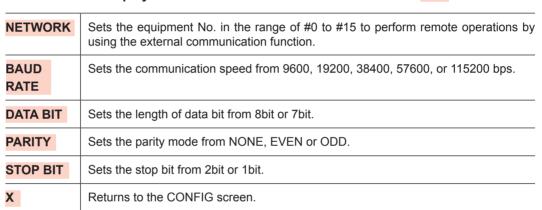
How to see the displayed items



RS-485 COMMUNICATION SETUP

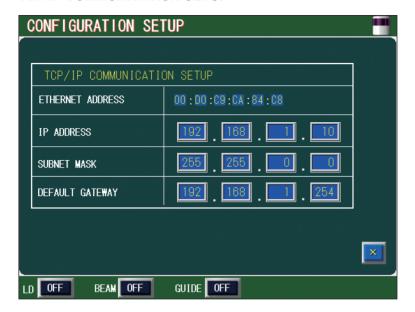


How to see the displayed items



: Settable item

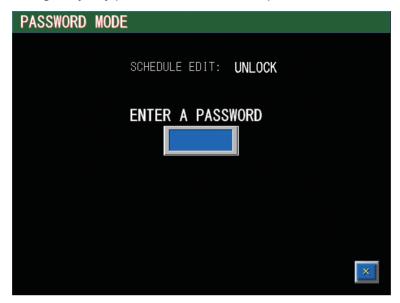
TCP/IP COMMUNICATION SETUP



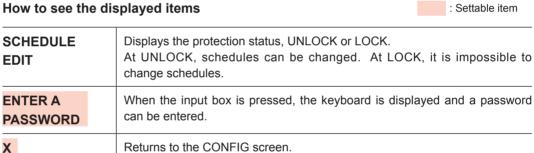
How to see the displayed items : Settable item **ETHERNET** Displays the Ethernet address. **ADDRESS** ΙP Sets the IP address. **ADDRESS** SUBNET Sets the subnet mask. MASK DEFAULT Sets the default gateway address. GATEWAY X Returns to the CONFIG screen.

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



Protecting Set Values

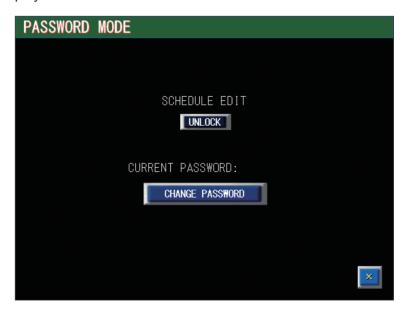
The method of protecting set values by setting the password is explained below.

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.



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.

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) ACTIVE HEAT CONTROL screen: MODE (Control method of each No. of STAGE 01 to 20) TARGET TEMP. (Target temperature) EXPERT SETTING (Detailed settings for the active heat control function)
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, GOC 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) ACTIVE HEAT CONTROL (OPT.) (Setting of upper limit value of temper ture indication) LANGUAGE 日本語 (Language switching) English (Language switching)

The above setting items become unchangeable and the set values are protected.

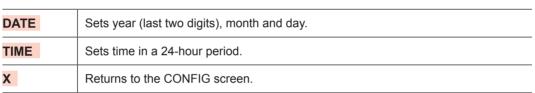
⇒ To change any set value, enter the password to display the password setting screen and set "SCHEDULE EDIT" to UNLOCK.

: Settable item

SETTING AT DATE AND TIME



How to see the displayed items



HEAT DETECTOR SETTING



How to see the displayed items

: Settable item

DEVICE INFO. F/W VERSION MEASURING RANGE	The firmware version of the heat detector is displayed. The measuring range of the heat detector is displayed. The range depends on the connected heat detector.	
THERMO SPAN H [deg]	Sets the upper limit value of temperature indication in the rated range of the heat detector. Generally, set the value of about 10% higher than the AHC target temperature.	
STAGE-END SIGNAL WIDTH	Sets the stage end signal width of the external output from 20 ms, 30 ms, or 40 ms.	
SPAN	Sets the scale of the measured temperature in the range of 0.500 to 2.000 for correcting the sensitivity of a sensor or the transmissivity when using the window material. The initial value is 1.000. When 1.000 or less is set, the upper limit of the measured temperature range becomes lower.	
OFFSET	Sets the deviation of the measured temperature in the range of -50.0 to 50.0. The initial value is 0.0. Moves in parallel with the full measurement range. Also, linearly corresponds to the temperature indicated value.	
CURT.TEMP.	The current measured temperature is displayed. When it is outside the measuring range, "" is displayed.	
X	Returns to the CONFIG screen.	

Appendixes

SET-POWER SYNCHRONIZE SETTING



How to see the displayed items

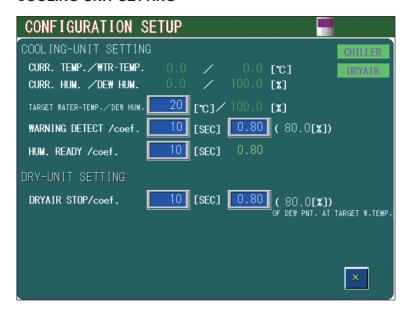


SCHEDULE No. Up to five sets of schedules to synchronize can be set in No.1 to No.5. In an example of the screen above, laser output set values of SCHEDULEs #0 and #10 are synchronized. When the laser output set value of #0 is changed, that of #10 is also changed into the same value. The laser output 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.



Returns to the CONFIG screen.

COOLING-UNIT SETTING



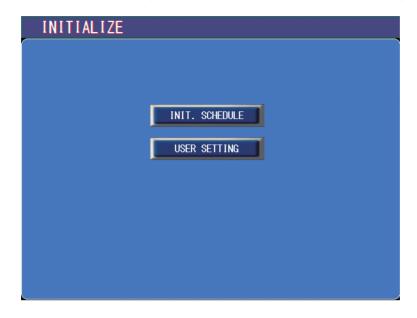
How to see the displayed items



CURR. TEMP./WTR-TEMP.	The current air temperature and the water temperature are displayed.	
CURR. HUM./DEW HUM.	EW HUM. The current humidity and the dew point are displayed.	
TARGET WATER-TEMP./ DEW HUM.	Sets the target water temperature. The dew point at the target water temperature is displayed.	
WARNING DETECT/coef.	Sets the condensation alarm judgment time/factor (*). * An alarm is given when the state "(dew point x factor) ≤ current humidity" continues for the judgment time.	
HUM. READY/coef.	Sets the proper humidity judgment time/factor (*). * Factor = alarm setting factor. An alarm is canceled when the state of the proper humidity continues for the judgment time.	
DRYAIR STOP/coef.	Displayed when the dry air unit (option) is running. Sets the dry air stop time/factor (*). * The dry air is stopped when the state "(dew point for the target water temperature x factor) ≤ current humidity" continues for the judgment time.	
CHILLER	Lights up when the chiller is running.	
DRYAIR	Lights up when the dry air unit (option) is running.	
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.

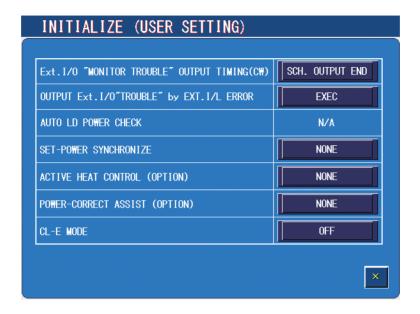


How to see the displayed items



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

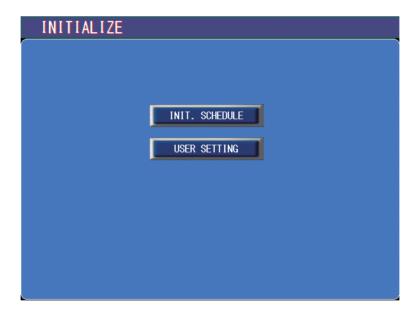
Ext.I/O "MONITOR TROU- BLE" OUTPUT TIMING (CW)	Sets the output timing of the monitor upper/lower limit check error in the CW waveform. SCH. OUTPUT END: Output when output ends (default) MON. TRB. DETECT: Output when the error occurs (The normal output signal is turned ON during output until the error occurs.)
OUTPUT Ext.I/O "TROUBLE" by EXT.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)	Sets whether to use the optional heat detector setting. Functions and displays related to the heat detector setting are valid only when this is set to USE. NONE: Not use (default) USE: Use
POWER-CORRECT ASSIST (OPTION)	Sets whether to use the laser output compensation function. NONE: Not use (default) USE: Use
CL-E MODE	Switches the CL-E mode. Settings and displays in the CL-E mode are valid only when this is set to ON. OFF: MF-C2000A-M/S (default) ON: MF-C2000A-MC/SC
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 control-
- ⇒ 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 (MF-C2000A-M/S Only)

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 is 200 to 2000. MIN The ratio of the preliminary oscillation output for "SET POWER" is displayed. For the preliminary oscillation, see page 108. **↑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. The setting and the slope may be different in a low output range of 0 to 200 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).</note>
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 \$\displaystyle 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 200 W. Check the waveform output on the monitor. To make more detailed settings, use the FLEX mode.</note>
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.</note>
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.</note>
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.
HEAT	Displayed when the active heat control function (option) is enabled. When this button is pressed, the active heat control setting screen for the selected schedule number opens. Blinks when the active heat control function is enabled. The function can be set on the ACTIVE HEAT CONTROL 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 81.

<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 RE-PEAT. For details, refer to "Limitations of Schedule Setting" on page 132.
- 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 132.

Preliminary Oscillation

For MF-C2000A-M/S, to stabilize the laser oscillation, the minimum power of laser (100 W) 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 is 200 to 2000.</note>	
MIN	The ratio of the preliminary oscillation output for "SET POWER" is displayed. For the preliminary oscillation, see page 108.	
4	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.</note>	
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.

HEAT	Displayed when the active heat control function (option) is enabled. When this button is pressed, the active heat control setting screen for the selected schedule number opens. Blinks when the active heat control function is enabled. The function can be set on the ACTIVE HEAT CONTROL 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 81.

<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 132.

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", supposing that the set value is the reference value (100%). FENCE VALUE" for the forecast value of laser output. <note> The settable value of laser output is 200 to 2000.</note>	
MIN	The ratio of the preliminary oscillation output for "SET POW For the preliminary oscillation, see page 108.	ER" is displayed.
4	Scrolls the POINT display column of POINT 01 to POINT 20 to When a POINT is not displayed, press this button to display it.	the right and left.
POINT 01 to 20	Set the laser output time and laser output value at each point "POINT 20."	of "POINT 01" to
REFERENCE VALUE	The forecast value of laser output (W) based on 100% POWE ser output schedules is displayed. <note> There is a little difference between the forecast value of lase measured value (actually measured value) depending on the cal characteristics. Use the forecast value of laser output as re</note>	er output and the optical and electri-
RESOL	When this button is pressed, the selected setting resolution cal 0.1 s, 0.01 s, or 0.001 s. When the setting resolution is changed, the currently-sele cleared and the initial value is set.	
MODU	When this button is pressed, the modulation setting screen schedule number opens. Blinks when the modulation function function can be set on the MODULATION screen.	
HEAT	Displayed when the active heat control function (option) is enabled. When this button is pressed, the active heat control setting selected schedule number opens. Blinks when the active heat control setting senabled. The function can be set on the ACTIVE HEAT CONTROLL.	control function is
Fn	When this button is pressed, a window to select function is displowing editorial assistant functions can be used. RESET: Initializes the currently-selected schedule. COPY: Copies the currently-selected schedule to a temporary PASTE: Restores data from a temporary memory buffer to the ed schedule.	memory buffer.

[⇒] For the common items in the upper/lower part of the screen, refer to page 81.

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 SCHED-ULE 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.

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: 1000, FLASH1: 3.6 ms/100%, COOL1: 0.0 ms, FLASH2: 2.4 ms/85%, COOL2: 0.0 ms, FLASH3: 1.9 ms/50%, up slope: 0.6 ms, and down slope: 1.2 ms are set as output schedules.

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



- (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 is 200 to 2000.

- (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 kev.

<Note>

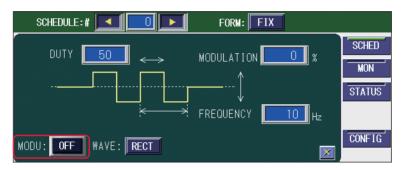
The output time of the last FLASH includes the time of "↓SLOPE." Set "↓SLOPE" so as to result in the following value.

↓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.

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 122.



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

Setting ON/OFF for the Output Schedules for Seam Processing

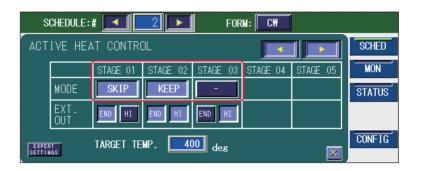
- (1) Press the "SEAM" button to display the SEAM screen.
- (2) Press the "SEAM" setting button and set the seam processing output schedule to ON/OFF.
 - At ON, the fade function for seam processing set on the SEAM screen is enabled. When this function is not used, set OFF.
- ⇒ For the setting method of the output schedules for seam processing, refer to "Setting the Output schedules for Seam Processing" on page 118.
- ⇒ 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.

Enabling/disabling the Active Heat Control Function (Option)

- (1) Press the "HEAT" button to display the ACTIVE HEAT CONTROL screen.
- (2) Press the "MODE" setting button of "STAGE 01" to "STAGE 02" to set the control method of each stage of waveform.
 - When SKIP or KEEP is set, the active heat control function set on the ACTIVE HEAT CONTROL screen is enabled.
- ⇒ For the setting method of the active heat control function, refer to "Setting the Active Heat Control Function (Option)" on page 127.

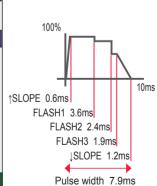


(3) Press the "X" button to display the SCHEDULE screen.

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.





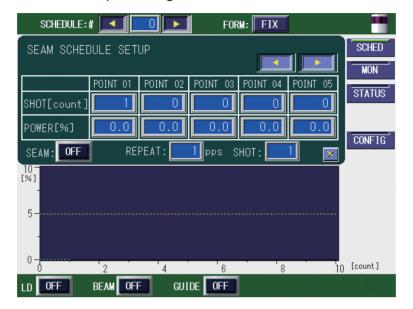
⇒ At the leading edge of waveform, an overshoot (higher form than the set value) may occur. In this case, extend "↑SLOPE" by 0.1 to 1.0 ms.

- (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.

: Settable item

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

SHOT

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.

Sets the laser light output count of POINT 01 to POINT 20 in the range of 1 to

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.

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.

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.

Returns to the SCHEDULE screen.

⇒ For the common items in the upper/lower part of the screen, refer to page 81.

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.

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.



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 kev. 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.

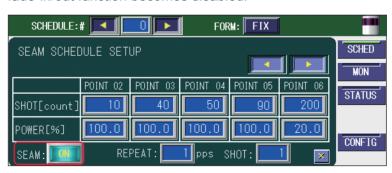
When the output count set in "SHOT" is larger than that set in "SHOT [count]", the POWER of the final set value in "SHOT [count]" is repeated until the output count reaches the output count set in "SHOT."

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.)

Enabling the Fade Function

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

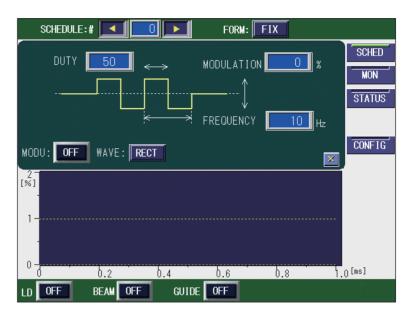
 The fade-in/out function for seam processing is enabled.
- ⇒ When the fade-in/out function is not used, keep the "SEAM" setting button OFF.
- ⇒ When the laser light output count is set to 9999 by using the "SHOT" setting button, a laser light is continuously output until the laser stop signal is input and the fade-in/out function becomes disabled.



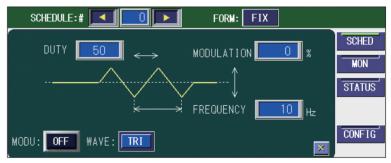
MODULATION Screen

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

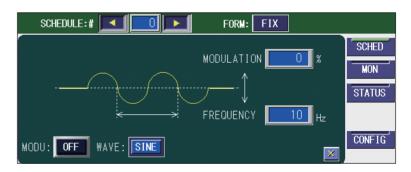
Rectangular wave (RECT)



Triangular wave (TRI)



Sinusoidal wave (SINE)



How to see the displayed items



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

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.</note>
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%.</note>
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 81.

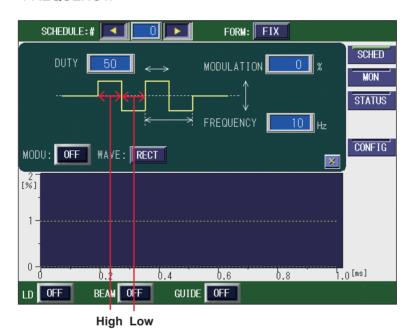
Setting the Modulated Waveform

The method of setting the modulated waveform after displaying the MODULA-TION screen is explained below.

- ⇒ When using the modulated waveform, normally set the laser output value "POW-ER [%]" to 100%.
- ⇒ When the modulated laser is output, the output time may be slightly longer than the setting.

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 MODU-LATION 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."

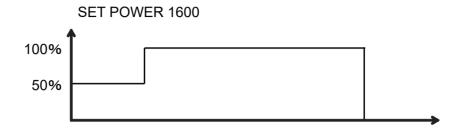


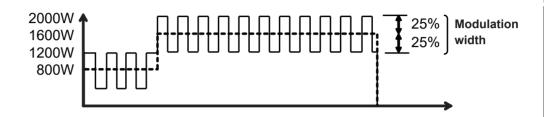
- (2) Press the "DUTY" setting button. Enter the ratio of the High period in a cycle (%) by using the numeric keypad and then press the ENT key.
- (3) Press the "MODULATION" setting button. Enter the modulation width whose center is the laser output set value (SET POWER x POWER [%]) by using the numeric keypad and then press the ENT kev.

<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.

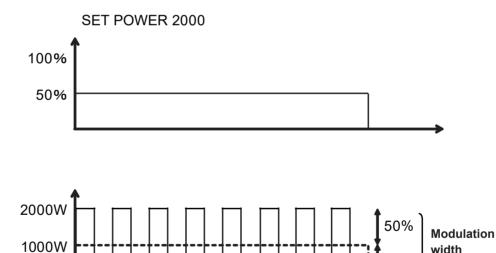
Ex. 1) When setting "SET POWER" to 1600 and making the following waveform





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 50% not exceeding 2000 W, the maximum set output.

Ex. 2) When performing modulation from the minimum to the maximum



The modulation width whose center is 1000 W can be obtained by setting SET POWER to 2000 and POWER to 50%. Set the modulation width to 100%.

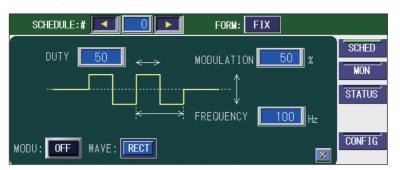
100W

At this time, the minimum output is not 0 W, but 100 W, the preliminary oscillation. The preliminary oscillation is a function for stabilizing the laser oscillation. For details, refer to "Preliminary Oscillation" on page 108.

width

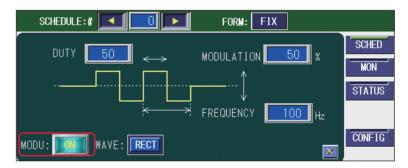
50%

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



Enabling the Modulation Function

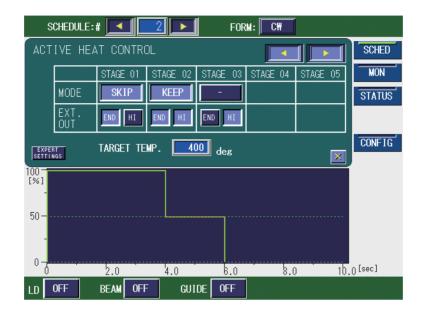
(1) Press the "MODU" setting button to set it to ON.



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

ACTIVE HEAT CONTROL Screen

On the ACTIVE HEAT CONTROL screen, the active heat control function (option) is set. The active heat control function detects the temperature of the processing part and stops laser when it exceeds the target temperature.



How to see the displayed items

: Settable item

MODE	Sets the control method for each stage of waveform. Can be selected from following three types. -: The active heat control is not performed. Laser is output with the set TIME and POWER. SKIP: Proceeds to the next stage when the temperature reaches the target temperature. KEEP: Laser is turned on and off with the target temperature. Switched each time the button is pressed. Can be set for each schedule.	
EXT.OUT	 END: When this button is selected, the stage end signal (Pin No.7 of the EXT. I/O (2) connector) is output at the end of the stage. This output time is specified in the [STAGE-END SIGNAL WIDTH] on the HEAT DETECTOR SETTING screen. HI: When this button is selected, the temperature reached signal (Pin No.12 of the EXT. I/O (2) connector) is output while the heat detector exceeds the target temperature. 	
TARGET TEMP.	Sets the target temperature for the SKIP or KEEP control in the rated range of the heat detector. Can be set for each schedule.	
EXPERT SETTING	Displays the detailed setting screen for active heat control function.	
X	Returns to the SCHEDULE screen.	

For the common items in the upper/lower part of the screen, refer to page 81.

EXPERT SETTINGS



How to see the displayed items : Settable item CORRECTION Sets the correction factor in the range of 0.05 to 1.00. MONITOR SPAN Sets the display time of the temperature waveform on the MONITOR screen. Display time of the temperature waveform = laser emission time × MONITOR SPAN (Setting range: 1.0 to 2.0) <Note> In the CW waveform, the display of the temperature waveform is finished at the time when the following operation is performed for the laser waveform with 500 ms. - Laser stops by the laser stop signal input within the time set in a schedule. - The next laser output starts. - The output setting or number of schedule is changed. - An error occurs. KEEP POW. Sets the output in KEEP operation in the range of 0 to 100%. Sets the moving average time of the measured temperature from 0.0001, SMOOTHING 0.001, 0.01, 0.1, or 0.2 s. When the temperature change is large and it is hard to read, increase the set time. The variation is displayed smaller. Smoothing Input value Input signal Time CLOSE Returns to the ACTIVE HEAT CONTROL screen.

Setting the Active Heat Control Function (Option)

The method of setting the active heat control function after displaying the AC-TIVE HEAT CONTROL screen is explained below.

Setting the Active Heat Control Function

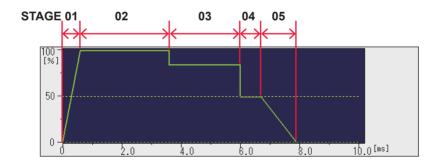
(1) Press the "HEAT" button to display the ACTIVE HEAT CONTROL screen.



- (2) Press the "MODE" setting button of "STAGE 01" to "STAGE 02" to set the control method of each stage of waveform.
- → According the number of stages of the set waveform, the "MODE" setting buttons are displayed. When the button of STAGE is pressed, the STAGE display column is scrolled to the right and left so as to display a STAGE that is not yet displayed.

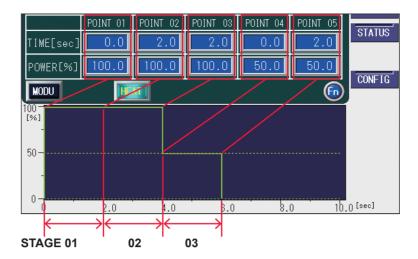
STAGE

For the waveform set on the SCHEDULE screen, a line representing the time is defined as a stage (STAGE 01, STAGE 02, and so on).



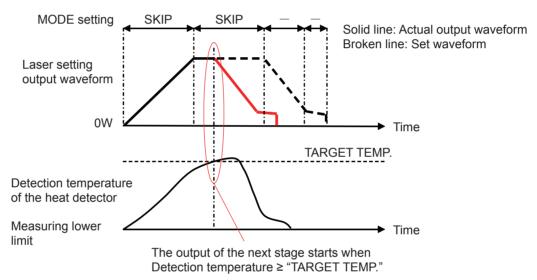
In the FLEX or CW mode, stages are divided when the laser output time is set in different POINT even if the line is flat.

In the setting shown below, the laser output value does not change until 4.0 s, but the time from 0 to 2.0 s falls on STAGE 01 and the time from 2.1 to 4.0 s falls on STAGE 02 since 2.0 s is set in POINT 02.

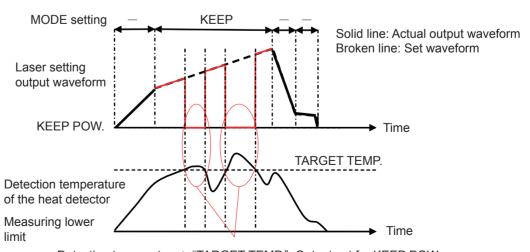


Control method (SKIP, KEEP)

In the stage set to SKIP, the operation proceeds to the next stage when the detection temperature is "TARGET TEMP." setting or higher or the laser outputs for the set time.



In the stage set to KEEP, the laser outputs with 0 W when the detection temperature is "TARGET TEMP." setting or higher. The laser outputs with the value setting in the schedule when the detection temperature is lower than "TARGET TEMP." setting.

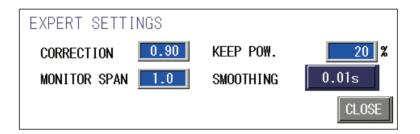


Detection temperature ≥ "TARGET TEMP.": Output set for KEEP POW. Detection temperature < "TARGET TEMP.": Output with the value set in the schedule When SKIP or KEEP is set, the active heat control function set on the ACTIVE HEAT CONTROL screen is enabled.

- ⇒ When this function is not used, set it to "-."
- (3) Press the "TARGET TEMP." button.
 - Enter the target temperature in the rated range of the heat detector by using the numeric keypad and then press the ENT key.
- ⇒ The setting range depends on the connected heat detector. You can check it on the HEAT DETECTOR SETTING screen. When changing the heat detector, make sure that the setting value does not exceed the setting range.

Making Detailed Settings

(1) Press the "EXPERT SETTING" button to display the EXPERT SETTINGS screen.



(2) Accordingly, set each items.

Setting the Correction Factor

The indicated temperature is not a warranty value. It may change depending on the workpiece material, the surface condition, or the angle of the output unit.

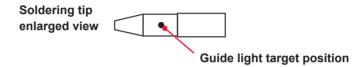
By changing the correction factor, you can correct the indicated temperature. When the correction factor is set higher, the indicated temperature is lowered.

- (1) Measure the workpiece temperature in processing with a contact-type temperature sensor such as thermocouple and thermistor.
 - At this time, note that the temperature is likely to be lower due to the heat conduction caused by contact pressure and contact.
- (2) Set the correction factor so that the indicated temperature fits to the workpiece temperature.

Making the Daily Check

The correction factor of soldering iron measured with a contact-type temperature is recorded before shipping. We recommend that you carry out a periodic check as follows.

(1) Set the "LD" setting button to OFF and the "BEAM" and "GUIDE" setting buttons to ON, and then adjust the position of guide light so that it falls on the following position.



(2) After adjusting the position, set the "GUIDE" setting button to OFF and check the temperature displayed on the MONITOR screen (HEAT DETECTOR CURRENT).



When the indicated temperature is low, check that the protective glass of the output unit is not dirty. Note that the low temperature is also displayed in an environment where there is much dust or gas, and humidity is high. On the contrary, when the high temperature is displayed, check that there is no high-temperature heat source or lighting nearby. If there are no problems in particular, adjust the correction factor to use it.

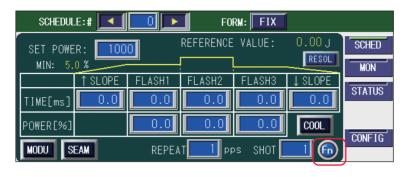
→ The temperature detection area differs depending on the lens configuration. Refer to the table below. The detection temperature is the average temperature.

Condensing lens	Temperature detection area (focal position)
f120	Approx. φ1.6 mm
f150	Approx. φ2.0 mm

- ⇒ When the guide light is out of the focal position, the temperature detection area is widened and the low temperature is detected.
- ⇒ The low temperature may be detected depending on the angle between the workpiece and the output unit.

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.

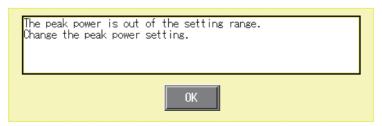
	FIX/FLEX	cw
SET POWER	200 to 2000	
REPEAT	1 to 1000 pps	_
SHOT	1 to 9999 (9999 is for endless output.)	_
TIME (FIX: value set in each FLASH) (FLEX/CW: value set in each point)	0.1ms resolution: 0.0 to 500.0 ms 0.05ms resolution: 0 to 99.95 ms (Can be set by a multiple of 0.05 ms. In FIX, set a lower 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	200 to 2000 W	
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	_

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.



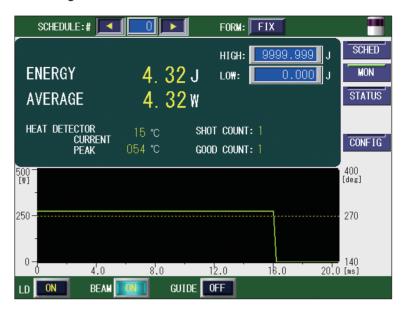
Parameters exceeding a range are displayed in the first line of dialogue, and parameters which needs to be reviewed are displayed in the second line. Review the settings of parameters displayed on the dialogue.

5. Monitoring Output (MF-C2000A-M/S Only)

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

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.
AVERAGE	Displays the average power (W) of output laser light. In the FIX/FLEX mode, an upper/lower limit judgment is not performed.
HIGH LOW	Sets the upper limit value "HIGH" and lower limit value "LOW" of the laser energy (*) to be monitored. When the laser energy (*) comes out of the set value range, 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. Refer to this number when

To reset the display to 0, perform a reset operation on the STATUS screen.

replacing the FC-LD.

: Settable item

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.
HEAT DETECTOR CURRENT PEAK	Displays the current detected temperature when the active heat control function (option) is enabled. When the temperature is outside the measuring range, "" is displayed. Displays the peak temperature of the 1-SHOT waveform when the active heat control function (option) is enabled. <note> The indicated temperature is not a warranty value. It may change depending on the workpiece material, the surface condition, or the angle of the output unit. By changing the correction factor, you can correct the indicated temperature. Refer to "Setting the Correction Factor" on page 129.</note>
Temperature scale	Displays the temperature scale at the lower right of the screen when the active heat control function (option) is enabled. Upper limit: "THERMO SPAN H" value set on the CONFIG screen Lower limit: Measuring lower limit

[⇒] For the common items in the upper/lower part of the screen, refer to page 81.

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 kev.

The measured energy value of the last output laser light and laser light waveform (green line) are displayed according to the set SCHEDULE.

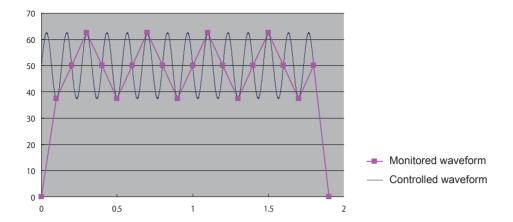


- → When the active heat control function (option) is enabled, the detected temperature waveform (red line) is displayed. The detected temperature waveform is displayed for the time "laser emission time × MONITOR SPAN." In the CW waveform, however, the display of the temperature waveform is finished at the time when the following operation is performed for the laser waveform with 500 ms.
 - Laser stops by the laser stop signal input within the time set in a schedule.
 - The next laser output starts.
 - The output setting or number of schedule is changed.
 - An error occurs.

<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 "AV-ERAGE" 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

The upper limit value of allowable energy is registered.

(2) Press the "LOW" setting button.

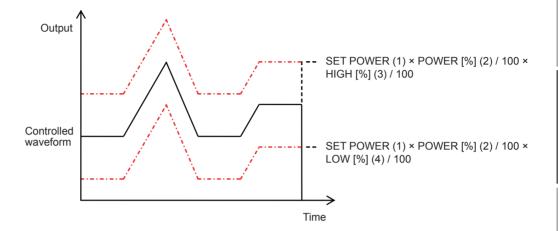
Enter the lower limit value by using the numeric keypad and then press the ENT

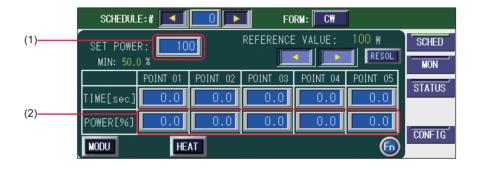
The lower limit value of allowable energy is registered.

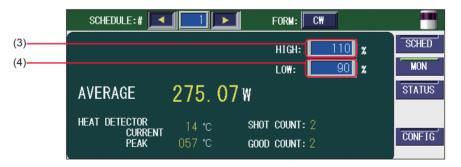


⇒ When laser light is out of the set allowable energy range, error No.035/LASER POWER OUT OF RANGE occurs and a monitor trouble is output. (Pin No.20 of the EXT. I/O (1) connector is closed for the time set on the CONFIG screen after a laser output.) When the total laser output time is 0.5 s or less 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.





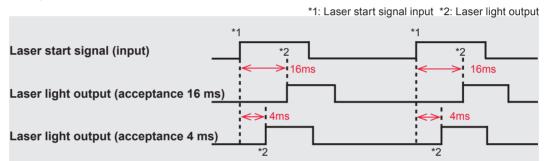


6. Changing the Acceptance Time for Laser Start Signal/ Schedule Signal (CONFIG Screen) (MF-C2000A-M/S Only)

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.



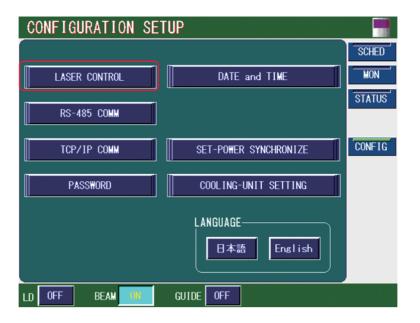
The laser start signal acceptance time and the schedule signal acceptance time are common. A different value cannot be set for the respective time.

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.

Displaying the CONFIG Screen

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



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.

7. CL-E Mode (MF-C2000A-MC/SC Only)

Since output schedules are set by CL-E100A in the CL-E mode, the settings by the laser welder are limited.

The touch panel also changes to the CL-E mode display. The content of limitation is as follows.

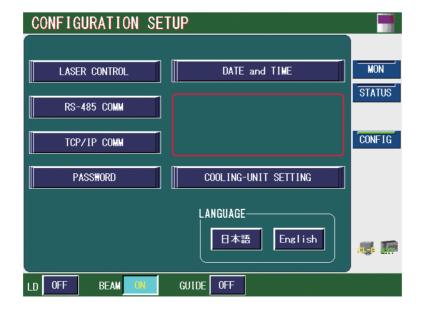
Common to Screens

SCHEDULE No. is fixed to #0 and FORM is fixed to CW. "CL-E" and "EXT" icons are also displayed.



CONFIG Screen

"ACTIVE HEAT CONTROL (OPT.)" and "SET-POWER SYNCHRONIZE" setting buttons cannot be selected. Also, the functions cannot be selected with the CL-E mode.



MONITOR Screen

The simplified MONITOR screen (flexible waveform (CW)) is displayed.

Press the "TIME SCL" button to set the estimated output time on CL-E100A. When the output exceeding the estimated output time, error No.259/MONITOR-POWER UNEXPECTED occurs.

The initial value of the estimated output time is 9999 [s]. To display a more detailed monitored waveform, set it lower.



AVERAGE

Displays the average power (W) of the output laser light. It will not be the same as the power monitor value displayed in SWDraw3 because the sampling period is different.

Operating Part

Chapter 3

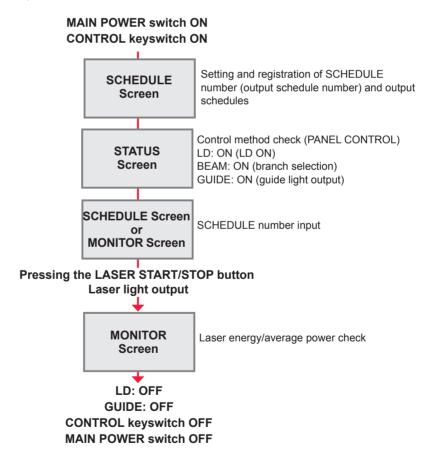
Laser Processing by Laser Controller (PANEL CONTROL)

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 CON-TROL).

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

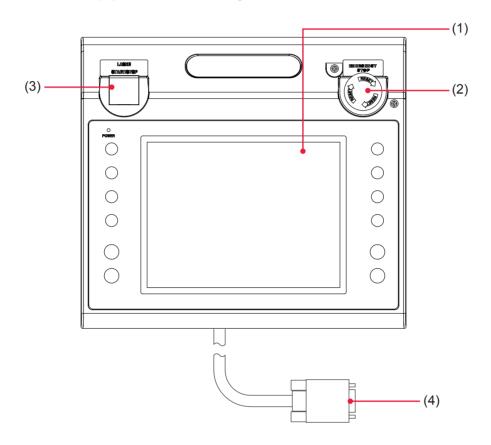


2. Laser Controller Functions

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 MONI-TOR 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)	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.
EMISSION (Lamp)	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 106. For connector functions, refer to Chapter 4, "3. Connector Functions" on page 153.
- ⇒ 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.

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.



When the dry air unit (option) is equipped, the "CHILLER" button is displayed on the KEY SWITCH CHECK screen. The chiller is normally kept running, but if you want to stop it, press the button twice within a second to switch between stop and

```
CURR.HUM. 43.4 [%]
DEW WRN. 42.0 [%]
                                                                  INITIALIZE
```

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



The SCHEDULE screen appears.

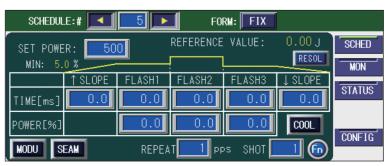
Setting Output Schedules

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 speci-
- ⇒ 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 is 200 to 2000. For the laser output value setting (% of FLASH), set the value within the setting range.

(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
```

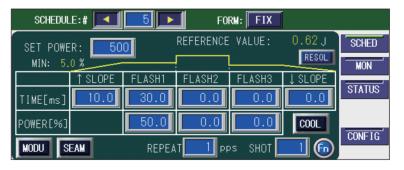
When setting "FLASH2" or "FLASH3", set the time required for laser light to downslow (the laser output is gradually weaker) to FLASH. Set "↓SLOPE" so as to result in the following value.

```
↓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 POW-ER=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.

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.

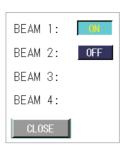
The LD lights up.



- (4) In the timesharing delivery, press the "BEAM" setting button.
 - A window to set the opening/closing of the beamsplitter is opened.
- ⇒ In the single delivery, the button cannot be pressed since the button is always turned ON.

(5) Press the setting buttons for "BEAM 1" to "BEAM 2" to set the opening/closing of the beamsplitters.

The selected beamsplitter is opened and the corresponding BEAM lamp comes on.



(6) Press the "CLOSE" button.

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

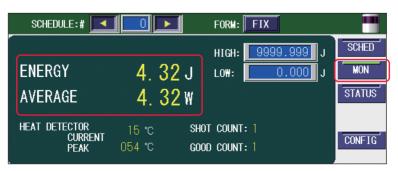
(7) Press the "GUIDE" setting button to set it to ON to output guide light. The "GUIDE" setting button is set to ON and a red dot of guide light appears at the laser light injecting position. Laser light is injected to the red-dot position.



(8) Check the laser light irradiation position.

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

- (9) Press the LASER START/STOP button.
 - Laser light is output.
- ⇒ Before pressing the LASER START/STOP button, display the SCHEDULE screen or MONITOR screen and input another registered SCHEDULE number. With this, laser light is output in the output conditions of this SCHEDULE.
- (10) Press the "MON" button to display the MONITOR screen, and check the laser output energy (J) and average power (W) of the output laser light.





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)

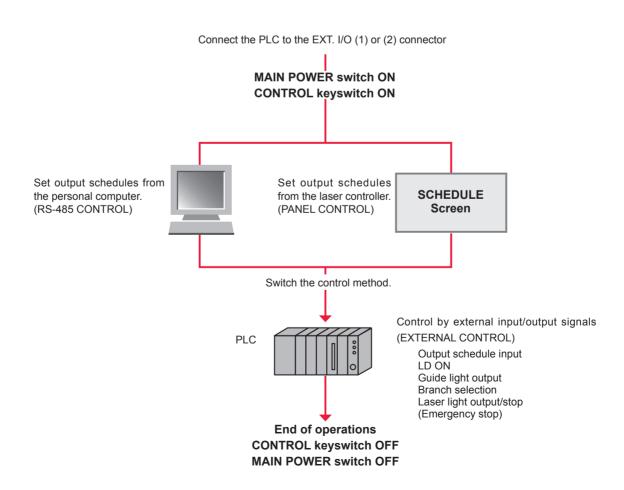
1. Operation Flow

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).

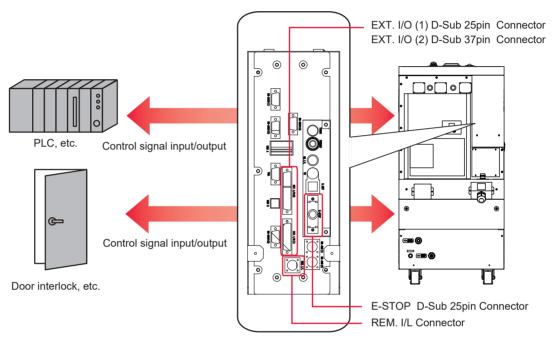


2. Preparations for Operations

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.



Rear of the main unit

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)	HIDOSE ELECTRIC CO. LTD.
EXT. I/O (2)	HDCB-37P(05)	HDC-CTH(10)	HIROSE ELECTRIC CO., LTD.
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 con-
- → 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.

CONTROL CHANGEOVER (in)	25	13	(out) Ready
OONTROE OF A TROE OF A TRO	24	12	(out) Guide on
External input receivable (out)	23	11	(out) LD on
End (out)	22	10	Input COM
` ,		9	(in) Old emergency stop (LASER STOP)
Output COM	21	8	
Monitor trouble (out)	20	7	
0V OUT	19	-	
	18	6	(in) TROUBLE RESET
Maritar a second (sect)		5	(in) Guide beam
Monitor normal (out)	17	4	(in) LD-ON/OFF
Trigger (out)	16	3	(in) LASER STOP
Laser output (out)	15		. ,
Trouble (out)	14	2	(in) LASER START
	(1	+24V OUT
		<u></u>	

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

⇒ Close pin No.25.

Pin No.	Description
	+24 V OUT
1	Power supply for external input signals. This pin is exclusively used for the MF-C2000A
	Series. Do not use it for any other purpose.
	LASER START
2	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. For the repeated output for which the number of outputs is set in "REPEAT" on the SCHEDULE screen, the laser output is stopped by closing the 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.</note>
10	Input COM
19	0 V OUT Power supply for external input signals. This pin is exclusively used for the MF-C2000A Series. 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.

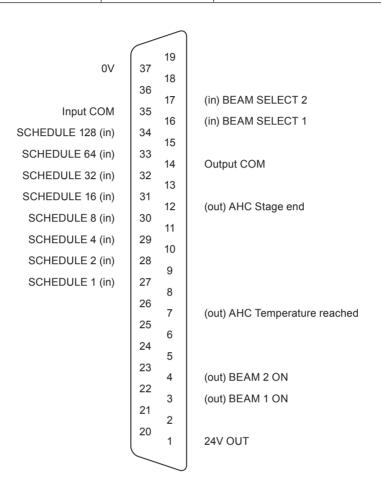
Type of output: Photo MOS relay output Rating of output: 24 V DC, 20 mA max.

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	BEAM SELECT 1
	Not used in the single delivery.
	In the timesharing delivery, when this pin is closed, the branch 1 is selected and the unit
	becomes ready to project a laser beam from the optical fiber selected to the branch 1.
	BEAM SELECT 2
17	Not used in the single delivery.
17	In the timesharing delivery, when this pin is closed, the branch 2 is selected and the unit
	becomes ready to project a laser beam from the optical fiber selected to the branch 2.
18	Unused
10	Do not connect anything.
19	Unused
	Do not connect anything.
20	Unused
20	Do not connect anything.

Pin No.		Description			
21	Unused Do not connect anything.				
22	Unused Do not connect anyth	Unused			
23	Unused Do not connect anyth	hing.			
24	Unused Do not connect anyt	hing.			
25	Unused Do not connect anything.				
26	Unused Do not connect anyt	hing.			
27	SCHEDULE 1				
28	SCHEDULE 2				
29	SCHEDULE 4				
30	SCHEDULE 8	Select a registered SCHEDULE number by combining schedule			
31	SCHEDULE 16	signal inputs 1, 2, 4, 8, 16, 32, 64 and 128.			
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 1 ON Normally closed in the single delivery. In the timesharing delivery, while BEAM 1 is ON, this pin is closed internally.
4	BEAM 2 ON Not used in the single delivery. In the timesharing delivery, while BEAM 2 is ON, this pin is closed internally.
5	Unused Do not connect anything.
6	Unused Do not connect anything.
7	AHC Temperature reached (only when using the active heat control (option)) When [HI] of the relevant stage is selected, this pin closed internally while the stage is executed and the heat detector exceeds the target temperature. This is not output in the stage set to SKIP because the stage ends simultaneously when the temperatures reaches.

3. Connector Functions

Pin No.	Description
8	Unused Do not connect anything.
9	Unused Do not connect anything.
10	Unused Do not connect anything.
11	Unused Do not connect anything.
12	AHC Stage end (only when using the active heat control (option)) When [END] of the relevant stage is selected, this pin closed internally for the time specified in [STAGE-END SIGNAL WIDTH] at the end of the stage. This may be continuous with the next stage end signal.
13	Unused Do not connect anything.
14	Output COM

Operating Part

REM. I/L Connector

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

!\ CAUTION

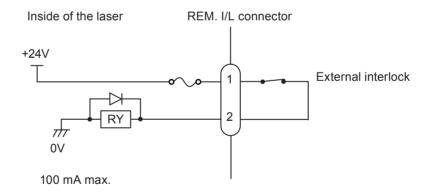
This connector can be used only when replacing our old products. Use the E-STOP connector for the emergency stop signal in accordance with machine safety standards.

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
2	off.

- ⇒ 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.

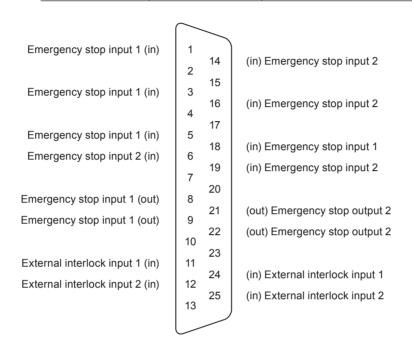


E-STOP Connector (D-Sub 25 pin)

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	Emergency stop input 1 When the section between Pin No.1 and Pin No.18 or the section between Pin No.3 and
3	Pin No.5 is put in an open circuit, an emergency stop is activated, and the LD is turned off.
5	To cancel it, put the sections between Pin No.1 and Pin No.18, between Pin No.14 and
18	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	Emergency stop input 2 When the section between Pin No.14 and Pin No.19 or the section between Pin No.6
14	and Pin No.16 is put in an open circuit, an emergency stop is activated, and the LD is turned off.
16	To cancel it, put the sections between Pin No.1 and Pin No.18, between Pin No.14 and
19	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	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.
24	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	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
25	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							
9	When the laser is put in an emergency stop, the section between pin No.8 and pin is put in an open circuit.							
21	Emergency stop output 2							
22	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.							

→ 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

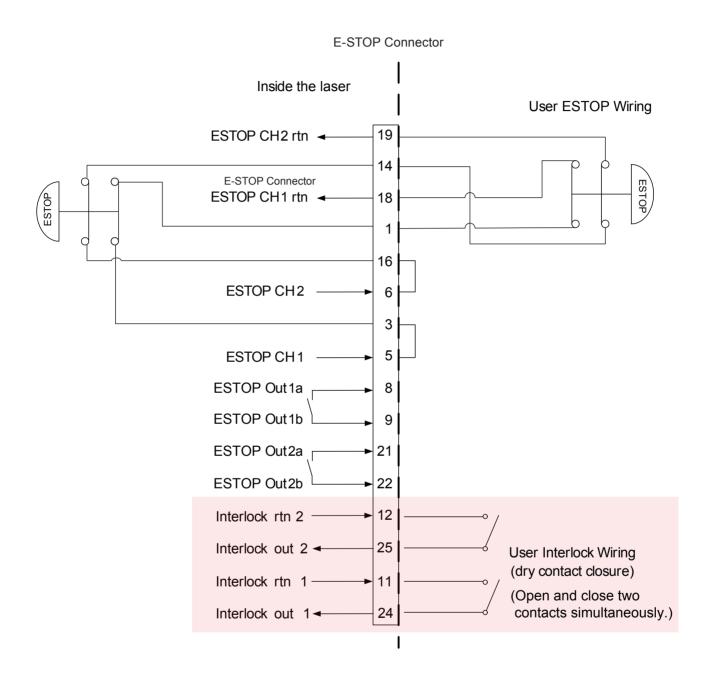
The emergency stop and interlock are made up of two dry contact inputs. These must be made to open and close simultaneously. After the interlock has opened and closed, reset is activated and interlock is canceled.

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.



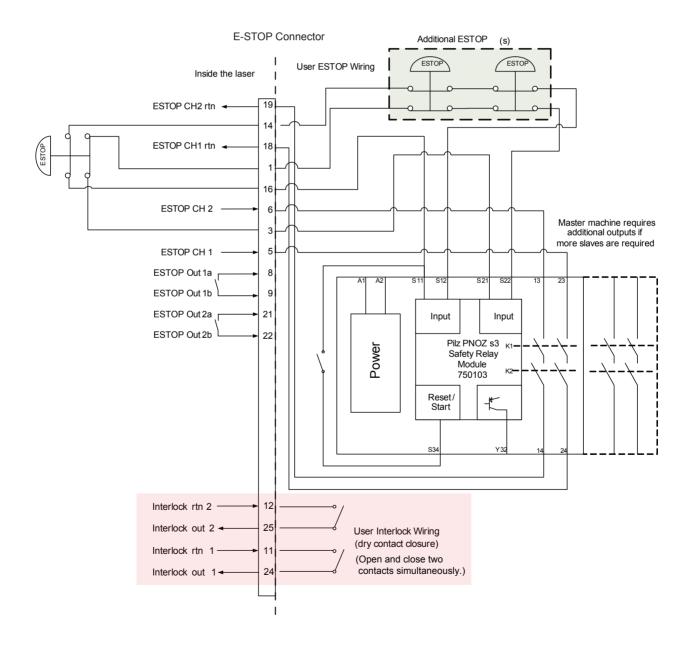
Emergency Stop for Complicated Systems

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 ES-TOP 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.

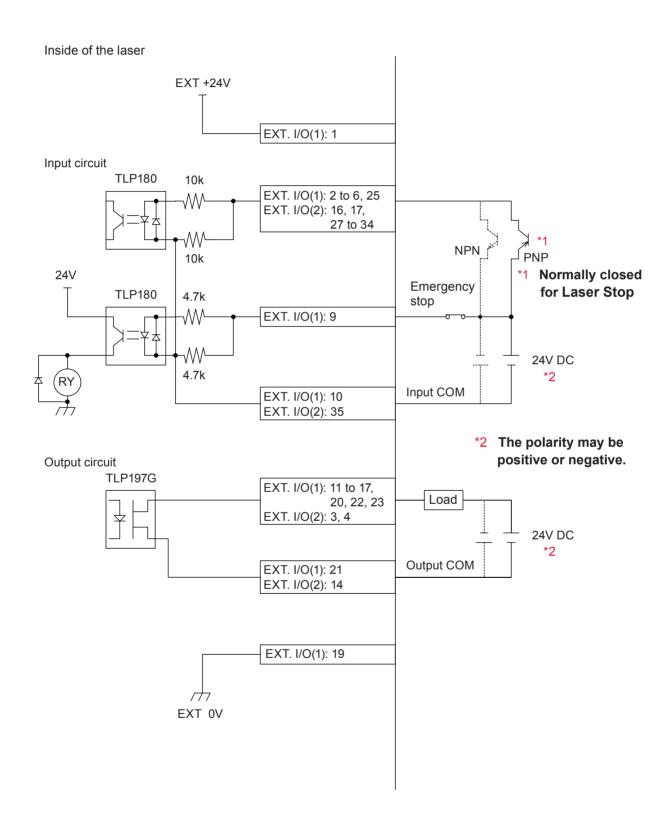
In this wiring example a Pilz PNOZ family safety relay module controls the Laser and interfaces two external emergency stop buttons. In this example the Pilz device would also control additional emergency stop functions outside of the Laser using expansion contacts. The more devices which must be implemented 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

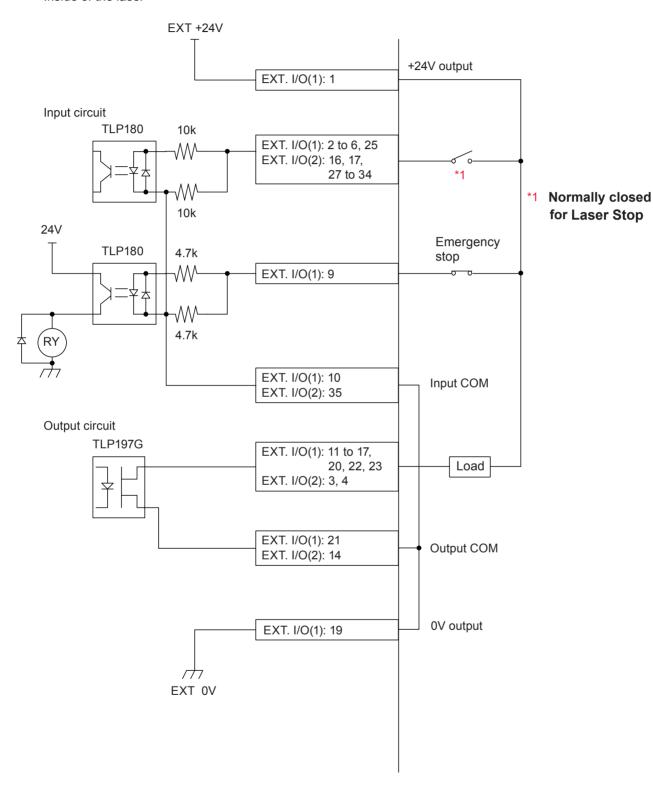
An example of external input/output signal connections is explained below.

When Connected to an External Power Source



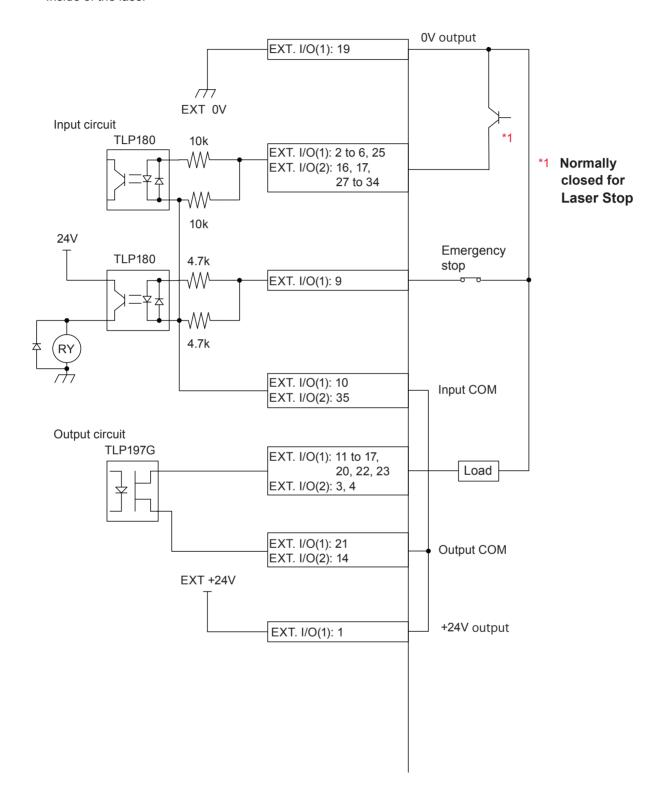
When Using a Contact Signal

Inside of the laser



When Using an Open-Collector Signal

Inside of the laser



4. Programming

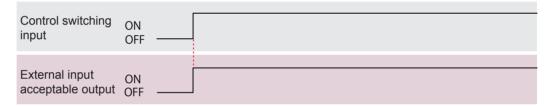
This section explains the precautions for programming laser processing by external input/output signals (EXTERNAL CONTROL).

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 branch 1, as an example.

Switching the Control Method

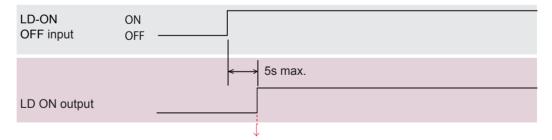
- (1) Put pin No.25 (control switching) of the EXT. I/O (1) connector in a closed circuit. Pin No.23 of the EXT. I/O (1) connector is put in a closed circuit and the signal (external input acceptable) is returned from the laser.
- ⇒ Press the STATUS button on the laser controller to display the STATUS screen. Then, you can confirm that "EXTERNAL CONTROL" is selected as the control method.



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.

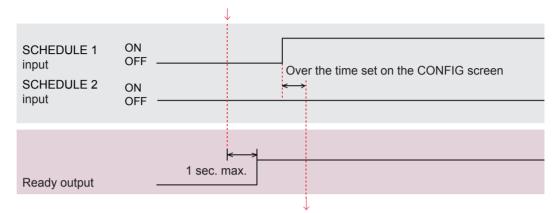


Setting Output Schedules (SCH.#01)

- (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.



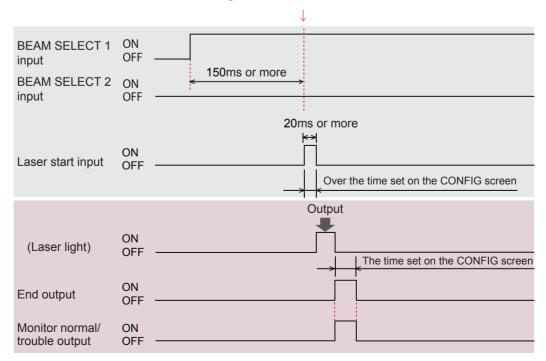
Selecting a Beam (Timesharing Only)

(1) Put the pin corresponding to the beam in a closed circuit. In this example, pin No.16 of the EXT. I/O (2) connector is put in a closed circuit to select Beam 1. The branch 1 is opened and the BEAM1 lamp comes on.

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.

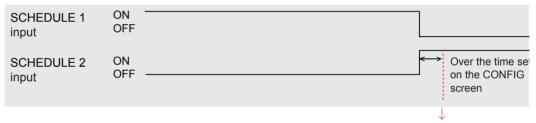
Pin No.22 (End output) of the EXT. I/O (1) connector is put in a closed circuit for 20 ms and a signal is returned from the laser. Pin No.17 (Monitor normal output) or pin No.20 (Monitor trouble output) of the EXT. I/O (1) connector is put in a closed circuit for 20 ms and a signal is returned from the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



- ⇒ In more than 150 ms after a beam select signal input in the timesharing delivery and 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.
- ⇒ Be sure to put the laser start pin in a closed circuit at least for 20 ms.

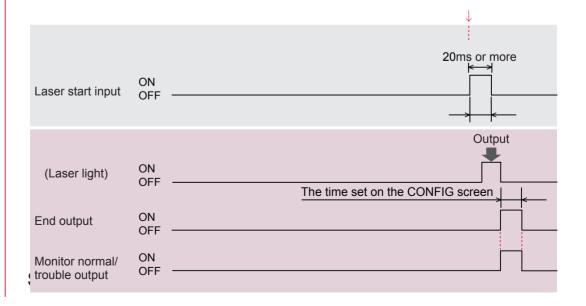
Setting Output Schedules (SCH.#02)

(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.



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 branch 1.
- ⇒ The details are the same as Step 5.



8

- (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)

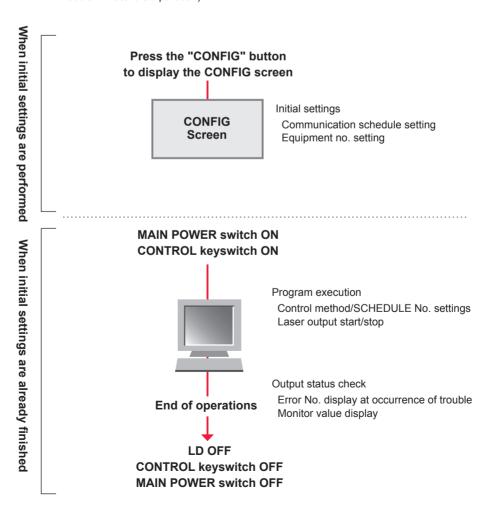
1. Operation Flow

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).

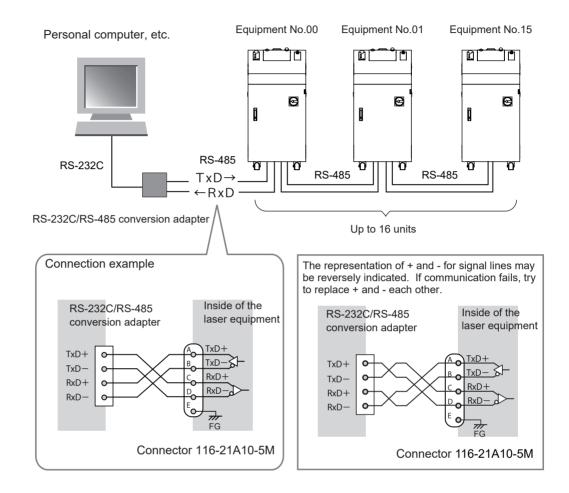
At the control by external communication (RS-485 CONTROL), the original customerdeveloped program is executed on the personal computer to set laser output schedules and read monitor data and various types of status.

* 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 31.
- > 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 duple:							
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							

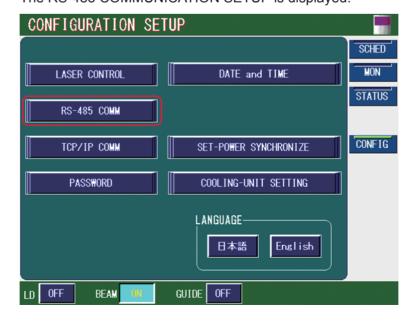
⇒ Set the transfer rate, data type, and equipment No. by displaying the RS-485 COMMUNICATION SETUP from the CONFIG screen by the laser controller of each equipment that is connected to the personal computer, etc.

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.

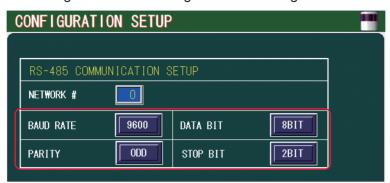
Displaying the CONFIG Screen

- (1) Press the "CONFIG" button to display the CONFIG screen.
- (2) Press the "RS-485 COMM" button. The RS-485 COMMUNICATION SETUP is displayed.



Specifying Communication Schedules

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



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 177 to "Reading the Equipment Name" on page 194.

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						Te	xt s	stru	ıctı	ıre								
\A/	Oatting a data	PC to laser	S T X	C H 1	CH0	W	L A 1	L A 0	S H 3	S H 2	S H 1	S H 0	D T 1	D T 0	:	da	ıta	E T X	ВСС
W	Setting data	Laser to PC	C H 1	C H 0	ACK	Or			C H 1	C H 0	N A K	se co	tting mmı	data is out of the grange or external nunication control is not med.				ot	
D	Dooding data	PC to laser	S T X	C H 1	CHO	R	L A 1	L A 0	S H 3	S H 2	SH1	S H 0	D T 1	D T 0	E T X	ООВ			
R	Reading data	Laser to PC	S T X	da	ita	E T X	всс		Or		C H 1	CH 0	N A K		a No		le N out o		
14/0	Setting the control method,	PC to laser	S T X	C H 1	CHO	W	S	S H 3	S H 2	S H 1	SHO	c n t	s 1	s 2		s 9	m o n	E T X	B C C
WS	SCHEDULE No., etc.	Laser to PC	C H 1	C H 0	ACK	Or			C H 1	C H 0	N A K	The specified status cannot be provided or external communication control is not performed.							
	Setting the	PC to laser	S T X	C H 1	CHO	W	D	Y 3	Y 	M O 1	⊠ 00	D 1	D 0	H 1	H 0	1 – M	M I 0	E T X	B C C
WD	system date and time	Laser to PC	C H 1	C H 0	A C K		Or		C H 1	C H 0	N A K	The specified status cannot be provided or external communication control is not performed.							
RS	Reading the control method,	PC to laser	S T X	C H 1	CH0	R	S	E T X	B C C										
Ko	SCHEDULE No., etc.	Laser to PC	S T X	C H 1	CIO	SH3	SH2	S H 1	S H 0	c n t	s 1	s 2	s 3		s 9	m o n	r d y	E T X	ВСС
PD	Reading the	PC to laser	S T X	C H 1	CIO	R	D	E T X	B C C										
KD_	RD system date and time	Laser to PC	S T X	Y 3	Y 2	Y 1	Y 0	M O 1	M O 0	D 1	D 0	H 1	H 0	M 1 1	M 1 0	ETX	ВСС		
# 2	Laser start	PC to laser	S T X	C H 1	CHO	\$	0	E T X	B C C										
\$ 0	command	Laser to PC	C H 1	C H 0	A C K		Or		C H 1	C H 0	N A K	N A COMPANY OF THE LD IS OFF, trouble occurs, or external communication control is not performed.					ot		

Code	Contents						Te	xt s	stru	ctu	ıre							
*	Laser stop	PC to laser	S T X	C H 1	C H 0	\$	9	E T X	ВСС									
\$9	command	Laser to PC	C H 1	C H 0	A C K		Or		C H 1									
C0	Trouble reset	PC to laser	S T X	C H 1	C H 0	С	0	E T X	ВСС									
	command	Laser to PC	C H 1	C H 0	A C K		Or		C H 1	OIO	N A K		terna ntrol					
C1	SHOT COUNT reset	PC to laser	S T X	C H 1	C H 0	С	1	E T X	ВСС									
	command	Laser to PC	C H 1	C H 0	A C K		Or		C H 1	OIO	N A K		tern: ntrol					
C2	GOOD COUNT reset	PC to laser	S T X	C H 1	C H 0	С	2	E T X	B C C									
02	command	Laser to PC	C H 1	C H 0	A C K		Or		C H 1	OHO	N A K	control is not performed						
RT	Reading	PC to laser	S T X	C H 1	C H 0	R	Т	E T X	всс									
KI	trouble	Laser to PC	S T X	E 2	E 1	E 0	,	E 2	E 1	E 0	,		E 2	E 1	E 0	E T X	ВСС	
RH	Reading the	PC to laser	S T X	C H 1	C H 0	R	Н	I D 3	П Д 2	1 1	- D O	E T X	всс					
- NII	error history	Laser to PC	S T X	(erro	r	ETX	всс										
RV	Reading the software	PC to laser	S T X	C H 1	C H 0	R	>	C _P 1	CPO	ETX	всс							
Κ.V	version	Laser to PC	S T X	version			E T X	ВСС										
RN	Reading the equipment	PC to laser	S T X	C H 1	C H 0	R	N	E T X	ВСС									
LIN	name	Laser to PC	S T X	r	am	e	E T X	ВСС										

Setting Data

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

Personal computer, etc.

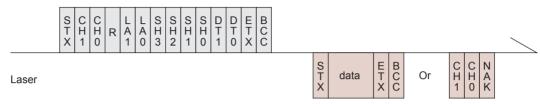
	S T X	C H 1	C H 0	W	L A 1	L A 0	S H 3	S H 2	S H 1	S H 0	D T 1	D T 0	:	data	E	2									
Laser																	C H 1	C H 0	A C K	0	r	C H 1	C H 0	N A K	•

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 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 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 179. • 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.

Personal computer, etc.



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 179. • 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 0.05ms, 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	00200 – 02000
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 - 099999 (×0.1J/×0.01J) CW: 000000 - 000999 (×1%)
07	[LOW] on the [MONITOR] screen Energy monitor lower limit setting	FIX/FLEX: 000000 - 099999 (×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	[\$\subseteq \text{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.	ltem	Data Range
01	[POINT 01] TIME on the [SCHEDULE] screen	0000 - 9999 (×1s/×0.1s/×0.01s/×0.001s)

Data No.	Item	Data Range
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%)

Data No.	Item	Data Range
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
08	[POINT 18] SHOT on the [SEAM] screen	0000 - 9999
09	[POINT 19] SHOT on the [SEAM] screen	0000 - 9999

Data No.	Item	Data Range
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.	ltem	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

Data No.	Item	Data Range
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.	ltem	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

Pulse width	Measurement interval
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	00000000000 - 999999999999
03*	[SUBNET MASK] on the [CONFIG] screen	00000000000 - 999999999999
04*	[DEFAULT GATEWAY] on the [CONFIG] screen	00000000000 - 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.

	C C H H 0		SH	S H 2	Н	Н			s 2								m o n	Τ	С	l
--	-----------	--	----	-------------	---	---	--	--	--------	--	--	--	--	--	--	--	-------------	---	---	---

Laser



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 page (space), the current schedule No. in use is entered.

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 \Box (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.

Set value	Control method to be set
0	0: Control by laser controller
2	2: Control by external communication control
0	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.)
	value 0 2 0

cnt

	* 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 □)	Unused (fixed to □)				
	Single delivery	Unused (fixed to □)				
s4	Timesharing delivery	Beam select 1 (0: OFF 1: ON □: Current status kept)				
.5	Single delivery	Unused (fixed to □)				
s5	Timesharing delivery	Beam select 2 (0: OFF 1: ON □: Current status kept)				
s6	Unused (fixed to □)					
s7	Unused (fixed to □)					
s8	Unused (fixed to □)	Unused (fixed to □)				
s9	Unused (fixed to □)					
mon	Automatic laser power monitor value transmission (0: OFF 1: ON \square : Current status kept) Each time the laser is output, "00 Laser Power Monitor-Energy, number of waveform data, etc." on page 185 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. C H 0 W D Laser

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.

S C C C T H H R S E B T C X C		
Laser	S C C S S S S C S S S S S S S S S S M T O D D D D D D D D D D D D D D D D D D	E B C C

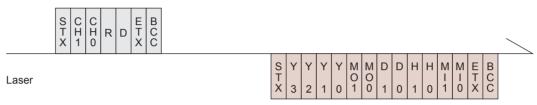
0114/0110	F. 1(N. (0114				
CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)				
SH3/SH2/SH1/SH0	Schedule No. (SH3 = thousands digit, SH2 = hundreds digit, SH1 = tens digit SH0 = units digit)				
cnt	the laser control 2: Control by exte 3: Maintenance m 4: (Missing numb	ernal input/output signals (Output schedules are set on oller.) ernal communication control node er) ernal input/output signals (Output schedules are set on			
s1	LD (0: OFF 1: ON)				
s2	Guide light (0: OFF 1: ON)				
s3	Unused (fixed to 0)				
s4	Single delivery	Unused (fixed to 1)			
54	Timesharing delivery	Beam select 1 (0: OFF 1: ON)			
s5	Single delivery	Unused (fixed to 0)			
50	Timesharing delivery	Beam select 2 (0: OFF 1: ON)			
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 185 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.

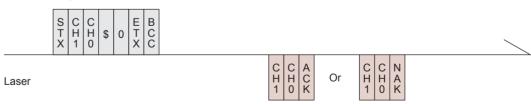
Personal computer, etc.



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.

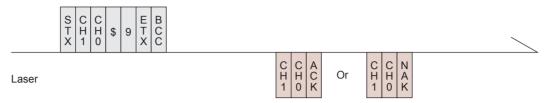


CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)			
	If the Laser is ready for use, it returns an [ACK]. If not, the Laser returns a [NAK].			
ACK or NAK	The Laser is not ready for use when: • An alarm is activated. • LD is OFF. • The Laser is not in external communication control mode.			

Stopping a Laser Light Output

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

Personal computer, etc.

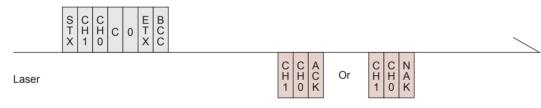


CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
ACK or NAK	The Laser accepts the command only when in external communication control (RS-485 CONTROL) mode. It returns a [NAK] when in any other control method.

Stopping an Error Signal Output

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

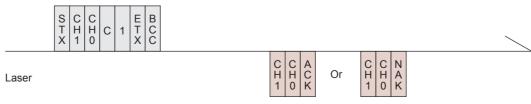
Personal computer, etc.



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

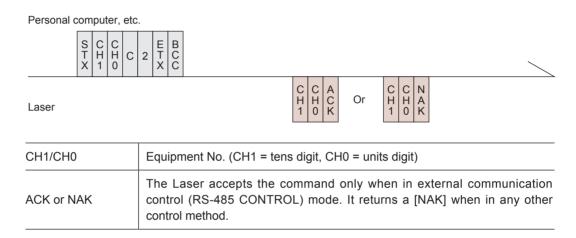
The command (code: C1) to reset the total number of outputs (SHOT COUNT) is explained below.



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.

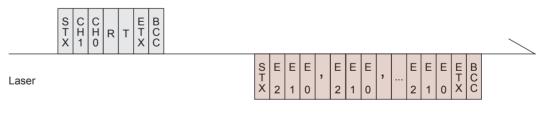
Resetting the Appropriate Number of Outputs

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



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 233.

Reading the Error History

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

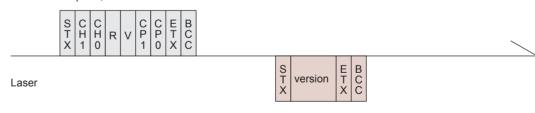
Personal computer, etc.

	S C T H X 1	C H 0	R	Н	I D 3	I D 2	1 D 1	- D 0	E T X	ВСС						
Laser											STX	2	error	E T X	ВСС	

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.

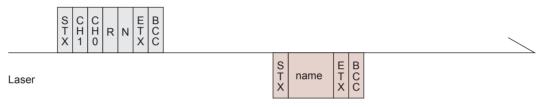


CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
CP1/CP0	CPU No. (CP1 = tens digit, CP0 = units digit) 00: CPU 01: MAIN FPGA 02: SUB FPGA • If "99" is entered, data is read in a batch.

	Version information (nnnnnnnnnnnnnnnnnssssssssssvvvvvvvvyyyymmddhhmm) nnnnnnnnnnnn Software name sssssssss Part No. vvvvvvvv Software version
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

Operating Part

Operating Part

Chapter 6

 Laser processing using external input/output signals in CL-E mode(MF-C2000A-MC/SC Only)

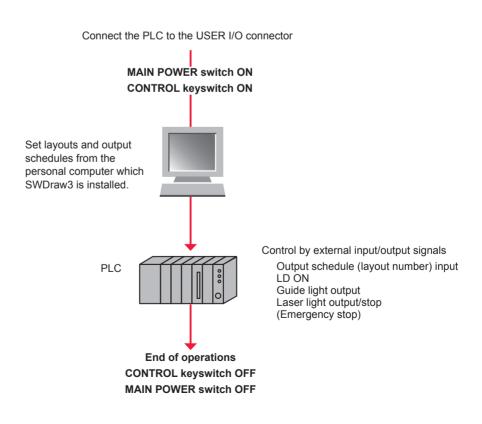
1. Operation Flow

This section explains an operation flow of laser processing in the CL-E mode.

The following three methods for laser processing operations are available: control from the connected personal computer (SWDraw3) and control by external input/output signals from the PLC (Programmable Logic Controller) connected to the connector and external communication control (RS-232C) for control by sending commands from a PC, etc.From these three types of control methods, select the method that matches the machining operation.

At the control by external input/output signals, output schedules are set by SWDraw3 in advance. After that, such control as schedule selection, laser light output and start/ 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. Operating Procedure

This section explains the operating procedure for laser processing in the CL-E mode.

Starting the Laser

- (1) Confirm that the MAIN POWER switch is turned OFF.
- (2) Confirm that the laser welder and computer are connected with the LAN cable.
- (3) 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.



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



The MONITOR screen appears.

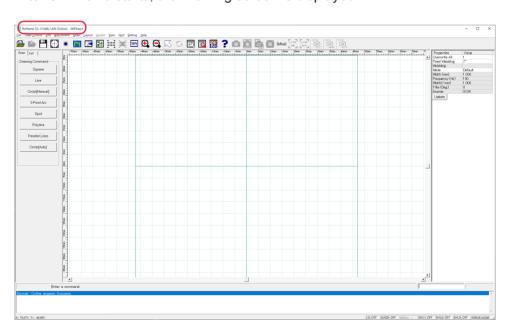
(5) Press the [TIME SCL] button to set the estimated output time on CL-E100A. Select a time longer than the scanning time.



Starting the Computer

(1) Double-click the [SWDraw3] icon on the desktop to start the SWDraw3 application

After SWDraw3 starts, the Drawing screen is displayed.



(2) Confirm that the equipment is connected correctly by checking the status display field on the Drawing screen.

"Online" displayed in the title bar indicates that the laser welder is online.

Creating a Layout

Refer to the operation manual for SWDraw3.

Setting Output Schedules

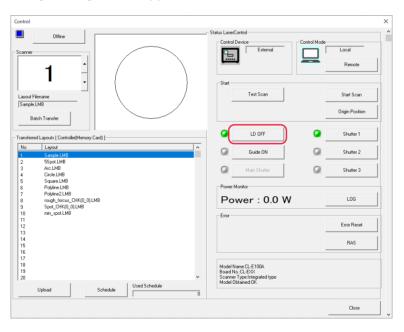
Refer to the operation manual for SWDraw3.

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) From the menu, select [Laser Control] -> [Control]. The [Control] screen appears.

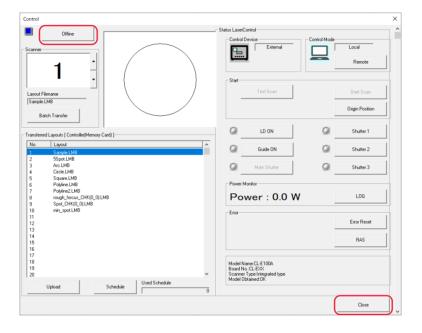


- (2) When the [LD] is ON, click the [LD OFF] button.
- (3) The "Cooling down" message is displayed on the Drawing screen while operation is stopped.

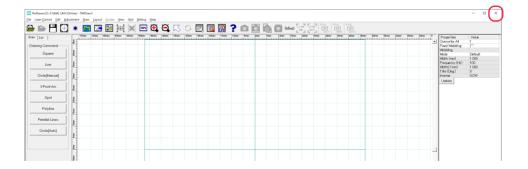


<Notes>

- Do not turn off the power switch while the Drawing screen displays the "Cooling down" message. Shutting off the power switch while the system is stopped will significantly reduce the life of the laser welder.
- Do not shut off the power while "Online" is displayed in the title bar. Shutting off the power switch while [Online] is displayed may result in the loss of data on memory card, preventing the system from restarting.
- (4) The "Cooling down" message disappears on the Drawing screen after the LD has finished shutting down.
- (5) Click the [Offline] button on the [Control] screen.



- (6) Click the [Close] button to close the [Control] screen.
- (7) To exit SWDraw3, select [File] -> [Exit] from the menu or click the Close box ([x] button) in the top-right corner of the screen.



(8) Exit Windows by selecting [Turn Off Computer] from the Start menu, and then turn off the computer.

- (9) Turn OFF the CONTROL keyswitch. The key can be pulled out.
- (10) 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.

3. Preparations for External Input/Output Control

This section explains the devices and connectors required for laser processing by external input/output signals in the CL-E mode.

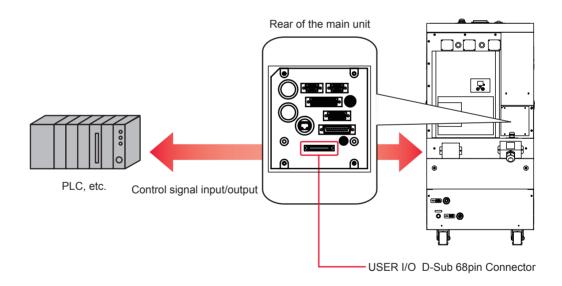
In the CL-E mode, MF-C2000A-MC/SC is controlled by using the external input/output signals (EXTERNAL CONTROL) of MF-C2000A-M/S.

Therefore, the following functions are disabled.

- Control from the laser controller (welding schedule setting and the LASER START/ STOP button)
- Control by the external input/output signals (EXT.I/O (1) and (2) connectors)
- Control by the external communication (RS-485)
- Simultaneous use of "SET-POWER SYNCHRONIZE", "ACTIVE HEAT CONTROL" and "POWER-CORRECT ASSIST" functions

Connect the PLC to the USER I/O connector provided at the connector panel 2 to control the main unit by executing the program from the outside.

As another system for safety, 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.



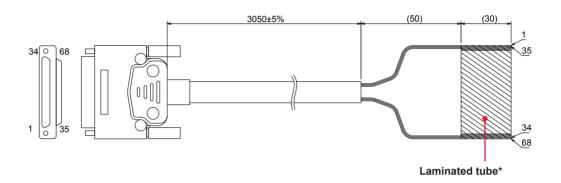
The plug, socket and case models of connectors are as follows.

Connector	Plug / Socket	Case	Manufacturer
USER I/O	HDRA-E68MA+	HDRA-E68LGKPA	HONDA TSUSHIN KOGYO CO.,LTD.
REM.I/L	116-12A10-2AF10.5	5	TAJIMI ELECTRONICS CO., LTD.
E-STOP	HDBB-25S(05)	HDB-CTH(10)	HIROSE ELECTRIC CO., LTD.

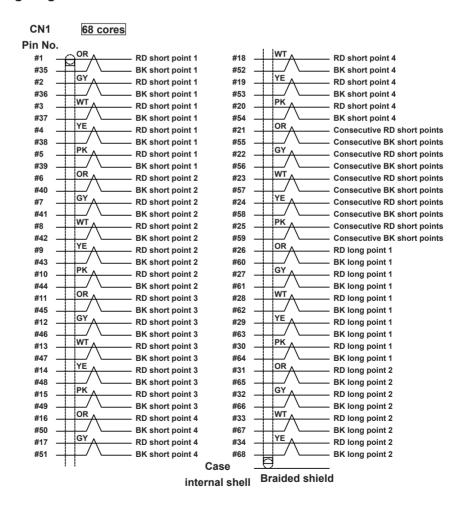
- > Prepare a program and its development environment for laser control on the customer side.
- It is recommended to use the shielded cable for inputting and outputting the control signal.

- → 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).

A one-end harness (HDRA68N3C300) is attached for the USER I/O connector.



Wiring diagram



* Terminal treatment

Cables are aligned at the laminated part in order. When performing wiring, peel them from the laminate tape. Also, avoid the use of the part peeled from the laminate tape (30 mm) since the cable coating may be deformed. In addition, the laminated part cannot be used for pressure contact.

4. Connector Functions

Pin Arrangement and Functions

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

USER I/O Connector (HDRA 68 pin)

The USER I/O 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
HDRA-E68MA+	HDRA-E68LGKPA	HONDA TSUSHIN KOGYO CO.,LTD.

0V OUT	68	34	+24V OUT
0V OUT	67	33	+24V OUT
00 001	66	32	Output COM
	65	31	Output GOIN
	64	30	
	63	29	
	62	28	
	61	27	
	60	26	(in) Layout no. confirmation strobe
	59	25	(in) Layout no. selection (binary code 512)
	58	24	(in) Layout no. selection (binary code 256)
	57	23	(in) Layout no. selection (binary code 128)
Layout no. confirmation (out)	56	22	(in) Layout no. selection (binary code 64)
, ,	55	21	(in) Layout no. selection (binary code 32)
	54	20	(in) Layout no. selection (binary code 16)
Data error (out)	53	19	(in) Layout no. selection (binary code 8)
	52	18	(in) Layout no. selection (binary code 4)
	51	17	(in) Layout no. selection (binary code 2)
Strobe (out)	50	16	(in) Layout no. selection (binary code 1)
Bootable (out)	49	15	
External input receivable (out)	48	14	
Remode (out)	47	13	(in) Operation complete input ACK
	46	12	(in) Control switching
	45	11	
	44	10	
Warning (out)	43	9	
Trouble (out)	42	8	(in) Error reset
Ready (out)	41	7	(in) Guide beam ON/OFF
Guide beam ON (out)	40	6	(in) LD-ON/OFF
LD ON (out)	39	5	(in) Scan stop
Laser output (out)	38	4	(in) Scan start
	37	3	Input COM
0V OUT	36	2	+24V OUT
0V OUT	35	1	+24V OUT
	\	<u></u>	

Operating Part

Input Pins of USER I/O Connector

⇒ Close pin No.12.

Pin No.	Description		
3	Input COM		
	Common terminal for input signals. Internally connected with Pin 37.		
	Scan start (Laser start) Effective only when the remote mode is er	nabled I aser is output when closed	
4		selected on the PC operating screen or the	
	Control switching input on the USER I/O. I	· · · · · · · · · · · · · · · · · · ·	
5	Scan stop (Laser stop)		
	·	nabled. Laser output is stopped when closed.	
6	LD-ON/OFF While this pin is closed, the LD is turned.	on While this nin is onened the LD is turned	
Ü	While this pin is closed, the LD is turned on. While this pin is opened, the LD is turned off.		
7	Guide beam ON/OFF		
7	Guide beam turns on at rising edge of clos	sing and turns off at falling edge of opening.	
8	Error reset (Trouble reset)		
	Close input cancels the trouble output.		
9	Unused Do not connect anything.		
	Unused		
10	Do not connect anything.		
	Unused		
11	Do not connect anything.		
	Control switching		
12	While this pin is closed, the remote mode is set and the external input signals are effec-		
	tive. Operation complete input ACK		
13	The carriage control operation is checked	to resume the scanning operation.	
1.1	Reserve		
14	Do not connect anything.		
15	Reserve		
	Do not connect anything.	T	
16	Layout no. selection (binary code 1)	_	
17	Layout no. selection (binary code 2)	_	
18 19	Layout no. selection (binary code 4)	_	
20	Layout no. selection (binary code 8) Layout no. selection (binary code 16)	-	
21	Layout no. selection (binary code 10)	Input the layout number by binary code.	
22	Layout no. selection (binary code 64)	-	
23	Layout no. selection (binary code 128)	-	
24	Layout no. selection (binary code 256)	-	
25	Layout no. selection (binary code 512)	-	
	Layout no. confirmation strobe		
26	Close (ON) output is supplied with the layer	out number confirmation.	
27	Reserve		
	Do not connect anything.		
28	Unused		
	Do not connect anything.		
29	Unused Do not connect anything.		
	Do not connect anything.		

Pin No.	Description
30	Unused Do not connect anything.
31	Unused Do not connect anything.
32	Output COM Common terminal for output signals. Internally connected with Pin 66.
37	Input COM Common terminal for input signals. Internally connected with Pin 3.
62	Unused Do not connect anything.
63	Unused Do not connect anything.
64	Unused Do not connect anything.
65	Unused Do not connect anything.
66	Output COM Common terminal for output signals. Internally connected with Pin 32.

Output Pins of USER I/O Connector

Pin No.	Description	
1	+24 V OUT Power supply for external I/O. Do not use it for any other purpose.	
2	+24 V OUT Power supply for external I/O. Do not use it for any other purpose.	
33	+24 V OUT Power supply for external I/O. Do not use it for any other purpose.	
34	+24 V OUT Power supply for external I/O. Do not use it for any other purpose.	
35	0 V OUT GND for external I/O. Do not use it for any other purpose.	
36	0 V OUT GND for external I/O. Do not use it for any other purpose.	
38	Laser output (for indicator) 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.	
39	LD ON While the LD is supplied, this Pin 39-COM circuit is closed internally.	
40	Guide beam ON While the guide beam is turned on, this Pin 40-COM circuit is closed internally.	
41	Ready When the LD or high voltage is turned on and the laser is ready to output, this Pin 41-COM circuit is closed internally.	
42	Trouble If trouble arises, this Pin 42-COM circuit is opened internally until it is reset.	

Pin No.	Description	
43	Warning If warning arises, this Pin 43-COM circuit is opened internally until it is reset.	
44	Reserve Do not connect anything.	
45	Reserve Do not connect anything.	
46	Reserve Do not connect anything.	
47	Remote When the remote mode is set, this Pin 47-COM circuit is closed internally.	
48	External input receivable When an external input signal is acceptable (when the section between Pin 12 and COM is in a closed circuit), the circuit is closed. In the open circuit status, an external input signal is not acceptable if it is input.	
49	Bootable While the LD is supplied, this Pin 49-COM circuit is closed internally.	
50	Strobe Turned ON when the carriage control operation is permitted.	
51	Reserve Do not connect anything.	
52	Reserve Do not connect anything.	
53	Data error When an unregistered layout no. is selected, this Pin 53-COM circuit is closed internally until it is reset.	
54	Reserve Do not connect anything.	
55	Reserve Do not connect anything.	
56	Layout no. confirmation Close (ON) output is supplied with the layout number confirmation.	
57	Unused Do not connect anything.	
58	Unused Do not connect anything.	
59	Unused Do not connect anything.	
61	Unused Do not connect anything.	
67	0 V OUT GND for external I/O. Do not use it for any other purpose.	
68	0 V OUT GND for external I/O. Do not use it for any other purpose.	

Type of output: Open collector output Rating of output: 24 V DC, 70 mA max.

REM.I/L Connector

E-STOP Connector

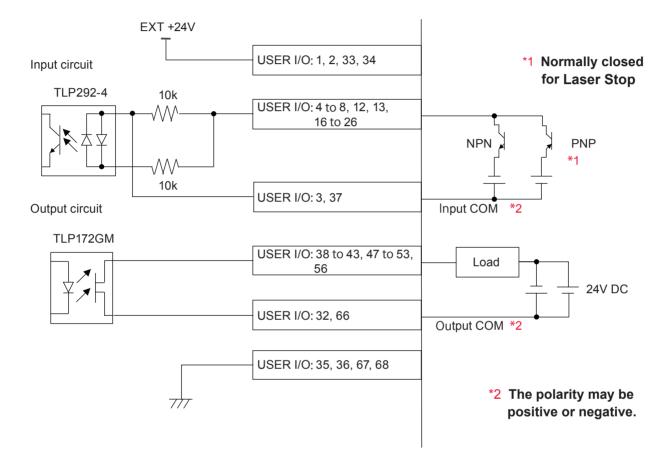
Refer to the Operating Part, Chapter 4.

Example Connections of External Input/Output Signals

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

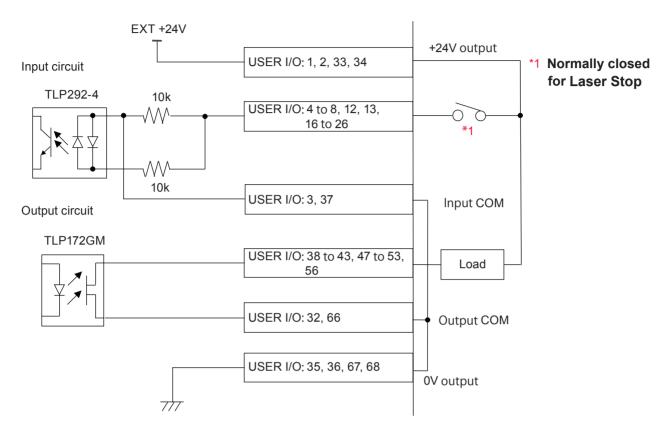
When Connected to an External Power Source

Inside of the laser



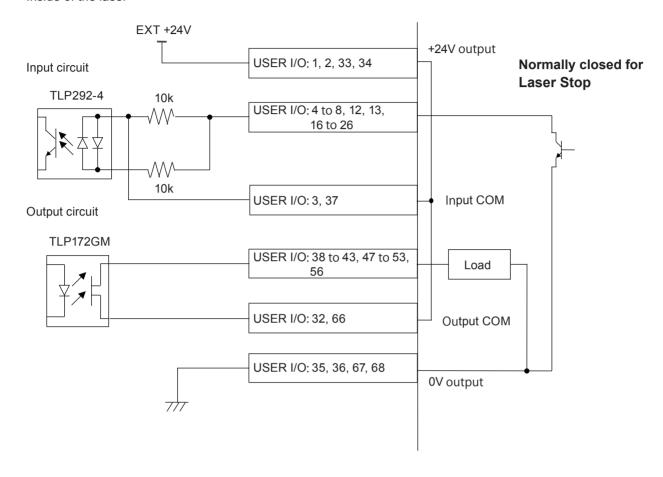
When Using a Contact Signal

Inside of the laser



When Using an Open-Collector Signal

Inside of the laser



5. Preparation for external communication control

Overview

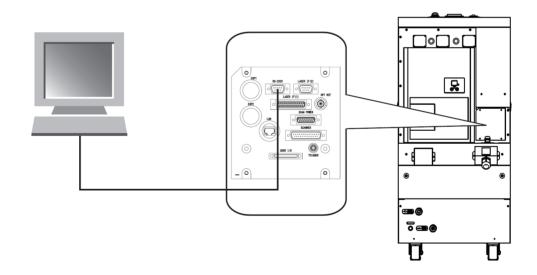
This section describes the devices and connectors required for laser processing by external communication control (RS-232C) in CL-E mode.

In CL-E mode, the MF-C2000A-MC/SC is controlled using the MF-C2000A-M/S external input/output signal control (EXTERNAL CONTROL).

As a result, the following features are disabled

- ⇒ Control from the laser controller (setting of welding conditions, LASER START/ STOP button)
- ⇒ Control by external input/output signals (EXT.I/O(1)(2) connector)
- ⇒ Control by external communication (RS-485)
- ⇒ Simultaneous use with "SET-POWER SYNCHRONIZE", "ACTIVE HEAT CONTROL" and "POWER-CORRECT ASSIST"

For external communication control (RS-232C) in CL-E mode, using the RS-232C connector provided on connector panel 2, conditions can be set and read from an externally connected PC, etc.

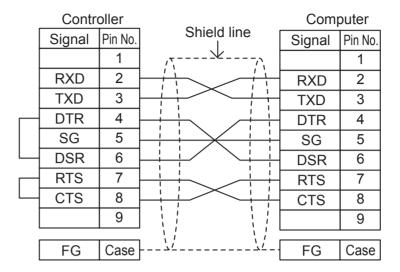


5.1 (RS-232C) interface

(1) Cable specifications

The specifications for the connecting cable are given below.

- D-Sub 9 pins, female
- UNC is used for nos. 4-40
- · Cross-connected
- · A shield line included
- · Maximum length: 9 m



The pin assignments are given below

pin	signal	Description
1	_	_
2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready
5	SG	Signal Ground
6	DSR	Data Set Ready
7	RTS	Request To Send
8	стѕ	Clear To Send
9	_	_
_	FG	Frame Ground: safety ground or cable shield

- ⇒ Use a connecting cable with a shield line.
- ⇒ Make sure that the case you connect to is designed to resist electromagnetic interference (EMI).

(2) Communication settings

Communication settings specifics are given below.

Item	Value
Electrical interface	Conforms to the RS-232C specification
Method	Asynchronous *1
Data bit length	8 bits
Stop bit length	1 bit
Parity check*2	Even
Baud rate*3	9600bps
Flow control*4	No
Checksum*5	OFF
Delimiter ETX	OFF

^{*1} Asynchronous communications involve interspersing control signals with the individual characters being sent. Specifically, the "start bit" and "stop bit" (indicating the start and end of the character, respectively) are added. If there is no data to send, only the stop bit signal will be sent. To receive data, the receiving side repeatedly acknowledges readiness to receive the next character after detecting a start bit.

^{*2} Parity check: parity-based error detection method. A single parity bit, 0 or 1 for binary data, indicates whether the amount of data is even or odd.

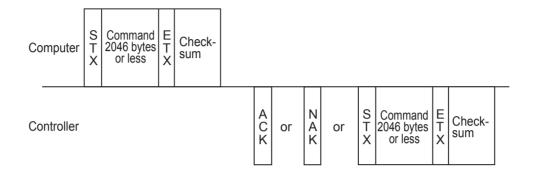
^{*3} Baud rate: communications rate. The volume of data transmitted per second in bits is given in bps.

^{*4} Flow control: control used to manage halting and resumption of data transmission between devices exchanging data.

^{*5} Checksum: error detection method for received data. Data totals are calculated and transmitted with data; the totals are calculated once again on the receiving side and compared to the transmitted totals. Sums that fail to match indicate an error.

5.2 Instructions for RS-232C Communications

RS-232C communications with the laser control unit involve exchange of ASCII data. Up to 2048 bytes may be sent or received at a time, including STX and ETX. If a transmission error occurs (parity errors, for example), the data is discarded. Only after successful reception up to the point of ETX will an ACK, NAK, or the usual data be returned.



5.3 Communications Protocol

In RS-232C communications with the laser control unit, data basically consists of the following elements:

STX Command Segment Response Segment (0-2046 bytes)	ETX	Checksum (2 bytes) (Only when selected)
---	-----	--

(1) Transmission control code

The transmission control codes are as follows:

Name	Value	Details
STX	0x02	Start transmission
ETX	0x03	End transmission
ACK	0x06	Acknowledge successful reception
NAK	0x15	Negative acknowledgment; processing errors occurred during reception

Conditions under which a NAK is returned:

- Incorrect checksum
- · Specified command does not exist.
- Specified value exceeds the setting range.
- · Insufficient internal RAM
- · Specified command cannot be executed at this time

(for example, if a command is issued to begin scanning when scanning is not possible).

(2) Numerical notation

• Signs

Plus	Nothing is added before the number.
Minus	0x2D is added before the character. Hexadecimal notation itself does not indicate the sign of a value.

Values

The value itself is expressed as a decimal number unless otherwise specified.

Decimal numbers	Available ASCII codes are from 0x30 to 0x39.
Hexadecimal numbers (in the checksum segment)	A value from 0x41 to 0x46 is added to the ASCII code available for the decimal numbers. Lowercase letters cannot be used.

· Data with decimals

Examples of numerical notation		
The decimal number "1":	0x31	
The decimal number "-1":	0x2D, 0x31	
The hexadecimal number "FFA0": 0x46, 0x46, 0x41, 0x30		
The axial rotation angle is "45.000000°": .	45000000	

(3)String notation

ASCII code (symbols and alphanumeric)	Single-byte code from 0x20 to 0x7F
Single-byte katakana	Single-byte code from 0xA1 to 0xDF
Kanji	Double-byte Shift-JIS code starting with a code from 0x80 to 0x9F or from 0xE0 to 0xFF

Example of string notation
123450x31, 0x32, 0x33, 0x34, 0x35, 0xB1, 0xB2, 0xB3, 0xB4,0xB5 (10 bytes)
ABC0x8A, 0xBF, 0x8E, 0x9A, 0x41, 0x42, 0x43 (7 bytes)

^{*} Commas are generally not expressed since commas are special characters used as delimiters. To indicate a comma used as a comma, add the special character "\" before the character. Characters after "\" are not treated as delimiters. Use "\," to designate a comma. To express "\," use "\\".

^{*} Strings can be up to 40 bytes unless otherwise specified.

5.4 Commands

The commands are listed below.

The beginning of a command segment signify specific command itself.

Command		Function details		
Read	Write	Parameter		Setting increment/details
RTR	RTW		Axial rotation angle	0.000001°
XOR	XOW		X-axis offset	1μm (0.001mm)
YOR	YOW	X and Y axes	Y-axis offset	1μm (0.001mm)
XYR	XYW		X-axis offset Y-axis offset Axial rotation angle	1μm (0.001mm) 1μm (0.001mm) 0.000001°
LMR	LMW		Laser start	0: OFF 1: ON
MSR	MSW		Scanning start	0: End 1: Scanning in progress
TSR	TSW	Laser control	Test scanning start	0: End 1: Test scanning in progress
GLR	GLW	Laser control	Guide beam	0: OFF 1: ON
LNR	LNW		Layout number selection	Layout number
RLR	RLW		Toggle external control	0: Local (internal) 1: Remote (external)
ERR			Reset errors	
TRB		Maintenance	Error code acquisition	
PORR		Lase power monitor control	Power monitor data acquisition	

5.5 Command Details

(1) RTR/RTW (Axial rotation angle)

Read/Write the axial rotation angle at which all layout data is rotated.

The setting increment is 0.000001°.

(2) XOR/XOW (X-axis offset)

Read/Write the X-axis offset for all the layout data.

The setting increment is 1 µm.

(3) YOR/YOW (Y-axis offset)

Read/Write the Y-axis offset for all layout data.

The setting increment is 1 µm.

(4) XYR/XYW (X-axis offset, Y-axis offset, Axial rotation angle)

Read/Write the X-axis offset, Y-axis offset and axial rotation angle for all layout data.

■ Write (XYW t0, t1, t2)

t0: X-axis offset (unit: 1 µm)

t1: Y-axis offset (unit: 1 µm)

t2: Axial rotation angle (unit: 0.000001°)

(5) LMR/LMW (Laser start)

Read/Write the LD activation status.

In this setting, 0 = OFF and 1 = ON.

(6) MSR/MSW (Scanning start), TSR/TSW (Test scanning start)

Read/Write the scanning status.

In the read setting, 0 = Finished and 1 = Scanning in progress.

In the write setting, 0 = Stop scanning and 1 = Start scanning.

Writing 1 (to start scanning) is valid only under local (internal) control. Writing 0 (to stop scanning) is valid under both local and remote control.

(7) GLR/GLW (Guide beam)

Read/Write the guide beam activation status.

In this setting, 0 = OFF and 1 = ON.

(8) LNR/LNW (Layout number selection)

Read the currently selected layout number.

Also used to change the layout number by writing the specified layout number instead.

(9) RLR/RLW (Toggle external control)

Obtain the current status of the device used for external control.

Also used to switch the control method.

In this setting, 0 = Local (Internal) and 1 = Remote (External).

Local	The layout number can be set and scanning initiated from the touch panel, computer, or device connected via RS-232C.
Remote	The layout number can be set and scanning initiated with an external I/O signal.

(10) ERR (Reset Errors)

Clear the current error.

| Computer -> Controller |: ERR

(11) TRB (Error code acquisition)

Obtain all current error codes.

Example

Emergency stop and layout command errors have occurred

Computer -> Controller

Controller -> Computer : 11, 22

When multiple errors have occurred, all error codes are returned, delimited by commas.

(Error codes are not sent in ascending order by error code number.)

If no error occurs, only STX, ETX, and checksum are returned.

(12) PORR (Power monitor data acquisition)

Obtains the average laser output of the entire layout scanned the most recently. The value of the power monitor data is reset at the scan start and determined after the scan end.

The power monitor data is displayed based on the power monitor signal of the laser equipment from the scan start to end of one layout. Therefore, it may be different from the power monitor value of the laser equipment or the measured value of the power meter.

Co	Controller -> Computer : s0,s1						
	T						
s0	Power monitor data	Less than 100 W: 0.000 □ to 99.999 □ 100 W or more / less than 1000 W: 100.00 □ to 999.99 □ 1000 W or more: 1000.0 □ to 99999.9 □ (□ denotes a single-bite space.)					
s1	Unit	Watt: W □□□ (□ denotes a single-bite space.)					
	Example						
Whe	When obtaining the power monitor data (123.45 W) of the layout No. 1						
С	Computer -> Controller : PORR						
С	Controller -> Computer : 123.45 □ ,W □□□						

⇒ This function is available only when the laser equipment has the power monitor signal.

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. or specification	Operation interval (standard) (*1)	Contents of operation (*2)	
Lithium battery (*3)		CR 2450	3 years	Replace	
MAIN POWE	ER switch	P3-100/V/SVB-SW	5 years	Replace	
		PLA300F-12			
Switching po	ower supply	PLA300F-24	5 years	Repair or Replace	
		FETA7000T-144		.,	
Relay		G7Z-3A1B-11Z-R DC24V	5 years	Replace	
Electromagr	netic contactor	SC-03/G	5 years	Replace	
Rear fan		AS1209225	5 years	Replace	
Optical unit	MF-C2000A-M/MC	FLC-2000M-W-CF-0513-AMY	4.40000	Replace	
(*4)	MF-C2000A-S/SC	FLC-2000S-W-CF-0310-AMY	4 years		
Mechanical	seal kit (for chiller)	HRG-S0211	3 years	Replace	
Beam couple	er (*5)	-	4 years	Replace	
Timesharing	unit (*5)	-	4 years	Replace	
Lithium batte unit) (*3, *5)	ery (for timesharing	JZSP-BA01	3 years	Replace	
	φ0.1 mm, 5 m	4-9521x01			
	φ0.1 mm, 10 m	4-9521x02			
Optical fiber (*5)	φ0.1 mm, 15 m	4-9521x03	4 years	Replace	
	φ0.1 mm, 20 m	4-9521x04			
□0.1 mm, 10 m		4-9725x02			
Filter cartridge (*6)		CW-50-R	6 months	Replace	
Dust-proof filter (for chiller)		LID0 00004	Every day	Clean	
		HRS-S0001	1 year	Replace	
Cooling wate (*7)	er (Purified water, 10L)	L-05115-001	6 months	Replace	

Part name	Model No. or specification	Operation interval (standard) (*1)	Contents of operation (*2)
		Every day	Clean
Protective glass	Specified glass for output unit	Every month	Replace (*8)
Lithium battery (*9)	CR2032 3V	3 years	Replace
Memory card (*9)	Compliant with SD Specification Ver3.01	3 years	Replace
Element assembly for AMH150 (*10)	AMH-EL150	2 years after use	Replace
Membrane module for IDG3 (*10)	IDG-EL3	10 years after use	Replace
Dewpoint checker set for IDG3 (*10)	IDG-DP01	2 years after use	Replace
Solenoid valve (*10)	VX210EGXCC	5 years	Replace

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

- *1: The operation interval means the maintenance time or expected life of the part, and is different from the 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 optical 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 "5. Connecting the Optical Fiber" on page 58 or keep the bending radius of the optical fiber, is not covered by the warranty.
- *5: For option.
- *6: The filter cartridge is the water filter used in the chiller.
- *7: Use cooling water meeting water quality standard established by Japan Refrigeration and Air Conditioning Industry Association (JRA GL-02-1994 / cooling water system - cyclic water - makeup water).
- *8: 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.
- *9: Only for MF-C2000A-MC/SC
- *10: Only when the dry air unit (option) is equipped

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 and protective glasses



CAUTION

Calibrate the laser power meter every year.

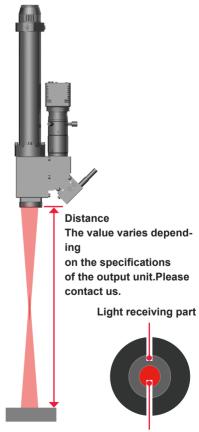
Operating Procedure

- (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 water temperature, flow rate, 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.



Guide light

Power meter

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.

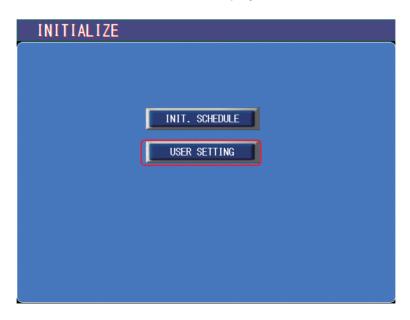
Validating the Laser Power Correction Function

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

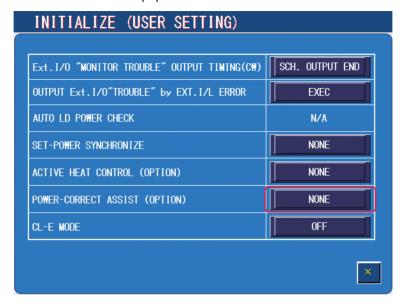


The INITIALIZE screen appears.

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



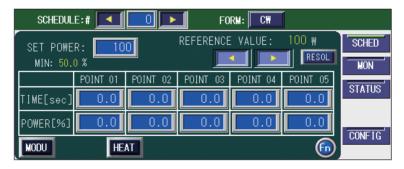
(4) Press the "POWER-CORRECT ASSIST (OPTION)" setting button and set to USE to restart the equipment.



Inputting the Measurement Conditions

(1) Press the "SCHEDULE" setting button.

Enter the SCHEDULE number by using the "<" and ">" buttons or numeric keypad and then press the ENT key.



- (2) Press the "FORM" setting button to set "CW."
- (3) Press the "SET POWER" setting button. Enter the laser output set value by using the numeric keypad and then press the ENT key.

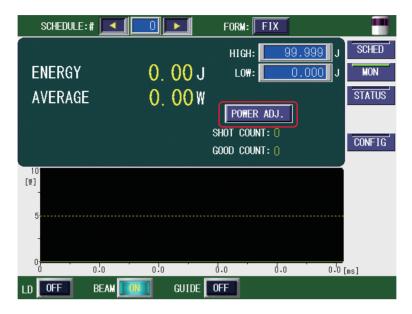
<Note>

Set the laser output value around the rated output after measuring with a low value. Refer to "Inspecting the Laser Output" on page 218.

- (4) Press the laser output time "TIME [sec]" and laser output value "POWER [%]" setting buttons of "POINT 01" to "POINT 05."
 - Enter each value by using the numeric keypad and then press the ENT key.
- ⇒ Due to characteristics of the power meter, it takes several seconds until the measurement value is stabilized after emission. It is recommended to set it to 60 to 100 sec.

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 the button.



(3) Press the "UP" button to increase the output and the "DOWN" button to decrease

Adjust it within the range of gauge. One-clicking button with a value around the rated output (2000 W) adjusts the output approx. 0.5% to 2%.

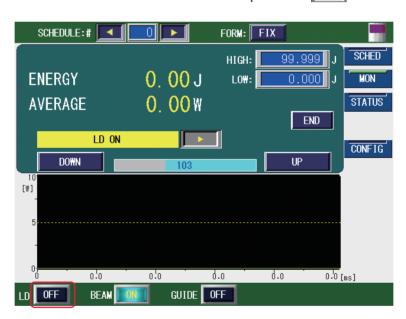


- → The UP/DOWN adjustment is effective only when "PRESS UP/DOWN" is displayed. When UP is clicked beyond the rated output, error No.221/OUTPUT POWER HIGH (A10) or No.223/INTERNAL UNIT OUTPUT POWER HIGH (A17) occurs. Confirm that the measurement of the power meter is proper.
- ⇒ Make the UP/DOWN adjustment within the range of gauge (100 to 110). The number of times of operation is limited to 5 times. If more adjustment is needed, proceed to Step (4) to set the "LD" setting button to ON and check the laser output and then make the UP/DOWN adjustment again.
- ⇒ 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 by approx. 0.5 to 2%.

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.

(4) Press the "LD" setting button to set it to ON. Confirm that the LD is turned ON and press the button.

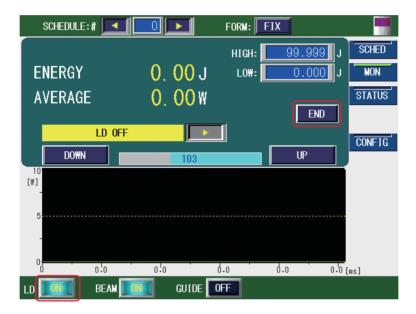


(5) Press the LASER START/STOP button of the laser controller.

Check the display on the power meter and confirm that the laser is emitted. After recording the power meter display, press the button.



(6) Press the "LD" setting button to set it to OFF and press the "END" button.



When a further adjustment is necessary, repeat Step 3.

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 Chiller

This section explains the maintenance of the chiller. For details, refer to the operation manual attached to the chiller.

WARNING

- Turn OFF the power supply during inspection or cleaning. Otherwise, that can cause electric leaks and injury.
- Do not water the chiller directly or clean it with water. Otherwise, that can cause electric leaks and malfunction.
- When you open the panel for inspection or cleaning, return the panel after the work. If the chiller is operated with the panel open or removed, you may touch the inside of the device and that can cause electric leaks and injury.

Replacing the Filter Cartridge

The filter cartridge in the filter housing has a function to filtrate the cooling water. Replace it within 6 months.

Item required

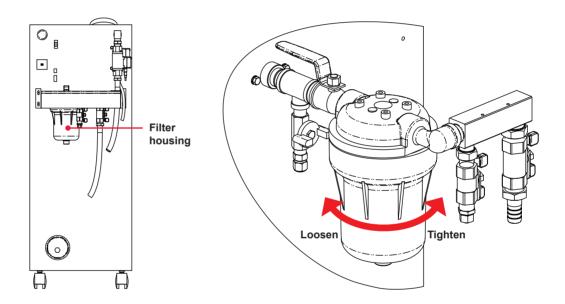
Filter cartridge, NFH tightening spanner, and tray to receive water

Removing the Filter Cartridge

- (1) Close valves on both sides of the filter housing.
- (2) Loosen the drain plug at the lower filter cartridge to drain water.
- Since water may spurt, loosen the drain plug slowly.
- → Take care that water does not splash over the equipment.
- (3) Hold the upper filter housing by hand, and loosen the cylinder with the NFH tightening spanner to remove it.
- (4) Remove the filter cartridge from the removed cylinder.
- (5) Mount the drain plug on the cylinder again.

Mounting a New Filter Cartridge

- (1) Insert the filter cartridge into the guide at the lower cylinder of the filter cartridge.
- (2) Insert the top end of the filter cartridge mounted to the cylinder into the guide at the upper filter housing.
- (3) Hold the upper filter housing by hand, and screw the cylinder until it hits the Oring in the cylinder.
- (4) Tighten the cylinder with the NFH tightening spanner, keeping holding the upper filter housing by hand.
- (5) Open valves on both sides and make a test run of water before operation to check for leaks.



Replacing the Cooling Water

Replace the cooling water within 6 months.

Item required

Cooling water (10 liters), water feed pump, and vinyl gloves



Use cooling water meeting water quality standard established by Japan Refrigeration and Air Conditioning Industry Association (JRA GL-02-1994 / cooling water system - cyclic water - makeup water) when preparing some by customers. Tap water, water for industrial use, or ground water may cause corrosion or clogging, resulting in fault of the equipment.

Inspecting Water Leaks from the Pump

Remove panels of the chiller to check the pump for abnormal leaks when replacing the cooling water (every 6 months recommended).

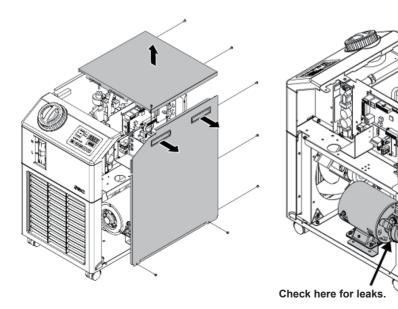
If abnormal water leaks, consult us to return the chiller and replace the mechanical seal.

Item required

Phillips screwdriver

/ CAUTION

Because of its structure, the mechanical seal cannot completely eliminate leakage. An amount of leakage is 3 ml/hour or less.



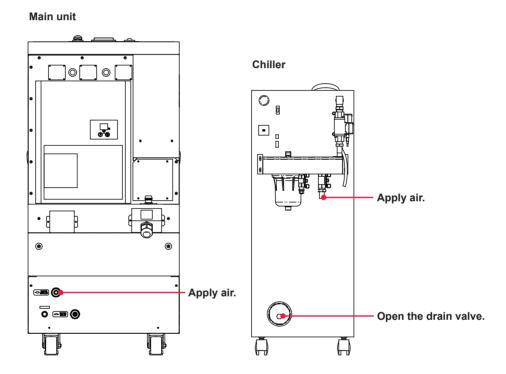
Draining the Cooling Water

When the laser welder is not used over two weeks or must be moved, drain the cooling water.

If water in pipes of the equipment or the optical fiber is frozen, the pipe is broken and results in fault of the equipment.

Operating Procedure

- (1) Remove pipes of the optical fiber IN and OUT.
- (2) Remove pipes of the main unit and the chiller.
- (3) Apply air at approx. 0.25 MPa into pipes to expel the remaining water in pipes.

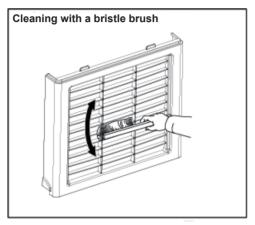


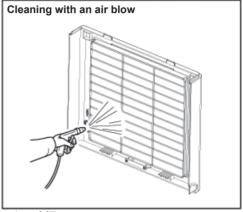
Cleaning the Dust-proof Filter

The dust-proof filter is provided at the front of the chiller. Clean it every day.

Item required

Bristle brush or air blow





4. Maintenance of the Dry Air Unit (Option)

This section explains the maintenance of the dry air unit (option).

Checking the Dry Air Unit

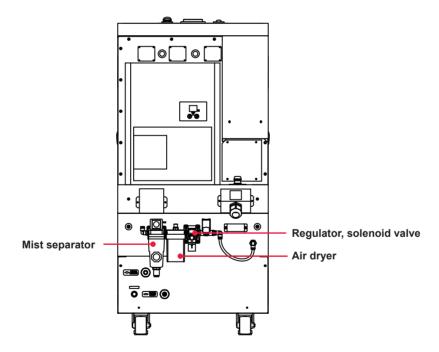
Check the dry air unit every week. Replace consumables accordingly. If any abnormality is found, consult us.

Item required

Waste water receiving plate

Operating Procedure

- (1) Check whether water stays in the mist separator through the sight glass (window for viewing the liquid level). If water stays there, put a waste water receiving plate under the mist separator and turn the drain under the mist separator from S to 0 to drain the water in the mist separator.
- (2) Check the air pressure that it is 0.5 MPa using the pressure gauge with the solenoid valve (with power ON and solenoid valve OFF). To adjust the main air pressure, turn the knob of the main air regulator.



<Notes>

- If water stays in the filter unit, check the air supply source (air dryer, etc.). There is a possibility that water may get into the mist separator, micro mist separator or micro mist separator with pre-filter. Inspect each of them at the same time.
- The air passing through the filter unit, mist separator and micro mist separator is supplied to the hand-held torch as purge air. If water or oil is mixed in the purge air, optical components may be contaminated by attached purge air.

Checking the Filter Separator

Check the filter separator every month. Replace consumables accordingly.

Operating Procedure

- (1) Make sure that drain is normally discharged from the filter separator on the primary side of this product.
- (2) Check whether there is any crack, flaw, or deterioration in the resin case.
- (3) Perform cleaning for the resin case periodically with a neutral cleaner to remove dirt. If it is very dirty, replace the resin case.
- (4) In two years after the start of use or when the pressure drop of each filter reaches 0.1 MPa, replace the filter element.

Checking the Membrane Air Dryer

Operating Procedure

(1) Check the dehumidifying function with a dew point checker.

Make sure by the color of the dew point checker that this product functions normally.

Performance status	Color of the dew point checker		
Initial status	White or pink		
Normal operation	Blue		
Performance drop	White, pink, brown or black		

The dew point checker is changed to pink by wet air, it becomes blue later if the dry air comes in. It takes about one hour to change the color of the dew point checker after air is caused to flow.

(2) Replace the membrane module (element).

Regarding the membrane module, replace it when the color of the dew point checker becomes white or pink. In the case of periodic replacement, replace it in ten years after the start of use, depending on the operating conditions (operation for ten hours a day). If the color of the dew point checker is changed to the above color even within this period, replace it.

(3) Replace the dew point checker.

An absorbent is used for the dew point checker. This absorbent picks up the evaporated oil or the like included in compressed air and gas other than air, and then may change into brown or black. When the color is changed to brown or black, replace the dew point checker. For periodic replacement, replace it in two years after the start of use as standard.

Maintenance Part

Chapter 2

Inspection and Measure To Be Taken at Occurrence of an Error

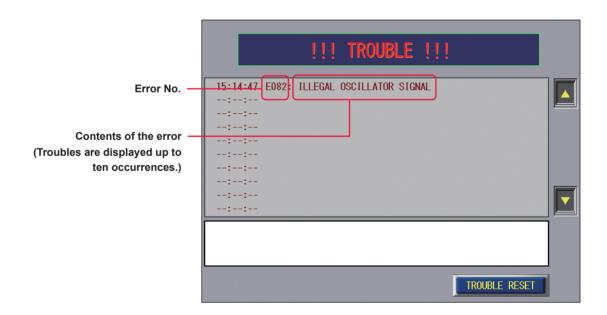
1. Error Display and How to Take a Measure

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.

Main Unit



LD "-": LD "OFF": Alarm output "-": Alarm output "ON":

State of LD doesn't change even if an error/fault occurs. LD is turned off automatically if an error/fault occurs. Error/Fault signal is not output if an error/fault occurs. 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.
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.
010 011	BEAM SWITCH 1 UNIT ERROR BEAM SWITCH 2 UNIT ERROR	OFF	ON	The beam switch unit is not ready or the alarm has occurred. Turn off the power supply and restart the equipment. If the trouble will continue even after the above measures, 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.104 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.

No.	Contents of error	LD	Alarm output	Measures
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.91, P.133, P.136, P.137, and P.155 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.
042	COOLER ERROR	OFF	ON	An error has occurred with the FA cooler unit on the rear. Check Error No. on the FA cooler and see the operation manual for ENC-GR500L-Pro on the Apiste's homepage.
043	HEAT DETECTOR ERROR	OFF	ON	The communication line between the heat detector and the laser equipment is abnormal. → P.65 Check the connector. The voltage of the heat detector may be low. Check the connector, and if the trouble will continue even after the RESET button is pressed, consult us.
046 047 049	FIBER ERROR1 FIBER ERROR2 FIBER ERROR3	OFF	ON	Breakage of an optical fiber has been detected. Check that the optical fiber is connected
048	HEAT DETECTOR TEMP. READ ERROR	ON	ON	An error has occurred when reading the temperature of the heat detector. Check the connector. The cable between the heat detector and the laser equipment may be disconnected.
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.

No.	Contents of error	LD	Alarm output	Measures
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.
086	AHC TARGET-TEMP. SETTING ERROR	OFF	ON	The "AHC TARGET-TEMP." setting is out of range in this schedule. Check the setting.
163	ILLEGAL WARNING SIGNAL	-	-	An oscillator warning signal of unknown cause has been detected. The laser equipment may recover normally before the warning type is identified. 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.
182	BRANCH UNIT MOTOR TEMP ER- ROR	OFF	ON	Abnormal motor temperature of the branch unit. After waiting for several minutes, press the TROU-BLE RESET button. If the trouble will continue even after the above measures, consult us.
183	BRANCH UNIT DUMPER TEMP ERROR	OFF	ON	Abnormal dumper temperature of the branch unit. After waiting for several minutes, press the TROU-BLE RESET button. If the trouble will continue even after the above measures, consult us.
185 186	BRANCH MIRROR 1 OPEN TROUBLE BRANCH MIRROR 2 OPEN TROUBLE	OFF	ON	The timesharing unit fault or a start signal is input while timesharing unit is operating. Extend the time from input of beam select signal to input of laser start signal. If the trouble will continue even after the above measures, consult us.
188 189	BRANCH MIRROR 1 CLOSE TROUBLE BRANCH MIRROR 2 CLOSE TROUBLE	OFF	ON	The timesharing unit fault or a start signal is input while timesharing unit is operating. Extend the time from input of beam select signal to input of laser start signal. If the trouble will continue even after the above measures, consult us.
192	SHUTTER/BEAM-CHECK FAILED	OFF	ON	The shutter/beam-check is not finished normally. If it hasn't been better by restarting, consult us.

No.	Contents of error	LD	Alarm output	Measures
198 199	BRANCH MIRROR 1 FALLEN AWAY BRANCH MIRROR 2 FALLEN AWAY	OFF	ON	A branch unit fault. A mirror on the branch side is not detected. The branch mirror may be fallen. Press the TROUBLE RESET button. If the trouble will continue even after the above measures, consult us.
200	CHILLER TROUBLE	OFF	ON	An error has been detected in the chiller. → P.40 Check connection between the chiller and the laser welder. Check operation of the chiller. When an alarm is displayed, see the operation manual of the chiller to eliminate the cause of trouble. AL31: Detected when flowrate to optical fiber is outside the range of 1.5 to 2.5 l/min. and to laser welder is outside the range of 15 to 25 l/min. AL32: Detected when the power to the laser welder is turned OFF when the chiller is ON.
201	WATER LEAK	OFF	ON	There is water leak. Consult us.
202	WATER TEMP HIGH ERROR	OFF	ON	Increase the cooling water flow rate. Check if the cooling water circulates normally.
203	WATER TEMP LOW ERROR	OFF	ON	If the ambient temperature is low, it takes time to raise the cooling water temperature.
204	DEW CONDENSATION ALARM	OFF	ON	The cooling water is too cold, or the air is too humid. Place the Laser in an atmosphere under the specification.
205 206	THERMAL 1 ERROR THERMAL 2 ERROR	OFF	ON	Abnormal temperature of the internal unit. After waiting for several minutes, press the TROU-BLE RESET button.
207	LDPS MONITOR VOLTAGE HIGH	OFF	ON	Abnormal voltage of the LD unit. Consult us.
209	NEGATIVE/OPEN-PHASE DETECTION	OFF	ON	Negative-/open-phase detective sensor is working. Turn primary-power off, and check source power.
210	INTERNAL UNIT TEMP WARNING (W01)	-	-	Increase the cooling water flow rate. Check the cooling water flow normally.
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.
213	INTERNAL UNIT OUTPUT LOW (W07)	-	-	Another FLU unit is required to get rating power. Consult us.
214	BACK REFLECTION HIGH ERROR (A01)	OFF	ON	It's too strong back reflection. Adjust the power setting to reduce back reflection.

No.	Contents of error	LD	Alarm output	Measures
215	INTERNAL UNIT TEMP ERROR (A02)	OFF	ON	Increase the cooling water flow rate. Check the cooling water flow normally. If this error happens often, consult us.
216	LD CURRENT HIGH (A03)	OFF	ON	Overcurrent of the LD. 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.222 Adjust the power setting to reduce back reflection.
222	INTERNAL UNIT OPEN (A14)	OFF	ON	The cover of inner unit is opened. Consult us.
223	INTERNAL UNIT OUTPUT POWER HIGH (A17)	OFF	ON	The power output is too high. → P.222 Adjust the power setting to reduce back reflection.
224	INTERNAL UNIT OUTPUT POWER LOW (A18)	OFF	ON	The optical circuit of inner unit is wrong. Consult us.
225	ILLEGAL LASER OUTPUT (A19)	OFF	ON	The inner unit is wrong. Consult us.
226	ILLEGAL TEMP.&HUMID-METER INPUT	OFF	ON	Check the TEMP.&HUMID-METER or the connection. If the TEMP.&HUMID-METER is OK and the error reoccurs, consult us.
228	GUIDE BEAM WARNING (W11)	-	-	The warning of guide light ON/OFF is given. Retry several minutes later. If this warning happens again, consult us.
238	FEED-FIBER BURNED (A23)	OFF	ON	The feed fiber is burnt out. Restart the Laser. If this error happens often, consult us.
239	COMBINER UNIT ALARM (A24)	OFF	ON	The combiner unit fault. Restart the Laser. If this error happens often, consult us.
250	DRY-AIR UNIT WARNING	-	-	The Warning signal has ON in the Dry-air unit. Check the Dry-air unit below the unit manual.
251	DRY-AIR FILTER WARNING	-	-	The filter-warning has occurred in the Dry-air unit. Check the filter.

No.	Contents of error	LD	Alarm output	Measures	
253	LD POWER SUPPLY WARNING	-	-	An warning has occurred with the LD power supply. If this error happens often by restarting, consult us.	
254	LD CIRCUIT-PROTECTOR WORK-ING	OFF	ON	The circuit-protector has worked in LD circuit. Consult us.	
255	DRY-AIR WARNING	-	-	The cooling water is too cold,or the air is too humid Place LASER in an atmosphere under the specification.	
256	OUT OF TEMPERATURE-RANGE	OFF	ON	The temperature is out of available range. → P.48 Please keep the temperature available.	
257	SCANNER CONTOLLER ERROR	OFF	ON	The alarm signal is ON in scanner controller. Check the error in scanner controller via the PC software SWDraw3, and also check the EXT.IO(1)-connector not slack.	
259	MONITOR-POWER UNEXPECTED	OFF	ON	The power-monitor detects outputs without emission. → P.141 Change the monitor-scale, in CL-E mode. Otherwise, the monitor-circuit is broken, consult us in this case.	
340	DEW CONDENSATION WARNING (W04)	-	-	Check the cooling water temperature of the laser oscillator. Control the humidity low, if the humidity is too high.	
349	ABNORMAL DEW CONDENSA- TION (A22)	OFF	ON	A dew condensation is detected in the laser oscillator. Control the humidity low, if the humidity is too high.	

Chiller

Contents of display	Measures				
AL31	The flow rate of the cooling water is out of range. Confirm that the pipe is not broken and adjust the flow rate with the adjusting valve. Flowrate to optical fiber is 1.5 to 2.5 l/min. and to laser welder is 15 to 25 l/min.				
AL32	The power to the laser welder is turned OFF. Confirm that there is no error and turn ON the laser welder. Or an error has occurred with the laser welder. Check the display screen of the laser welder.				

For errors other than above, refer to the operation manual for the chiller.

CL-E Mode

If a system error occurs, pressing the [RAS] button displays details of the error on the PC (SWDraw3). For details of the [RAS] button, refer to the manual for SWDraw3.

No.	Contents of error	LD	USER I/O (output)	Measures
1003	Part Unregistered	-	Data error	Register data. The part has not been registered. Register the data.
1007	Layout Data Unregistered	-	Data error	The layout data has not been registered. Register the data. Choose a starting number other than "0".
1008	Loops (100) Excessive	-	Data error	If this message is displayed, please contact us.
1009	Scanning Speed Error	-	Data error	Scanning speed setting error. Adjust scanning speed.
1010	ACK Timeout	-	Data error	There is no ACK response (indicating completion) from the transfer unit within the allotted time. Check the transfer unit.
1011	Layout Command Error	-	Data error	Layout error. After restarting the controller and your computer, transfer the layout data.
1012	Layout Parameter Error	-	Data error	Layout error. After restarting the controller and your computer, transfer the layout data.
1013	Insufficient Layout Command Error	-	Data error	Layout error. After restarting the controller and your computer, transfer the layout data.
1016	Scanning Area Error	-	Data error Reset the system and PC before sending the data.	
1020	Battery Voltage Low	-	Warning	Low battery voltage. Replace the battery.
1030	Laser Error	OFF	Trouble	A laser device error, emergency stop, or interlock has been input. Check the 3-digit error number displayed on the laser controller (touch panel type liquid crystal display) and the status, and then perform the corrective action described in this chapter. After that, input the error reset of the USER I/O connector or press the [Error reset] button of SWDraw3. If the problem persists even after resetting, turn off the power once and then restart. If the problem persists, please contact us.
1060	Controller Error (*1)	-	Data error	There is a problem with the controller. If the error persists after restarting, please contact us.
1070	Setting Range Over	-	Data error	The maximum number of lines has been exceeded. Reduce the number of lines.

No.	Contents of error	LD	USER I/O (output)	Measures
1074	Controller Error	OFF	Trouble	There is a problem with the controller. If the error persists after restarting, please contact us.
1084	Memory Card Full	OFF	Trouble	The capacity of memory card is full. Delete the data or prepare a new memory card.
1085	Memory Card Error	OFF	Trouble	There is a problem with the memory card. If the error persists after restarting, please contact us.
1098	Out Of Memory: RAM Registration	-	Data error	If these massages are displayed, please contact us.
1099	Out Of Memory: Part Registration	-	Data error	Memory capacity has been reached when attempting to register a part, or the part may be unsupported. Check part registration.
1100	Out Of Memory: Layout Registration	OFF	Trouble	Memory capacity has been reached when attempting to register a layout file, or the layout file may be unsupported. Check layout file registration.
1117	Scanner Connection Error	OFF	Trouble	A scanner connection error has occurred. Confirm the connection.
1184	AC Power Down	OFF	Trouble	AC power has been disconnected. If you turn off the power without turning off the LD, this error is added to RAS. Please turn off the power after turning off the LD.
1190	Data buffer overflow	-	Data error	The figure size exceeded the limit for data. Reduce the size of the data.
1200	Schedule Data controller version error	-	Data error	The controller version of schedule data is incorrect. Please check the controller version.
1201	Schedule Data peak power error	-	Data error	It is outside the setting range of peak power of schedule data. Check the setting value.
1202	Schedule Data frequency error	-	Data error	It is outside the setting range of schedule data frequency. Check the setting value.
1203	Schedule Data duty error	-	Data error	It is out of the setting range of the duty ratio of schedule data. Check the setting value.
1204	Schedule Data upslope power error	-	Data error	It is out of the setting range of the up slope power of schedule data. Check the setting value.
1205	Schedule Data downslope power error	-	Data error	It is out of the setting range of down slope power of schedule data. Check the setting value.
1206	Schedule Data upslope distance error	-	Data error	It is out of the setting range of the up slope distance of schedule data. Check the setting value.
1207	Schedule Data downslope distance error	-	Data error	It is outside the setting range of the down slope distance of schedule data. Check the setting value.

No.	Contents of error	LD	USER I/O (output)	Measures
1208	Schedule Data upslope time error	-	Data error	It is out of the setting range of the up slope time of schedule data. Check the setting value.
1209	Schedule Data downslope time error	-	Data error	It is outside the setting range of the down slope time of schedule data. Check the setting value.
1211	Analog Power Slope line slope points error	-	Data error	The specified slope is abnormal. Check the schedule data and layout length.
1213	Analog Power Slope spot slope not feasible	-	Data error	The specified slope exceeds the layout time. Check schedule data and layout time.
1214	Analog Power Slope spot slope points error	-	Data error	The specified slope is abnormal. Check schedule data and layout time.
1216	Controller error (specifying laser engine error)	-	Data error	The specified laser engine can not be recognized. Check the connected engine from System parameter settings.
1217	APA Error (pattern matching failure)	-	Data error	APA pattern matching failed.
1218	APA Error (connection error)	-	Data error	Disconnected from PC during APA processing. Please check the connection with the PC.
1220	Scanner Error (Power or Over position)	OFF	Trouble	Scanner power error or position is out of range. Please check the scanner connection or layout settings.
1221	Scanner Error (Temperature)	OFF	Trouble	A scanner temperature error has occurred.
1223	Scanner Error (Position acknowledge X axis)	OFF	Trouble	An error occurred in the X coordinate operation of the scanner. Please check the scanning speed setting.
1224	Scanner Error (Position acknowledge Y axis)	OFF	Trouble	An error occurred in the Y coordinate operation of the scanner. Please check the scanning speed setting.

^{*1:} An error occurred during operation in the CL-E mode is reset by the PC or external input/output signals. However, when the CONTROL keyswitch is OFF, reset the error by the TROUBLE RESET button of the laser controller. (When resetting by the TROUBLE RESET button is impossible, the TROUBLE RESET button is greyed out.)

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.)		

Specifications

Main Unit

Item			MF-C2000A-M/MC	MF-C2000A-S/SC
	Maximum rated output		2000 W	
	Minimum setting output		200 W	
	Mode		Multi	Single
		REPEAT mode	Standard: 0.1–500.0 ms (0.1ms steps) Setting switching: 0.05–500.00 ms (0.05ms steps)	
	Pulse width *1	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 num modulation	ber of pulse/	1 to 1000 pps	
	Modulation fun	ction	1 to 5000 Hz (rectangular wave,	triangular wave, sinusoidal wave)
	Oscillation way	relength	1070 ± 5 nm	
Oscillator	Class		4	
Coomator	Positioning guide beam		Built-in visible laser (red)	Wavelength: 650 nm (red) Class: 2
	Output stability		±2% max. Ambient temperature: ±5°C ma Cooling water temperature: ±1 Cooling water flowrate: 18 to 2 Laser emission time: 8 hours n	°C max. at 21 to 25°C 0 liters/min
	Optical fiber core diameter		φ0.05 mm	-
	Mode field diameter		-	0.022 mm
	Beam quality (Values in [] indicates calculated values.)	BPP	2.5 mm-mrad max.	[0.48 mm-mrad max.]
		M ²	[7.3 max.]	1.45 max.
	Cooling systen	า	Water cooling (chiller connection)	
	Input power supply supply		3-phase, 200 V to 240 V AC (±1	0%)
		Frequency	50/60 Hz	
	Max. input current		20 A	
Power	Max. apparent power		7.2 kVA	
Supply	Power	Maximum (including LD deterioration)	6.9 kW	
	consumption	Maximum (when shipped)	6.5 kW	
		Standby	1.0 kW	

Item		MF-C2000A-M/MC	MF-C2000A-S/SC	
Power Supply	Breaker rated current (to be supplied by customers)		For the power supply side, we ea age breaker with the rated curren cable to harmonics and surges.	
	Ground		Class D (ground resistance: 100 Ω	! max.)
	Number of sch	nedules	256	
	Schedule setting	REPEAT mode	Laser output waveform Laser energy for upper/lower limit Number of outputs per second Number of repeated outputs Modulation output waveform (when	•
		CW mode	Laser output waveform Modulation output waveform (when	n using the modulation function)
	Measurement	function	Laser energy (J), Average power (W)
Laser Controller	Counter		Displays the total number of outpu Displays the number of acceptable Displays the total LD ON time (7 d Displays the laser output time (7 d	e outputs (9 digits) igits)
	Cable length		Standard 1 m	
	Display language		Japanese and English (switchable)
	Active heat control function (option)		Detecting range of heat detector 1 Detecting range of heat detector 2 <note> Either the heat detector 1 or 2 can The temperature is not a warranty pending on the workpiece materia as a guide. Effective only when using the lase active heat control with the output</note>	be selected. value. Since it may change deal or the surface condition, use it
	Ambient temperature		5 to 40°C	
	Ambient humidity		20% to 85% RH (non-condensing) <note> For the upper limit of amb</note>	
	Temperature during transport or storage		-10 to 50°C (with cooling water rer	noved)
Operating	Humidity during transport or storage		20% to 90% RH	
Environ-	Vibration during transport		4.9 m/s² (0.5 G) max.	
ment	Impact during	transport	49 m/s ² (5 G) max.	
	Vibration durin	g operations	10 to 60 Hz: 0.98 m/s² (0.1 G) max.	
	Intermittent vib	oration during	Less than 2 Hz : 4.9 m/s ² (0.5 G) max.	
	Pollution degre	ee *2	2	
	Altitude		2000 m or less	

	Item		MF-C2000A-M/MC	MF-C2000A-S/SC
	Mass		250 kg or less	
	Dimensions		Approx. 1153 (H) × 556 (W) × 108	3 (D) mm
Others	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 130.
- *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 nonconductive pollution occurs but temporary conductivity may be produced due to condensation.

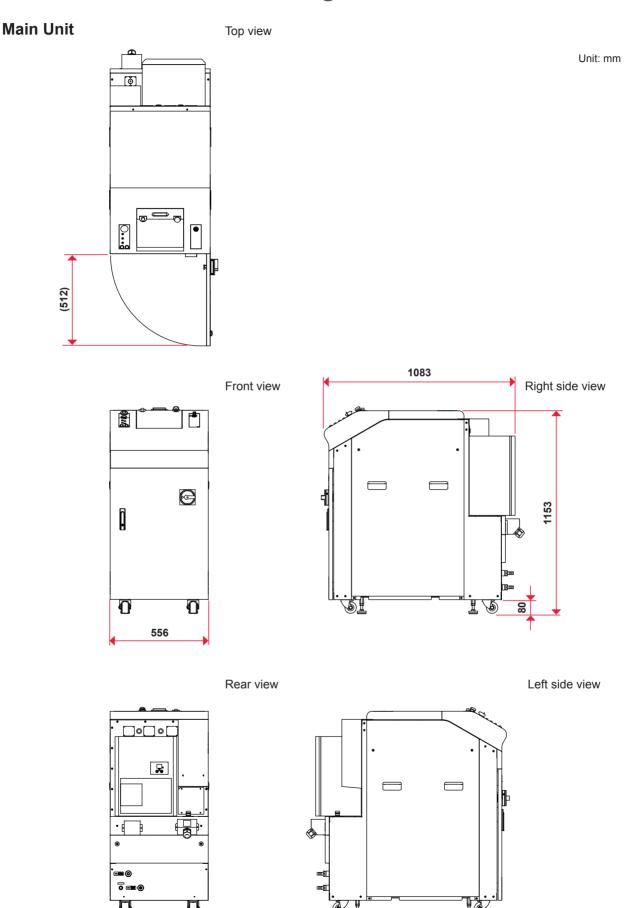
This Product uses the Source Code of T-Kernel under T-License granted by the T-Engine Forum (www.t-engine.org).

Chiller

It is necessary to perform pairing with the laser welder main unit. For detail specifications of the chiller, refer to the operation manual attached to the chiller.

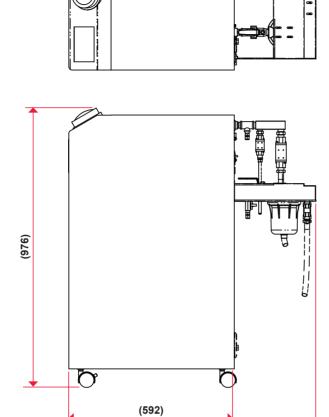
Cooling system		Air cooled refrigeration type		
Used refrigerant		R410A (HFC)		
Power supply	Input power supply	Single-phase, 200 V to 230 V AC (±10%)		
	Frequency	50/60 Hz		
Breaker rated current (to be supplied by customers)		20 A		
Rated operation current (50/60 Hz)		8.0 A / 11.0 A		
Rated power consumption (50/60 Hz)		1.68 kVA / 2.20 kVA		
Dimensions		Approx. 976 (H) × 377 (W) × 900 (D) mm		

Dimensional Outline Drawings

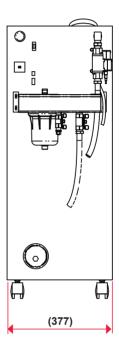


Chiller

Unit: mm



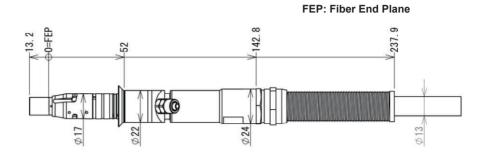
(900)

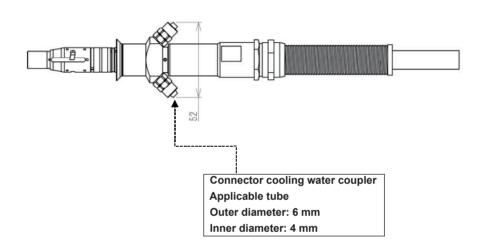


Fiber Connector

For single delivery

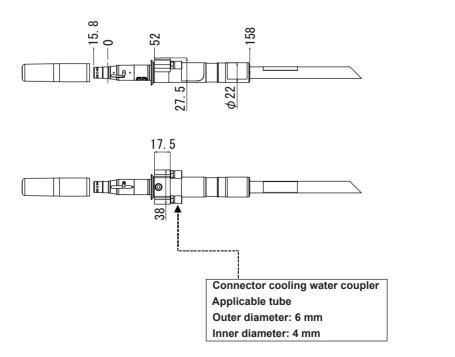
Unit: mm





For single delivery (beam coupler) and 2-timesharing

Unit: mm



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 7 types of timing chart are mentioned for your reference.

Operation by laser controller (PANEL CONTROL)

Operation by external input signals (EXTERNAL CONTROL)

2-timesharing

Operation by external input signals (EXTERNAL CONTROL)

Repeated operation (EXTERNAL CONTROL)

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

CL-E mode

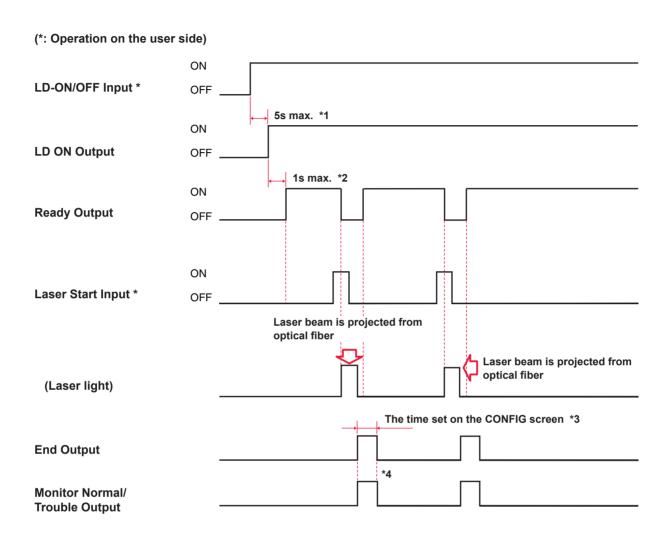
During normal operations

During errors (unregistered layouts and other errors)

- → 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.



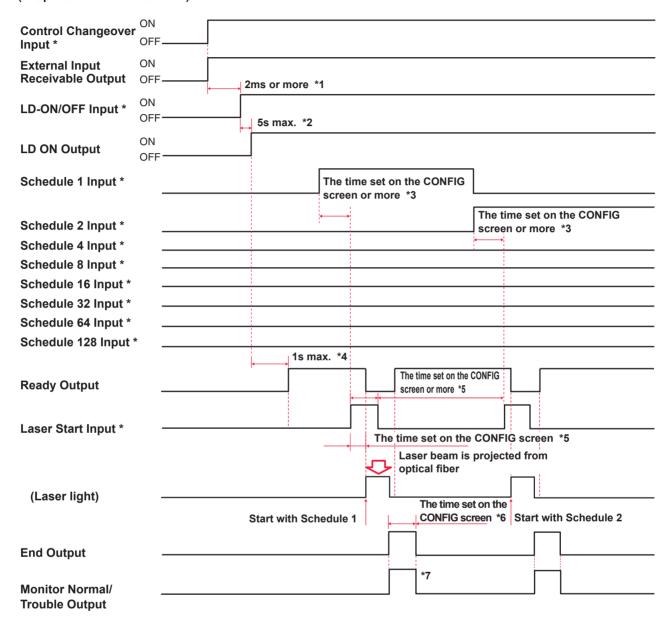
*1	5s max.	LD power supply ON time
*2	1s max.	LD output preparation time. In the REPEAT mode, the signal is kept turned off for certain time after laser output to keep the average power below the maximum rated output. The signal is not output until a valid schedule is selected.
*3		Time required for 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)

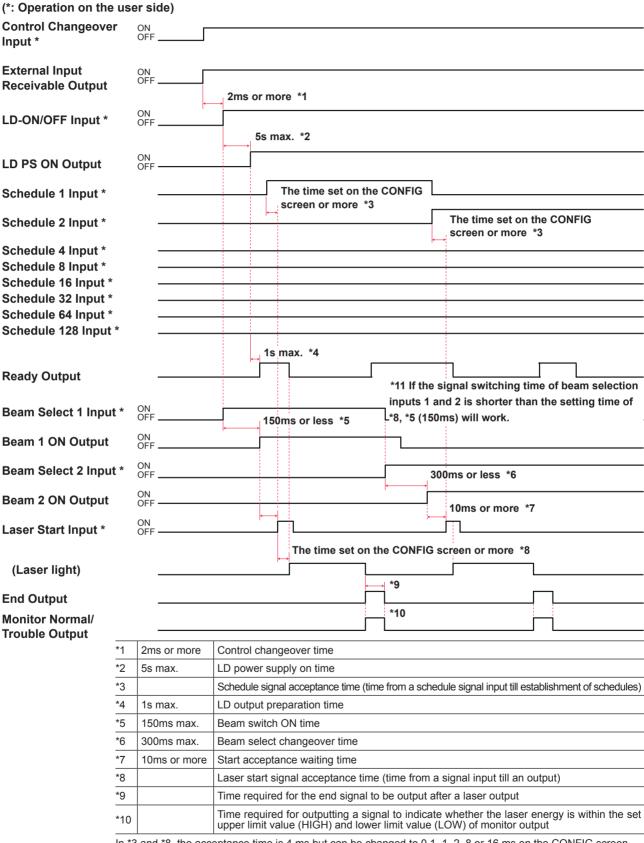


*1	2ms or more	Control changeover time
*2	5s max.	LD power supply ON time
*3		Schedule signal acceptance time (time from a schedule signal input till establishment of schedules) About 200 ms is required when the active heat control function (option) is enabled and the heat detector setting is changed.
*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.

2-timesharing ... Operation by external input signals (EXTERNAL CONTROL)

The following diagram shows the lapse of time in the case where a schedule signal input, Beam 1 and 2 are selected and laser light is output from optical fiber (branch 1 and 2) respectively with a time difference.



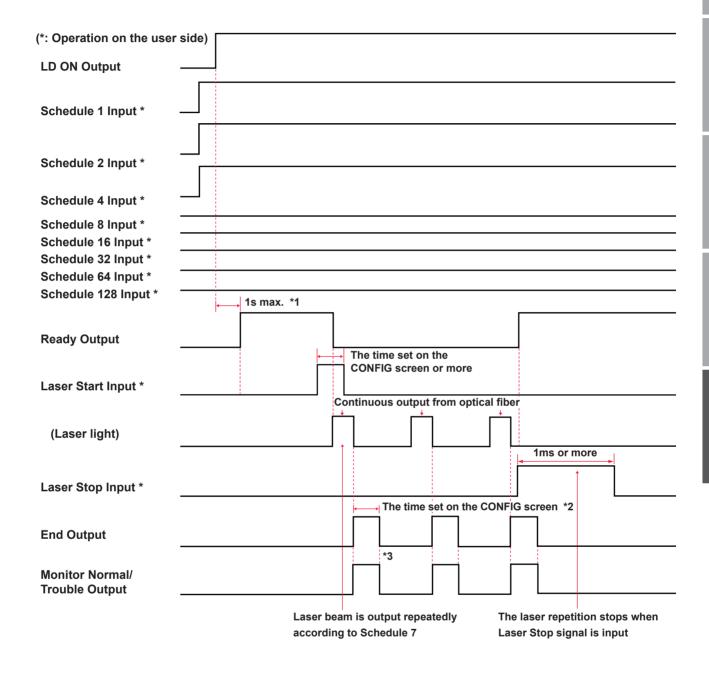
In *3 and *8, the acceptance time is 4 ms but can be changed to 0.1, 1, 2, 8 or 16 ms on the CONFIG screen.

^{*7} is not necessary when the beam select is not changed.

In *9 and *10, 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.

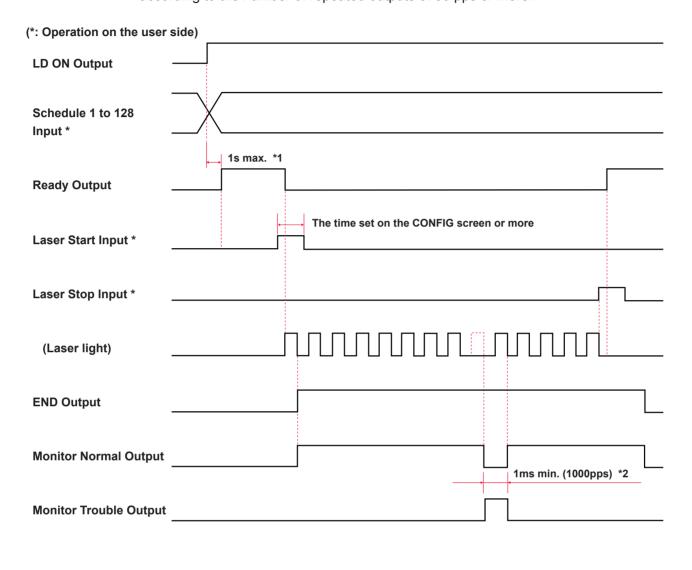


*1	1s max.	LD output preparation time
*2		Time required for the end signal to be output after a laser output
*3		Time required for outputting a signal to indicate whether the laser energy is within the set upper limit value (HIGH) and lower limit value (LOW) of monitor output

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)

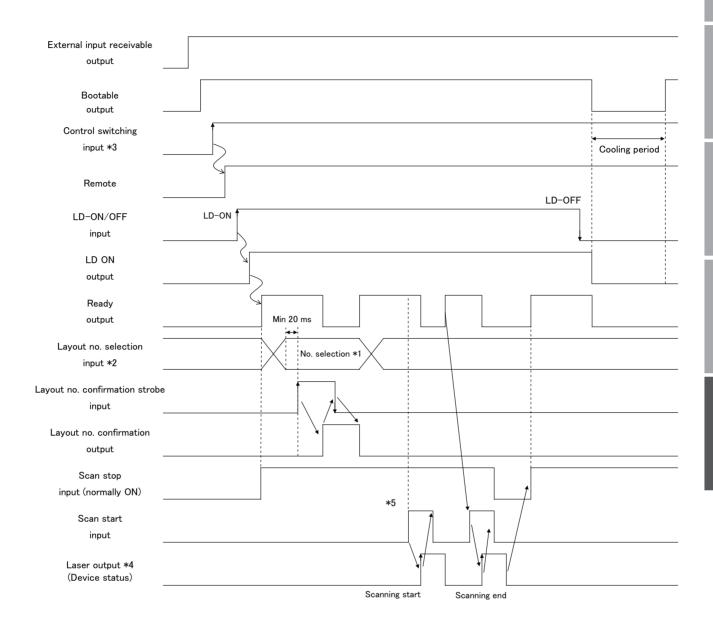
The following diagram shows the lapse of time in the case where laser is output according to the number of repeated outputs of 50 pps or more.



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

CL-E mode ... During normal operations

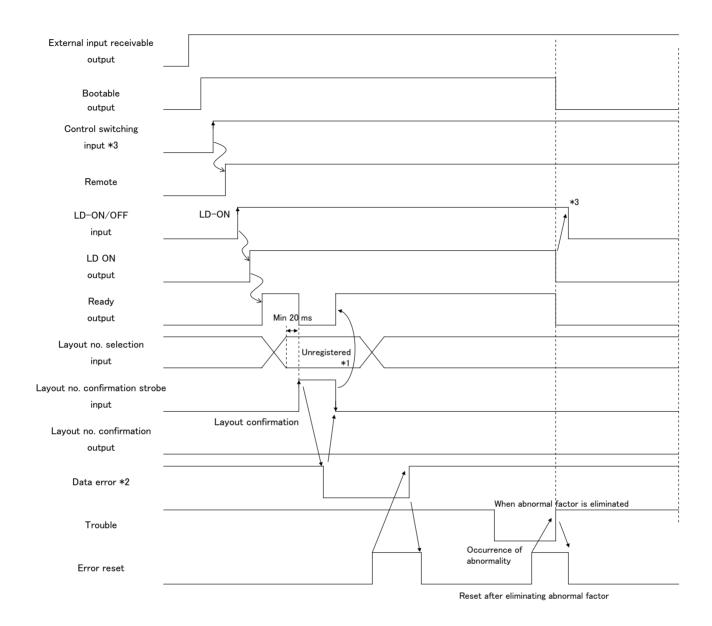
The following diagram shows the lapse of time of input/output signals in the case where laser light is output on MF-C2000A-MC/SC.



- *1: Layout no. input setting range: 1 to 1023. Treated as 1 if set to 0.
- *2: Layout no. is confirmed at rising edge of Layout no. confirmation strobe input. Layout no. confirmation strobe input is enabled while External receivable output is on and Laser outputting output is off.
- *3: The control switching can be set from a computer or the Control switching input on the USER I/O.
- *4: The laser output indicates the equipment status. Other signals indicate the I/O signals.
- *5: Confirm that Ready is on before turning on Scan start.

CL-E mode ... During errors (unregistered layouts and other errors)

The following diagram shows the lapse of time of input/output signals from when an error occurs until it is restored on MF-C2000A-MC/SC.



- *1: When an unregistered number is selected at the time of the layout no. confirmation, the layout no. before confirmation is selected.
- *2: When the data error occurs at the time of the layout no. confirmation, scanning can be started without the error reset.
- *3: When Data error and LD ON output are off, turn off the LD-ON/OFF signal.

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). \rightarrow P.175
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.
В	
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. \rightarrow P.175
С	
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. \rightarrow P.110
D	
Data bit	Bit to indicate one-character data that is used for asynchronous communication. → P.155
Diode laser	Package that mounts the LD bar in a heat sink.
E	
ETX	Control code that is used for communication between computers. → P.175
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. \rightarrow P.106

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. \rightarrow P.106
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. \rightarrow P.109
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. \rightarrow P.109
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. \rightarrow P.155
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. \rightarrow P.45
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. \rightarrow P.81
н	
Harmonic	Waveform having 3 to 40 times of frequency of the basic frequency (50/60 Hz). \rightarrow P.51
ı	
Input unit	Unit to transmit laser light to the optical fiber. \rightarrow 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. \rightarrow P.51
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.10
LD	General term for diode laser and FC-LD.
LD chip	Semiconductor laser device.

	Explanation of Terminology
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.175
0	
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. \rightarrow P.24 and P.60
Р	
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. \rightarrow P.153
PE	Protective earthing terminal. This is a terminal that is provided to ground a device. Abbreviation of Protective Earth. \rightarrow P.51
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. \rightarrow P.155
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. \rightarrow P.159 and P.160
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. \rightarrow P.172		
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.172		
RxD	Pin for received data out of signal lines of the communication connector. → P.172		
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. \rightarrow P.106		
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.		
sq (square)	Unit that represents a sectional area of cable. Square millimeter. \rightarrow P.52		
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. \rightarrow P.155		
STX	Control code that is used for communication between computers. → P.175		
Surge	Abnormal overvoltage or overcurrent applied momentarily to the electric circuit. → P.51		
т			
3-phase	Current composed of a set of 3 alternating currents with a phase difference of 120°. This current is mainly used for a power of business use.		
Timesharing	Laser light delivery specification. When the incorporated timesharing unit is operated, laser light is output to a single optical fiber. This function is provided in the timesharing specification of this laser. \rightarrow P.24		
Unit that mounts mirrors to reflect laser light. Laser light is output to the selected when the mirror is operated. This unit is incorporated in the laser oscillator section the timesharing specification of this laser.			
TxD	Pin for send data out of signal lines of communication connector. → P.172		
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

		SETTING	No.	SCHEDULE (Enter No. optionally.)
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†SL0PE	TIME	00.0 - 20.0	ms	
0 < 1	TIME	00.2 - 50.0	ms	
12437	POWER	000.0 - 200.0	%	
C00L1	TIME	00.0 - 20.0	ms	
C 0	TIME	00.0 - 50.0	ms	
ZLYSIJZ	POWER	000.0 - 200.0	%	
COOL2	TIME	00.0 - 50.0	ms	
0 0 0	TIME	00.0 - 20.0	ms	
	POWER	000.0 - 200.0	%	
†SLOPE	TIME	00.0 - 20.0	ms	
SET POWER)WER	200 - 2000		
REPEAT	EAT	0001 - 1000	sdd	
SHOT	JT	0001 - 9999		
>000	HIGH	00.000 - 99.999	J	
	LOW	666.66 - 000.00	٦	

NETWORK #

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

H		SETTING	No.	SCHEDULE (Enter No. optionally.)
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†SLOPE	TIME	0.00 - 50.0	sm	
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C00L1	TIME	00.0 - 50.0	ms	
0 0	TIME	00.0 - 50.0	ms	
rLASHZ	POWER	000.0 - 200.0	%	
COOL2	TIME	00.0 - 50.0	ms	
0 <	TIME	00.0 - 50.0	ms	
CHOSH3	POWER	000.0 - 200.0	%	
↑SLOPE	TIME	0.00 - 50.0	ms	
SET POWER	VER	200 - 2000		
REPEAT	\T	0001 - 1000	sdd	
SHOT		0001 - 9999		
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NETWORK #

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

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POWER 00.0 - 200.0 TIME 00.0 - 50.0 POWER 000.0 - 200.0 TIME 00.0 - 50.0 POWER 00.0 - 200.0	POINT 13	TIME	0.00 - 50.0	sm	
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TIME 00.0 - 50.0 POWER 000.0 - 200.0	<u>t</u>	POWER	000.0 - 200.0	%	
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

onally.)																
Enter No. opti																
SCHEDULE (Enter No. optionally.)																
No.		S		S		s		S		S			S			
Z /	UNIT	ms	%	ms	%	ms	%	ms	%	ms	%		sdd		J (
SETTING	RANGE	0.05 - 0.00	0000.0 - 200.0	0.05 - 0.00	000.0 - 200.0	0.00 - 50.0	0000.0 - 200.0	0.05 - 0.00	000.0 - 200.0	0.05 - 0.00	0000.0 - 200.0	200 - 2000	0000 - 1000	0001 - 9999	666'66 - 000'00	666:66 - 000:00
Y4:		TIME	POWER	TIME	POWER	TIME	POWER	TIME	POWER	TIME	POWER	OWER	ЕАТ	ОТ	HIGH	NOT
E		A TIMO		THIOD		DOINT 10		DOINT 40		OC TIMICO		SET POWER	REPEAT	SHOT	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	

NETWORK #

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

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

<u> </u>	3	SETTING	No.	SCHEDULE (Enter No. optionally.)
	Z	RANGE	LIND	
DOINT 16	TIME	6.66 - 0.00	sec	
	POWER	0000.0 - 200.0	%	
POINT 17	TIME	6.66 - 0.00	sec	
	POWER	000.0 - 200.0	%	
BOINT 18	TIME	6.66 - 0.00	sec	
	POWER	000.0 - 200.0	%	
PAIN TO	TIME	6.66 - 0.00	sec	
	POWER	00000 - 200.0	%	
OC TIMIOG	TIME	6.66 - 0.00	sec	
POINT 20	POWER	000.0 - 200.0	%	
SET POWER	WER	200 - 2000		
\\\ED\\CE	нЫН	666 - 000	%	
AVENAGE	TOW	666 - 000	%	

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