PULSED FIBER LASER WELDER

ML-3030AS/3015AS (EU)

OPERATION MANUAL

AMADA®

How to Use This Document

ATTENTION
This operation manual is common to both ML-3030AS and ML-3015AS. The ML-3030AS is used in the explanatory drawings unless there is a significant difference.

Thank you for purchasing our product.

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

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

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

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

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

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

Organization of This Document and Its Contents

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

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

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

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

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

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For Use in Safety

Safety Precautions

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

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

A meaning of a figure sign

⚠ **DANGER**	Denotes operations and practices that may imminently result in serious injury or loss of life if not correctly followed.
⚠ **WARNING**	Denotes operations and practices that may result in serious injury or loss of life if not correctly followed.
⚠ **CAUTION**	Denotes operations and practices that may result in personal injury or damage to the equipment if not correctly followed.
🚫🚫🚫🚫	Denote "prohibition." They are warnings about actions out of the scope of the warranty of the product.
❗⏚	Denote actions which operators must take.
⚡	Denotes caution for electrical shock.

⚠ DANGER

Do not touch the inside of the Laser unnecessarily.
Since source voltage of or single-phase 200 V/220 V/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.

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

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

⚠ CAUTION

Do not splash water on the Laser.
Water splashed over the electric parts, can cause electric shock and short circuits.

Use proper tools (wire strippers, pressure wire connectors, etc.) for termination of the connecting cables.
Do not cut the wire conductor. A fire or electric shock will occur.

Install the Laser on a firm and level surface.
If the Laser falls or drops, injury may result.

Do not place a water container on the Laser.
If water spills, insulation of the Laser will deteriorate, and that can cause electric leaks and fire.

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

Do not apply the laser beam to combustible materials.
To avoid risk of fire never apply the laser beam to flammable or combustible materials.

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

Do not use this Laser for purposes other than metal processing.
Use of the Laser in a manner other than specified can cause electric shock and fire.

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

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

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

Precautions for Handling

Laser Safety Supervisor

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

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

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

Routine Handling

⇒ Perform inspection periodically referring to the Maintenance Part, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection/Replacement" on page 165.

⇒ 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 or get caught between the outer panel and the frame.

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

Minimum bending radius of the optical fiber

Core Diameter	Minimum Bending Radius
φ 0.05, 0.1, 0.2, 0.3, 0.4 mm	100 mm
φ 0.6 mm	150 mm
φ 0.8 mm	200 mm

⇒ When outputting laser light, confirm that the optical fiber(s) based on the number of deliveries is/are connected. Laser light cannot be output with the optical fiber(s) disconnected.

⇒ 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.

⇒ Use the product in a place where the ambient temperature is 10 to 35ºC and the ambient humidity is 50 to 85% RH and yet a sudden temperature change does not occur.

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

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

IEC Standards IEC60825-1 "Safety of laser products Part1: Equipment Classifications, requirements and use's guide"

For Transportation

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

⇒ Package the Laser when transporting it.

⇒ The worker must wear a helmet, safety shoes and gloves for safety. (Leather gloves are recommended.)

⇒ When transporting the Laser, use a lift truck, pallet truck, etc., of at least 170 kg allowable load.

⇒ Do not transport the Laser with its casters. The casters are for fine adjustment of installation position.

⇒ Retract the level adjuster fully when transporting the Laser.

Precautions for using a fork lift

The following figure shows fork inserting positions.

⇒ As shown at right, adjust the distance between the forks; distance between the outer sides of the forks must be 250 to 330 mm, but the fork must not hit the level adjuster.

⇒ When transporting, belt the Laser to fix and keep it horizontal.
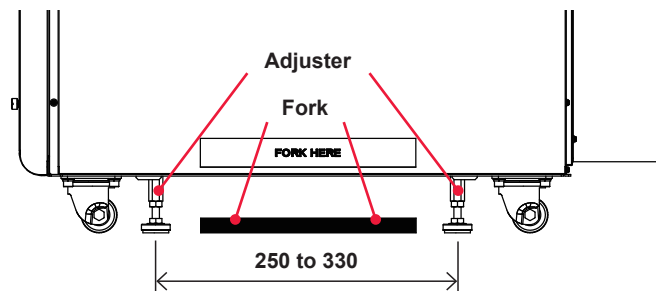
Figures below show example forking; insert the forks fully till the points appear from under the Laser.
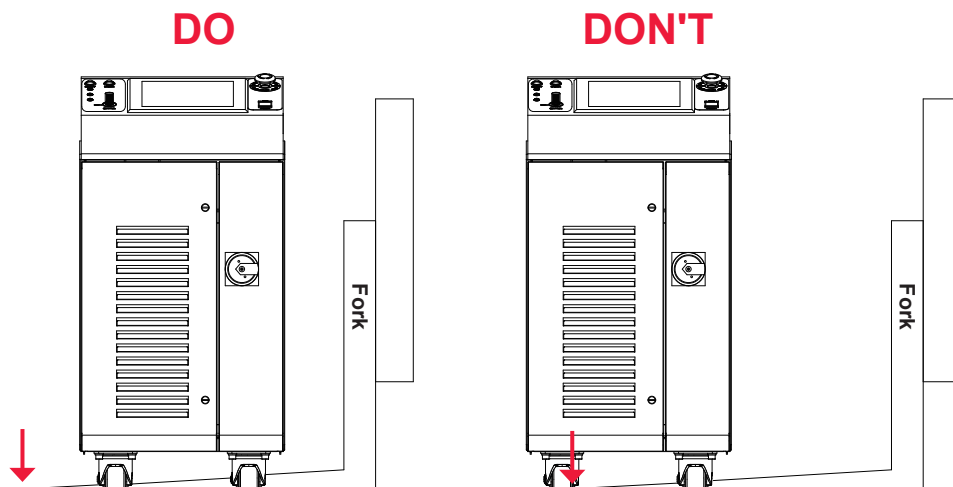
Precautions for transportation

⇒ Transport it using a dedicated package to prevent a fall, damage due to vibration.

⇒ Retract the level adjuster fully when freighting 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.

⇒ When putting the Laser up on the skid with a slope, do not push it up by main force. When it is hard to push it up, consult us.

⇒ 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) Open the package and install the slope.

Skid

Slope

Optical fiber
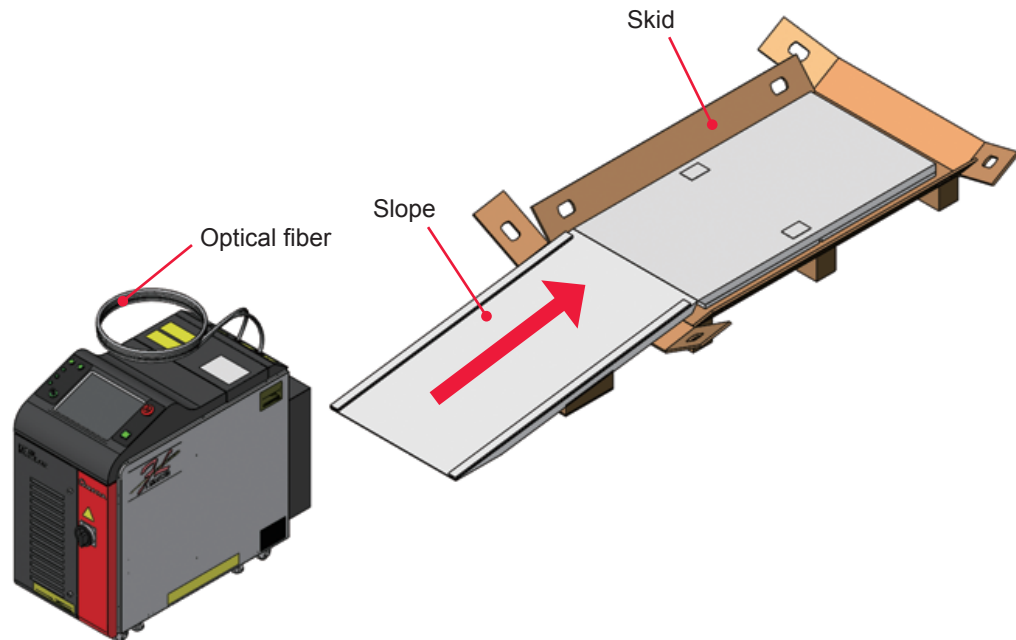
(2) Put the equipment on the skid using the slope.
⇒ To avoid bending the slope, put laminated cardboard blocks (2 positions) at the bottom of slope with the hook and loop fastener.

Laminated cardboard blocks
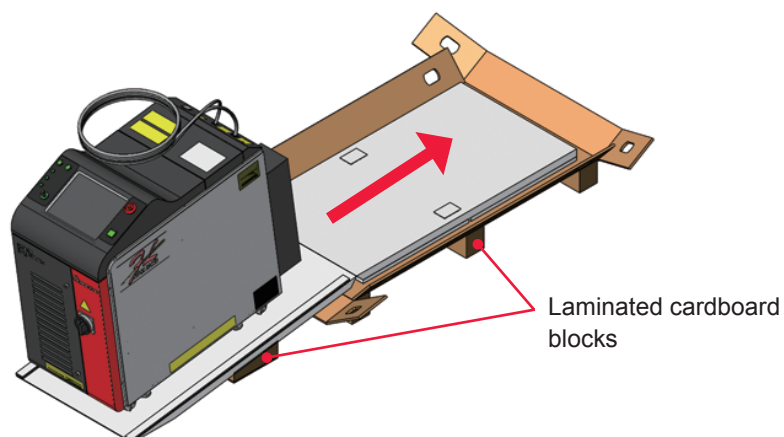
(3) Remove laminated cardboard blocks after putting the equipment in place.

Laminated cardboard block

Hook and loop fastener
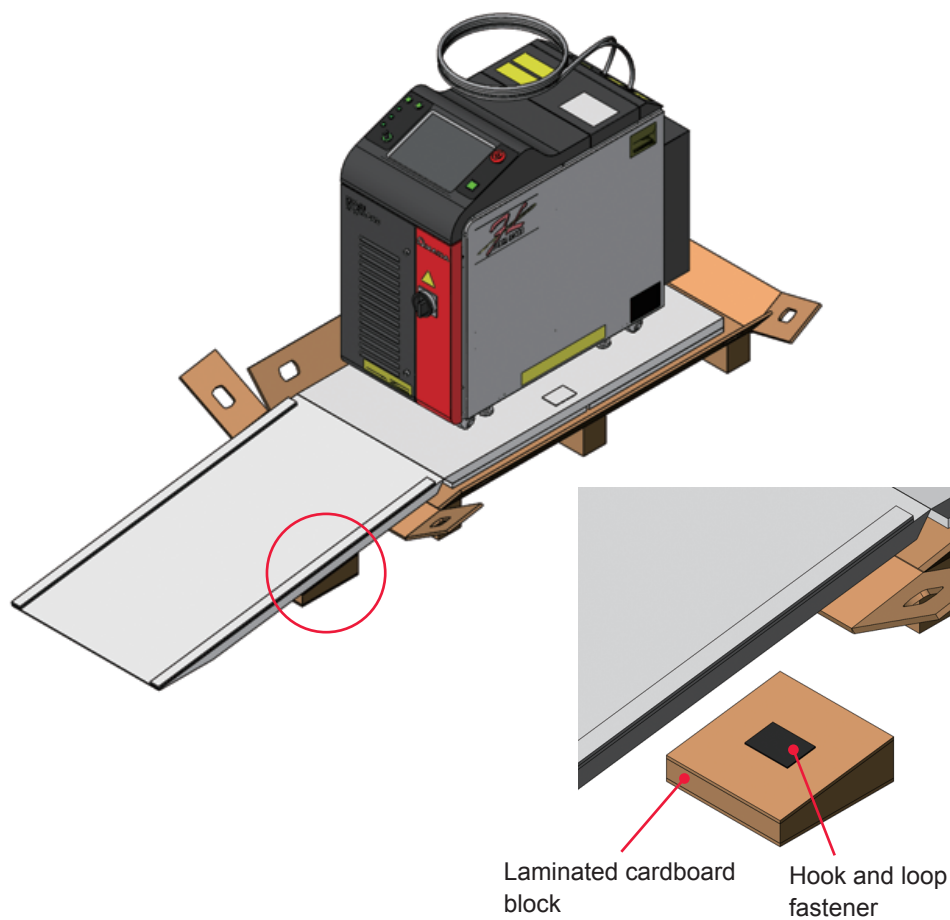
(4) Stand the slope straight up.

Slope

Hook and loop fastener
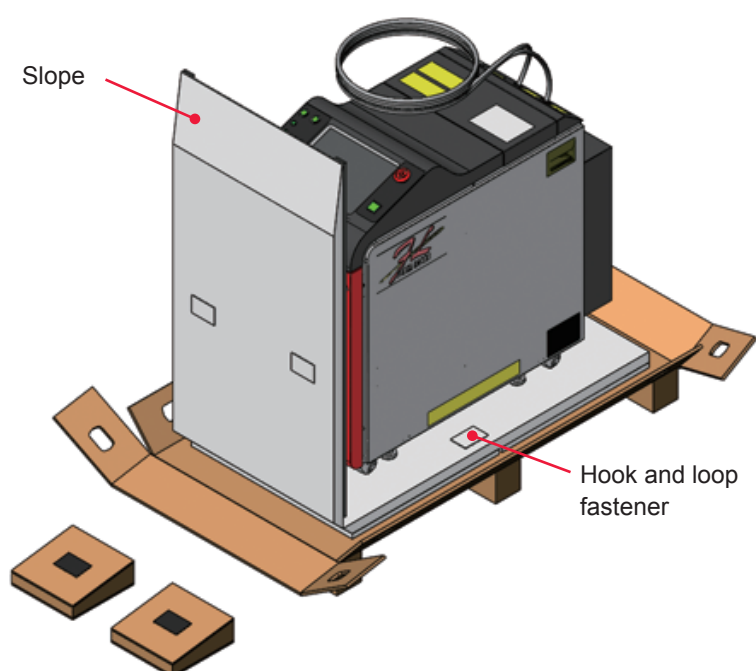
(5) Put the removed laminated cardboard blocks in place with the hook and loop fastener.

Hook and loop
fastener
(Rear of block)
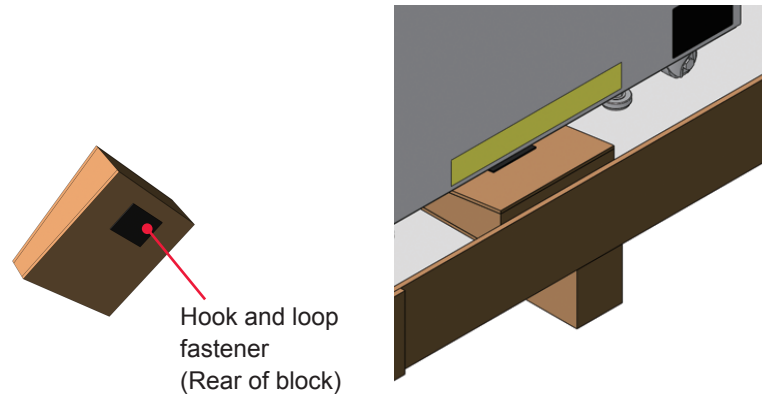
(6) Secure the corners of the bottom cap with joint clips.

Bottom cap
(4 positions)
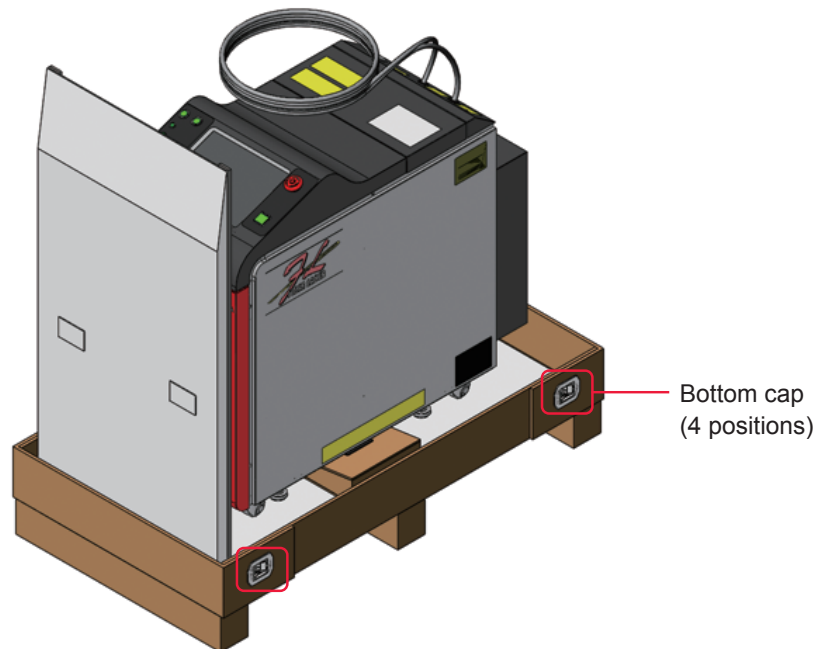
(7) Put the cushion for cable storage on the top of the equipment and store the optical fiber in it.

⇒ Be careful of the bending radius of fiber.

Cushion for cable storage
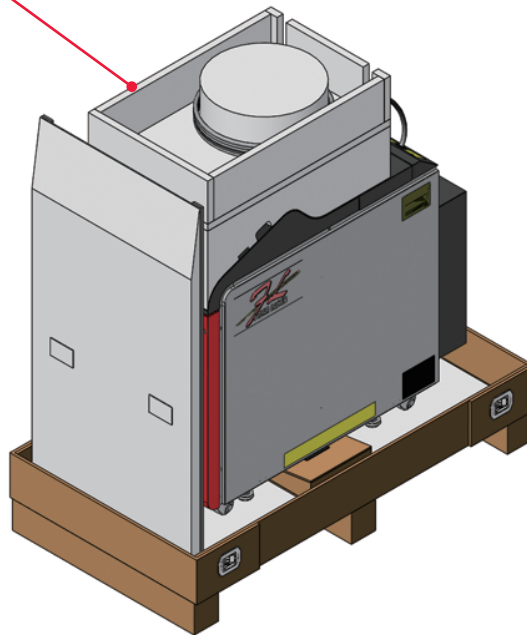
(8) Install an external packaging sleeve.

External packaging sleeve
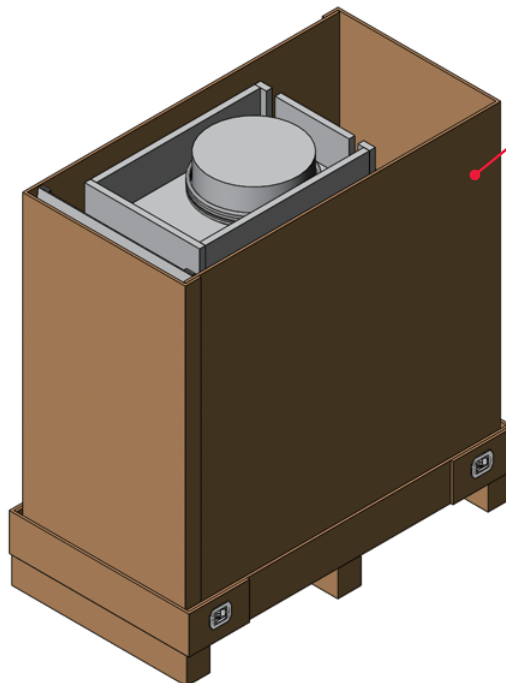
(9) Put rear cushions.

Rear cushions
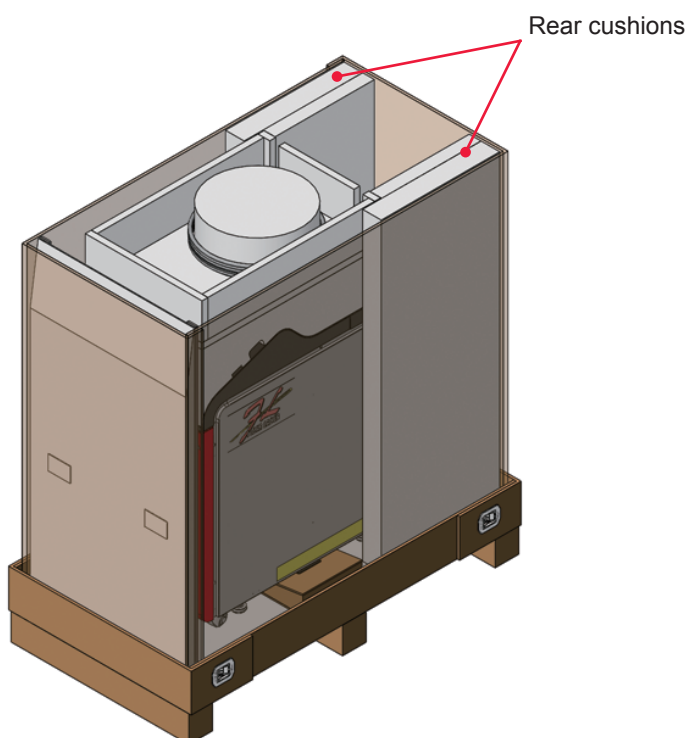
(10) Put front cushions.

Front cushions
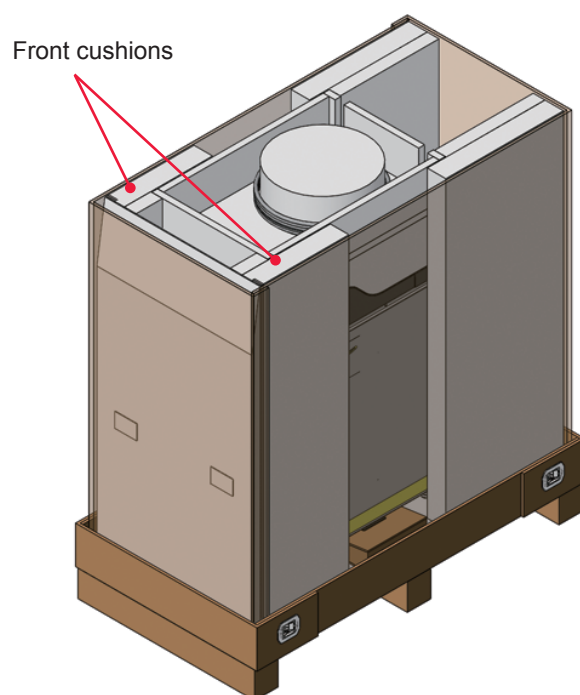
(11) Install the top cap and fix the package with bands.

Top cap

Bands
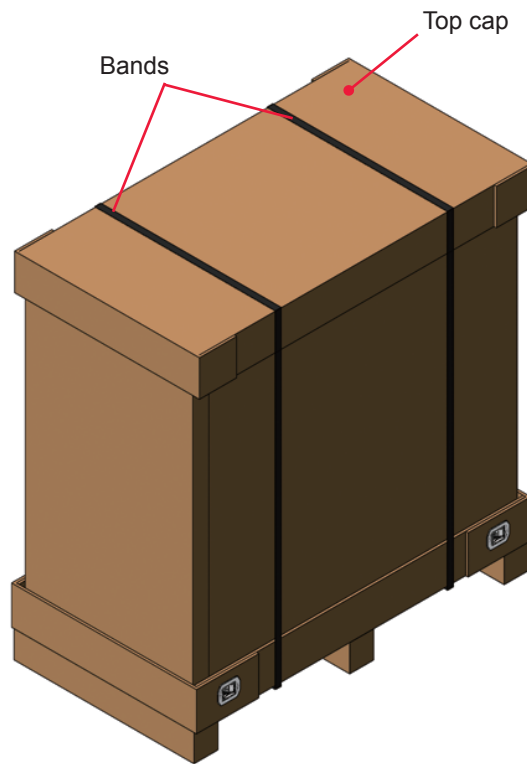
For Disposal

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

Sticking Warning/Danger Labels

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

(1)
```
ファイバの曲げ半径は
仕様の範囲内でお取扱下さい
Keep the bend radius of fiber
within the specified range.
```

(2)
```
AVOID EXPOSURE
VISIBLE AND INVISIBLE LASER RADIATION
IS EMITTED FROM THIS APERTURE
可視及び不可視
レーザ放射の出口
被ばく回避のこと - この開口から
可視及び不可視レーザ放射が出る
```

(3)
```
DANGER

VISIBLE AND/OR INVISIBLE LASER RADIATION
AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION

MAX OUTPUT
PULSE DURATION
WAVELENGTH(S)

CLASS IV LASER PRODUCT
P-1221
```

(4)
```
危険 - 不可視レーザ放射
DANGER - INVISIBLE LASER RADIATION
ビームや散乱光の目又は皮膚への被ばくを避けること
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION
最大出力 / MAX                :
パルス持続時間/ PULSE DURATION  : 0.2ms~CW
波　長 / WAVE LENGTH          : 0.90~1.20μm
クラス4レーザ製品  CLASS 4 LASER PRODUCT        JIS C6802:2014
```

(MAX OUTPUT) ML-3030AS: 5000W

ML-3015AS: 2500W

(5)
```
危険
ここを開き,そしてインタロックを解除すると,
クラス4のレーザ放射が出る　ビームや散乱光
の目又は皮膚への被ばくを避けること

DANGER
CLASS 4 LASER RADIATION WHEN OPEN AND
INTERLOCKS DEFEATED   AVOID EYE OR SKIN
EXPOSURE TO DIRECT OR SCATTERED RADIATION
```

(6)
```
危険                      DANGER
ここを開き,そしてインタロックを解除すると,  CLASS 4 LASER RADIATION WHEN OPEN AND
クラス4のレーザ放射が出る　ビームや散乱光   INTERLOCKS DEFEATED   AVOID EYE OR SKIN
の目又は皮膚への被ばくを避けること        EXPOSURE TO DIRECT OR SCATTERED RADIATION
```

(7)
```
FORK HERE
```

(8)
```
AMADA

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          200-240 VAC
              Hz              Phase 50/60Hz
     MAX. RMS AMPS            A
 MAX. AVERAGE LASER POWER     W
   MAX. PULSE ENERGY          J
     PULSE DURATION 0.2 ms  -  CW
         WAVELENGTH 1067  - 1073  nm
 PULSE REPETITION RATE 1  - 1000  Hz

                     CLASS IV LASER PRODUCT
                              L81174646
```

(9)
```
注意 - 可視レーザ放射
CAUTION VISIBLE LASER RADIATION
ビームを見たり,望遠光学計器を使って見ないこと
DO NOT STARE INTO BEAM OR EXPOSE USERS TELESCOPIC OPTICS CLASS 2M LASER PRODUCT
最大出力 / MAX                : <1mW
パルス持続時間/ PULSE DURATION  : CW
波　長 / WAVE LENGTH          : 0.60~0.70μm
クラス2Mレーザ製品  CLASS 2M LASER PRODUCT        JIS C6802:2014
```

(11)
```
注意
装置のキャスターを使って運搬しないでください。
装置の運搬には、許容荷重170kg以上のフォーク
リフト、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, USE A LIFT TRUCK,
PALLET TRUCK, ETC., OF AT LEAST 170KG ALLOWABLE LOAD.
```

(10)

Introduction Part

Introduction Part

Chapter 1

● Overview of the Pulsed Fiber Laser Welder

1. Fiber Laser

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

The Yb fiber laser wavelength generated in this laser welder is 1070 ± 3 nm of 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. Multiple beams of laser light can be split from single laser equipment to multiple optical fibers.

Powersharing

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

Timesharing

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

For example, if when the number of deliveries is 2, laser light is irradiated once each from 2 optical fibers. Up to 2 deliveries are available for this laser equipment at time-sharing.

Common Fiber Laser Equipment Configuration
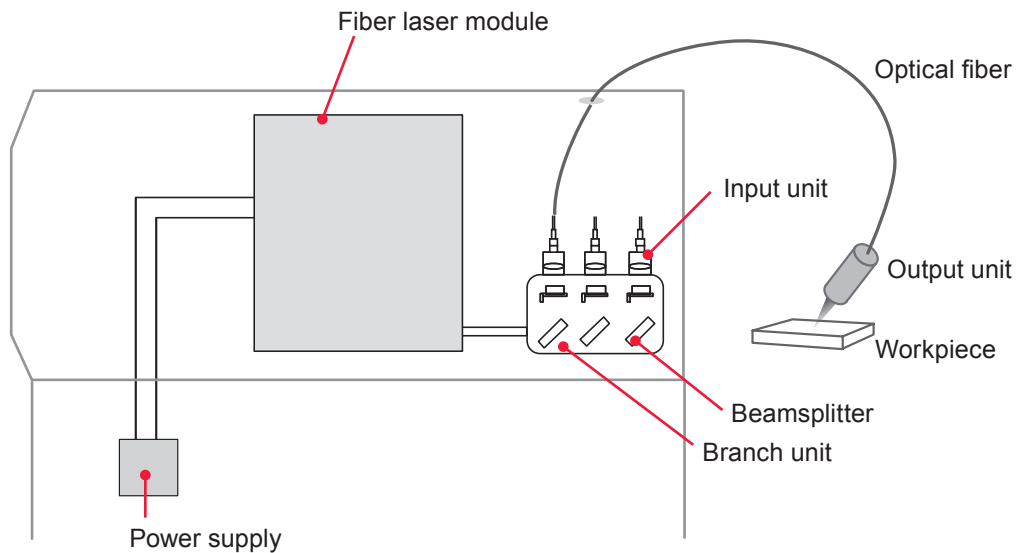
Example of 2 deliveries
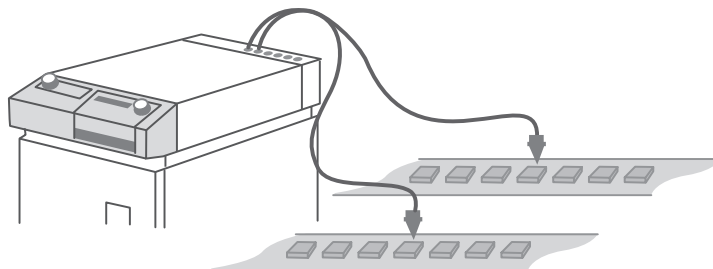
3. Functions of the ML-3030AS/3015AS

⇒ 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.

⇒ Laser power feedback control and optional waveform control functions

- The Laser can handle a wide variety of workpieces. Up to 256 different settings for weld schedules using waveform control are available.
- High-repetition laser output (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.
- Up to 2 deliveries of laser output, including powersharing and timesharing, are available. (The powersharing or timesharing specification is option.)
- Powersharing permits obtaining uniform outputs for each delivery without energy loss.
- Various kinds of processing can be done with the modulation function.
- The isolation function (option) protects the oscillator from light reflected from the processing point.

⇒ Simple operations and maintenance

- Fully air-cooled. No coolant or coolant filters needed.
- Remote control is available using the optional Laser Controller.
- A welding schedule is input from the large-shaped touch panel type color display. Accordingly, operations can be easily and accurately performed.
- Language displayed on the Laser Controller can be switched between Japanese and English.
- A variety of input and output signals allow the Laser to be connected to automatic machines.
- Both the laser energy (J) and its mean power (W) are monitored. If the desired energy range has been preset and the laser energy is out of the range, the trouble signal is output. This function is provided for quality control purposes.
- Optical fiber detection is available to check fiber connection.
- Using the external communication function permits managing data such as welding schedules and monitor values in centralized form.

⇒ The factory environment can be improved by space saving.

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

⇒ The Laser conforms to the following standards.

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

In compliance with IEC Standards IEC60825-1 "Safety of laser products Part1: Equipment Classifications, requirements and use's guide"

Introduction Part

Installation and Preparation Part

Operating Part

Maintenance Part

Appendixes

Chapter 1 Overview of the Pulsed Fiber Laser Welder

4. Product Composition

Packaging

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

	Dimensions	Mass (including packaged products)
Package for main unit	Approx. 1100 (H) × 600 (W) × 1155 (D) mm	Approx. 170 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.	Q'ty
Pulsed Fiber Laser Welder	ML-3030AS/3015AS	1

Package for accessories

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

Product name		Model No.	Q'ty
Adjuster pressure plate		KC-1275C-3	4
Protective glasses		CE YL-717S	1
Operation manual		AS1178495(OM1178496,OM1178497)	1
Power harness (6 m)		AS1178984	1
CE label		P-1215	1
Connector	Plug	HDCB-37P(05)	1
		116-12A10-5F10.5	2
	Case	HDC-CTH(10)	1

Main Unit, Optical Fiber, and Output Unit

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

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

Main unit

Optical fiber   Output unit
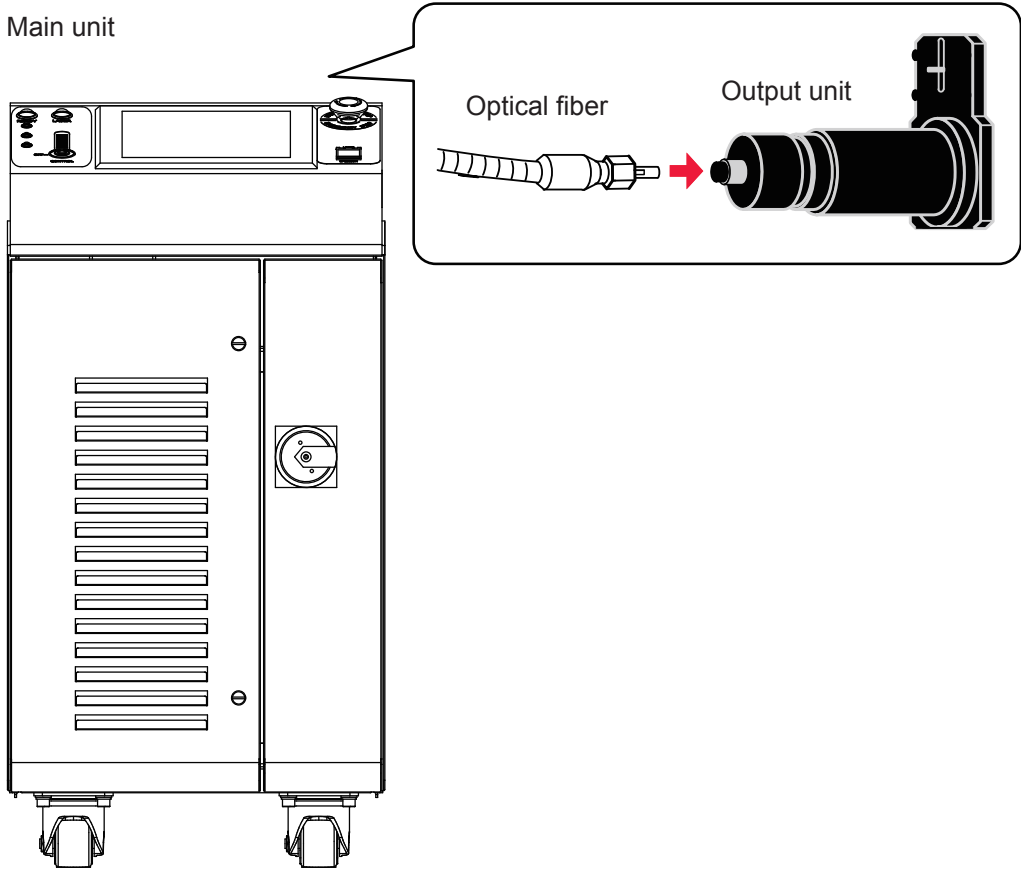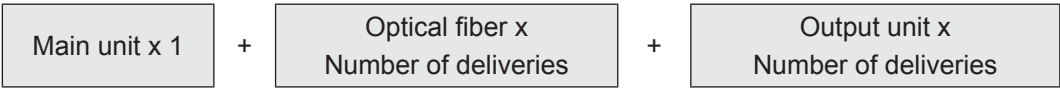
Main unit

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

Model	Sharing method	Specification
ML-30□□AS-010 ML-30□□AS-110	Single delivery	Output to a single fiber
ML-30□□AS-020	2-powersharing	Simultaneous output to 2 fibers
ML-30□□AS-002	2-timesharing	Output to one optionally selected from 2 fibers

An isolator is installed according to the specifications additionally selected at the time of purchase.

The isolator decreases the power by up to 10%.

The isolator cannot be mounted on ML-30□□AS-110.

Optical fiber

For ML-30□□AS-110, the optical fiber having a core diameter of φ 0.05 mm and length of 4 m is connected.

For other models, any optical fiber of the followings is connected to the main unit depending on the specification that you selected at the time of purchase. Dedicated fibers with AR coat can be connected to this product. Do not connect other fibers.

Model	Part name	Core dia.	Length
PO1178504	KVLKA2 AR2 ST100E 5m	φ 0.1 mm	5 m
PO1178505	KVLKA2 AR2 ST100E 10m	φ 0.1 mm	10 m
PO1178506	KVLKA2 AR2 ST200E 5m	φ 0.2 mm	5 m
PO1178507	KVLKA2 AR2 ST200E 10m	φ 0.2 mm	10 m
PO1175451	KVLKA2 AR2 ST300E 5m	φ 0.3 mm	5 m
PO1175452	KVLKA2 AR2 ST300E 10m	φ 0.3 mm	10 m
PO1175453	KVLKA2 AR2 ST400E 5m	φ 0.4 mm	5 m
PO1175454	KVLKA2 AR2 ST400E 10m	φ 0.4 mm	10 m
PO1175455	KVLKA2 AR2 ST600F 5m	φ 0.6 mm	5 m
PO1175456	KVLKA2 AR2 ST600F 10m	φ 0.6 mm	10 m
PO1177722	KVLKA2 AR2 ST800G 5m	φ 0.8 mm	5 m
PO1177723	KVLKA2 AR2 ST800G 10m	φ 0.8 mm	10 m

Output unit

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

⇒ As the spot diameter is bigger, the visibility of guide light becomes lower.

Options

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

Part name		Model No.
Laser controller (with 1-m circuit cable)		MLE-122A-15-00
Touch panel extension cable	5 m	AS1162937
	10 m	AS1162938
	15 m	AS1162940
RS-232C/RS-485 conversion adapter		MSC-08S
AC adapter for RS-232C/RS-485 conversion adapter		Exclusively for MSC-08

Part name		Model No.
RS-485 cable	5 m	AS1155931
	10 m	AS1156028
	15 m	AS1156029
RS-232C cable, 0.2 m		KRS-9F25F02K
End face checker		EC-02(LED)(50)
Warning label	Small	P-0211
	Medium	P-0212
	Large	P-0213

⇒ For the maintenance parts separately sold, refer to the Maintenance Part, Chapter 1 "1. Maintenance Parts and Standard Intervals of Inspection/Replacement" on page 165.

RS-232C/RS-485 Conversion Adapter

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

RS-485(1)

RS-485 connector of the main unit

RS-485 cable

RS-232C/RS-485 conversion adapter

Personal computer, etc.

RS-232C cable

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Chapter 2 Name and Functions of Each Section

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Chapter 2

● Name and Functions of Each Section

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

Front Cover Section

This section explains each section of the front cover of the main unit.
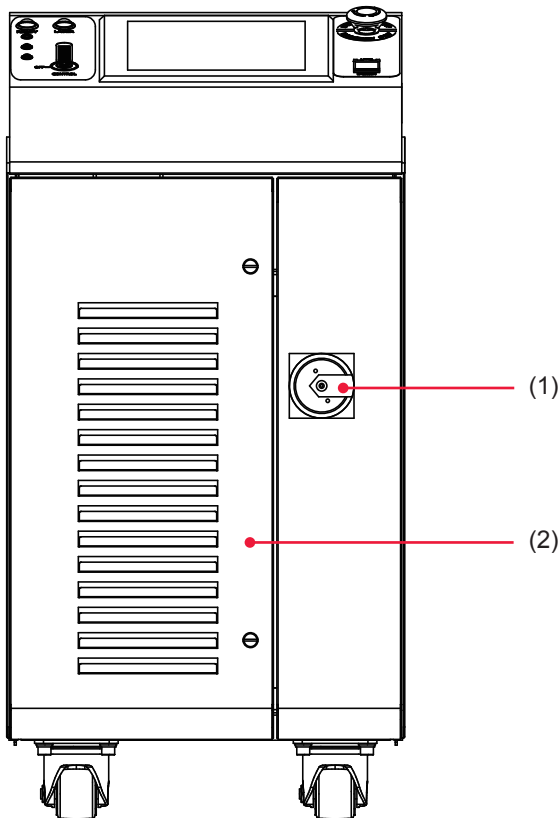
Function of Each Section on the Front Cover

(1) MAIN POWER Switch	Turns ON and OFF the power supply.
(2) Front Door	This door is opened to perform maintenance of air filter.

Inside of the Front Side

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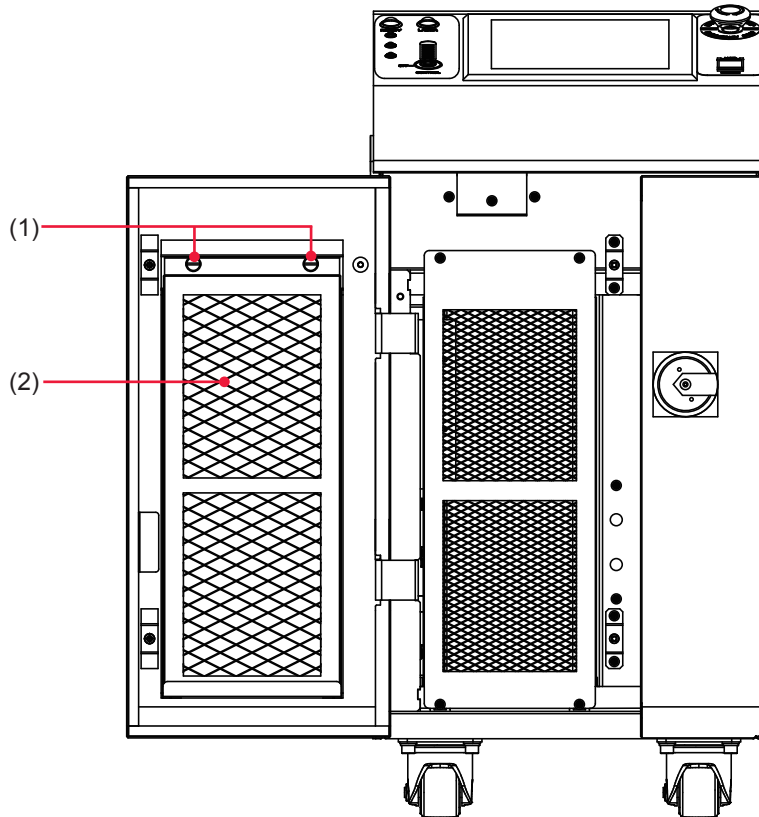
Function of Each Section inside the Front Side

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

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

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

Function of Each Section on the Top Side

(1)	**Optical Fiber In-lets**	Pass the optical fibers through these holes.
(2)	**Optical Fiber Fix-tures**	Secures the optical fiber. The numbers and positions are different according to the sharing specification.
(3)	**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.
(4)	**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.
(5)	**Control Panel**	This panel is used to set welding schedules and operate the laser. Setting items and set values are displayed on the liquid crystal display.

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(6) READY Lamp	Lights up when the LD is turned on for outputting the laser.
(7) LASER Lamp	Indicates that laser is being output.
(8) 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.
(9) SHUTTER Lamp (1 to 2)	Stay(s) on while some (one) of the safety shutters 1 to 2 are (is) open.
(10) CONTROL Key-switch	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. Name and Function of Each Section on the Rear Side

This section explains each section on the rear side.

(With the connectror cover removed)
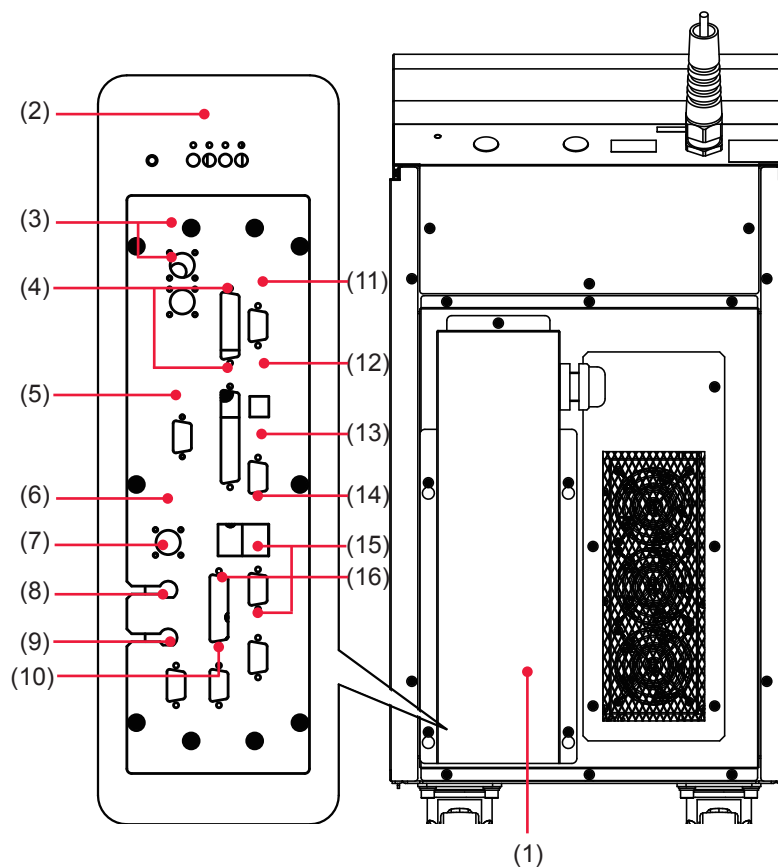
Function of Each Section on the Rear Side
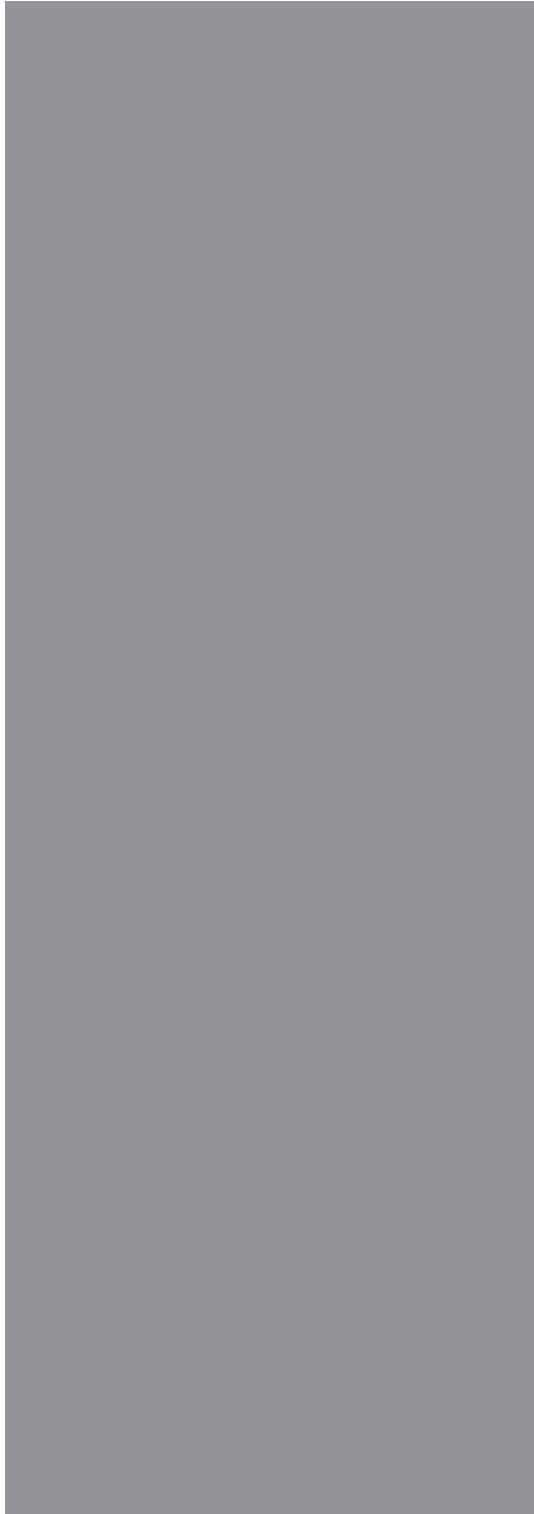
(1) Connector Cover	For the external I/O connectors.
(2) Power Supply Terminals	Connect the terminals to a single-phase power supply of 200/220/240 V AC, depending on specifications.

(3) RS-485 (1), (2) Connectors	Connects a personal computer to use the external communication function.
(4) EXT. I/O (1), (2) Connectors	Used to output signals, e.g., alarm signals and monitor judgment signals; and to input signals, e.g., start signal and schedule signals.
(5) RS-232C (4) Connector	Used for maintenance only.
(6) REM. I/L Connector	Connect it to the Remote Interlock for emergency stop. When this connector is closed, the safety shutter of the laser welder are closed to shut off the laser light output.
(7) 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.
(8) BRMON Connector	BNC connector used to output an analog signal representing the monitor waveform of reflected light. When viewing the waveform of reflected light, connect to an oscilloscope.
(9) LASER CONT.IN Connector	At delivery, the LASER CONT.OUT connector and the LASER CONT. IN connector are connected with the shorting cable. When using an optional laser controller, disconnect the shorting cable.
(10) LASER CONT. OUT Connector	Connects an optional laser controller. Disconnect the shorting cable and connect the laser controller to control the laser remotely. (During that time, the control panel cannot be controlled.)
(11) RS-232C (3) Connector	Used for maintenance only.
(12) USB B Connector	Used for maintenance only.
(13) VGA Connector	Used for maintenance only.
(14) USB A Connector	Used for maintenance only.
(15) RS-232C (1), (2) Connector	Used for maintenance only.
(16) E-STOP Connector	Used to connect to the Remote Interlock for emergency stop or input/output Emergency signals.

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Installation and Preparation Part

Chapter 1

● Installation

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

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

1. Installation Place

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

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

⇒ For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 15 A or more, which is applicable to harmonics and surges.

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

Space Required for Installation

In the installation place of this product, a space is required in the surroundings.

Install the product in a place remote from the wall as shown in the following figure.

⇒ Air flows in the direction of the red arrow shown in the following figure. Install the product so as not to interrupt the air flow.
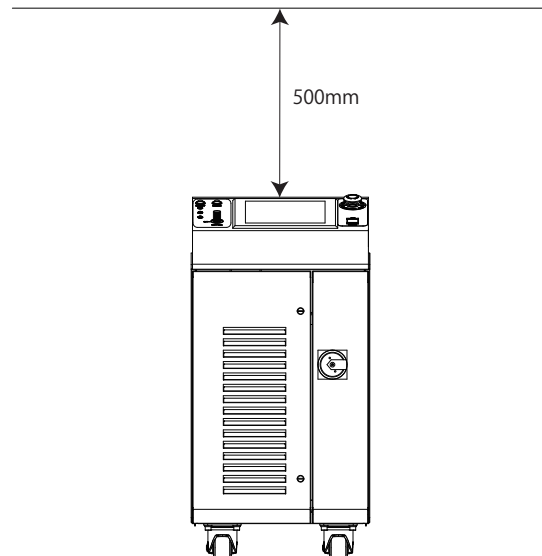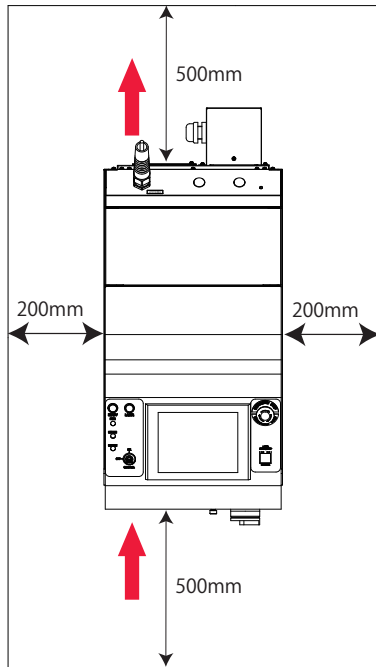
Environment Suitable for Installation and Precautions

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

⇒ Use the product in a place where the ambient temperature is 10 to 35ºC and the ambient humidity is 50 to 85% RH and yet a sudden temperature change does not occur.

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

■ Place where there is considerable dirt, dust, or oil mist,

■ where the Laser may be subjected to vibration or impact,

■ where the Laser may be exposed to chemicals,

■ where there is a nearby high noise source,

■ where moisture may be condensed on the surface of the Laser,

■ where the concentration of CO_2, NOx or SOx is high.

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

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Chapter 1 Installation

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.

**Adjuster pressure fixture
(4 positions)**

418

**Adjuster pressure
fixture**

420
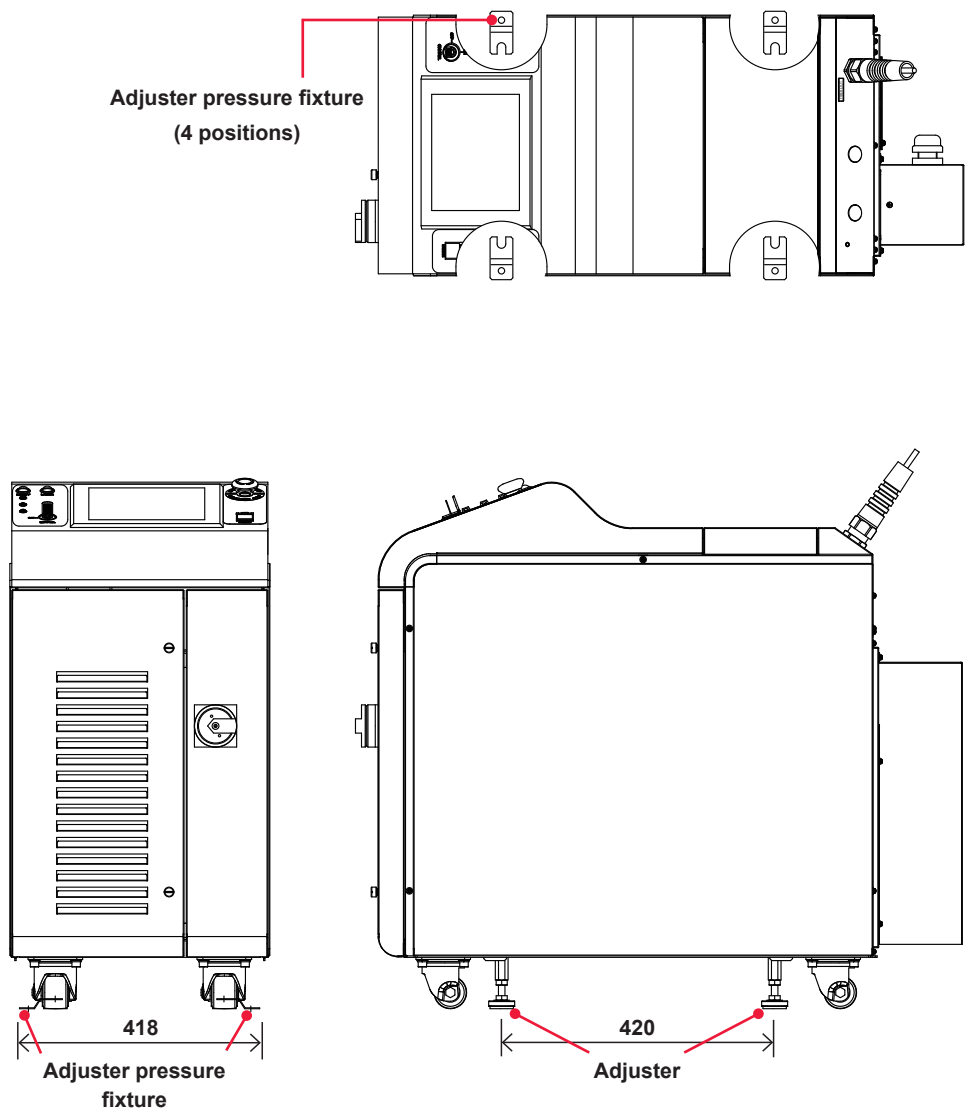
Adjuster

(2) Fix each adjuster on the floor by using a connecting apparatus such as anchor.
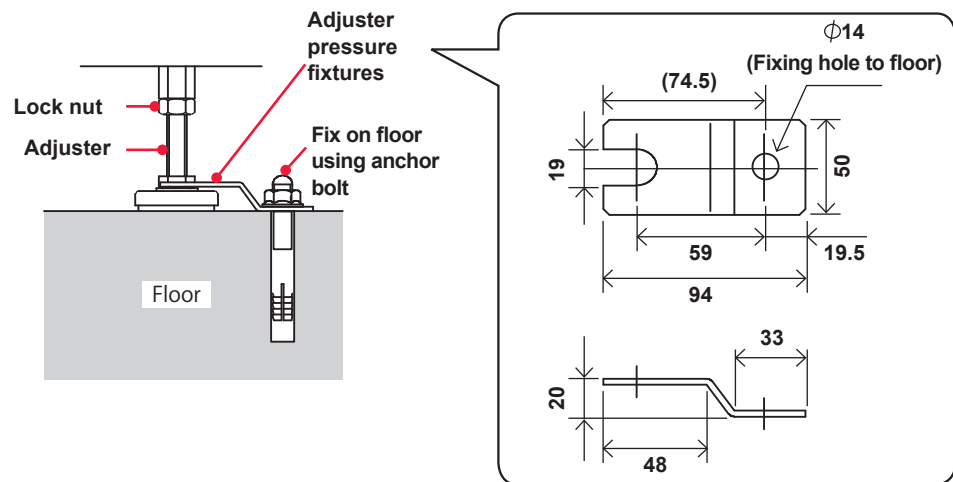
⇒ The connecting apparatus is not attached as an accessory. Prepare it on the customer side.

Installation and Preparation Part

Chapter 2

● Connections and Preparations of Each Section

1. Connecting the Power Supply

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

> ⚠ **CAUTION**
>
> **For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 15 A or more, which is applicable to harmonics and surges.**

Item required

Slotted screwdriver and Phillips screwdriver

● Operating Procedure

(1) Open the connector cover on the rear.

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

(3) While confirming the terminal colors of the power harness, connect the power harness to the L (white), N (black), and PE (green) power input terminals, and secure it with screws.

(4) Install the connector cover.

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

When the connector cover is open

Power input terminals

L   N   PE

Black
White Green
Ferrule terminal for 5.5 sq
5.5 sq
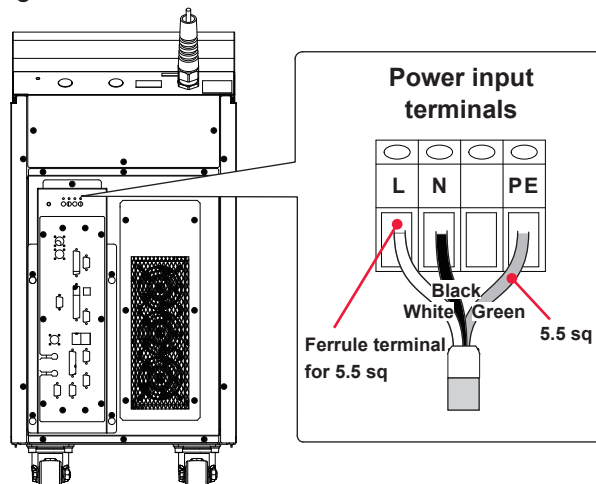
2. Connecting the Optical Fiber

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

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

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

Models other than ML-30□□AS-110

Precautions during Operation

⇒ During operation, wear fingerstalls or gloves (power free).

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

Minimum bending radius of the optical fiber

Core Diameter	Minimum Bending Radius
φ 0.1, 0.2, 0.3, 0.4 mm	100 mm
φ 0.6 mm	150 mm
φ 0.8 mm	200 mm

Item required

Fingerstalls or gloves (power free), air blow (gas type), end face checker, lens cleaning paper, HYPERCLEAN (EE-3310), lighting, and clean booth

1 ● Cleaning the End Face of the Optical Fiber

(1) Loosen the set screw (M3) on the output unit side to remove the cable gland and the cylinder, and then pass the optical fiber through them.
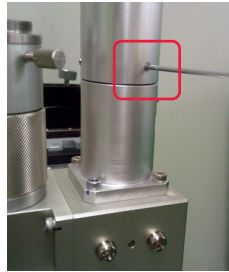
(2) Remove the cap at the end of the optical fiber.

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

Cap
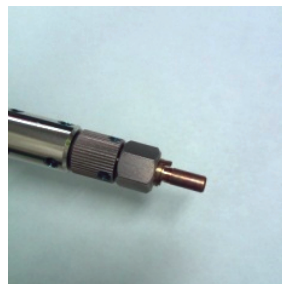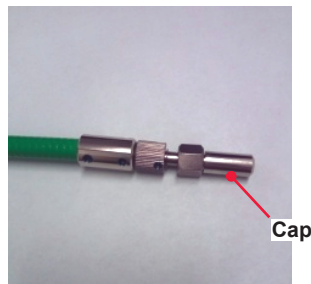
(3) Align the groove on the output unit side and the key provided on the optical fiber side to mount the optical fiber on the end face checker, and then apply light from the oblique direction.

Lighting
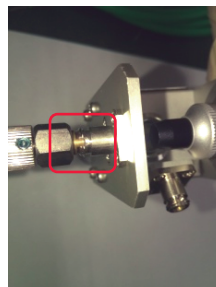
(4) Check the end face of the optical fiber.

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

(5) If it is stained or dust is attached, blow off dust by using the air blow and check the end face again.

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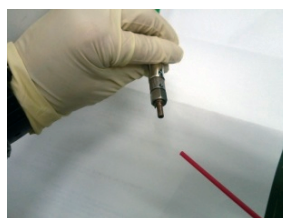
(6) If the dirt cannot be removed by the air blow, apply HYPERCLEAN (EE-3310) on the cleaning paper. Place it on the optical fiber and wipe the optical fiber by pulling the cleaning paper across it.

(7) Check the end face with the end face checker again. If there is stain, dust and streak, repeat above steps.
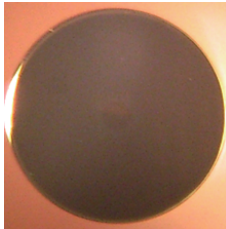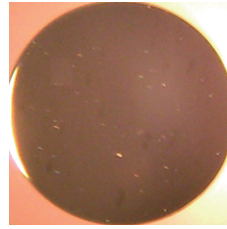
(8) Check that there is no stain, dust and streak and mount it on the output unit (Step **2**).

2 ● Connecting the Optical Fiber

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

⇒ At this time, take care that the end face of the optical fiber does not contact with the output unit. The end face of the optical fiber and the ferrule are the same height.
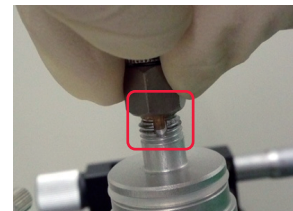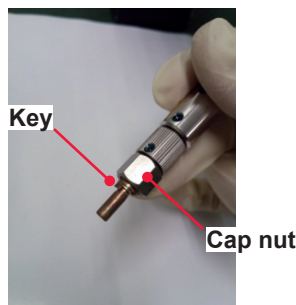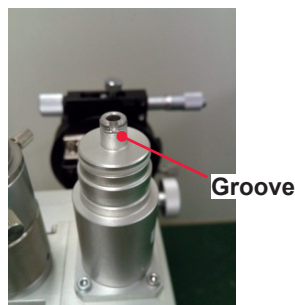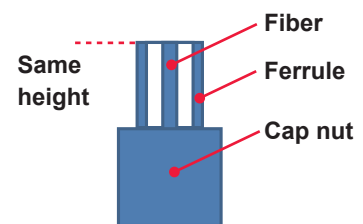
(2) Turn the outer-side cap nut of the plug in the direction of the arrow to fix the optical fiber.

⇒ Strongly tighten the cap nut by hand without using a tool.

⇒ The connector section cannot be bent. Take care not to give excessive force to this section.
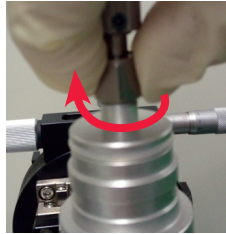
(3) Mount the cylinder and tighten the set screw. Finally, tighten the cable gland.
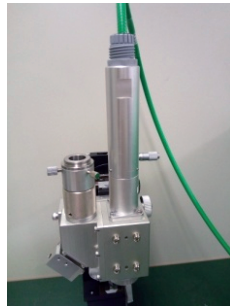
ML-30□□AS-110

Precautions during Operation

⇒ During operation, wear fingerstalls or gloves (power free).

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

Minimum bending radius of the optical fiber

Core Diameter	Minimum Bending Radius
φ 0.05 mm	200 mm

⇒ 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 (power free), lens cleaning paper, and HYPERCLEAN (EE-3310)

1. Cleaning the End Face of the Optical Fiber

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

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

⇒ Keep the recover cap in a clean place in custody. If a dirty cap is mounted again, this will cause seizure.
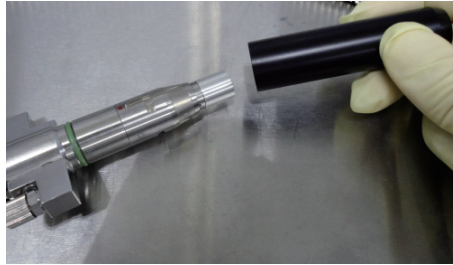
(2) Remove the protective pipe at the end of the optical fiber.

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

(4) Place a drop of HYPERCLEAN (EE-3310) in the quartz block area over the cleaning paper. Wipe the quartz block by pulling the cleaning paper across it.
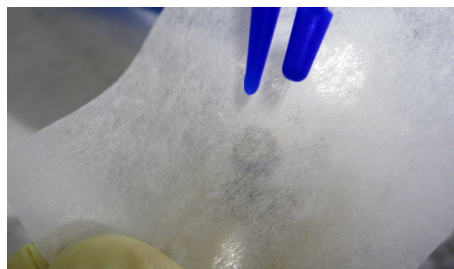
(5) Check that there is no stain, dust and streak on the end of the quartz block and return the protective pipe.

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2 Connecting the Optical Fiber

(1) Remove the cap at the end of the connector section.

⇒ Keep the cap in combination with the cap of the optical fiber removed in Step **1** to prevent a dust from entering the inside.

Cap

Cap of the optical fiber

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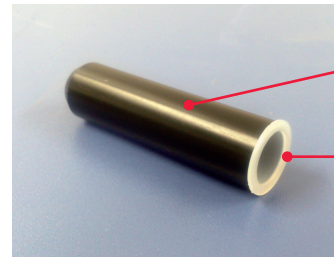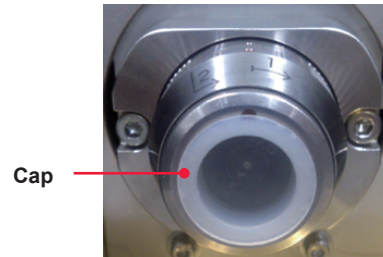
(2) Insert the optical fiber so that a red dot on the optical fiber is in line with the two red dots on the connector section.

⇒ Take care not to fall the O-ring.
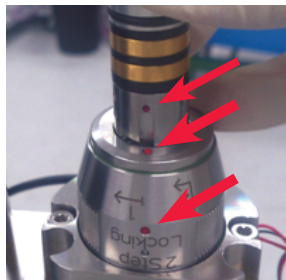
(3) Turn the connector section about 37° in the direction of the arrow 1 indicated on it.

⇒ Turn the connector section by hand without using a tool.

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

3. Connecting the Laser Controller (Option)

When using the laser controller as a remote controller, connect the cable.

> ⚠️ **CAUTION**
>
> **Be sure to turn OFF the power supply before starting to connect the laser controller.**

Item required

Laser controller and circuit cable

● Operating Procedure

(1) Open the connector cover and disconnect the short circuit cable.

(2) Connect between the main unit and the laser controller by circuit cable.
⇒ The laser controller and circuit cable are options.
⇒ When the laser controller is connected, operations from the control panel are disabled.

Laser Controller

LASER CONT.OUT

Connect Laser Controller to [LASER CONT.OUT] connector using circuit cable.
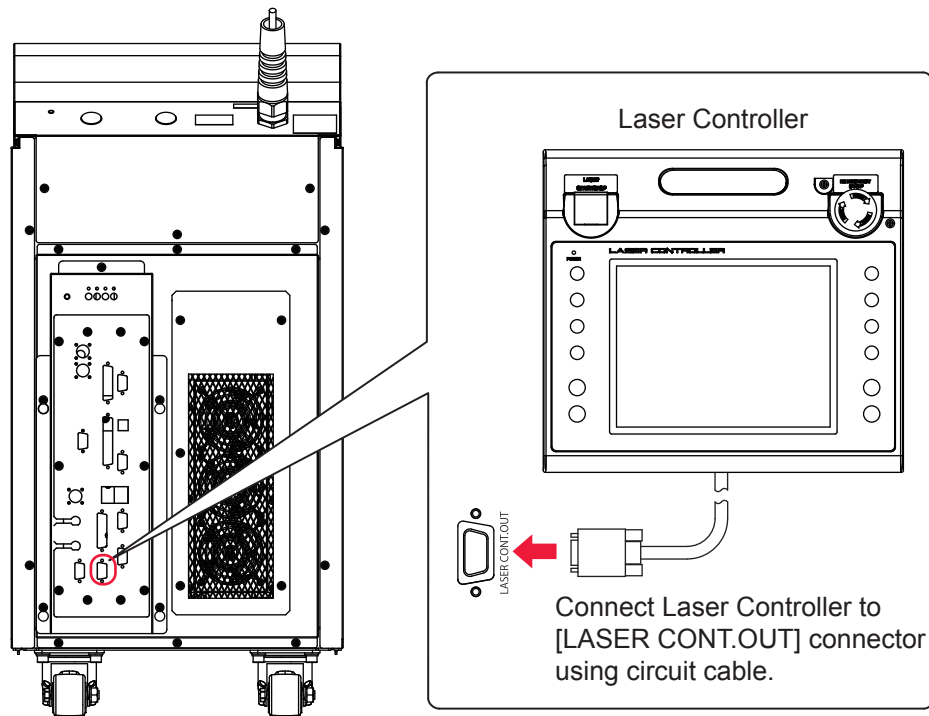
4. Connecting the External Communication Conversion Adapter (Option)

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

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

Item required

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

Operating Procedure

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

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

RS-485 Cable

RS-232C/RS-485 conversion adapter

RS-232C Cable

Personal computer, etc.

RS-485(1) Connector
RS-485(2) Connector

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Chapter 1 Control Method, and Start and Stop
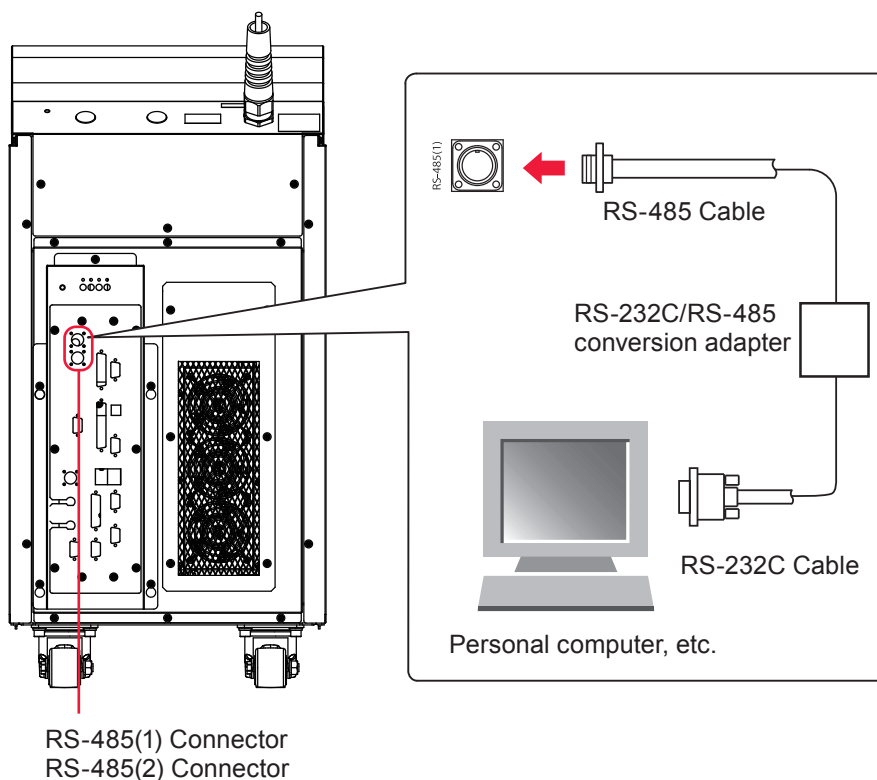
Operating Part

Chapter 1

● Control Method, and Start and Stop

1. Control Method

This section explains the control method for the laser.

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

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

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

Switching the Control Method

Control by Control Panel (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 control panel.

⇒ To switch the control by external input/output signals over to the control by control panel, 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 control panel, 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 control panel. When the CONTROL keyswitch is turned on again, the control method is switched to the control from the control panel 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 control panel 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 control panel or external input/output signals.

2. Start and Stop

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

How to Start the Laser

● Operating Procedure

(1) Turn ON the MAIN POWER switch.

(2) Turn ON the CONTROL keyswitch.

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

⇒ For the control by control panel, 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.

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● Various Settings

1. Screen Configuration

This section explains the method of setting various laser welding schedules by using the control panel. 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 welding schedule.

There are 5 types of basic screen as shown below which are displayed on the liquid crystal display of the control panel. 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:

SCHED	MON	STATUS	CONFIG
SCHEDULE Screen	MONITOR Screen	STATUS Screen	CONFIG Screen
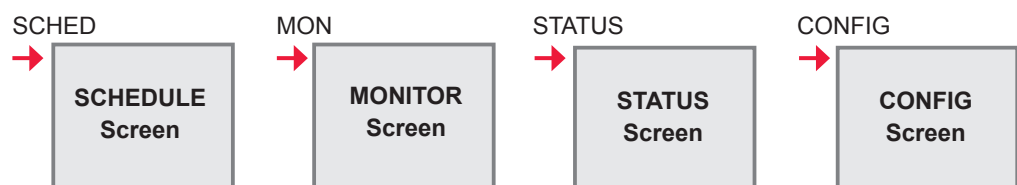
How to Use the Touch Panel

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

The colors of the setting buttons displayed on the basic screens are deep blue, green, and blue.
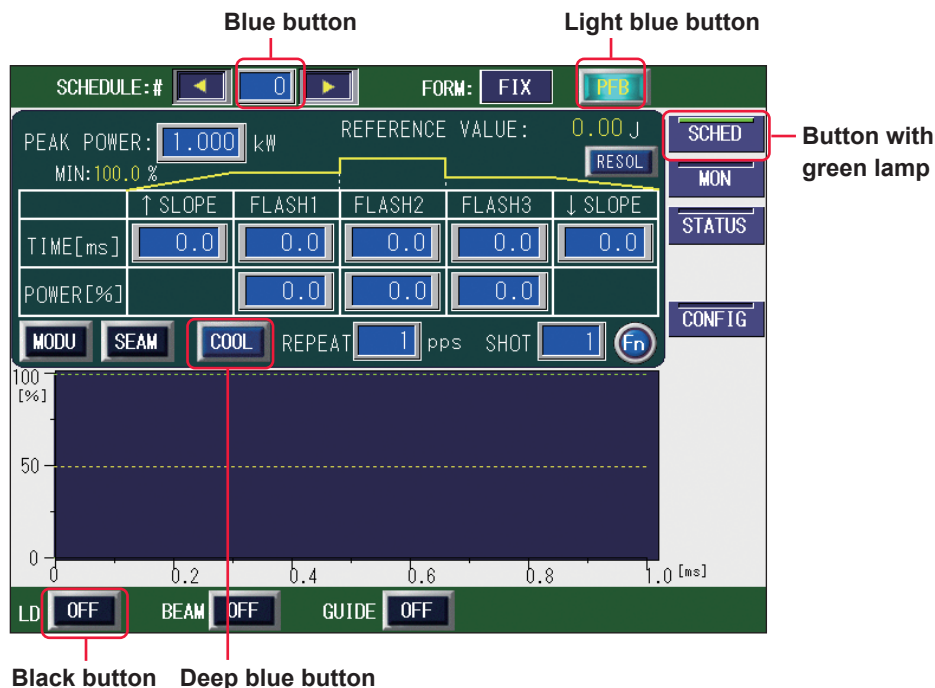
COOL (deep blue) / **OFF** (black) / **ON** (light blue) / **SCHED** (w/ green lamp) button

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

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

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

Example: **OFF** → When pressing ON → **ON** (blinking)

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

100.0 (blue) button

The blue button is used to set a numeric value.

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

Example: **0.0** → Numbers of the numeric keypad → **100.0** are pressed and then the **ENT** key is pressed.

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.

SCHEDULE:# ◀ 0 ▶   FORM: FIX   PFB —— **Display items and setting buttons**

SCHED
MON
STATUS   —— **Screen selecting buttons**

CONFIG

LD OFF   BEAM OFF   GUIDE OFF —— **Display items and setting buttons**
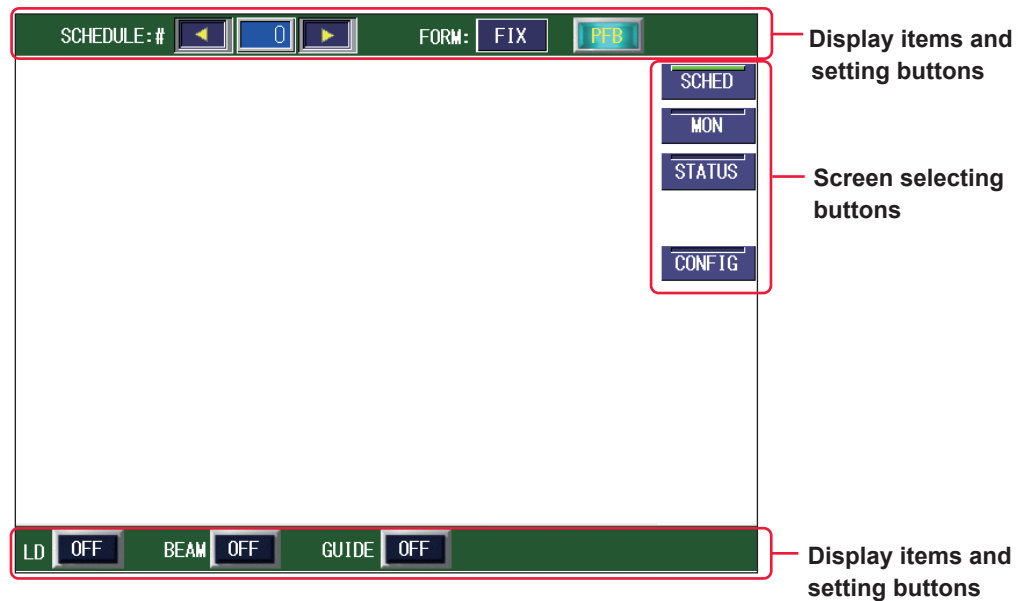
How to See the Display Items and How to Use the Setting Buttons   : Settable item

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.
PFB	Sets the power feedback to ON/OFF. The lamp lights up at ON, and the power feedback control is performed when a laser is output with currently-selected schedule.
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	Sets the beam selection to ON/OFF. With this button pressed, a window to select the delivery to output for beam is displayed. (The window depends on the setting of the memory switch.) At ON, the safety shutter of the selected delivery is opened, the beamsplitter operates, and a beam can be output. When there is even one delivery set to ON, the button is displayed in blinking light blue. *<Note>* For ML-30□□AS-110, it has no safety shutter and no beamsplitter. Even if the button is pressed, no window is displayed. When the CONTROL keyswitch is turned ON after starting the Laser, the button is displayed in blinking light blue.
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 welder 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.

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 control panel. RS-485 CONTROL (external communication control): 　　Control is exerted by the personal computer connected to the RS-485 (1) 　　or RS-485 (2) connector.
DELIVERY SYSTEM	Displays the laser light sharing method such as single delivery, powersharing, and timesharing.
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 total time of LD.
FLASH WORK TIME	Displays the laser output time.
Laser Unit Temp.	Displays the temperature of each laser unit in the equipment.
Ext. I/O	Displays the TERMINAL MONITOR screen. Then, the external input/output monitor is displayed.
ERROR LOG	Displays the ERROR LOG screen. Then, the error history is displayed.
EVENT LOG	Displays the EVENT LOG screen. Then, the event history is displayed.

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

⇒ For the common items in the upper/lower part of the screen, refer to page 59.

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 Control Panel (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 control panel 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 MONI-TOR screen appears. On this screen, the external input/output is monitored.

EXT. I/O (1)

TERMINAL MONITOR (EXT. I/O(1))		
INPUT		
2	LASER START	OFF
3	LASER STOP	OFF
4	LD ON	OFF
5	GUIDE BEAM	OFF
6	TROUBLE RESET	OFF
7	RESERVE	OFF
8	RESERVE	OFF
9	EMERGENCY STOP	OFF
10	INPUT COM	-
19	0V OUT	-
24	RESERVE	OFF
25	CONTROL CHANGEOVER	OFF

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

EXT.I/O(1)   EXT.I/O(2)   SIM. OFF   ✕

EXT. I/O (2)

TERMINAL MONITOR (EXT. I/O(2))		
INPUT		
15	RESERVE	OFF
16	BEAM SELECT 1	OFF
17	BEAM SELECT 2	OFF
18	BEAM SELECT 3	OFF
19	BEAM SELECT 4	OFF
20	RESERVE	OFF
21	RESERVE	OFF
22	TIMESHARING UNIT 1	OFF
23	TIMESHARING UNIT 2	OFF
24	RESERVE	OFF
25	RESERVE	OFF
26	RESERVE	OFF
27	SCHEDULE 1	OFF
28	SCHEDULE 2	OFF
29	SCHEDULE 4	OFF
30	SCHEDULE 8	OFF
31	SCHEDULE 16	OFF
32	SCHEDULE 32	OFF
33	SCHEDULE 64	OFF
34	SCHEDULE 128	OFF
35	INPUT COM	-
36	STROBE	OFF
37	0V OUT	-

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

EXT.I/O(1)   EXT.I/O(2)   SIM. OFF   ✕

How to see the displayed items

: Settable item

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

ERROR LOG Screen

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

How to see the displayed items

: Settable item

--.--.--	Displays the date when the error occurred.
--:--:--	Displays the time when the error occurred.
E*	Displays the error code.
: -----	Displays the error messages corresponding to error codes.
Page	Displays currently-displayed page number / total number of pages.
▲ ▼	Scrolls the line up and down. When a line is not displayed, press this button to display it.
▲ ▼	Scrolls the page up and down. When a page is not displayed, press this button to display it.
X	Returns to the STATUS screen.

EVENT LOG Screen

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

How to see the displayed items   ▨ : Settable item

--.--.--	Displays the date when the event occurred.
--:--:--	Displays the time when the event occurred.
Input source	Displays the input source of instruction which causes the event.
Event contents	Displays the contents of equipment operation.
Page	Displays currently-displayed page number / total number of pages.
▲ ▼	Scrolls the line up and down. When a line is not displayed, press this button to display it.
⯅ ⯆	Scrolls the page up and down. When a page is not displayed, press this button to display it.
X	Returns to the STATUS screen.

SOFTWARE VERSION Screen

When the VERSION button is pressed on the STATUS screen, the SOFTWARE VERSION screen appears. On this screen, the version of each software is displayed.
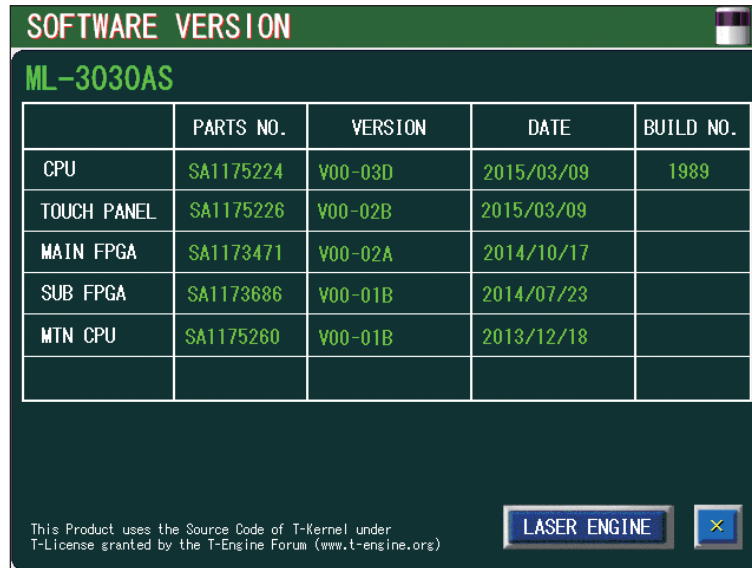
How to see the displayed items

: Settable item

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

LASER ENGINE VERSION
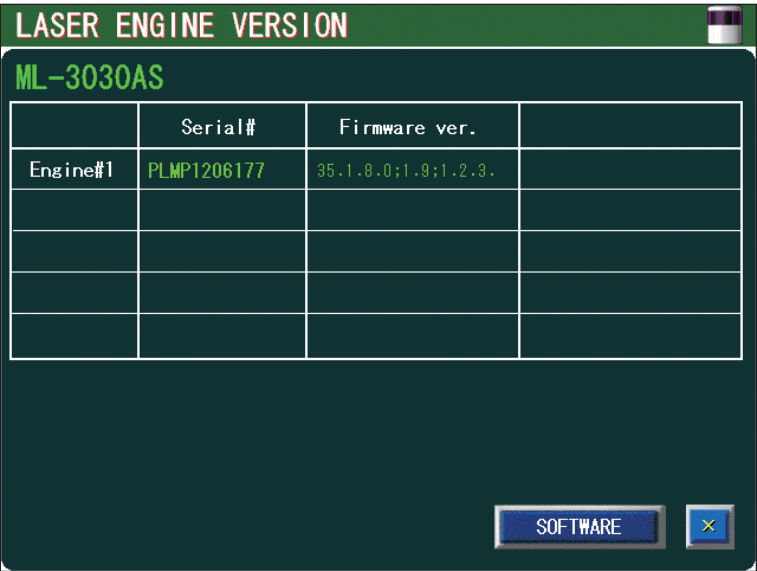
How to see the displayed items   : Settable item

Serial #	Displays the serial number of the laser engine.
Firmware ver.	Displays the firmware version of the laser engine.
SOFTWARE	Returns to the SOFTWARE VERSION screen.
X	Returns to the STATUS screen

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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.

```
CONFIGURATION SETUP

    LASER CONTROL          DATE and TIME           SCHED
                                                   MON
    RS-485 COMM                                    STATUS

    TCP/IP COMM          PEAK-POWER SYNCHRONIZE    CONFIG
                        LANGUAGE
    PASSWORD            日本語   English

LD  OFF    BEAM  OFF    GUIDE  OFF
```
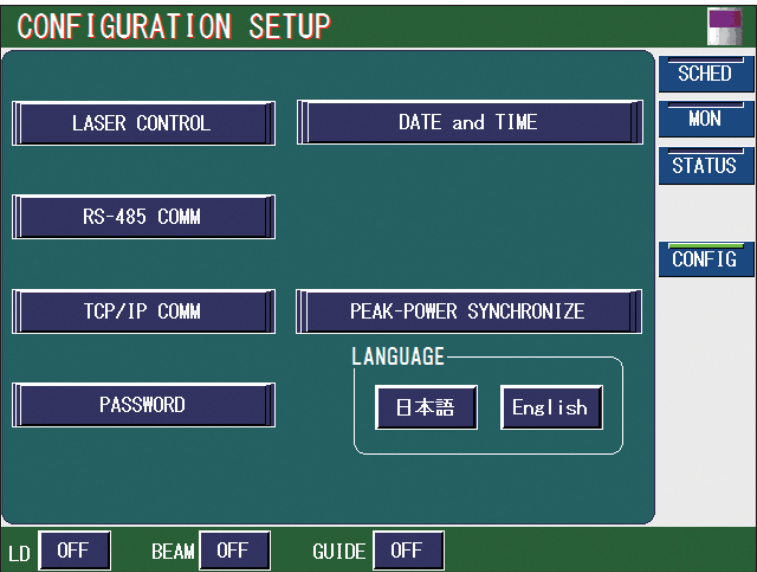
How to see the displayed items   : Settable item

LASER CONTROL	Displays the setting screen for laser control.
RS-485 COMM	Displays the setting screen for RS-485 communication.
TCP/IP COMM	Displays the setting screen for TCP/IP communication.
PASSWORD	Displays the password setting screen.
DATE and TIME	Displays the setting screen for date and time.
PEAK-POWER SYNCHRONIZE	Displayed when the peak power synchronize function is enabled. When this button is pressed, the setting screen for the peak power synchronize setting displayed.
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.
日本語	Switches to the Japanese display.
English	Switches to the English display.

LASER CONTROL OPTION PARAMETERS

```
CONFIGURATION SETUP

  LASER CONTROL OPTION PARAMETERS

  LD AUTO START      [ OFF ]    NG LASER STOP        [ OFF ]

  LASER START DELAY  [ 16ms ]   GUIDE BLINK          [ OFF ]

  EXT.I/O PULSE WIDTH [ 20ms ]  CW SLOPE CHK DISABLE [ OFF ]

                                                    [ × ]

  LD [ OFF ]    BEAM [ OFF ]    GUIDE [ OFF ]
```

How to see the displayed items   ▢ : Settable item

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

RS-485 COMMUNICATION SETUP

How to see the displayed items

: Settable item

NETWORK	Sets the equipment No. in the range of #0 to #15 to perform remote operations by using the external communication function.
BAUD RATE	Sets the communication speed from 9600, 19200, 38400, 57600, or 115200 bps.
DATA BIT	Sets the length of data bit from 8bit or 7bit.
PARITY	Sets the parity mode from NONE, EVEN or ODD.
STOP BIT	Sets the stop bit from 2bit or 1bit.
X	Returns to the CONFIG screen.

TCP/IP COMMUNICATION SETUP

How to see the displayed items   : Settable item

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

PASSWORD Screen

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

```
PASSWORD MODE

                SCHEDULE EDIT:  UNLOCK

              ENTER A PASSWORD
              ┌─────────────┐
              │             │
              └─────────────┘



                                          ┌───┐
                                          │ × │
                                          └───┘
```
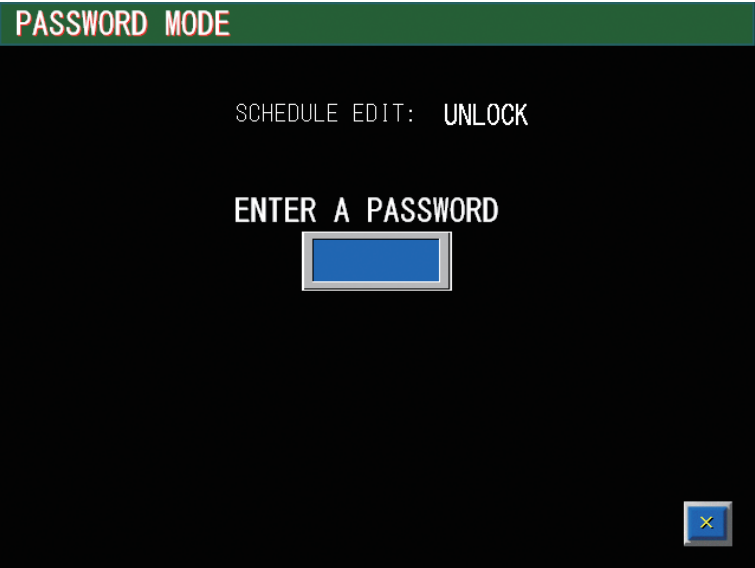
How to see the displayed items   ▨ : Settable item

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

Protecting Set Values

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

1 ● Entering the Present Password

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

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

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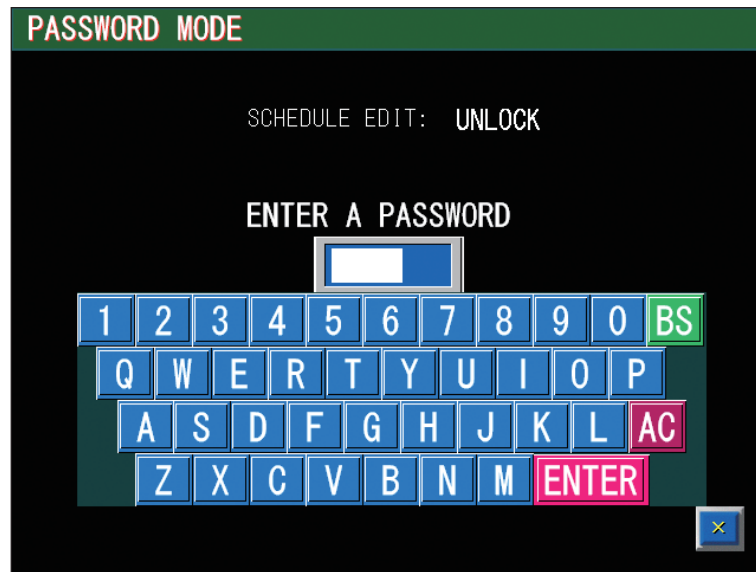
(3) Enter the set password into the password input box.
Press the password by pressing keyboard keys on the screen. The AC key deletes all the entered characters. The BS key deletes a character in front of the cursor one by one. The ENTER key is used to check the entered password for correctness.

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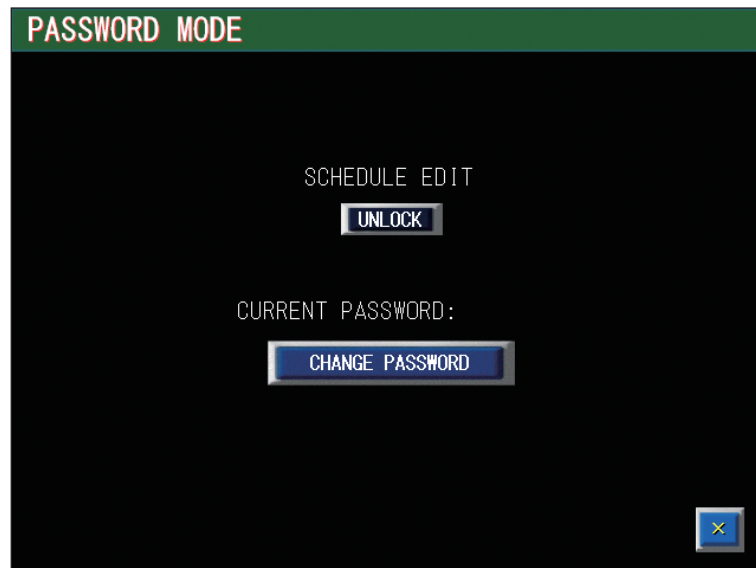
When the entered password is wrong, the WRONG PASSWORD screen is displayed.
Then, enter the set password once again.

WRONG PASSWORD.
ENTER CORRECT ONE.
OK

2 ● Validating the Password

(1) Press the "SCHEDULE EDIT" button.
When "LOCK" is selected on the window, the display on the button changes to "LOCK." The password is validated and a part of setting items is protected, disabling a change.
⇒ When "UNLOCK" is selected, the display changes to "UNLOCK" and the protection is cancelled, enabling a change.

3 ● Setting a New Password

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

PASSWORD MODE (PASSWORD CHANGE)

ENTER A NEW PASSWORD

ENTER A NEW PASSWORD AGAIN

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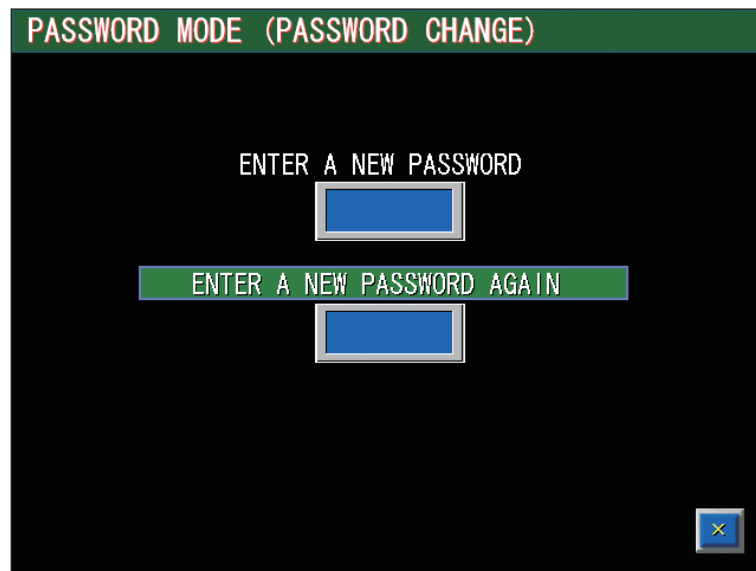
(2) Press the password input box (upper portion).
The keyboard appears.

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

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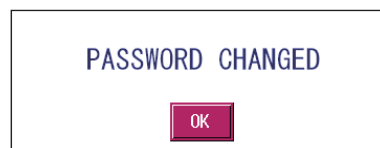
(6) Press the OK button.
The PASSWORD screen appears.
⇒ The display of CURRENT PASSWORD changes to the changed password.

The items that can be protected are as follows.

Display Screen	Item

SCHEDULE Screen	SCHEDULE (Schedule number)
	FORM (FIX/FLEX/CW waveform switching)
	PFB (Power feedback ON/OFF)
	PEAK POWER (Laser output peak 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)
	↓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 POINT 20)
	  POWER (Laser output value % of each No. of POINT 01 to POINT 20)
	  SEAM (Fade function ON/OFF)

MONITOR Screen	SCHEDULE (Schedule number) FORM (FIX/FLEX/CW waveform switching) PFB (Power feedback ON/OFF) 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) PFB (Power feedback ON/OFF) SHOT COUNT (Resetting the total number of laser light outputs, SHOT COUNT) GOOD COUNT (Resetting the appropriate number of laser light outputs, GOOD COUNT)
CONFIG Screen	LASER CONTROL (Laser control setting) RS-485 COMM (RS-485 communication setting) TCP/IP COMM (TCP/IP communication setting) DATE and TIME (Date and time setting) LANGUAGE 日本語 (Language switching) English (Language switching)

The above setting items become unchangeable and the set values are protected.
⇒ To change any set value, enter the password to display the password setting screen and set "SCHEDULE EDIT" to UNLOCK.

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SETTING AT DATE AND TIME


```
CONFIGURATION SETUP

SETTING AT DATE AND TIME
DATE  '11 . 11 . 26    TIME   20 : 39


                                          ×

LD  OFF      BEAM  OFF      GUIDE  OFF
```
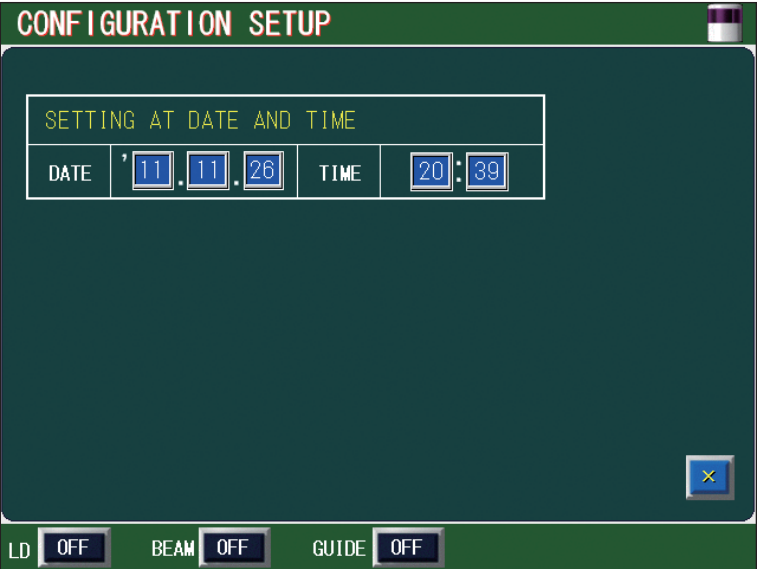
How to see the displayed items   : Settable item

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

PEAK-POWER SYNCHRONIZE SETTING

```
CONFIGURATION SETUP

    PEAK-POWER SYNCHRONIZE SETTING
         SCHEDULE No.
    No.1      0      >>      10
    No.2     ---     >>     ---
    No.3     ---     >>     ---
    No.4     ---     >>     ---
    No.5     ---     >>     ---

                              ×
```

How to see the displayed items

: Settable item

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

INITIALIZE Screen

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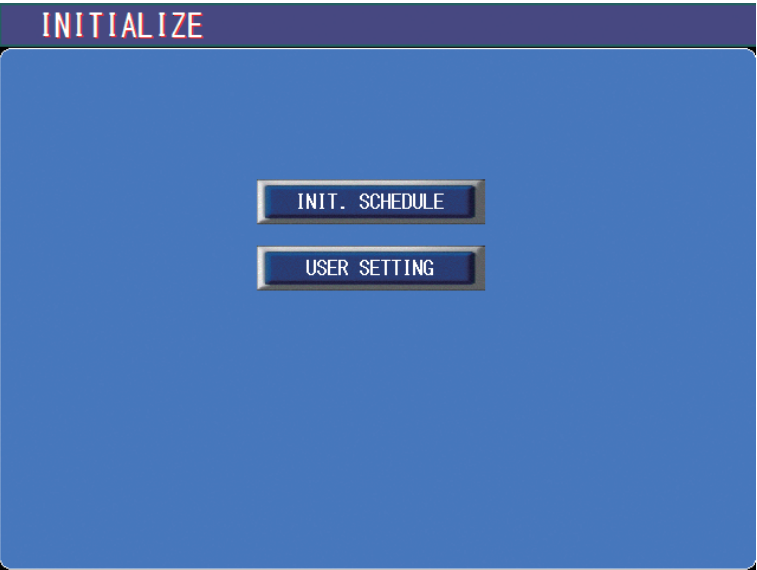
How to see the displayed items

<div style="float:right">: Settable item</div>

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

[pink box] : 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 "TROU-BLE" by REM.I/L ERROR	Sets whether to output the error by the external input/output when error No.022/EXTERNAL INTERLOCK OPENED occurs. EXEC: Output (default) NONE: Not output
AUTO LD POWER CHECK	Not used.
PEAK-POWER SYNCHRONIZE	Sets whether to use the peak power synchronize setting. Functions and displays related to the peak power synchronize setting are valid only when this is set to USE. NONE: Not use (default) USE: Use
X	Returns to the INITIALIZE screen.

● ## Displaying the INITIALIZE Screen

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

(2) While the KEY SWITCH CHECK screen is displayed, press the "INITIALIZE" button and the right button (red portion in the above figure) of the laser controller simultaneously.

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

The INITIALIZE screen appears.

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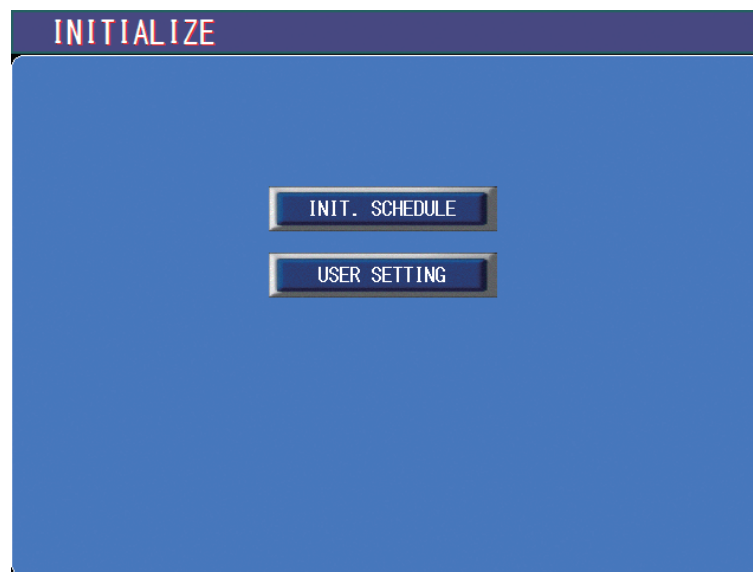
4. Setting the Laser Light Output Schedule

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

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

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

SCHEDULE Screen (Fixed Waveform (FIX))

How to see the displayed items   : Settable item

PEAK POWER	Sets the peak value of laser output (value when "FLASH1" to "FLASH3" are 100%). Regarding the actual laser output value ("FLASH1" to "FLASH3"), set the ratio (%) to the peak value supposing that the set peak value is the reference value (100%). *<Note>* The settable peak value of laser output differs depending on the model. ML-3030AS: 0.5 to 2.7 kW / ML-3015AS: 0.25 to 1.35 kW
↑SLOPE	Sets the up-sloping (the laser output becomes gradually stronger) time to "FLASH1." After setting "FLASH1", set this time in the range of ↑SLOPE ≤ FLASH1.

FLASH1	Sets the laser output time TIME [ms] and laser output value POWER [%] of the first laser in the following range.
	Laser output time (TIME [ms])
	    When "RESOL" is 0.1 ms: 0.2 to 50.0 ms
	    When "RESOL" is 0.05 ms: 0.20 to 50.00 ms
	Laser output value (POWER [%]): 0 to 200%
	The time of ↑SLOPE is included in the output time of FLASH1.

FLASH2	Sets the laser output time TIME [ms] and laser output value POWER [%] of the second laser in the same range as that for the first laser.
FLASH3	Sets the laser output time TIME [ms] and laser output value POWER [%] of the third laser in the same range as that for the first laser. The time of ↓SLOPE is included in the output time of FLASH3.

↓SLOPE	Sets the down-sloping (the laser output becomes gradually weaker) for the last FLASH. Sets this time in the range of ↓SLOPE ≤ FLASH1, FLASH2, FLASH3.
REFERENCE VALUE	The forecast value of laser output energy (J) based on the set laser output schedules is displayed. *<Note>* This laser calculates the laser light output energy by laser power feedback control. However, there is a little difference between the forecast value of laser output energy and the measured value (actually measured value) depending on the optical and electrical characteristics. Use the forecast value of laser output energy as reference.
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 welding is enabled. The function can be set on the SEAM screen.
COOL	Sets the COOL1/COOL2. COOL1: Sets a value other than 0.0 ms to insert the 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.
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 59.

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<Notes>

- **The laser output value (%) setting range is 0 to 200%. However, the laser output value cannot be set exceeding the maximum value of "PEAK POWER" x 100%. If the laser output value is set to 100%, the value set in "PEAK POWER" is selected.**

- **There are limitations of the total time of the laser output time FLASH1 + COOL1 + FLASH2 + COOL2 + FLASH3 in combination with values of PEAK POWER and REPEAT. For details, refer to "Limitations of Schedule Setting" on page 100.**

- **Within the range of 10% of the maximum peak 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 100.**

SCHEDULE Screen (Flexible Waveform (FLEX))

How to see the displayed items

    : Settable item

PEAK POWER	Sets the peak value of laser output (value when "POWER" are 100%). Regarding the actual laser output value ("POWER"), set the ratio (%) to the peak value supposing that the set peak value is the reference value (100%). *<Note>* The settable peak value of laser output differs depending on the model. ML-3030AS: 0.5 to 2.7 kW / ML-3015AS: 0.25 to 1.35 kW
◄ ►	Scrolls the POINT display column of POINT 01 to POINT 20 to the right and left. When a POINT is not displayed, press this button to display it.
POINT 01 . . . POINT 20	Sets the laser output time and laser output value (POWER [%]) at each point of "POINT 01" to "POINT 20." *<Note>* There are limitations of settable values in combination with values of PEAK POWER and REPEAT. For details, refer to "Limitations of Schedule Setting" on page 100.

REFERENCE VALUE	The forecast value of laser output energy (J) based on the set laser output schedules is displayed. ***<Note>*** This laser calculates the laser light output energy by laser power feedback control. However, there is a little difference between the forecast value of laser output energy and the measured value (actually measured value) depending on the optical and electrical characteristics. Use the forecast value of laser output energy as reference.
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 welding is enabled. The function can be set on the SEAM screen.
REPEAT	Sets the number of laser light outputs per second in the range of 1 to 1000 pps (pulse per second).
SHOT	Sets the number of laser outputs in the range of 1 to 9999. When the laser output count reaches the set value, the laser output is stopped. When 1 is set, a single-shot output is performed. When 9999 is set, laser light is continuously output until a laser stop signal is input.
Fn	When this button is pressed, a window to select function is displayed and the following editorial assistant functions can be used. RESET: Initializes the currently-selected schedule. COPY: Copies the currently-selected schedule to a temporary memory buffer. PASTE: Restores data from a temporary memory buffer to the currently-selected schedule.

$\Rightarrow$ For the common items in the upper/lower part of the screen, refer to page 59.

<Notes>

- **The laser output value (%) setting range is 0 to 200%. However, the laser output value cannot be set exceeding the maximum value of "PEAK POWER" x 100%. If the laser output value is set to 100%, the value set in "PEAK POWER" is selected.**

- **There are limitations of the total time of the laser output time FLASH1 + COOL1 + FLASH2 + COOL2 + FLASH3 in combination with values of PEAK POWER and REPEAT. For details, refer to "Limitations of Schedule Setting" on page 100.**

- **Within the range of 10% of the maximum peak 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 100.**

SCHEDULE Screen (Flexible Waveform (CW))

How to see the displayed items

<div style="text-align: right">▭ : Settable item</div>

PEAK POWER	Sets the peak value of laser output (value when "POWER" are 100%). Regarding the actual laser output value ("POWER"), set the ratio (%) to the peak value supposing that the set peak value is the reference value (100%). *<Note>* The settable peak value of laser output differs depending on the model. ML-3030AS: 50 to 270 W / ML-3015AS: 25 to 135 W
◄ ►	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.
RESOL	When this button is pressed, the selected setting resolution can be set from 1 s, 0.1 s, 0.01 s, or 0.001 s. When the setting resolution is changed, the currently-selected schedule is cleared and the initial value is set.
POINT 01 . . . **POINT 20**	TSet the laser output time and laser output value (POWER [%]) at each point of "POINT 01" to "POINT 20." *<Note>* There are limitations of settable values in combination with values of PEAK POWER and REPEAT. For details, refer to "Limitations of Schedule Setting" on page 100.
MODU	When this button is pressed, the modulation setting screen for the selected schedule number opens. Blinks when the modulation function is enabled. The function can be set on the MODULATION screen.
Fn	When this button is pressed, a window to select function is displayed and the following editorial assistant functions can be used. RESET: Initializes the currently-selected schedule. COPY: Copies the currently-selected schedule to a temporary memory buffer. PASTE: Restores data from a temporary memory buffer to the currently-selected schedule.

⇒ For the common items in the upper/lower part of the screen, refer to page 59.

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 welding, enter the registered SCHEDULE numbers and laser welding can be performed in the set output schedules.

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

1 ● Setting Output Schedules by Fixed Waveform (FIX)

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

In the following example, SCHEDULE No.: #0, peak value: 1.000 kW, 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 "PEAK POWER" setting button.
Enter the laser output peak value by using the numeric keypad and then press the ENT key.

<Note>

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

ML-3030AS : 0.5 to 2.7 kW / ML-3015AS : 0.25 to 1.35 kW

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

<Notes>

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

0.2 ms ≤ FLASH1 + FLASH2 + FLASH3 ≤ 50.0 ms

- When the laser output value (%) is set to 0.1% or more, the laser output peak value (PEAK POWER x laser output value POWER [%]) cannot be set falling below the minimum value of laser output (ML-3030AS: 0.5 kW, ML-3015AS: 0.25 kW).

(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 ≤ 50.0 ms

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

<Note>

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

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

↑SLOPE ≤ FLASH1

(9) Press the "↓SLOPE" setting button.
Enter the time "TIME [ms]" required for laser light to down-slope (get gradually weaker) in the last FLASH by using the numeric keypad, and then press the ENT key.

<Note>

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

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

↓SLOPE ≤ FLASH1, FLASH2, FLASH3

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

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

2 Setting ON/OFF for the Modulation Function

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

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

⇒ For the setting method of the modulation function, refer to "Setting the Modulated waveform" on page 97.
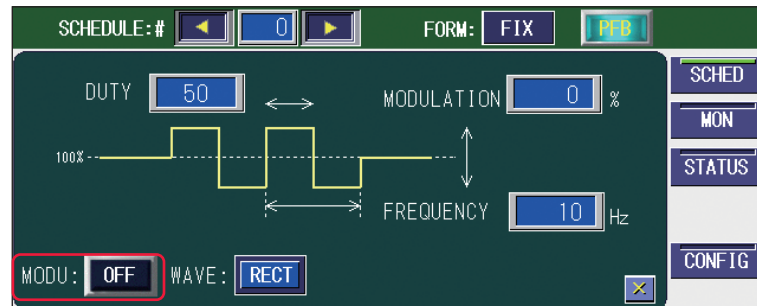
(3) Press the "X" button to display the SCHEDULE screen.

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

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

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

⇒ For the setting method of the output schedules for seam welding, refer to "Setting the Output schedules for Seam Welding" on page 93.

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

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

4 ● Checking Output Schedules

(1) Check the waveform displayed on the screen.
The set laser output time and laser output value are graphically displayed and the output laser light can be checked as a waveform.
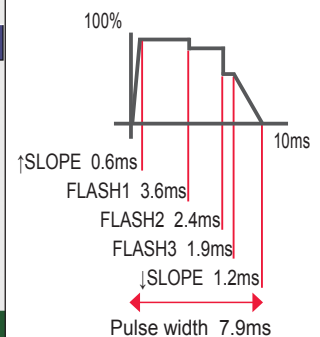
⇒ At the leading edge of waveform, an overshoot (higher form than the set value) may occur. In this case, extend "↑SLOPE" by 0.1 to 1.0 ms.

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

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

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SEAM Screen

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

How to see the displayed items

: Settable item

◀ ▶	Scrolls the POINT display column of POINT 01 to POINT 20 to the right and left. When a POINT is not displayed, press this button to display it.
SHOT [count]	Sets the laser light output count of POINT 01 to POINT 20 in the range of 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 "PEAK 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 welding. When this item is set to ON, the fade function for seam welding is enabled. When the item is set to OFF, this function is disabled. When this function is not used, set it to OFF.
REPEAT	Sets the number of laser light outputs per second in the range of 1 to 1000 pps (pulse per second). Common to "REPEAT" on the SCHEDULE screen.
SHOT	Sets the number of laser outputs in the range of 1 to 9999. When the laser output count reaches the set value, the laser output is stopped. When 1 is set, a single-shot output is performed. When 9999 is set, laser light is continuously output until a laser stop signal is input. Common to "SHOT" on the SCHEDULE screen.
X	Returns to the SCHEDULE screen.

⇒ For the common items in the upper/lower part of the screen, refer to page 59.

Setting the Output Schedules for Seam Welding

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

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

1 Setting the Output Schedules

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

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

(1) Press the "SEAM" button to display the SEAM screen.
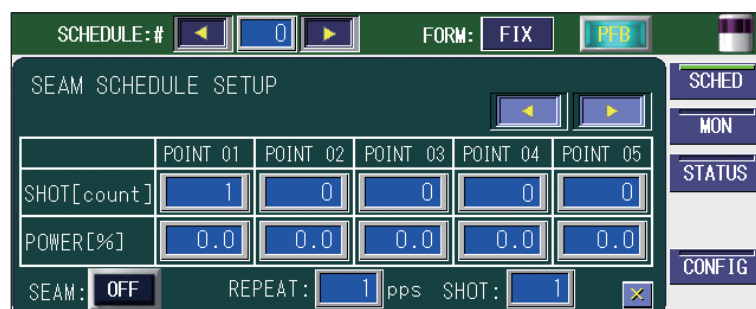
2 Setting the Fade-in/out Function

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

(2) Press the "POWER [%]" setting button of "POINT 01."
Enter the laser output value (%) by using the numeric keypad and then press the ENT key.
Set the ratio to "PEAK POWER" set on the SCHEDULE screen in the range of 0 to 150.0%.
<Note>

When the laser output value (%) is set to 0.1% or more, the laser output peak value (PEAK POWER x laser output value POWER [%]) cannot be set falling below the minimum value of laser output (ML-3030AS: 0.5 kW, ML-3015AS: 0.25 kW).

(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.

<Notes>

- **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.)

- **To protect the laser oscillator, the minimum power (ML-3030AS: 0.5 kW, ML-3015AS: 0.25 kW) of laser is output for the set laser output time regardless of the laser output value (%).**

3 ● Enabling the Fade Function

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

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

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

MODULATION Screen

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

Rectangular wave (RECT)
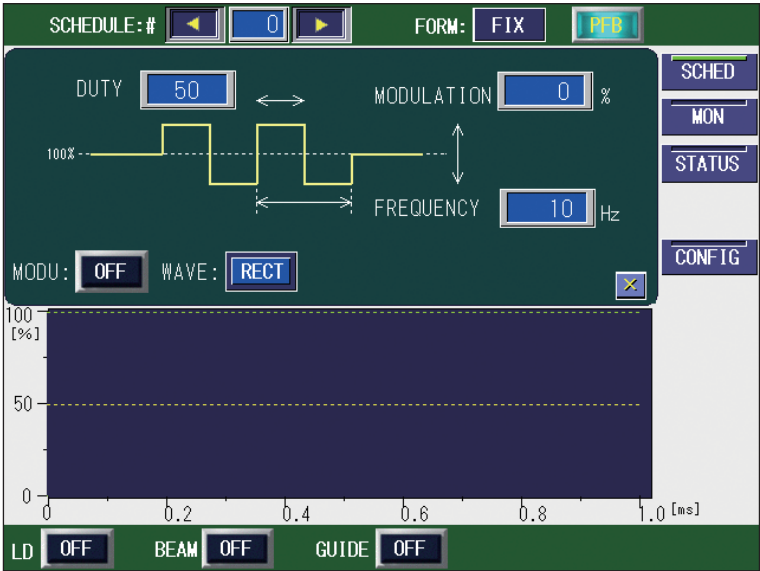
Triangular wave (TRI)
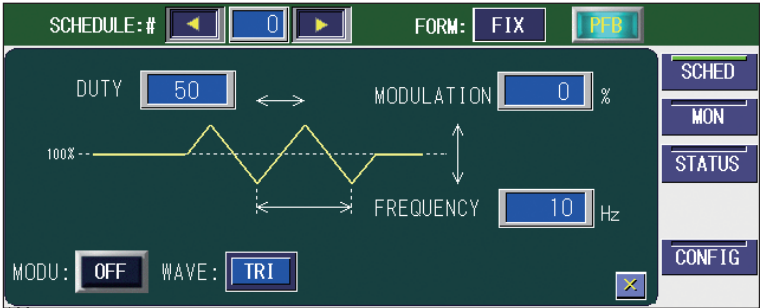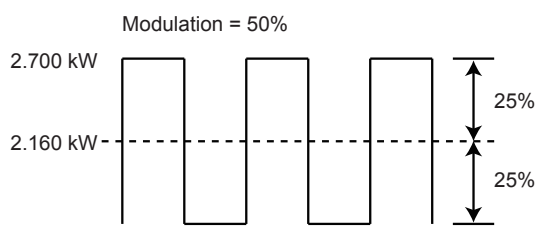
Sinusoidal wave (SINE)
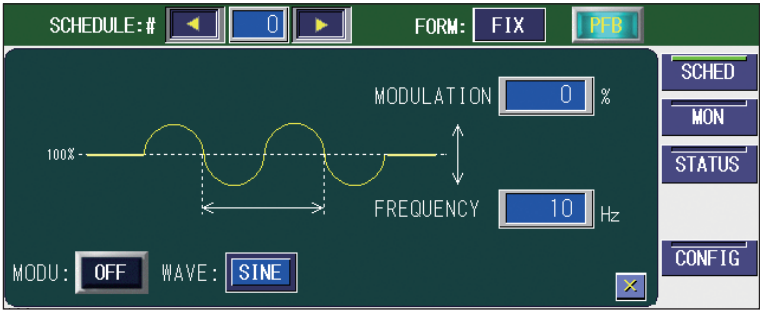
How to see the displayed items

: Settable item

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

MODULATION	Sets the modulation degree of the laser output value. Sets the modulation width whose center is the laser output peak value (100% output value) in the range of 0 to 100% as a percentage of power. *<Note>* The modulation width can be set in the range from the minimum value of laser output (ML-3030AS: 0.5 kW, ML-3015AS: 0.25 kW) to the maximum value of the laser output peak value set on the SCHEDULE screen. Ex.) When "PEAK POWER" is 2.160 kW on ML-3030AS, the result is "PEAK POWER 2.160 kW x Upward modulation width 25% = 2.700 kW." The setting more than 50% cannot be set. Modulation = 50% 2.700 kW 2.160 kW 25% 25%
FREQUENCY	Sets the frequency of the laser output value. The setting range is 1 to 5000 Hz. Sets the cycle of modulation.
MODU	Set the modulation function to ON or OFF. When this item is set to ON, the settings is enabled. When the item is set to OFF, this function is disabled. *<Note>* When using the modulation function, set the laser output value (POWER [%]) to 100%.
WAVE	Sets the type of modulation waveform from rectangular wave (RECT), triangular wave (TRI), or sinusoidal wave (SINE).
X	Returns to the SCHEDULE screen.

⟹ For the common items in the upper/lower part of the screen, refer to page 59.

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.

1 ● Setting the Modulated Waveform

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

⇒ Data for a cycle of modulation wavelength is displayed as a graph on the 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."

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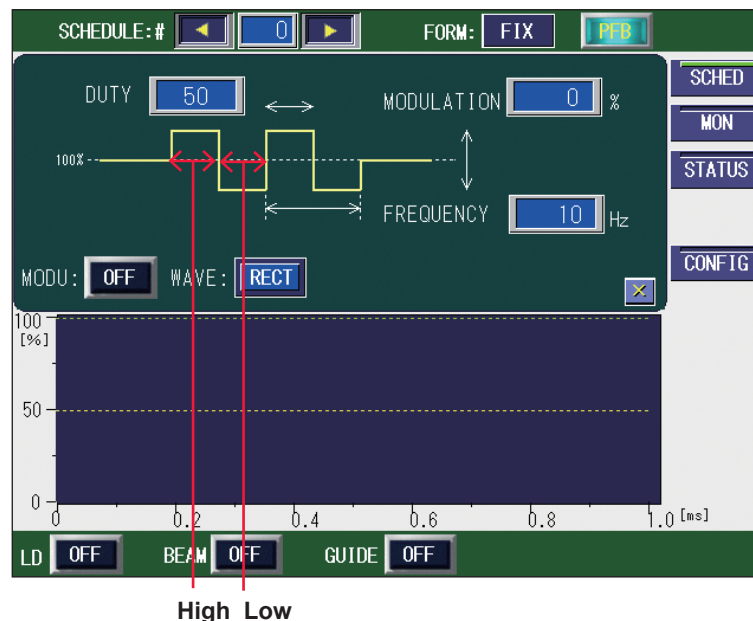
(2) Press the "DUTY" setting button.
Enter the ratio of the High period in a cycle (%) by using the numeric keypad and then press the ENT key.

(3) Press the "MODULATION" setting button.
Enter the modulation width whose center is the laser output peak value (100% output value) by using the numeric keypad and then press the ENT key.

<Notes>

The modulation width can be set in the range from the minimum value of laser output (ML-3030AS: 0.5 kW, ML-3015AS: 0.25 kW) to the maximum value of the laser output peak value set on the SCHEDULE screen.

Ex.) When "PEAK POWER" is 2.160 kW on ML-3030AS, the result is "PEAK POWER 2.160 kW x Upward modulation width 25% = 2.700 kW." The setting more than 50% cannot be set.

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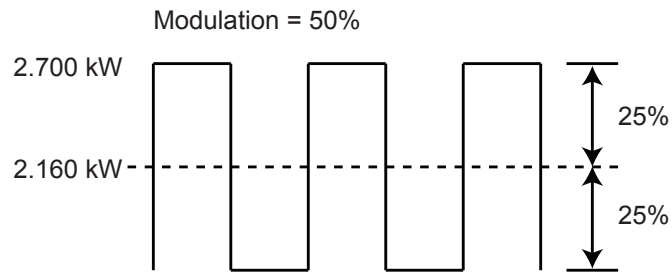
Modulation = 50%

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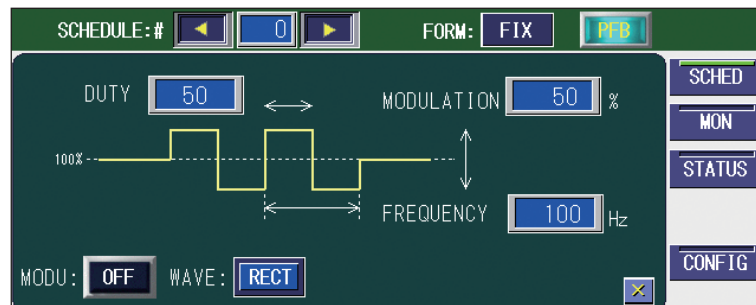
2 ● Enabling the Modulation Function

(1) Press the "MODU" setting button to set it to ON.
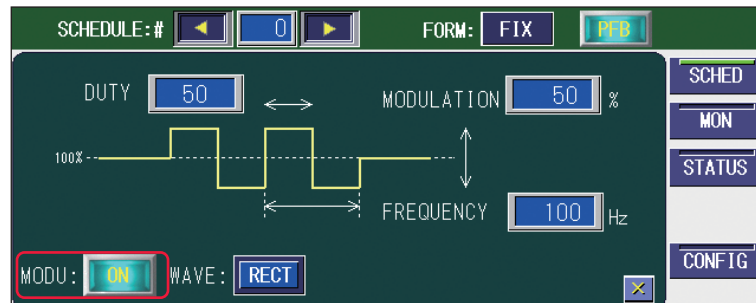
⇒ When the modulation function is not used, keep the "MODU" setting button OFF.

4. Setting the Laser Light Output Schedule

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Editorial Assistant Function

When the "Fn" button is pressed on the SCHEDULE screen, a schedule can be initialized (RESET), copied (COPY) or pasted (PASTE).
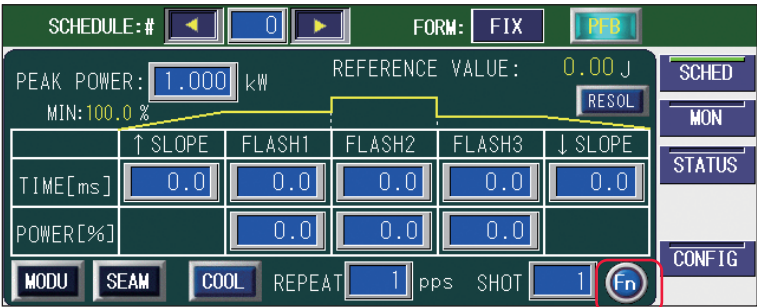
There is a beffer on a memory for storing a schedule data. With copy and paste functions, you can transfer a schedule data to or from the buffer.

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	
	ML-3030AS	**ML-3015AS**	**ML-3030AS**	**ML-3015AS**
PEAK POWER	0.5 to 2.7 kW	0.25 to 1.35 kW	50 to 270 W	25 to 135 W
REPEAT	1 to 1000 pps		—	
SHOT	1 to 9999 (9999 is for endless output.)		—	
TIME	0.1ms resolution: 0 to 50.0 ms 0.01ms resolution: 0, 0.05 to 50.00 ms (Can be set in 0.05ms steps. 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	0.0 to 2.7 kW	0.00 to 1.35 kW	0 to 270 W	0 to 135 W
	(However, when the value is lower than a lower limit, the actual output becomes a lower limit. *3)		(However, when the value is lower than a lower limit, the actual output becomes a lower limit.)	
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, 0.2 to 50.0 ms 0.01ms resolution: 0, 0.20 to 50.00 ms (Can be set in 0.05 ms steps)		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 × 2)		—	
Output energy (REFERENCE VALUE)	0 to 30 J	0 to 15 J	—	
Average output (output energy × REPEAT)	300 W	150 W	—	

*1   The laser output value is as follows:

PEAK 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.

```
The pulse energy (J) is out of the setting range.
Change peak power, POWER, and TIME settings.
```

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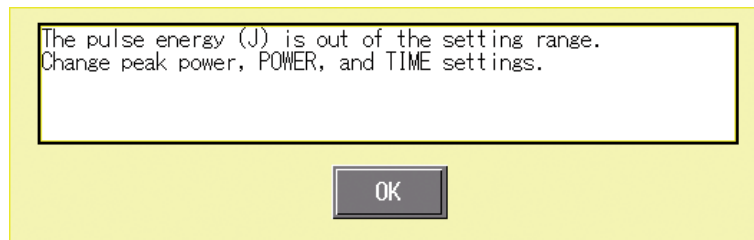
Parameters exceeding a range are displayed in the first line of dialogue, and parameters which needs to be reviewed are displayed in the second line. Review the settings of parameters displayed on the dialogue.

In the above dialogue, the message shows that the output energy exceeds the setting range. Change settings of PEAK POWER, POWER and TIME so as to fall within 0 to 30 J (ML-3030AS) or 0 to 15 J (ML-3015AS).

*2   Output waveform

When the laser output value is lower than the lower limit shown below, the actual laser output value becomes the lower limit.

	ML-3030AS		ML-3015AS	
	PFB ON	PFB OFF	PFB ON	PFB OFF
FIX/FLEX	0.5 kW	0.3 kW	0.25 kW	0.15 kW
CW	50 W	30 W	25 W	15 W

In a graph on the SCHEDULE screen, a set waveform is displayed with a broken line, and a waveform which reflects the above value (actually output waveform) is displayed with a solid line. The lower limit value is displayed in graph with a broken line and also numerically displayed below PEAK POWER in %.

Power feedback ON
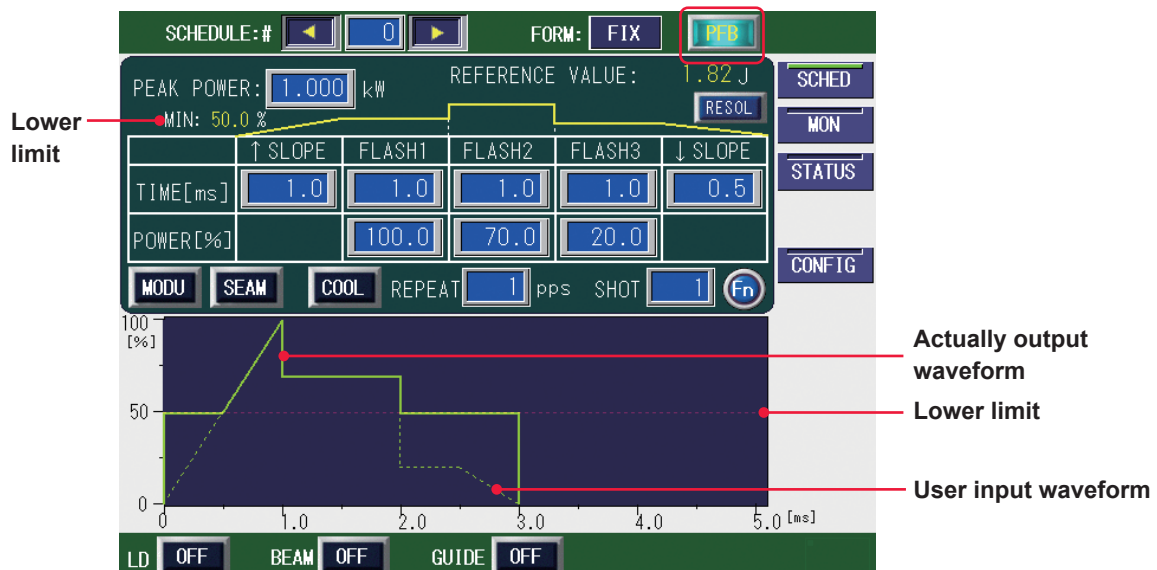
As shown above, since the lower limit changes according to ON/OFF of power feed-back, the output waveform also changes according to ON/OFF of power feedback even with the same settings, as shown below.

Power feedback OFF
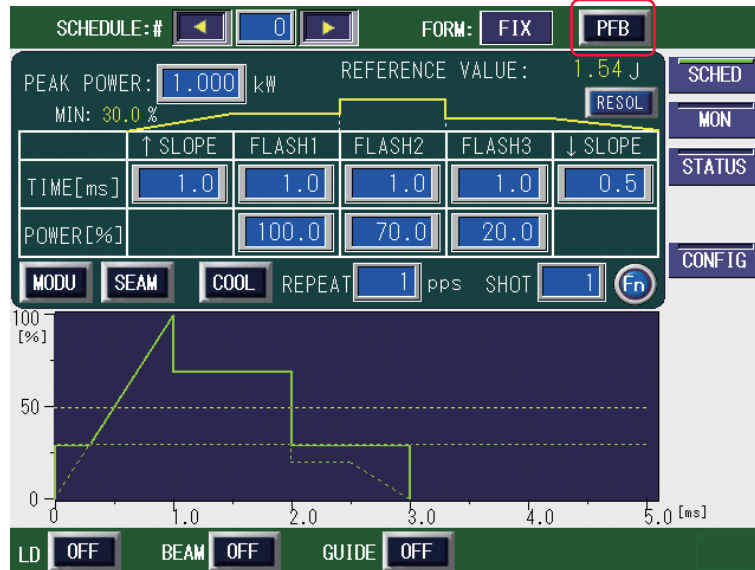
*3   When SEAM or modulation is ON, *2 applies to each waveform which SEAM or modulation is applied, as shown below.

Ex.) Set waveform
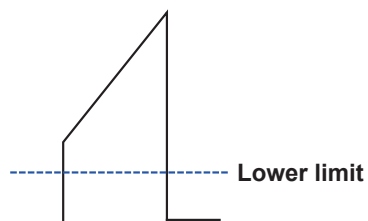
SEAM setting is ON
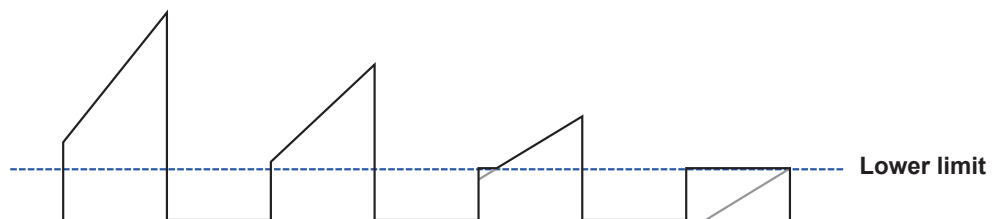
5. Monitoring Output

MONITOR Screen

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

FIX / FLEX

CW

How to see the displayed items   : Settable item

ENERGY (**FIX / FLEX**)	Displays the measured value (J) of laser energy. Each time laser light is output, the laser energy is measured and its value is displayed. In the case of a high-speed repeated output, however, the energy is displayed at certain intervals because the display timing is too quick.
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 (PEAK POWER × POWER [%]) in the CW mode. The trouble is not detected in 0.5 s or less. Also, use the value as reference.
SHOT COUNT	Displays the total number of laser light outputs. To reset the display to 0, perform a reset operation on the STATUS screen.

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

⇒ For the common items in the upper/lower part of the screen, refer to page 59.

Setting the Output Status Check Screen

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

Checking the Measured Energy Value of Laser Light

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

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

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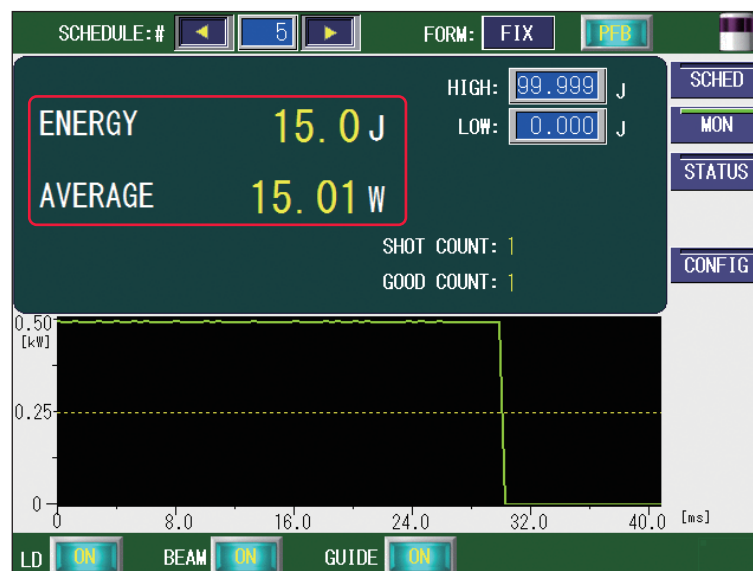
- **In the CW waveform, the displayed waveform may differ from the actual laser output due to the sampling period of data for displaying a waveform. When the modulation function is set in the CW mode, the average power displayed in "POWER" may also differ from the actual laser output power.**
  Ex.)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

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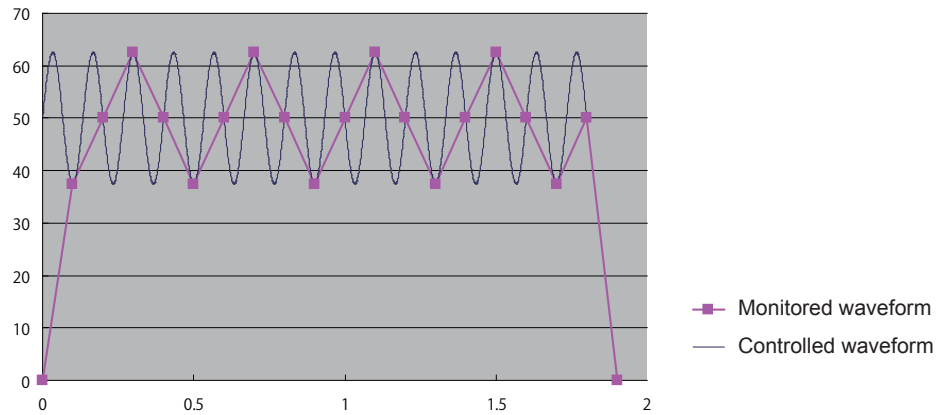
- **When the waveform is set with less than 1 ms of pulse width, the average power displayed in "POWER" may differ from the actual laser output power.**
- **When the set time exceeds 100 seconds in the CW waveform, the waveform shows trends in the past 100 seconds.**

Setting the Laser Energy Range To Be Monitored

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

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

(2) Press the "LOW" setting button.
Enter the lower limit value by using the numeric keypad and then press the ENT key.
The lower limit value of allowable energy is registered.
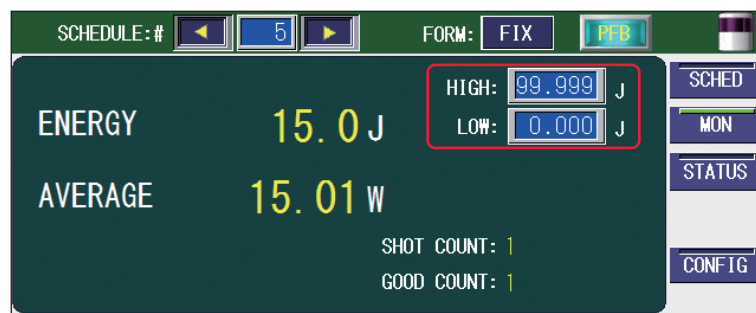
⇒ When laser light is out of the set allowable energy range, error No.035/LASER POWER OUT OF RANGE occurs and a monitor trouble is output. (Pin No.20 of the EXT. I/O (1) connector is closed for the time set on the CONFIG screen after a laser output.) When the total laser output time is less than 0.5 s in the CW mode, however, a monitor trouble does not occur even if laser light is out of the range.

6. Setting the Laser Light Delivery

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

Laser Light Sharing

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

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

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

The ML-3030AS/3015AS main unit is provided with a safety shutter with opening/closing sensor and a timesharing unit according to the sharing specification. At delivery, the number of deliveries is initially set.

For this laser, the following 3 types of sharing specification are available.

Sharing method	Corresponding model
Single: Output to single optical fiber	ML-30□□AS-010 ML-30□□AS-110
2-powersharing: Simultaneous output to 2 fibers	ML-30□□AS-020
2-timesharing: Output to one optionally selected out of 2 optical fibers	ML-30□□AS-002

In the above timesharing, as soon as the safety shutters are opened by setting "BEAM 1" to "BEAM 2" to ON after pressing the "BEAM" setting button, the timesharing unit is automatically operated to split laser light.

Single

A single safety shutter is opened to output laser light only to a single optical fiber.
⇒ For ML-30□□AS-110, it has no safety shutter and no beamsplitter. Therefore, operation is different.
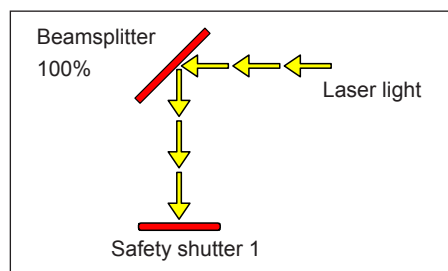
Laser light is reflected on the beamsplitter and transferred from opened safety shutter 1. The timesharing unit is not installed.

2-powersharing delivery

Laser light is split according to the number of built-in safety shutters and then simultaneously output. For example, in the 2-powersharing delivery, two safety shutters are opened to branch laser light into 2 beams, so that these beams are output simultaneously.
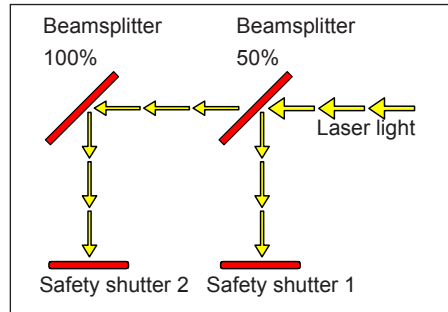
Laser light is reflected on the beamsplitter and split, and then simultaneously transferred from opened safety shutters 1 and 2.

2-timesharing delivery

One optionally selected out of the built-in safety shutters is opened to output laser light. For example, when safety shutter 2 is opened, laser light is output to the optical fiber connected to input unit 2. Two or more safety shutters cannot be opened.
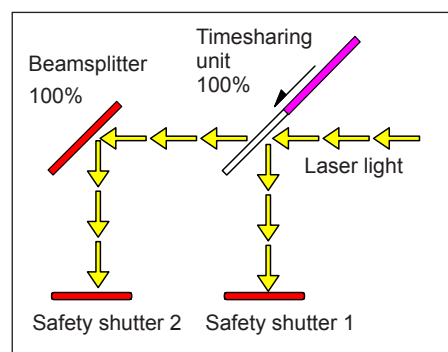
Laser light is reflected on the beamsplitter by operated timesharing unit and transferred from opened safety shutter 2.

Operating Safety Shutters on Each Screen

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

Perform open/close operations for safety shutters to transfer laser light.

● Operating Procedure

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

```
BEAM 1:    OFF
BEAM 2:    OFF
BEAM 3:
BEAM 4:

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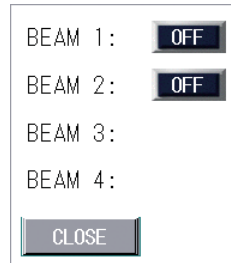
(2) Press the setting button for "BEAM 1" to "BEAM 2" corresponding to the connected optical fiber to set it to ON.
"BEAM 1" to "BEAM 2" are associated with safety shutters 1 to 2 and input units 1 to 2. The safety shutter that is set to ON is opened to allow laser light to be transmitted. The safety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

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

\<Note\>

For powersharings, be sure to connect optical fibers based on the number of deliveries. You cannot output a laser with closing either one of safety shutters.

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

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

This section explains how to change the acceptance time for the laser start signal and schedule signal to be input into the EXT. I/O (1) and (2) connectors by setting the CONFIG screen when EXTERNAL CONTROL is exerted by external input/output signals.

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

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

*1: Laser start signal input *2: Laser light output
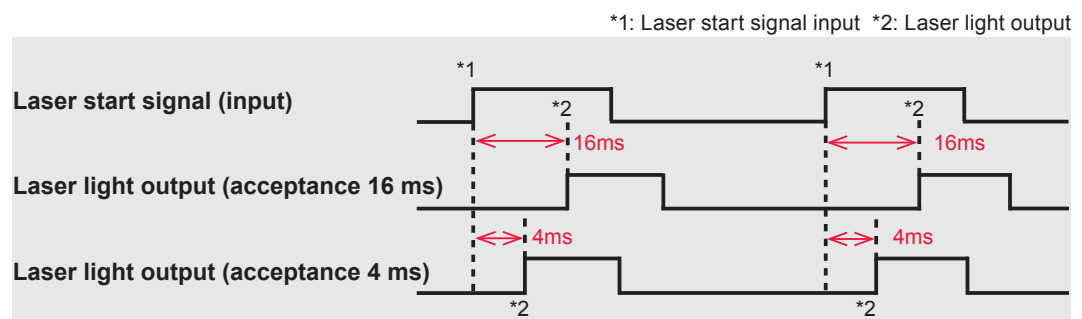
⇒ The laser start signal acceptance time and the schedule signal acceptance time are common. A different value cannot be set for the respective time.

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

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

1 ● **Displaying the CONFIG Screen**

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

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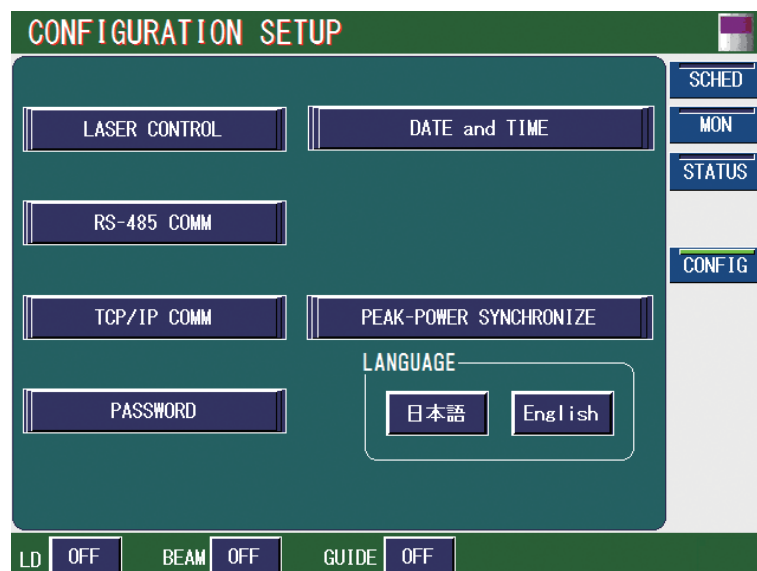
2. Changing the Acceptance Time

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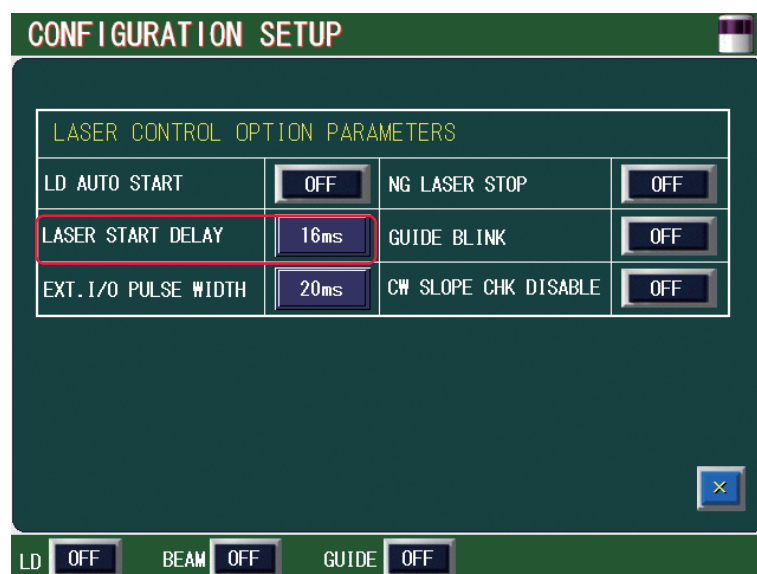
(2) Press the "X" button.
The CONFIG screen reappears and the acceptance time for laser start signal and schedule signal is changed.

Operating Part

Chapter 3

● Laser Welding by Control Panel (PANEL CONTROL)

1. Operation Flow

This section explains a laser welding operation flow by control panel.

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

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

MAIN POWER switch ON
CONTROL keyswitch ON

| SCHEDULE Screen | Setting and registration of SCHEDULE number (output schedule number) and output schedules |

| STATUS Screen | Control method check (PANEL CONTROL)
 LD: ON (LD ON)
 BEAM: ON (safety shutter selection)
 GUIDE: ON (guide light output) |

| SCHEDULE Screen or MONITOR Screen | SCHEDULE number input |

Pressing the LASER START/STOP button
Laser light output

| MONITOR Screen | Laser energy/average power check |

LD: OFF
BEAM: OFF
GUIDE: OFF
CONTROL keyswitch OFF
MAIN POWER switch OFF

2. Control Panel Functions

This section explains the functions of the control panel.

At PANEL CONTROL, welding schedules are set by using the control panel keys and laser light is output by pressing the LASER START/STOP button. After the output, you can check the laser output energy on the MONITOR screen.

⇒ When the optional laser controller is connected, laser welding operations can be performed by using the control panel of the laser controller in the same way in a place remote from the laser.

When the laser controller is used, the control panel and LASER START/STOP button of the main unit cannot be used. However, the EMERGENCY STOP button and CONTROL keyswitch can be used.
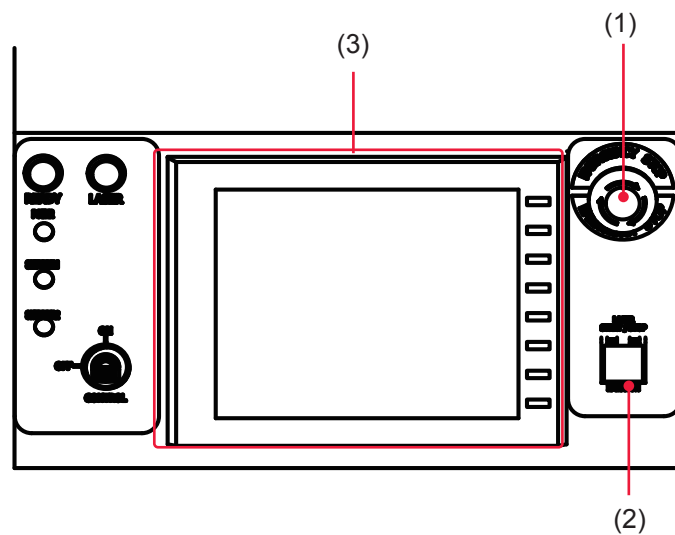
Function of Each Section on the Control Panel

(1) 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.
(2) LASER START/STOP (Button) **EMISSION (Lamp)**	If you press the button when a laser light output becomes ready, laser light is output. If the button is pressed again while laser light is repeatedly output, the repeated output is stopped. 　＊ Pin No.25 (control switching) of the EXT. I/O (1) connector is in a closed circuit and the LD is turned on. When the LD is turned on, the EMISSION lamp comes on.
(3) Control Panel	This panel is used to set welding schedules and operate the laser. Setting items and set values are displayed on the liquid crystal display.

3. Operating Procedure

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

⇒ For the details of welding schedule settings, refer to Chapter 2, "4. Setting the Laser Light Output Schedule" on page 83. For connector functions, refer to Chapter 4, "3. Connector Functions" on page 121.

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

1 ● Starting the Laser

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

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

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

(2) Turn ON the CONTROL keyswitch.
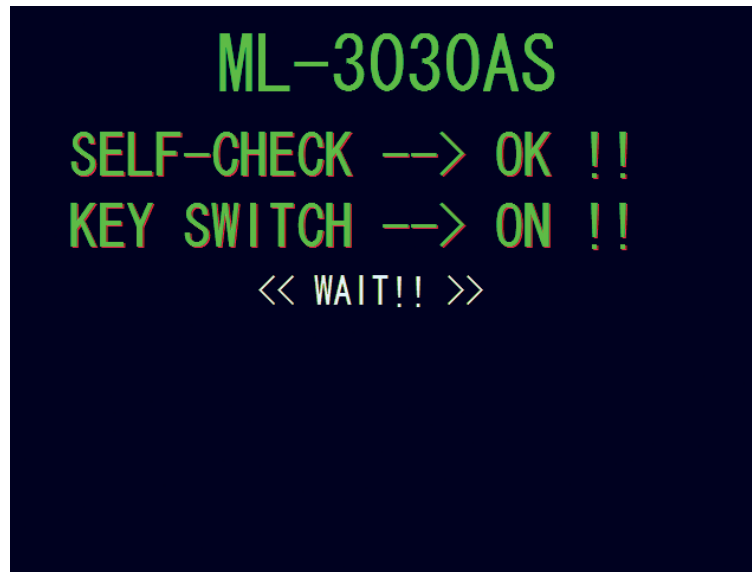
The SCHEDULE screen appears.

2 ● Setting Output Schedules

As an example, the procedure for setting SCHEDULE No.5, laser output peak value 1.000 kW, 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 numeric keypad and then press the ENT key

In this example, set #5.

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

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

(3) Press the "PEAK POWER" setting button.

Enter the laser output peak value by using the numeric keypad and then press the ENT key.

In this example, set 1.000 kW.

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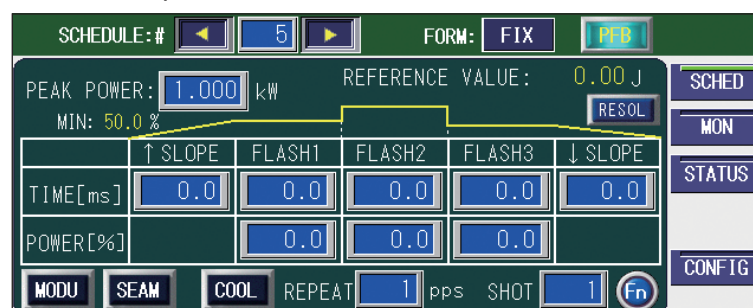
The settable value of laser output peak value differs depending on the model. For the laser output value setting (% of FLASH), set a value not exceeding the maximum value. For the laser output value setting (% of FLASH), set a value within the setting range.

ML-3030AS: 0.5 to 2.7 kW (FIX/FLEX) **50 to 270 W (CW)**	**ML-3015AS: 0.25 to 1.35 kW (FIX/FLEX)** **25 to 135 W (CW)**

(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.

0.2 ms ≤ "FLASH1" + "FLASH2" + "FLASH3" ≤ 50.0 ms

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

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

In this example, set 10.0 ms.

<Note>

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

↑SLOPE ≤ FLASH1

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

↓SLOPE ≤ FLASH1, FLASH2, FLASH3

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

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

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

⇒ For the laser output value, set the ratio (%) supposing that the set laser output peak value is 100%. In this example, this peak value is 50% of "PEAK POWER=1.000 kW", so that the actual laser output value is 0.500 kW. In this case, even if "PEAK POWER=0.500 kW" and "FLASH1 100 ms 100%" are set, the actual laser output value is the same.

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

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

3 ● Outputting Laser Light

⚠ **WARNING**

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

<Note>

For ML-30□□AS-110, it has no safety shutter and no beamsplitter. Since no window is displayed even if the "BEAM" setting button is pressed, bypass Steps (4) to (6). When the CONTROL keyswitch is turned ON after starting the Laser, the button is displayed in blinking light blue.

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

When Pin No.25 (control switching) of the EXT. I/O (1) connector remains in an open state, external input signals are disabled and "PANEL CONTROL" is displayed in "CONTROL DEVICE."
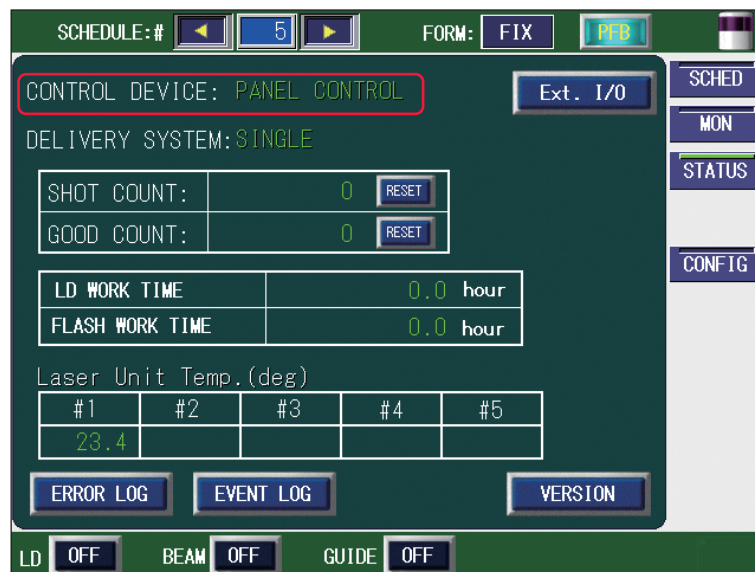
(2) Adjust the workpiece and output unit positions to set an appropriate work distance (distance between the workpiece and the output position).

(3) Press the "LD" setting button.

The LD lights up.

(4) Press the "BEAM" setting button.

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

⇒ The displayed window depends on the specification.

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

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

```
BEAM 1:     ON
BEAM 2:
BEAM 3:
BEAM 4:
  CLOSE
```
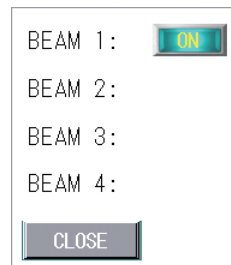
(6) Press the "CLOSE" button.

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

⇒ For powersharing, set all the BEAMs to be used to ON to open all the safety shutters.

(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.

```
23.4
ERROR LOG    EVENT LOG              VERSION
LD  ON    BEAM  ON    GUIDE  ON
```

(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.

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Chapter 3   Laser Welding by Control Panel (PANEL CONTROL)
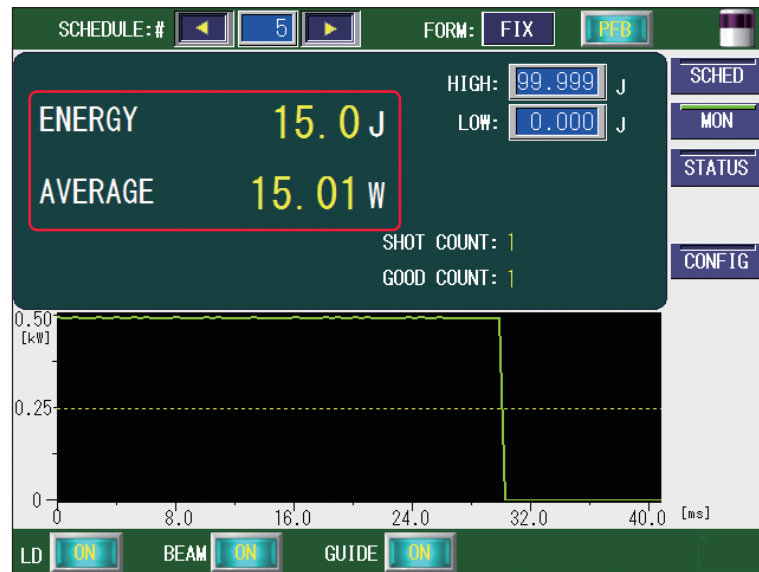
4 ● Stopping Laser Welding

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

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

⇒ For ML-30□□AS-110, it has no safety shutter and no beamsplitter. Therefore, operation of the "BEAM" setting button is not necessary.

(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.

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Chapter 4

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

1. Operation Flow

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

The following methods for laser welding operations are available: control from the control panel (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).

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

MAIN POWER switch ON
CONTROL keyswitch ON

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

Set output schedules from the control panel. (PANEL CONTROL)

SCHEDULE Screen

Switch the control method.

PLC

Control by external input/output signals (EXTERNAL CONTROL)

Output schedule input
Safety shutter selection
Guide light output
LD ON
Laser light output/stop
(Emergency stop)

End of operations
CONTROL keyswitch OFF
MAIN POWER switch OFF
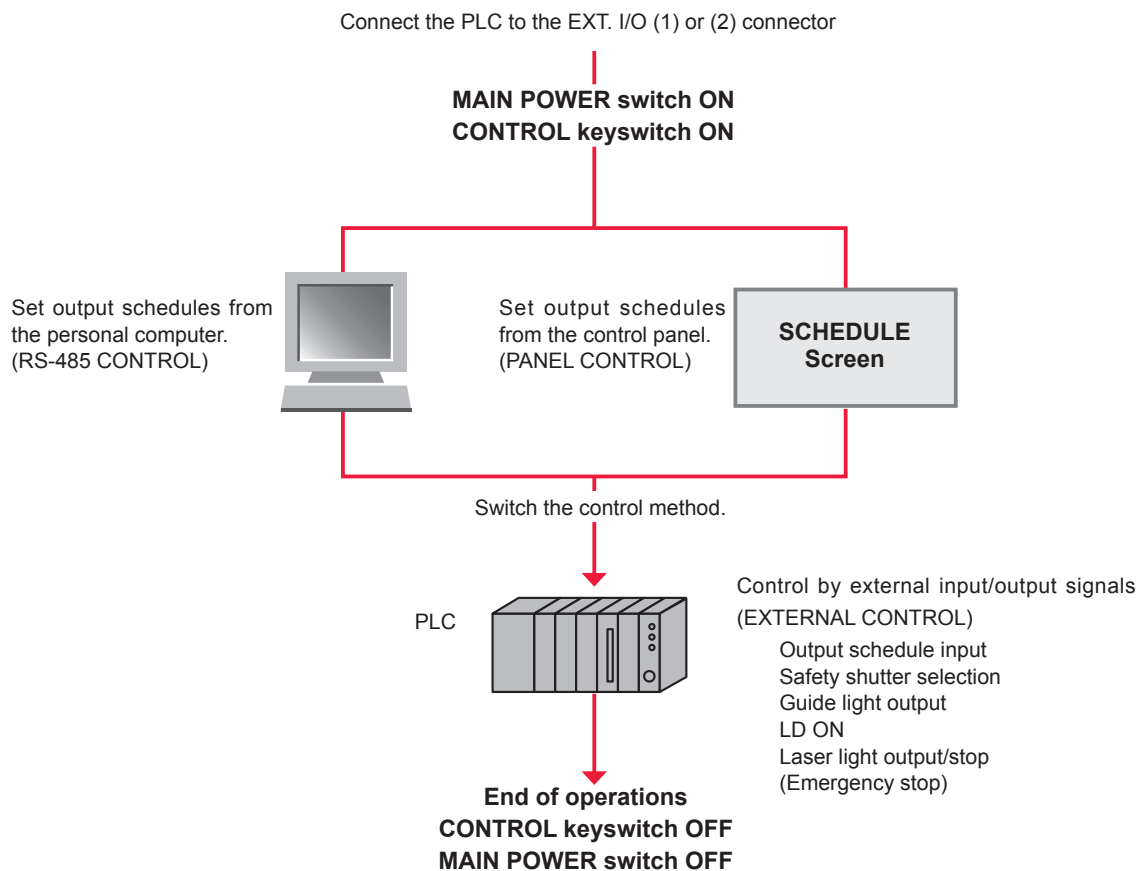
2. Preparations for Operations

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

Connect the PLC to the EXT. I/O (1) 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 welding. If the door is suddenly opened, the safety shutter is closed to cut off laser light.

EXT. I/O (1) D-Sub 25pin Connector
EXT. I/O (2) D-Sub 37pin Connector

PLC, etc.   Control signal input/output

Control signal input/output

Door interlock, etc.

E-STOP D-Sub 25pin Connector
REM. I/L Connector

Rear of the main unit
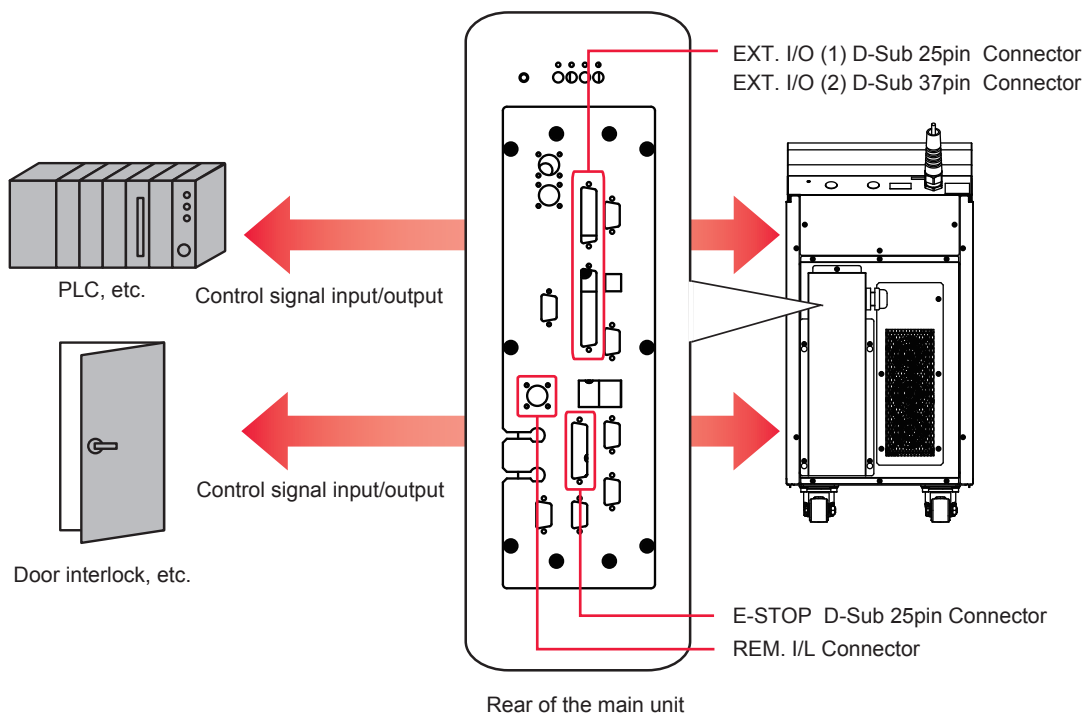
The plug, socket and case models of connectors are as follows.

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

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

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

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

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⇒ 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 mounted on the main unit.

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

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

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

⇒ Close pin No.25.

Pin No.	Description
1	+24 V OUT Power supply for external input signals. This pin is exclusively used for the ML-3030AS/3015AS. Do not use it for any other purpose.

Pin No.	Description
2	LASER START When Pin 3 is closed, the laser beam is output. Make sure that the circuit is left closed for at least the laser start acceptance time set on the CONFIG screen. When the signal is input repeatedly, make sure that the circuit is left open for at least the laser start acceptance time set on the CONFIG screen between each input. Confirm that Pin 13 (Ready output) is closed before inputting the laser start signal.
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. It could take up to 10 seconds to cancel the alarm.
7	Unused Do not connect anything.
8	Unused Do not connect anything.
9	Old emergency stop (LASER STOP) When this pin is opened, the equipment is brought to an emergency stop, which is in the same state as the CONTROL keyswitch is OFF. *<Note>* This pin can be used only when replacing our old products. Use the E-STOP connector for the emergency stop signal in accordance with machine safety standards.
10	Input COM
19	0 V OUT Power supply for external input signals. This pin is exclusively used for the ML-3030AS/3015AS. 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 is turned on, this pin is closed internally.
12	Guide beam 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. *<Note>* In the REPEAT mode, the signal is turned off for certain time after laser output to keep the average power below the maximum rated output.

Pin No.	Description
14	Trouble If trouble arises, this pin is opened internally until it is reset.
15	Laser output While the laser is output, this pin is closed internally. This is a signal for turning on an indicator during laser output. Do not use for timing control.
16	Laser weld monitor This pin is dedicated to the laser weld monitor. Do not connect to other pins.
17	Monitor normal When the monitor value of laser energy is in the range of "HIGH" and "LOW" set on the MONITOR screen, the circuit is closed for 20 ms.
18	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.

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

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

⇒ Use the following product out of the attached connectors.

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

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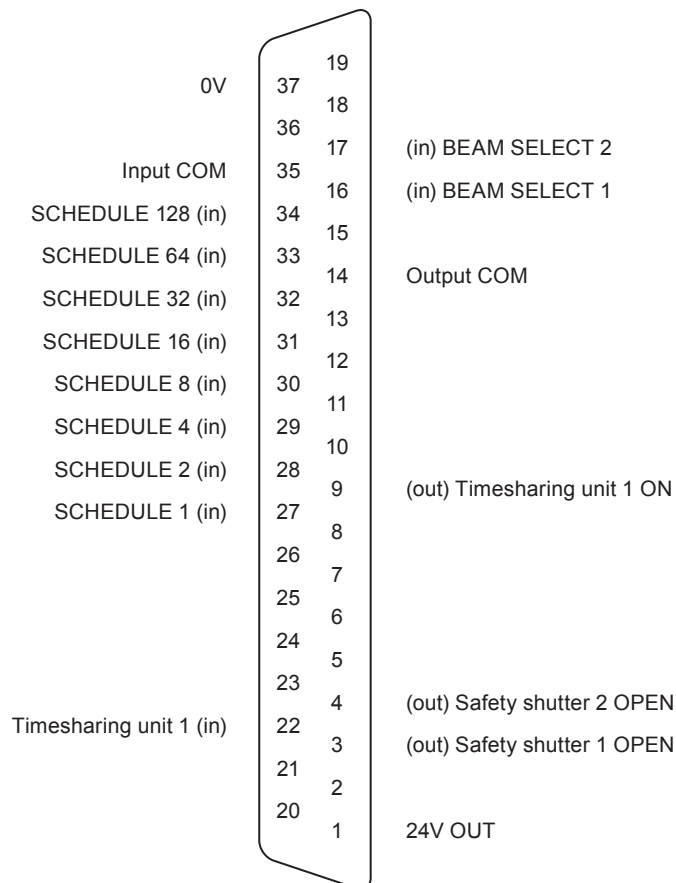
Input Pins of EXT. I/O (2) Connector

Pin No.	Description
16	BEAM SELECT 1 When this pin is closed, laser beam input unit 1 is selected and the unit becomes ready to project a laser beam.
17	BEAM SELECT 2 When this pin is closed, laser beam input unit 2 is selected and the unit becomes ready to project a laser beam.
18	Unused Do not connect anything.
19	Unused Do not connect anything.
20	Unused Do not connect anything.
21	Unused Do not connect anything.

Pin No.	Description	
22	Timesharing unit 1 Used for maintenance only.	
23	Unused Do not connect anything.	
24	Unused Do not connect anything.	
25	Unused Do not connect anything.	
26	Unused Do not connect anything.	
27	SCHEDULE 1	
28	SCHEDULE 2	
29	SCHEDULE 4	
30	SCHEDULE 8	Select a registered SCHEDULE number by combining schedule signal inputs 1, 2, 4, 8, 16, 32, 64 and 128.
31	SCHEDULE 16	
32	SCHEDULE 32	
33	SCHEDULE 64	
34	SCHEDULE 128	
35	Input COM Common terminal for input signals.	
36	Unused Do not connect anything.	
37	0V Ground for +24 V DC output.	

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

Pin No.	Description
1	24V OUT Power supply for external I/O.
2	Unused Do not connect anything.
3	Safety shutter 1 OPEN While safety shutter 1 is open, this pin closes internally. *<Note>* For ML-30□□AS-110, it has no safety shutter and no beamsplitter. When the CONTROL keyswitch is turned ON after starting the Laser, this pin closes internally.
4	Safety shutter 2 OPEN While safety shutter 2 is open, this pin closes internally. *<Note>* For ML-30□□AS-110, it has no safety shutter and no beamsplitter. When the CONTROL keyswitch is turned ON after starting the Laser, this pin closes internally.
5	Unused Do not connect anything.
6	Unused Do not connect anything.
7	Unused Do not connect anything.
8	Unused Do not connect anything.

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Pin No.	Description
9	Timesharing unit 1 ON While timesharing unit 1 operates, this pin closes internally.
10	Unused Do not connect anything.
11	Unused Do not connect anything.
12	Unused Do not connect anything.
13	Unused Do not connect anything.
14	Output COM
15	Unused Do not connect anything.

REM. I/L Connector

The REM. I/L connector closes the safety shutter and connects the interlock to cut off laser light in an emergency.

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

⇒ Use the following connector mounted on the main unit.

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 safety
2	shutter is closed.

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

⇒ 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 control panel.

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ML-3030AS/3015AS **127**
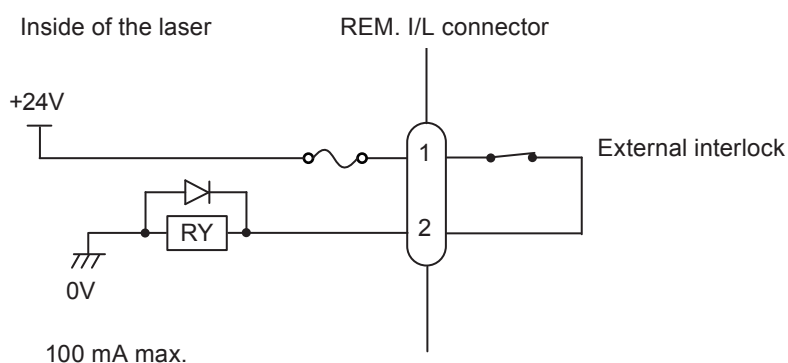
E-STOP Connector (D-Sub 25 pin)

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

⇒ Use the following product mounted on the main unit.

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

Emergency stop input 1 (in) — 1
14 — (in) Emergency stop input 2
2
15
Emergency stop input 1 (in) — 3
16 — (in) Emergency stop input 2
4
17
Emergency stop input 1 (in) — 5
18 — (in) Emergency stop input 1
Emergency stop input 2 (in) — 6
19 — (in) Emergency stop input 2
7
20
Emergency stop input 1 (out) — 8
21 — (out) Emergency stop output 2
Emergency stop input 1 (out) — 9
22 — (out) Emergency stop output 2
10
23
External interlock input 1 (in) — 11
24 — (in) External interlock input 1
External interlock input 2 (in) — 12
25 — (in) External interlock input 2
13

Input Pins of E-STOP Connector

Pin No.	Description
1	Emergency stop input 1
3	When the section between pin No.1 and pin No.18 or the section between pin No.3 and pin No.5 is put in an open circuit, an emergency stop is activated, the LD is turned off, and the safety shutter is closed.
5	To cancel it, put all the sections between pin No.1 and pin No.18, between pin No.14 and pin No.19, between pin No.3 and pin No.5, and between pin No.6 and pin No.16 in open circuit and put them in closed circuits. Then, input the trouble reset signal.
18	
6	Emergency stop input 2
14	When the section between pin No.14 and pin No.19 or the section between pin No.6 and pin No.16 is put in an open circuit, an emergency stop is activated, the LD is turned off, and the safety shutter is closed.
16	To cancel it, put all the sections between pin No.1 and pin No.18, between pin No.14 and pin No.19, between pin No.3 and pin No.5, and between pin No.6 and pin No.16 in open circuit and put them in closed circuits. Then, input the trouble reset signal.
19	
11	External interlock input 1
	When the section between pin No.11 and pin No.24 is put in an open circuit, the safety shutter is closed.
24	To cancel it, put all the section between pin No.11 and pin No.24 and the section between pin No.12 and pin No.25 in open circuits and put them in closed circuits. 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 safety shutter is closed.
25	To cancel it, put all the section between pin No.11 and pin No.24 and the section between pin No.12 and pin No.25 in open circuits and put them in closed circuits. 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 No.9 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 close the safety shutter and 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.

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E-STOP Connector

Inside the laser

User ESTOP Wiring

ESTOP CH2 rtn → 19

14

E-STOP Connector
ESTOP CH1 rtn → 18

1

16

ESTOP CH2 → 6

3

ESTOP CH1 → 5

ESTOP Out1a → 8

ESTOP Out1b → 9

ESTOP Out2a → 21

ESTOP Out2b → 22

Interlock rtn 2 → 12

Interlock out 2 ← 25   User Interlock Wiring
                              (dry contact closure)
Interlock rtn 1 → 11
                              (Open and close two
Interlock out 1 ← 24   contacts simultaneously.)

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.

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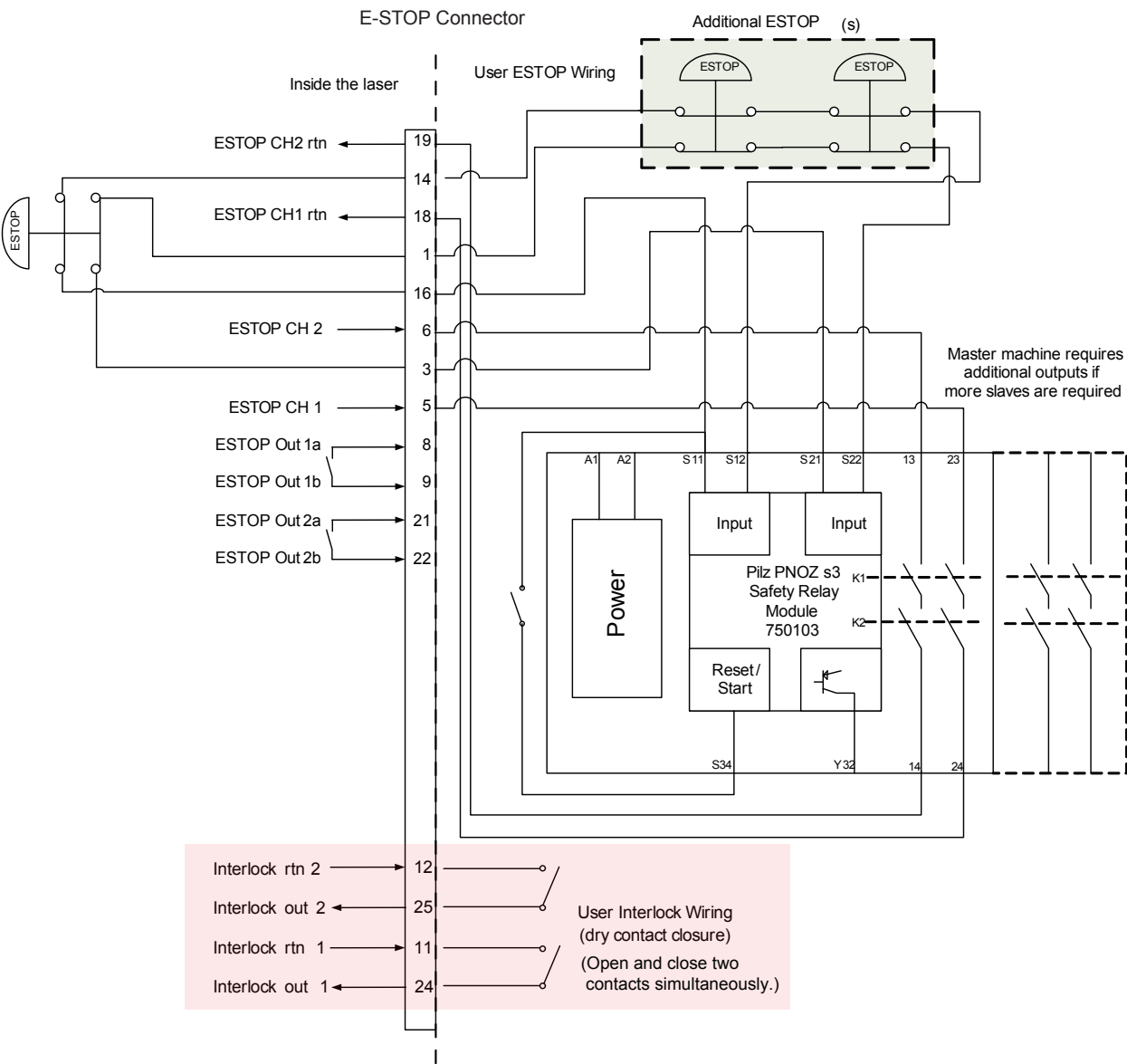
Example Connections of External Input/Output Signals

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

When Connected to an External Power Source

Inside of the laser

EXT +24V

EXT. I/O(1): 1

Input circuit

TLP180   10k

EXT. I/O(1): 2 to 6, 25
EXT. I/O(2): 16, 17, 22
      27 to 34

10k

NPN   PNP   *1

24V

TLP180   4.7k

EXT. I/O(1): 9

Emergency
stop

*1 **Normally closed
    for Laser Stop**

4.7k

RY

EXT. I/O(1): 10
EXT. I/O(2): 35

Input COM

24V DC
*2

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

Output circuit

TLP197G

EXT. I/O(1): 11 to 17, 20,
      22, 23
EXT. I/O(2): 3, 4, 9

Load

24V DC
*2

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

Output COM

EXT. I/O(1): 19

EXT 0V

When Using a Contact Signal

Inside of the laser

EXT +24V

EXT. I/O(1): 1 — +24V output

Input circuit

TLP180   10k

EXT. I/O(1): 2 to 6, 25
EXT. I/O(2): 16, 17, 22, 27 to 34

*1

*1 **Normally closed for Laser Stop**

10k

24V

TLP180   4.7k

EXT. I/O(1): 9 — Emergency stop

RY

4.7k

EXT. I/O(1): 10
EXT. I/O(2): 35 — Input COM

Output circuit

TLP197G

EXT. I/O(1): 11 to 17, 20, 22, 23
EXT. I/O(2): 3, 4, 9 — Load

EXT. I/O(1): 21
EXT. I/O(2): 14 — Output COM

EXT. I/O(1): 19 — 0V output

EXT 0V

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When Using an Open-Collector Signal

Inside of the laser

	EXT. I/O(1): 19	0V output
EXT 0V		

Input circuit

TLP180   10k

EXT. I/O(1): 2 to 6, 25
EXT. I/O(2): 16, 17, 22, 27 to 34

*1

*1 **Normally closed for Laser Stop**

10k

24V

TLP180   4.7k

EXT. I/O(1): 9

Emergency stop

RY

4.7k

EXT. I/O(1): 10
EXT. I/O(2): 35

Input COM

Output circuit

TLP197G

EXT. I/O(1): 11 to 17, 20, 22, 23
EXT. I/O(2): 3, 4, 9

Load

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

Output COM

EXT +24V

EXT. I/O(1): 1

+24V output
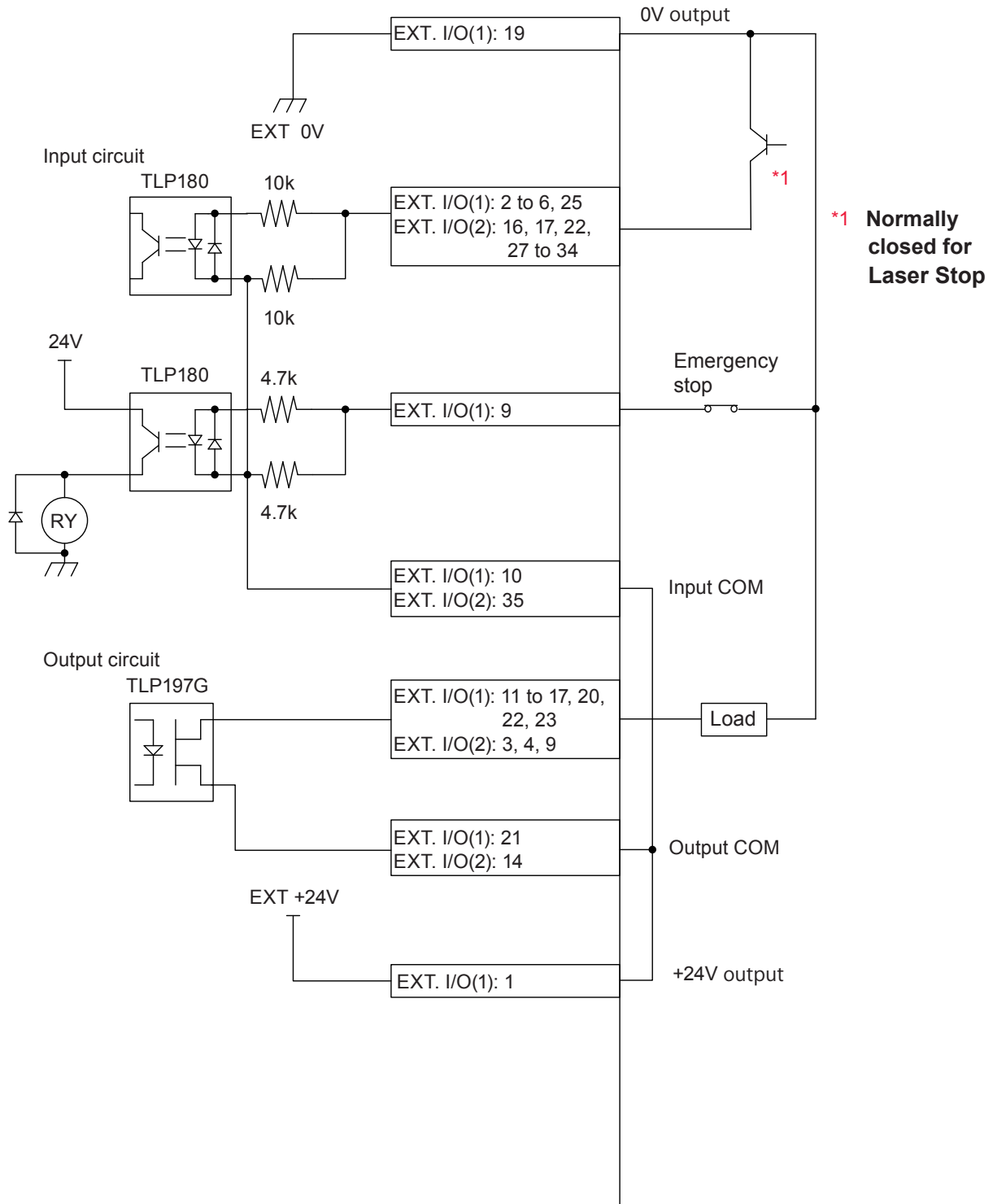
4. Programming

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

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

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

1 ● Switching the Control Method

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

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

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

| Control switching input | ON / OFF |
| External input acceptable output | ON / OFF |

2 ● Turning ON the LD

(1) Put pin No.4 of the EXT. I/O (1) connector in a closed circuit to turn ON the LD.

Pin No.13 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.

⇒ The signal is not output until the temperature of fiber laser module becomes 10°C. (1 hour max.)

LD-ON OFF input   ON / OFF

LD ON output   5s (1h) max.

Ready Output   1s max.
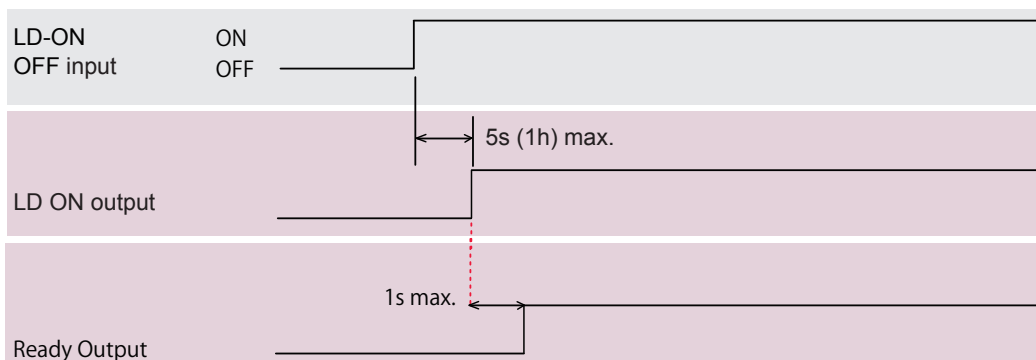
3 Selecting a Beam (Setting the Safety Shutter)

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

⇒ For ML-30□□AS-110, Beam 1 is selected regardless of the status of pin No.16 of the EXT. I/O (2) connector. Therefore, the pin can be kept open. When the CONTROL keyswitch is turned ON, the SHUTTER lamp comes on.

BEAM SELECT
1 input   ON
           OFF

150ms or more

Over the time set on
the CONFIG screen

Laser start input   ON
                     OFF
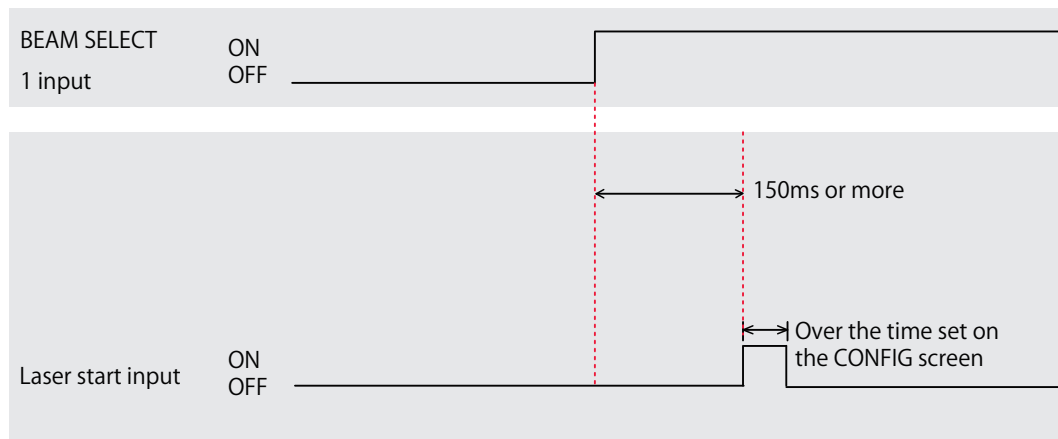
4 Setting Output Schedules (SCH.#01)

(1) Set the SCHEDULE number by combining pin No.27 to pin No.34 of the EXT. I/O (2) connector. In this example, pin No.27 of the EXT. I/O (2) connector is put in a closed circuit for 4 ms or more to set SCH.#01.

⇒ At delivery, the signal acceptance time (time from a signal input till establishment of schedules) of welding schedules is set to 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 "7. 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.

LD ON output

BEAM SELECT 1
input   ON
         OFF

SCHEDULE 1
input   ON
         OFF

SCHEDULE 2
input   ON
         OFF

Over the time set on the CONFIG screen

1 sec. max.

Ready output
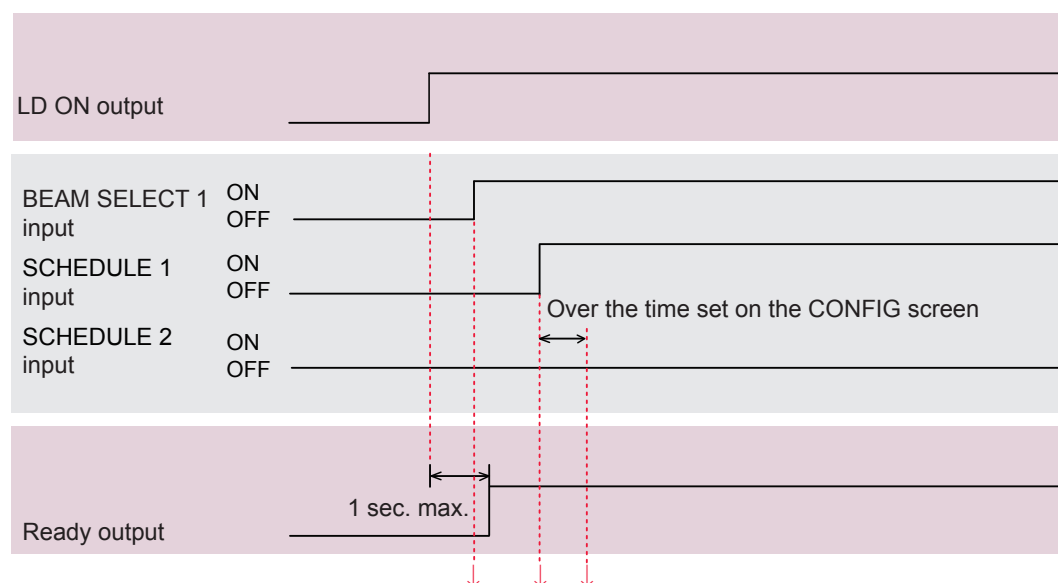
5 Outputting Laser Light

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

Laser light is output from Beam 1.

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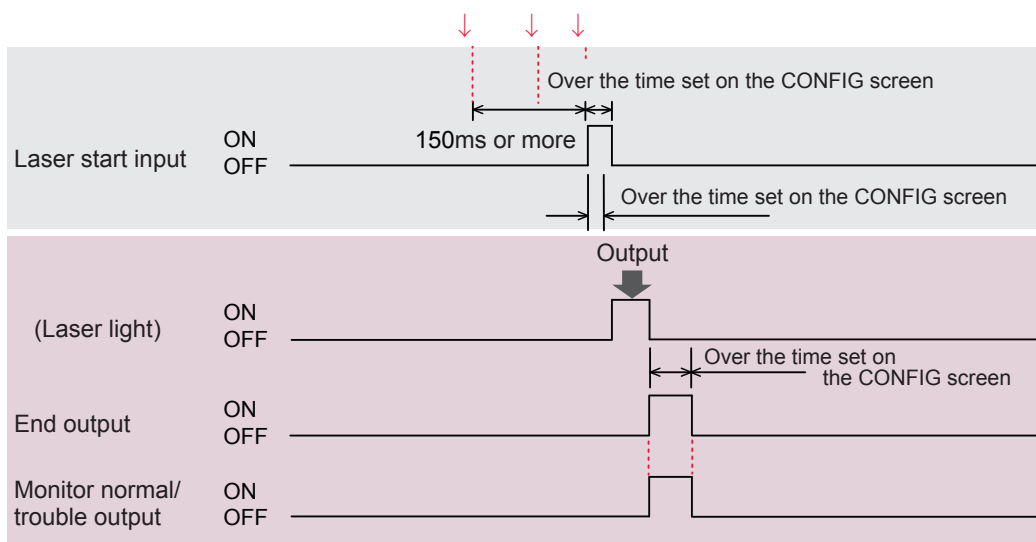
⇒ In more than 150 ms after a beam select signal input or in more than the time set on the CONFIG screen after the setting of welding conditions, close the LASER START pin.

⇒ At delivery, the laser start acceptance time (time from a signal input till an actual output of laser light) is set to 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, "7. 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.

6 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.

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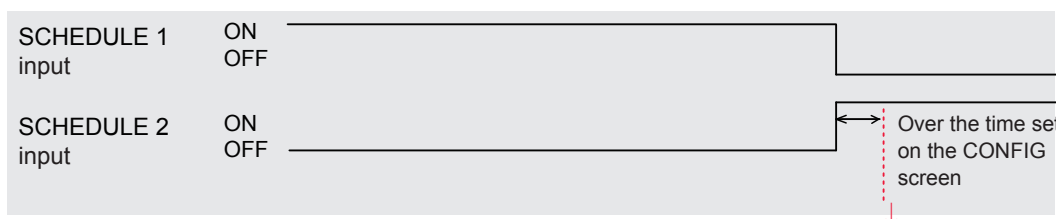
7 Outputting Laser Light

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

Laser light is output from Beam 1.

⇒ The details are the same as Step 5.

		Over the time set on the CONFIG screen
Laser start input	ON OFF	
		Output
(Laser light)	ON OFF	Over the time set on the CONFIG screen
End output	ON OFF	
Monitor normal/ trouble output	ON OFF	
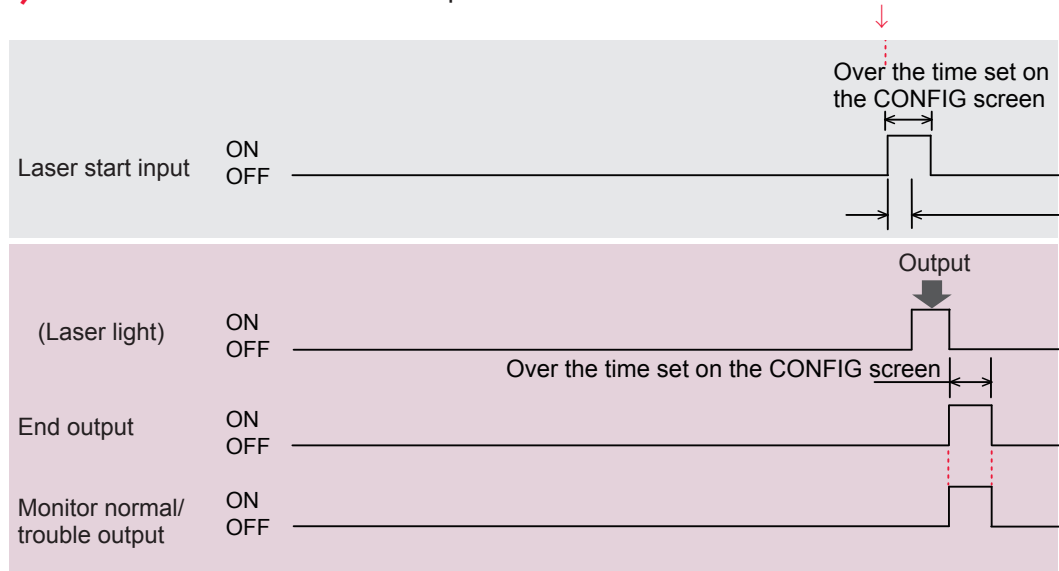
8 Stopping the Operation

(1) Put pin No.4 of the EXT. I/O (1) connector in an open circuit to turn off the LD.

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

Making a Position Adjustment by Guide Light

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

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

(2) Put pin No.5 of the EXT. I/O (1) connector in a closed circuit.

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

(3) Check the laser light irradiation position.

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

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Chapter 5

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

1. Operation Flow

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

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

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

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

When initial settings are performed

Press the "CONFIG" button to display the CONFIG screen

CONFIG Screen

Initial settings
 Communication schedule setting
 Equipment no. setting

When initial settings are already finished

**MAIN POWER switch ON
CONTROL keyswitch ON**

Program execution
 Control method/SCHEDULE No./safety shutter settings
 Mirror setting for timesharing unit
 Laser output start/stop

Output status check
 Error No. display at occurrence of trouble
 Monitor value display

End of operations

**LD OFF
CONTROL keyswitch OFF
MAIN POWER switch OFF**
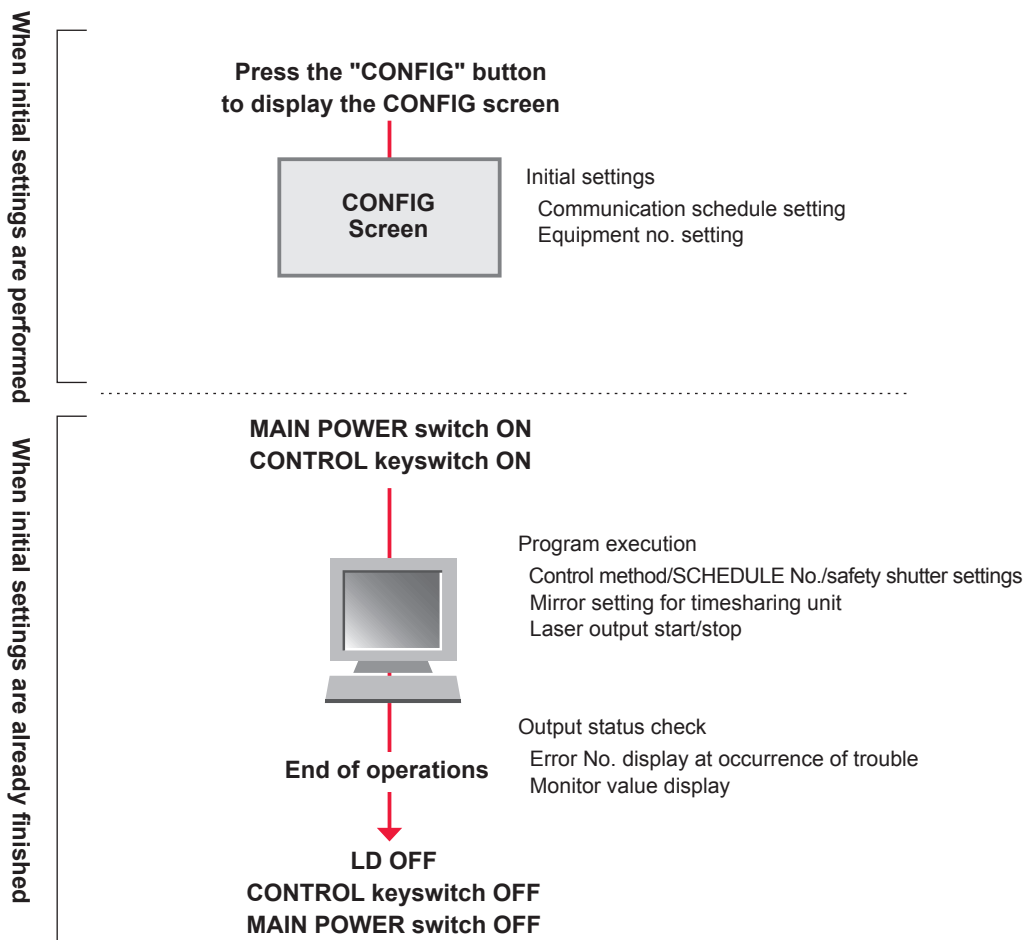
2. Preparations for Operations

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.
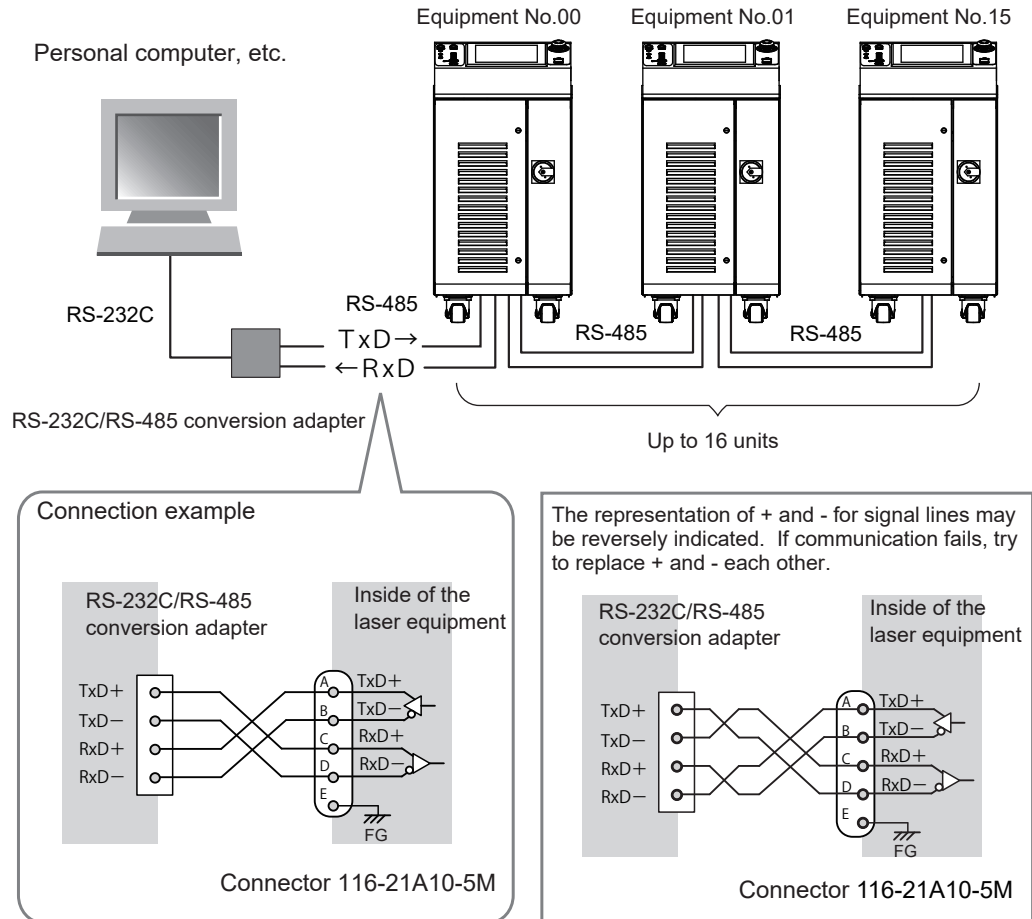
⇒ For controlling multiple lasers by single personal computer, it is necessary to register equipment No. (NETWORK #) for each equipment. Set equipment No. without duplication. If duplication of equipment No. exists, a data collision will occur on the communication line and the laser cannot be correctly 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 29.

⇒ 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 welding by external communication (RS-485 CONTROL). Set communication schedules and equipment No. on the control panel.

The communication schedules for data transfer are as follows.

Data transfer system	Conforming to RS-485, asynchronous, full duplex	
Transfer rate	9600, 19200, 38400, 57600, 115200 bps	
Data type	Start bit	1
	Data bit	8 or 7
	Stop bit	2 or 1
	Parity bit	Even/odd/none
Character code	ASCII	

⇒ Set the transfer rate, data type, and equipment No. by displaying the RS-485 COMMUNICATION SETUP from the CONFIG screen by the control panel 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 control panel of the equipment.

1● Displaying the CONFIG Screen

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

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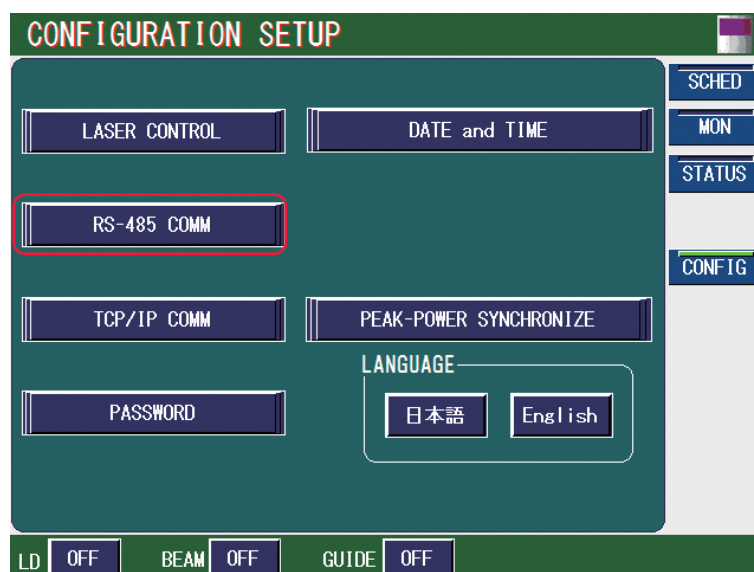
2 ● Specifying Communication Schedules

(1) Set communication schedules in "RS-485 COMMUNICATION SETUP." Press the setting button to be changed for this setting.
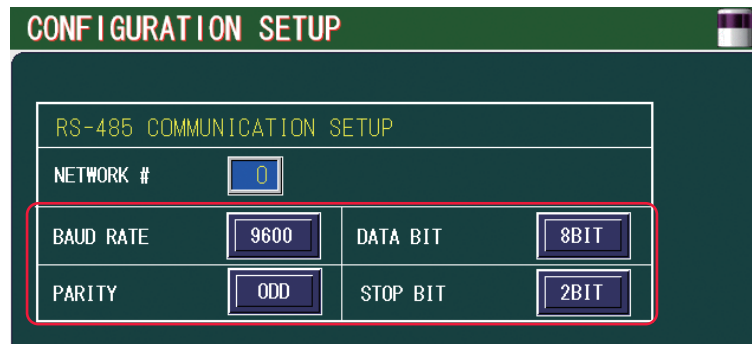
3 ● Specifying Equipment No.

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

Enter the laser welder 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.
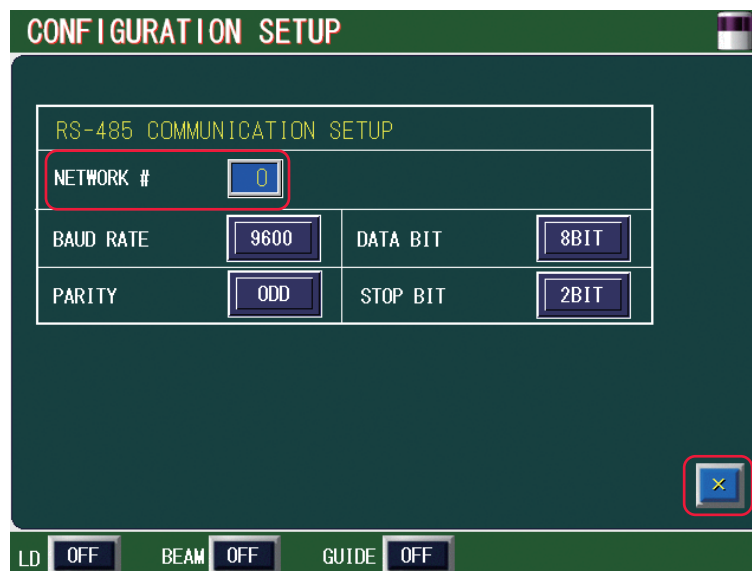
(2) Press the "X" button.

Returns to the CONFIG screen.

4. Commands

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

Code Table

The codes for external communication with a personal computer and the text structure are as follows. For details, refer to "Setting Data" on page 145 to "Reading the Equipment Name" on page 162.

Control Codes (Hexadecimal Codes)

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

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

Code	Contents		Text structure
W	Setting data	PC to laser	STX CH1 CH0 W LA1 LA0 SH3 SH2 SH1 SH0 DT1 DT0 : data ETX BCC
		Laser to PC	CH1 CH0 ACK Or CH1 CH0 NAK — Write data is out of the setting range or external communication control is not performed.
R	Reading data	PC to laser	STX CH1 CH0 R LA1 LA0 SH3 SH2 SH1 SH0 DT1 DT0 ETX BCC
		Laser to PC	STX data ETX BCC Or CH1 CH0 NAK — The schedule No. or data No. is out of the range.
WS	Setting the control method, SCHEDULE No., safety shutter, etc.	PC to laser	STX CH1 CH0 W S SH3 SH2 SH1 SH0 cnt s1 s2 … s9 mon ETX BCC
		Laser to PC	CH1 CH0 ACK Or CH1 CH0 NAK — The specified status cannot be provided or external communication control is not performed.
WD	Setting the system date and time	PC to laser	STX CH1 CH0 W D Y3…Y0 MO1 MO0 D1 D0 H1 H0 MI1 MI0 ETX BCC
		Laser to PC	CH1 CH0 ACK Or CH1 CH0 NAK — The specified status cannot be provided or external communication control is not performed.
RS	Reading the control method, SCHEDULE No., safety shutter, etc.	PC to laser	STX CH1 CH0 R S ETX BCC
		Laser to PC	STX CH1 CH0 SH3 SH2 SH1 SH0 cnt s1 s2 s3 … s9 mon rdy ETX BCC
RD	Reading the system date and time	PC to laser	STX CH1 CH0 R D ETX BCC
		Laser to PC	STX Y3 Y2 Y1 Y0 MO1 MO0 D1 D0 H1 H0 MI1 MI0 ETX BCC
$0	Laser start command	PC to laser	STX CH1 CH0 $ 0 ETX BCC
		Laser to PC	CH1 CH0 ACK Or CH1 CH0 NAK — The LD is OFF, trouble occurs, or external communication control is not performed.

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Code	Contents		Text structure
$9	Laser stop command	PC to laser	STX | CH1 | CH0 | $ | 9 | ETX | BCC
		Laser to PC	CH1 | CH0 | ACK Or CH1 | CH0 | NAK External communication control is not performed.
C0	Trouble reset command	PC to laser	STX | CH1 | CH0 | C | 0 | ETX | BCC
		Laser to PC	CH1 | CH0 | ACK Or CH1 | CH0 | NAK External communication control is not performed.
C1	SHOT COUNT reset command	PC to laser	STX | CH1 | CH0 | C | 1 | ETX | BCC
		Laser to PC	CH1 | CH0 | ACK Or CH1 | CH0 | NAK External communication control is not performed.
C2	GOOD COUNT reset command	PC to laser	STX | CH1 | CH0 | C | 2 | ETX | BCC
		Laser to PC	CH1 | CH0 | ACK Or CH1 | CH0 | NAK External communication control is not performed.
RT	Reading trouble	PC to laser	STX | CH1 | CH0 | R | T | ETX | BCC
		Laser to PC	STX | E2 | E1 | E0 | , | E2 | E1 | E0 | , | … | E2 | E1 | E0 | ETX | BCC
RH	Reading the error history	PC to laser	STX | CH1 | CH0 | R | H | ID3 | ID2 | ID1 | ID0 | ETX | BCC
		Laser to PC	STX | error | ETX | BCC
RV	Reading the software version	PC to laser	STX | CH1 | CH0 | R | V | CP1 | CP0 | ETX | BCC
		Laser to PC	STX | version | ETX | BCC
RN	Reading the equipment name	PC to laser	STX | CH1 | CH0 | R | N | ETX | BCC
		Laser to PC	STX | name | ETX | BCC

Setting Data

The command (code: W) to set welding 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 T X | B C C |

Laser

| C H 1 | C H 0 | A C K | Or | 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 and FLEX 85 Schedule settings for FIX 86 Schedule settings for FLEX, TIME 01 to 10 87 Schedule settings for FLEX, TIME 11 to 20 88 Schedule settings for FLEX, POWER 01 to 10 89 Schedule settings for FLEX, POWER 11 to 20 66 Schedule settings for CW, TIME 01 to 10 67 Schedule settings for CW, TIME 11 to 20 68 Schedule settings for CW, POWER 01 to 10 69 Schedule settings for CW, POWER 11 to 20 75 SEAM setting value SEAM ON/OFF 76 SEAM setting value SHOT 01 to 10 77 SEAM setting value SHOT 11 to 20 78 SEAM setting value POWER 01 to 10 79 SEAM setting value POWER 11 to 20 64 Modulation function ON/OFF 65 Modulation function settings
SH3/SH2/SH1/SH0	Schedule No. (SH3 = thousands digit, SH2 = hundreds digit, SH1 = tens digit, SH0 = units digit) Enter the No. of the schedule you want to change within the data range of 0000 to 0255. If ☐☐☐☐ (spaces) are entered, the currently selected schedule is used.
DT1/DT0	Data No. (DT1 = tens digit, DT0 = units digit) • For detailed information on the data No., see "Set Value/Monitor Value Table" on page 147. • If "99" is entered, data is written in a batch. data: (Data No.1), (Data No.2), (Data No.3), … (the last Data No.) Insert [,] between individual data. The monitor data (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.

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Reading Data

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

Personal computer, etc.

| S
T
X | C
H
1 | C
H
0 | R | L
A
1 | L
A
0 | S
H
3 | S
H
2 | S
H
1 | S
H
0 | D
T
1 | D
T
0 | E
T
X | B
C
C |

Laser

| S
T
X | data | E
T
X | B
C
C | Or | 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 and FLEX 85 Schedule settings for FIX 86 Schedule settings for FLEX, TIME 01 to 10 87 Schedule settings for FLEX, TIME 11 to 20 88 Schedule settings for FLEX, POWER 01 to 10 89 Schedule settings for FLEX, POWER 11 to 20 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 50 LD ON total time 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 147. • If "99" is entered, data is read in a batch. data: (Data No.1), (Data No.2), (Data No.3), … (the last Data No.) Insert [,] between individual data.
ACK or NAK	The Laser returns a [NAK] if the classification No., schedule No., or data No. falls outside the specified range.

Set Value/Monitor Value Table

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

⇒ The value in ( ) indicates the unit.

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

84 Schedule Settings for FIX, FLEX and CW

Data No.	Item	Data Range
01	[FORM] on the [SCHEDULE] screen Selection of waveform setting method 0: FIX 1: FLEX 2: CW	0 – 2
02	Turning ON/OFF the graph display on the [SCHEDULE] screen 0: OFF 1: ON	Fixed to 1

03	[PEAK POWER] on the [SCHEDULE] screen
	Laser output peak value
		ML-3030AS :
		  FIX/FLEX : 00500 – 02700 (×1W)
		  CW : 00050 – 00270 (×1W)
		ML-3015AS :
		  FIX/FLEX : 00250 – 01350 (×1W)
		  CW : 00025 – 00135 (×1W)

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/×0.01ms)
02	[FLASH 1] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
03	[FLASH 2] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
04	[FLASH 3] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
05	[↓SLOPE] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
06	Unused	Fixed to 0000
07	[FLASH 1] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)
08	[FLASH 2] POWER on the [SCHEDULE] screen	0000 – 2000 (×0.1%)

Data No.	Item	Data Range
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/×0.01ms)
13	[COOL 2] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×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/×0.01ms)
02	[POINT 02] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
03	[POINT 03] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
04	[POINT 04] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
05	[POINT 05] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
06	[POINT 06] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
07	[POINT 07] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
08	[POINT 08] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
09	[POINT 09] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
10	[POINT 10] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×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/×0.01ms)
02	[POINT 12] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
03	[POINT 13] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
04	[POINT 14] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
05	[POINT 15] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
06	[POINT 16] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
07	[POINT 17] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
08	[POINT 18] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
09	[POINT 19] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×0.01ms)
10	[POINT 20] TIME on the [SCHEDULE] screen	0000 – 5000 (×0.1ms/×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%)

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

89 Schedule Settings for FLEX — POWER 11 to 20

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

66 Schedule Settings for CW — TIME 01 to 10

Data No.	Item	Data Range
01	[POINT 01] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
02	[POINT 02] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
03	[POINT 03] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
04	[POINT 04] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
05	[POINT 05] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
06	[POINT 06] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
07	[POINT 07] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
08	[POINT 08] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
09	[POINT 09] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
10	[POINT 10] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)

67 Schedule Settings for CW — TIME 11 to 20

Data No.	Item	Data Range
01	[POINT 11] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
02	[POINT 12] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
03	[POINT 13] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
04	[POINT 14] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)

Data No.	Item	Data Range
05	[POINT 15] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
06	[POINT 16] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
07	[POINT 17] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
08	[POINT 18] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
09	[POINT 19] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)
10	[POINT 20] TIME on the [SCHEDULE] screen	0000 – 9999 (×1s/×0.1s/×0.01s/×0.001s)

68 Schedule Settings for CW — POWER 01 to 10

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

69 Schedule Settings for CW — POWER 11 to 20

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

75 SEAM setting value SEAM ON/OFF

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

76 SEAM setting value SHOT 01 to 10

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

77 SEAM setting value SHOT 11 to 20

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

78 SEAM setting value POWER 01 to 10

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

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79 SEAM setting value POWER 11 to 20

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

64 Modulation Function ON/OFF

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

65 Modulation Function Settings

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

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

Data No.	Item	Data Range
01*	[SHOT COUNT] on the [MONITOR] screen Total number of outputs until the present	000000000 – 999999999
02*	[GOOD COUNT] on the [MONITOR] screen Number of outputs of appropriate energy	000000000 – 999999999
03*	[AVERAGE] on the [MONITOR] screen Average power of output laser light	000000 – 999999 (×1W)

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

Data No.	Item	Data Range
01*	Schedule No. of laser power monitor data	0000 – 0255

Data No.	Item	Data Range
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)

*   When the pulse width is 0.2 to 0.3 ms, a measured value is sent at intervals of 0.005 ms.
*   When the pulse width is 0.4 to 4.8 ms, a measured value is sent at intervals of 0.05 ms.
*   When the pulse width is 4.9 to 9.8 ms, a measured value is sent at intervals of 0.1 ms.
*   When the pulse width is 9.9 to 19.8 ms, a measured value is sent at intervals of 0.2 ms.
*   When the pulse width is 19.9 to 39.8 ms, a measured value is sent at intervals of 0.4 ms.
*   When the pulse width is 39.9 to 50.0 ms, a measured value is sent at intervals of 1.0 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.

50 LD ON Total Time

Data No.	Item	Data Range
01*	[LD WORK TIME] on the [STATUS] screen	0000000 – 9999999 (×1H)

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51 LD Output Total Time

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

40 Backup Memory Settings

Data No.	Item	Data Range
01*	[NETWORK #] on the [CONFIG] screen	00 – 15
02*	[IP ADDRESS] on the [CONFIG] screen	000000000000 – 999999999999
03*	[SUBNET MASK] on the [CONFIG] screen	000000000000 – 999999999999
04*	[DEFAULT GATEWAY] on the [CONFIG] screen	000000000000 – 999999999999
05*	Unused	Fixed to 00
06*	Unused	Fixed to 000
07*	[POWER FEEDBACK MODE] on the maintenance screen LD output mode 0: Power feedback ON 1: Power feedback OFF	0 – 1
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

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

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

Personal computer, etc.

S T X	C H 1	C H 0	W	S	S H 3	S H 2	S H 1	S H 0	c n t	s 1	s 2	s 3	s 4	s 5	s 6	s 7	s 8	s 9	m o n	E T X	B C C

Laser

C H 1	C H 0	A C K	Or	C H 1	C H 0	N A K

CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
SH3/SH2/SH1/SH0	Schedule No. (SH3 = thousands digit, SH2 = hundreds digit, SH1 = tens digit, SH0 = units digit) The data range is 0000 to 0255, and the schedule No. to be changed is entered. For □□□□ (space), the current schedule No. in use is entered.

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

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

	* When the external input/output control is turned OFF at "1: Control by external input/output signals (Output schedules are set on the control panel)", the control method is changed to "0: Control by control panel."
	* When the external input/output control is turned OFF at "5: Control by external input/output signals (Output schedules are set on the personal computer)", the control method is changed to "2: Control by external communication control."
s1	LD (0: OFF 1: ON □: Current status kept)
s2	Guide light (0: OFF 1: ON □: Current status kept)
s3	Unused (fixed to □)

s4	Models other than ML-30□□AS-110	Safety shutter 1 (0: OFF 1: ON □: Current status kept)
	ML-30□□AS-110	Unused (fixed to □)

s5	Models other than ML-30□□AS-110	Safety shutter 2 (0: OFF 1: ON □: Current status kept)
	ML-30□□AS-110	Unused (fixed to □)

s6	Unused (fixed to □)
s7	Unused (fixed to □)
s8	Unused (fixed to □)
s9	Unused (fixed to □)
mon	Automatic laser power monitor value transmission (0: OFF 1: ON □: Current status kept) Each time the laser is output, "00 Laser Power Monitor-Energy, number of waveform data, etc." on page 152 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.

S T X	C H 1	C H 0	R	S	E T X	B C C

Laser

S T X	C H 1	C H 0	S H 3	S H 2	S H 1	S H 0	c n t	s 1	s 2	s 3	s 4	s 5	s 6	s 7	s 8	s 9	m o n	r d y	E T X	B C C

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

Y3/Y2/Y1/Y0	Year (Y3 = thousands digit, Y2 = hundreds digit, Y1 = tens digit, Y0 = units digit)
MO1/MO0	Month (MO1 = tens digit, MO0 = units digit)
D1/D0	Day (D1 = tens digit, D0 = units digit)
H1/H0	Hour (H1 = tens digit, H0 = units digit)
MI1/MI0	Minute (MI1 = tens digit, MI0 = units digit)
ACK or NAK	Valid only at external communication control. If there is any setting that cannot be changed, all are invalidated and [NAK] is returned.

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

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

Personal computer, etc.

	STX	CH1	CH0	W	D	Y3	Y2	Y1	Y0	MO1	MO0	D1	D0	H1	H0	MI1	MI0	ETX	BCC

Laser

CH1	CH0	ACK	Or	CH1	CH0	NAK

CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)	
SH3/SH2/SH1/SH0	Schedule No. (SH3 = thousands digit, SH2 = hundreds digit, SH1 = tens digit, SH0 = units digit)	
cnt	Control method 　0: Control by control panel 　1: Control by external input/output signals (Output schedules are set on the control panel.) 　2: Control by external communication control 　3: Maintenance mode 　4: (Missing number) 　5: Control by external input/output signals (Output schedules are set on the personal computer.)	
s1	LD (0: OFF 1: ON)	
s2	Guide light (0: OFF 1: ON)	
s3	Unused (fixed to 0)	
s4	Models other than ML-30□□AS-110	Safety shutter 1 (0: OFF 1: ON)
	ML-30□□AS-110	Unused (fixed to 0)
s5	Models other than ML-30□□AS-110	Safety shutter 2 (0: OFF 1: ON)
	ML-30□□AS-110	Unused (fixed to 0)

s6	Unused (fixed to 0)
s7	Unused (fixed to 0)
s8	Unused (fixed to 0)
s9	Unused (fixed to 0)
mon	Automatic laser power monitor value transmission (0: OFF 1: ON) Each time the laser is output, "00 Laser Power Monitor-Energy, number of waveform data, etc." on page 152 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.

S T X	C H 1	C H 0	R	D	E T X	B C C

Laser

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 I 1	M I 0	E T X	B C C

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

Starting a Laser Light Output

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

Personal computer, etc.

S T X	C H 1	C H 0	C	1	E T X	B C C

Laser

C H 1	C H 0	A C K	Or	C H 1	C H 0	N A K

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

Stopping a Laser Light Output

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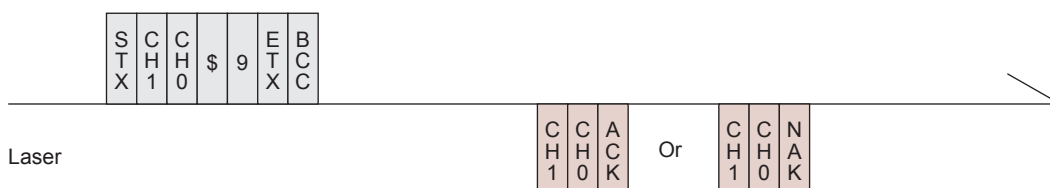
Personal computer, etc.

S T X	C H 1	C H 0	$	9	E T X	B C C

Laser

C H 1	C H 0	A C K

Or

C H 1	C H 0	N A K

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.

S T X	C H 1	C H 0	C	0	E T X	B C C

Laser

C H 1	C H 0	A C K

Or

C H 1	C H 0	N A K

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.

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Resetting the Total Number of Outputs

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

Personal computer, etc.

S T X	C H 1	C H 0	$	0	E T X	B C C

Laser

C H 1	C H 0	A C K	Or	C H 1	C H 0	N A K

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

Resetting the Appropriate Number of Outputs

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

Personal computer, etc.

S T X	C H 1	C H 0	C	2	E T X	B C C

Laser

C H 1	C H 0	A C K	Or	C H 1	C H 0	N A K

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

Reading Error No. at Occurrence of Trouble

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

Personal computer, etc.

S T X	C H 1	C H 0	R	T	E T X	B C C

Laser

S T X	E 2	E 1	E 0	,	E 2	E 1	E 0	,	...	E 2	E 1	E 0	E T X	B C C

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 169.

Reading the Error History

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

Personal computer, etc.

Laser

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

Reading the Software Version

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

Personal computer, etc.

Laser

CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
CP1/CP0	CPU No. (CP1 = tens digit, CP0 = units digit) 00: CPU 01: MAIN FPGA 02: SUB FPGA • If "99" is entered, data is read in a batch.
version	Version information (nnnnnnnnnnnnnnssssssssssssvvvvvvvvvyyyymmddhhmm) nnnnnnnnnnnnnn Software name ssssssssss Part No. vvvvvvvv Software version yyyy Year mm Month dd Day hh Hour mm Minute version: (Data No.1), (Data No.2), (Data No.3), … (the last Data No.) Insert [,] between individual data.

Reading the Equipment Name

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

Personal computer, etc.

S T X	C H 1	C H 0	R	N	E T X	B C C

Laser

S T X	name	E T X	B C C
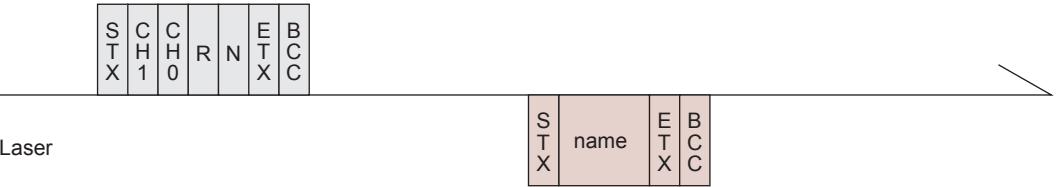
CH1/CH0	Equipment No. (CH1 = tens digit, CH0 = units digit)
name	Equipment name

Maintenance Part # Chapter 1

● How to Perform Maintenance

NOTE

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

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

⚠ **WARNING**

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

⚠ **CAUTION**

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

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Chapter 1 How to Perform Maintenance

1. Maintenance Parts and Standard Intervals of Inspection/Replacement

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

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

Part name		Model No.	Operation interval (standard) (*1)	Contents of operation (*2)
Air filter		PC1178315	Every month	Clean
			1 year	Replace
Lithium battery (*3)		CR 2450	3 years	Replace
P-type load switch		T3-1-102/E+SVB-SW-T0	5 years	Replace
SPS unit 1		PBA1500F-48	5 years	Repair or Replace
SPS unit 2		PBA300F-24	5 years	Repair or Replace
Electromagnetic contactor		SC-4-1/G coil DC24V 1b	5 years	Replace
Branch unit	Single	AS1178501	2 years	Replace
	2-powershasring	AS1178503		
	2-timesharing	AS1178502		
Safety shutter (*4)		AS1174565	5 million times	Replace
Timesharing unit (*5)		AS1177380	1 million times	Replace
Optical fiber (*6)	φ 0.1mm, 5m	PO1178504	2 years	Replace
	φ 0.1mm, 10m	PO1178505		
	φ 0.2mm, 5m	PO1178506		
	φ 0.2mm, 10m	PO1178507		
	φ 0.3mm, 5m	PO1175451		
	φ 0.3mm, 10m	PO1175452		
	φ 0.4mm, 5m	PO1175453		
	φ 0.4mm, 10m	PO1175454		
	φ 0.6mm, 5m	PO1175455		
	φ 0.6mm, 10m	PO1175456		
	φ 0.8mm, 5m	PO1177722		
	φ 0.8mm, 10m	PO1177723		

Part name	Model No.	Operation interval (standard) (*1)	Contents of operation (*2)
Protective glass	Specified glass for output unit	Everyday	Clean
		—	Replace (*7)

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: An expected life of the safety shutter is 5 million times. Switching ON and OFF of the safety shutter according to the ON/OFF state of the laser can lead to shortening the operation interval. The safety shutter can be used for a longer time by setting it to ON at startup of the equipment and keeping it ON during the laser operation in principle.

*5: An expected life of the timesharing unit is 1 million times. When operating the timesharing unit over the operation interval, the optical fiber may be damaged by the optical axis deviation due to degradation in stop accuracy of the timesharing unit. We recommend a periodic inspection.

*6: For ML-30□□AS-110, the dedicated optical fiber (incorporated directly in the main unit) is used.

*7: 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.

2. Maintenance of the Power Supply Section

Cleaning the Air Filter

An air filter on the front face of the main unit is provided at the air inlet to the power supply section. Perform cleaning every month.

<Note>

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

● **Operating Procedure**

(1) Open the front door.

(2) Remove two filter fixing screws by manually turning them.

Filter fixing screw (2 positions)
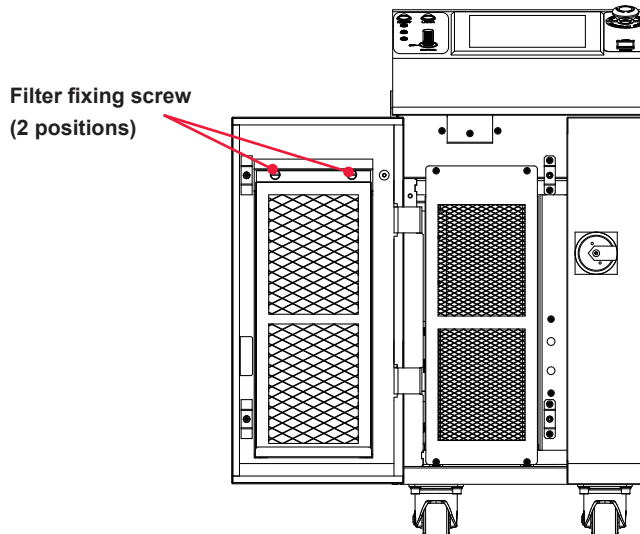
(3) Take out the air filter and wash it in tap water. Then, dry the air filter completely.
⇒ When the air filter is very dirty, use a neutral cleaner.

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

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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 control panel 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.

Error No.

Contents of the error
(Troubles are displayed up to ten occurrences.)

```
        !!! TROUBLE !!!

15:14:47  E082: ILLEGAL OSCILLATOR SIGNAL
--:--:--
--:--:--
--:--:--
--:--:--
--:--:--
--:--:--
--:--:--
--:--:--

                              TROUBLE RESET
```

<Note>
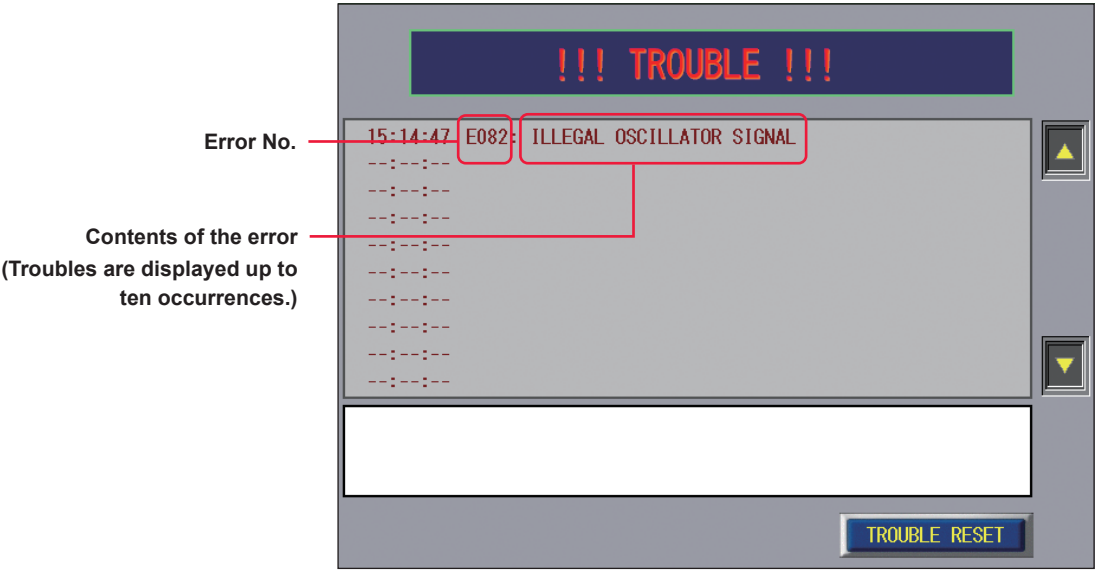
If the safety interlock is activated, a safety circuit will work to stop the safety shutter and timesharing unit (depending on specifications) forcibly. For this reason, "SAFETY SHUTTER OPEN/CLOSE TROUBLE" or "BRANCH MIRROR OPEN/CLOSE TROUBLE" may be displayed other than the relevant error/fault message.

LD "-":	State of LD doesn't change even if an error/fault occurs.
LD "OFF":	LD is turned off automatically if an error/fault occurs.
Alarm output "-":	Error/Fault signal is not output if an error/fault occurs.
Alarm output "ON":	Error/Fault signal is output if an error/fault occurs.

No.	Contents of error	LD	Alarm output	Measures
000	COMMUNICATION LINE ERROR	OFF	ON	The communication line between the laser power supply 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.
003 004 005 006	INTERNAL COMM. ERROR(IO2) INTERNAL COMM. ERROR(IO3) INTERNAL COMM. ERROR(IO4) INTERNAL COMM. ERROR(IO5)	OFF	ON	An error has occurred with the wiring in the main unit. Consult us.
012 to 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.
017	INTERFACE BOARD ERROR	OFF	ON	A connection error has occurred with the main unit interior. Consult us.
018 019	CONTROL BOARD ERROR	OFF	ON	An error has occurred with the controller unit. Consult us.
020	COVER OPENED	OFF	ON	The cover is removed. Mount them.
022	EXTERNAL INTERLOCK OPENED	OFF	ON	The REM. I/L connector circuit is opened. → P.81 Close it to turn off the [Trouble] output and fault code indication.
023	EMERGENCY STOP	OFF	ON	An emergency stop signal is input. Close Pin No.1 and Pin No.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 control panel.
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.
026	CONTROL BOARD TEMP. HIGH ERROR	OFF	ON	Overheating occurs in the main unit. After waiting for several minutes, press the TROUBLE RESET button.

No.	Contents of error	LD	Alarm output	Measures
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. Consult us.
029	SHUTTER BOARD 5V ERROR	OFF	ON	A 5V DC power error has occurred with the shutter drive board. Consult us.
035	LASER POWER OUT OF RANGE	-	-	The monitor value of laser energy is out of the range of "HIGH" and "LOW" set on the MONITOR screen. → P.70, P.103, P.105, and P.123 Check "HIGH" and "LOW" settings. If monitored value is abnormal, consult us.
036	LASER CONTROL PARAMETER ERROR	OFF	ON	A set value of laser energy (PEAK POWER, output time, REPEAT) exceeds the capacity. The error message is displayed when inputting the set value. The set value is reset to the value before the change.
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.
050 to 054	POWER FEEDBACK OVERFLOW to POWER FEEDBACK4 OVERFLOW	OFF	ON	The power set by the power feedback cannot be output. When interlock is operated during laser output, this error may occur. If E050 to E054 occurs alone, consult us.
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.
062	DIV BY 0 ERROR	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.

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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.
079	LASER ERROR SIGNAL ERROR	OFF	ON	An oscillation error signal of unknown cause has been detected. Consult us.
080	OSCILLATOR NOT READY	OFF	ON	The oscillator has not started normally. Consult us.
081	CIRCUIT DISCHARGE TIMEOUT	OFF	ON	An error has occurred with the discharge circuit. Consult us.
082	ILLEGAL OSCILLATOR SIGNAL	OFF	ON	A signal from the oscillator is abnormal. Consult us.
083	OSCILLATOR1 LASER POWER HIGH ERROR	OFF	ON	The laser output energy exceeds the capacity. Consult us.
084	OSCILLATOR1 STANDBY POWER HIGH ERROR	OFF	ON	The standby laser output energy exceeds the capacity. Consult us.
099	TOTAL LASER POWER HIGH ERROR	OFF	ON	The laser output energy exceeds the capacity. Consult us.
100	TOTAL STANDBY POWER HIGH ERROR	OFF	ON	The standby laser output energy exceeds the capacity. Consult us.
103	OSCILLATOR1 OVER HEAT	OFF	ON	Overheating occurs in the oscillator. After waiting for several minutes, press the TROUBLE RESET button.
104	OSCILLATOR1 BR HIGH ERROR	OFF	ON	An excessive reflected light error has been detected in the oscillator. Reposition the workpiece so that the reflected light decreases.
105	OSCILLATOR1 PULSE WIDTH HIGH ERROR	OFF	ON	An excessive pulse width error has been detected. Consult us.
106	OSCILLATOR1 PULSE WIDTH LOW ERROR	OFF	ON	A short pulse width error has been detected. Consult us.
107	OSCILLATOR1 PULSE ENERGY HIGH ERROR	OFF	ON	An excessive pulse energy error has been detected. Consult us.
108	OSCILLATOR1 LD POWER SUPPLY ERROR	OFF	ON	No power is supplied to the oscillator. Consult us.
109	OSCILLATOR1 DUTY HIGH ERROR	OFF	ON	An excessive duty ratio error has been detected. Consult us.
110	OSCILLATOR1 TEMP LOW ERROR	OFF	ON	The temperature of oscillator falls below the operable range. After waiting for a while at room temperature of 10 degrees C, restart the equipment.

No.	Contents of error	LD	Alarm output	Measures
111	OSCILLATOR1 LEAK CURRENT HIGH ERROR	OFF	ON	An excessive leak current error has been detected. Consult us.
112	OSCILLATOR1 CRITICAL ERROR	OFF	ON	A serious failure has occurred with the oscillator. Consult us.
113	OSCILLATOR1 AVERAGE POWER HIGH ERROR	OFF	ON	An excessive average power error has been detected. Consult us.
114	OSCILLATOR1 FIBER INTERLOCK ERROR	OFF	ON	An optical fiber is wrongly connected or may be broken. Check that the fiber is normally connected. If the trouble will continue even after the above measures, consult us.
169	ISOLATOR DUMPER TEMP ERROR	OFF	ON	Abnormal temperature of the isolator dumper. After waiting for several minutes, press the TROUBLE RESET button.
170 171	SAFETY SHUTTER 1 OPEN TROUBLE SAFETY SHUTTER 2 OPEN TROUBLE	OFF	ON	The safety shutter unit fault. Consult us.
174 175	SAFETY SHUTTER 1 CLOSE TROUBLE SAFETY SHUTTER 2 CLOSE TROUBLE	OFF	ON	The safety shutter unit fault. Consult us.
178 179	SAFETY SHUTTER 1 TEMP ERROR SAFETY SHUTTER 2 TEMP ERROR	OFF	ON	Abnormal temperature of the safety shutter. After waiting for several minutes, press the TROUBLE RESET button.
182	BRANCH MIRROR TEMP ERROR	OFF	ON	Abnormal temperature of the branch unit. After waiting for several minutes, press the TROUBLE RESET button.
185	BRANCH MIRROR 1 OPEN TROUBLE	OFF	ON	An error has occurred with the timesharing unit. Consult us.
188	BRANCH MIRROR 1 CLOSE TROUBLE	OFF	ON	An error has occurred with the timesharing unit. Consult us.
191	SHUTTER CONTROL ERROR	OFF	ON	A control error of the shutter unit. Make sure that the laser start signal is not input before a shutter is open.
193 194	FIBER SENSOR 1 TROUBLE FIBER SENSOR 2 TROUBLE	OFF	ON	An optical fiber may be broken; or end face, damaged. Check all the optical fibers for breakage. If the end face is broken, consult us.

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2. Troubles not Displaying Fault Code

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

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Specifications

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Item			ML-3030AS	ML-3015AS
Oscillator	Maximum rated output (from oscillator) *1 *2	REPEAT mode	0.3 kW	0.15 kW
		CW mode	270 W	135 W
	Maximum peak power (from oscillator) *1	REPEAT mode	Maximum: 2.7 kW Minimum: 0.5 kW (PFB ON), 0.3 kW (PFB OFF)	Maximum: 1.35 kW Minimum: 0.25 kW (PFB ON), 0.15 kW (PFB OFF)
		CW mode	Maximum: 270 W Minimum: 50 W (PFB ON), 30 W (PFB OFF)	Maximum: 135 W Minimum: 25 W (PFB ON), 15 W (PFB OFF)
	Pulse width *2	REPEAT mode	Standard: 0.2–50.00 ms (0.05 ms steps) [Energy (J)] x [Repetition (pps)] = 0.300 kW or less However, the pulse energy is 30 J or less and the DUTY is 50% or less. *<Note>* When using the output waveform of 0.600 kW, the pps value is limited to keep the average power below 0.300 kW. As a result, the duty ratio becomes 50% or less. Also, when outputting a waveform with a shot (SHOT = 1), the READY signal is automatically turned off for certain time after laser output to keep the average power below 0.300 kW, and the next laser start is not accepted.	Standard: 0.2–50.00 ms (0.05 ms steps) [Energy (J)] x [Repetition (pps)] = 0.150 kW or less However, the pulse energy is 15 J or less and the DUTY is 50% or less. *<Note>* When using the output waveform of 0.300 kW, the pps value is limited to keep the average power below 0.150 kW. As a result, the duty ratio becomes 50% or less. Also, when outputting a waveform with a shot (SHOT = 1), the READY signal is automatically turned off for certain time after laser output to keep the average power below 0.150 kW, and the next laser start is not accepted.
		CW mode	Standard: 0.1–1000.0 s (0.1s steps) Setting switching: 0.001–10.000 s (0.001s steps) 0.01–100.00 s (0.01s steps) 1–10000 s (1s step)	
	Repeated number of pulse/modulation		1 to 1000 pps (REPEAT mode)	
	Modulation function		1 to 5000 Hz (rectangular wave, triangular wave, sinusoidal wave) (CW mode)	
	Oscillation wavelength		1070 ± 3 nm	
	Safety shutter		With open/close sensor	
	Positioning guide beam		Built-in visible laser (red)	
	Prevention of reflected beam		Built-in reflected beam sensor	
	Output stability		±2% @ max. rated output / 4 hours (constant temperature)	

*1   When the optional isolator is mounted, the laser power output from the fiber decreases by up to 10%.

Item			ML-3030AS	ML-3015AS
Power Supply	Power supply	Input power supply	Single-phase, 200 V to 240 V AC (+10%/-15%)	
		Frequency	50/60 Hz	
	Max. input current		11 A (200 V), 10 A (220 V), 9 A (240 V)	9 A (200 V), 8.2 A (220 V), 7.5 A (240 V)
	Max. apparent power		2.2 kVA	1.8 kVA
	Power consumption	Maximum	2.0 kW	1.6 kW
		Standby	0.2 kW	
	Breaker rated current (to be supplied by customers)		For the power supply side, we earnestly recommend using a leakage breaker with the rated current of 15 A or more, which is applicable to harmonics and surges.	
	Ground		Class D (ground resistance: 100 Ω max.)	
Control Panel	Number of schedules		256	
	Schedule setting	REPEAT mode	Laser output waveform Laser energy for upper/lower limit judgment Number of outputs per second Number of repeated outputs Modulation output waveform (when using the modulation function)	
		CW mode	Laser output waveform Modulation output waveform (when using the modulation function)	
	Measurement function		Laser energy (J), Average power (W)	
	Counter		Displays the total number of outputs (9 digits) Displays the number of acceptable outputs (9 digits) Displays the total LD ON time (7 digits) Displays the laser output time (7 digits)	
	Configuration		Integrated type (standard), Separate type (option), 3-m extension cable (option)	
Operating Environment	Ambient temperature *2		10 to 35°C	
	Ambient humidity		50% to 85% RH (non-condesning)	
	Temperature during transport or storage		-10 to 50°C	
	Humidity during transport or storage		20% to 90% RH	
	Vibration during transport		4.9 m/s^2 (0.5 G) max.	
	Impact during transport		49 m/s^2 (5 G) max.	
	Vibration during operations		10 to 60 Hz: 0.98 m/s^2 (0.1 G) max.	
	Intermittent vibration during operations		Less than 2 Hz: 4.9 m/s^2 (0.5 G) max.	
Others	Mass		150 kg or less	
	Dimensions		810 (H) × 400 (W) × 770 (D) mm	
	Noise level	A; Weighted equivalent continuous sound pressure level	75 dB (A) max.	
		C; Sound pressure level	0.3 Pa max.	

This Product uses the Source Code of T-Kernel under T-License granted by the T-Engine Forum (www.t-engine.org).
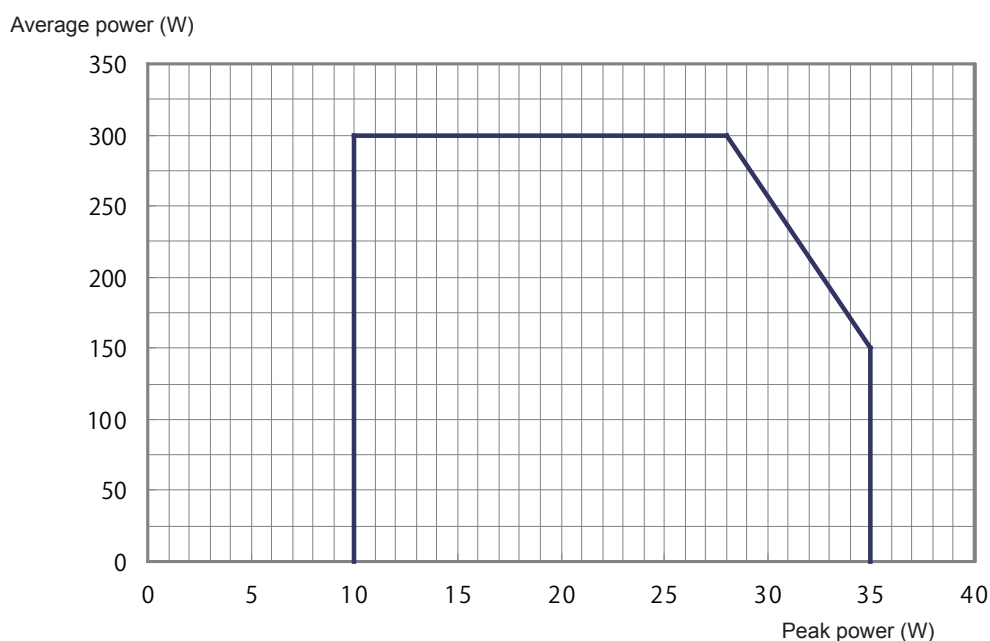
*2   There are following limitations:

Average power limitation by ambient temperature (limitation of duty cycle)
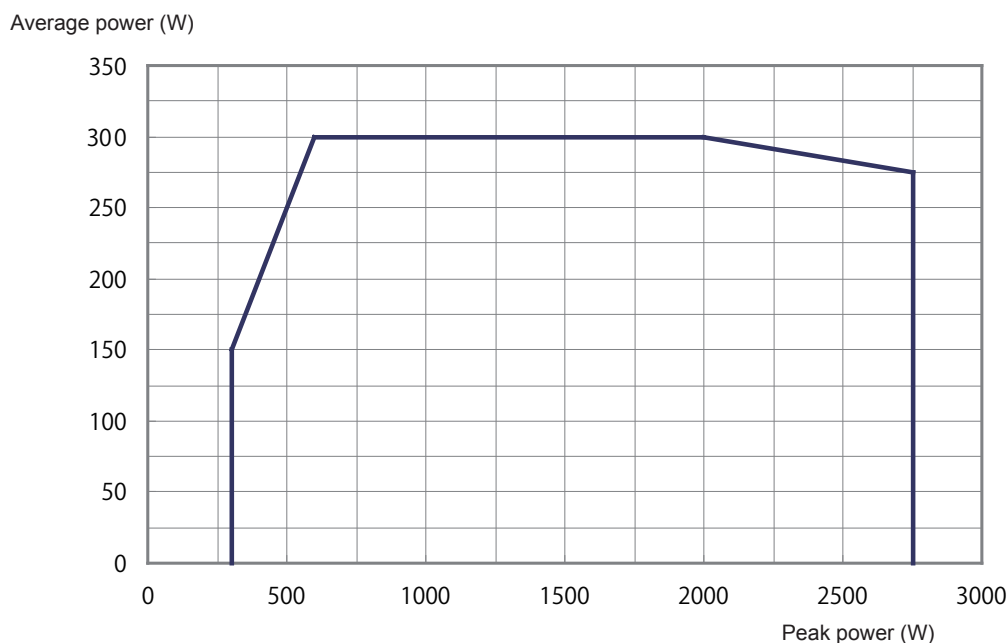
There are limitations of duty cycle at ambient temperature above 28°C. Refer to the graph below to set the average power so that the average power does not exceed the limit within 60 seconds.

ML-3030AS

Ex.) When "300 W of power output for 30 seconds and then stopped for 30 seconds" is repeated at ambient temperature 35°C, the average power becomes 150 W in 60 seconds, and it does not exceed the limit.

Average power (W)

Peak power (W)

Average power limitation by peak power

Average power (W)

Peak power (W)

ML-3015AS

Ex.) When "150 W of power output for 30 seconds and then stopped for 30 seconds" is repeated at ambient temperature 35°C, the average power becomes 75 W in 60 seconds, and it does not exceed the limit.
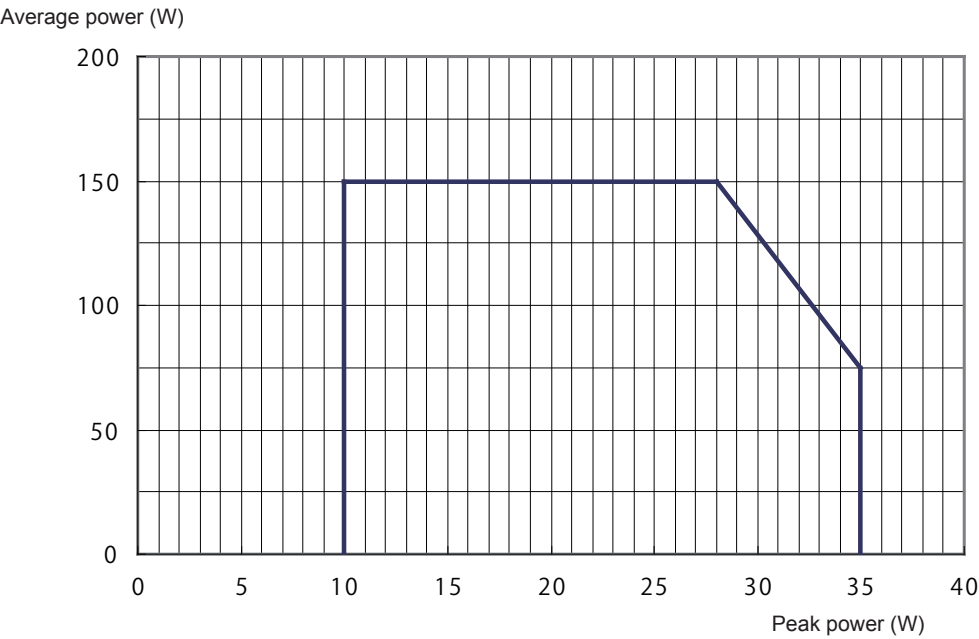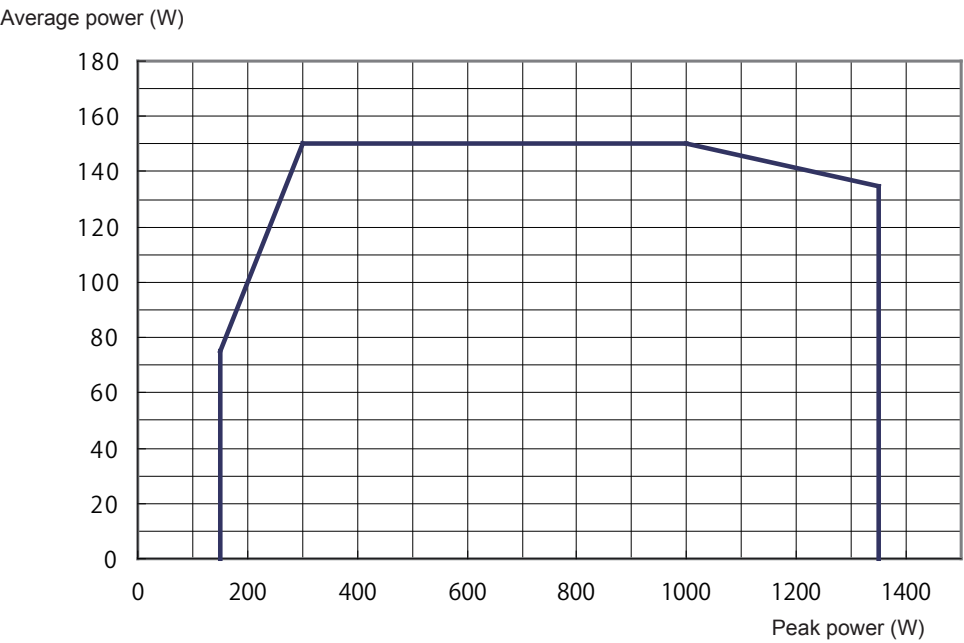
Average power (W)

Peak power (W)

Average power limitation by peak power

Average power (W)

Peak power (W)

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Peak power limitation by ambient temperature and average power (duty cycle)

There are limitations of peak power by average power (duty cycle) at ambient temperature above 21°C. Refer to the graph below to set the peak power so that the peak power does not exceed the limit.

ML-3030AS

Ex.) A limitations of peak power with 300 W of average power is 2.65 kW (REPEAT mode) at ambient temperature 35°C. In this case, configure the setting of the pulse waveform to 2.65 kW or less. (Do not include the area above 2.65 kW.)

REPEAT mode
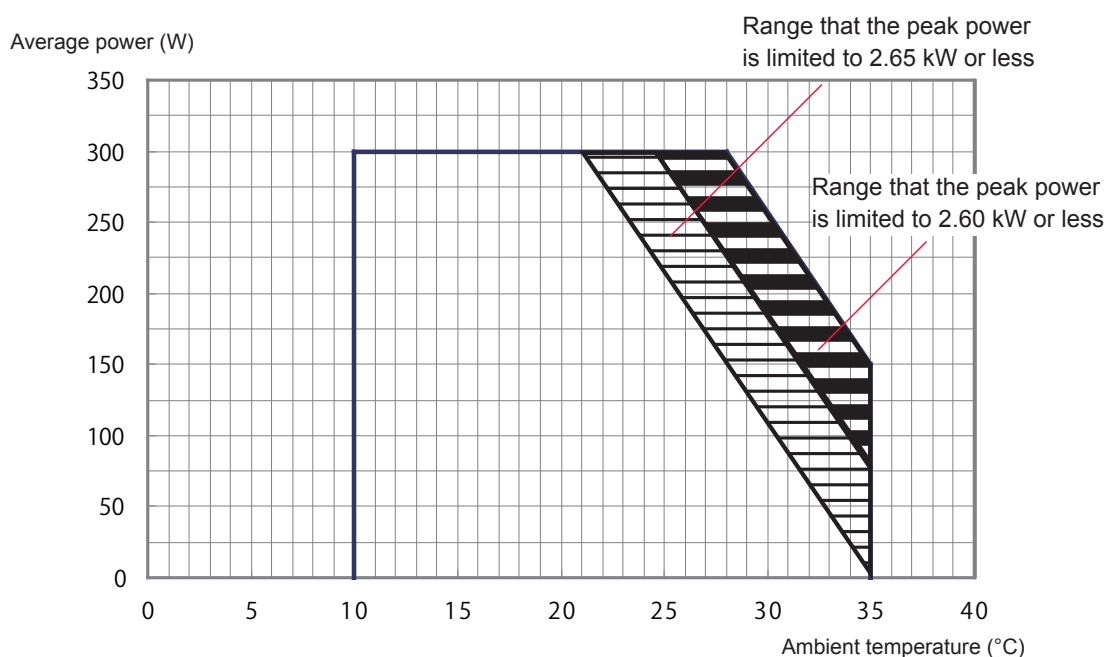
CW mode
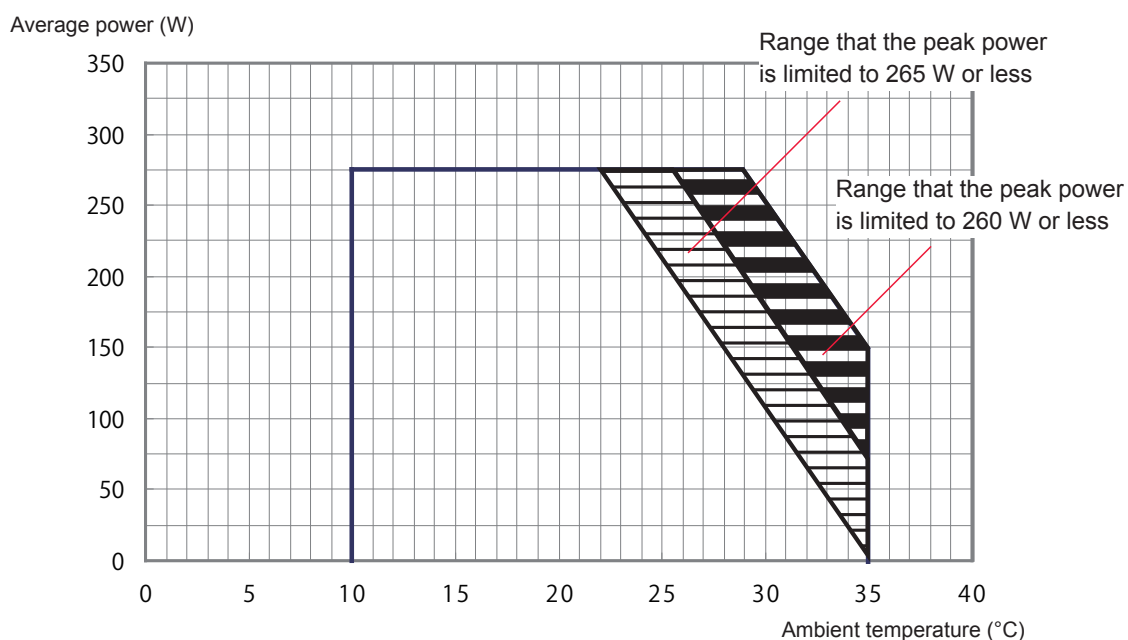
ML-3015AS

Ex.) A limitations of peak power with 150 W of average power is 1.32 kW (REPEAT mode) at ambient temperature 35°C. In this case, configure the setting of the pulse waveform to 1.32 kW or less. (Do not include the area above 1.32 kW.)

REPEAT mode

Average power (W)

Range that the peak power is limited to 1.32 kW or less

Range that the peak power is limited to 1.30 kW or less

Ambient temperature (°C)

CW mode

Average power (W)

Range that the peak power is limited to 130 W or less

Range that the peak power is limited to 132 W or less

Ambient temperature (°C)

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Dimensional Outline Drawings

Unit: mm

Top view

(262)

Front view

810

400

Right side view

740

904

Rear view

Left side view
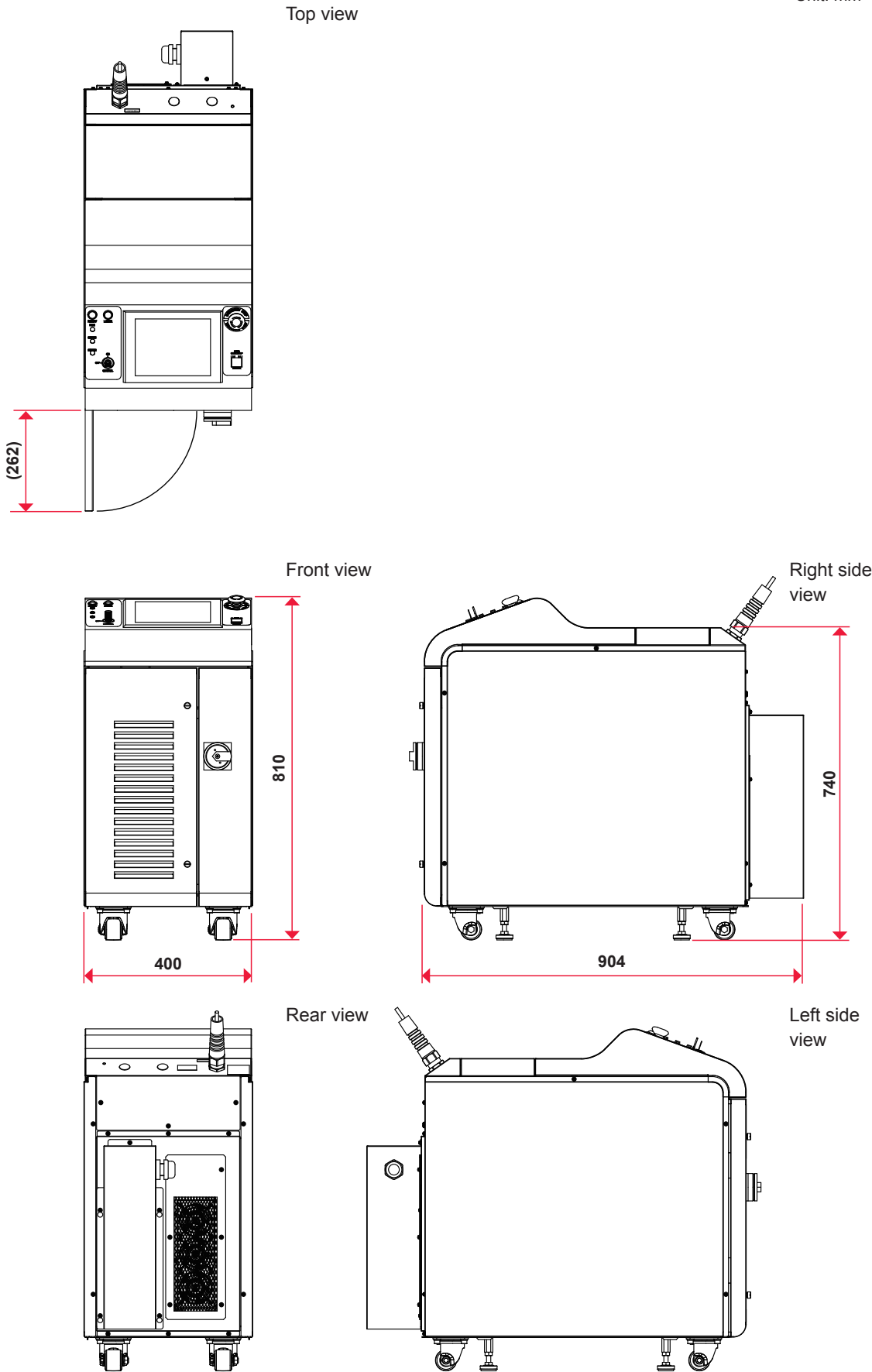
Timing Chart

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 5 types of timing chart are mentioned for your reference.

Single

    Operation by control panel (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)

⇒ For ML-30□□AS-110, Beam is selected regardless of the status of pin No.16 (beam select) of the EXT. I/O (2) connector. Therefore, the pin can be kept open. When the CONTROL keyswitch is turned ON, the SHUTTER lamp comes on.

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

⇒ For the control panel, 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 control panel (PANEL CONTROL)

The following diagram shows the lapse of time in the case where the "BEAM" setting button is pressed and "BEAM 1" is set to ON on the control panel, and then laser light is output from input unit 1 after the safety shutter is opened.

(*: Operation on the user side)
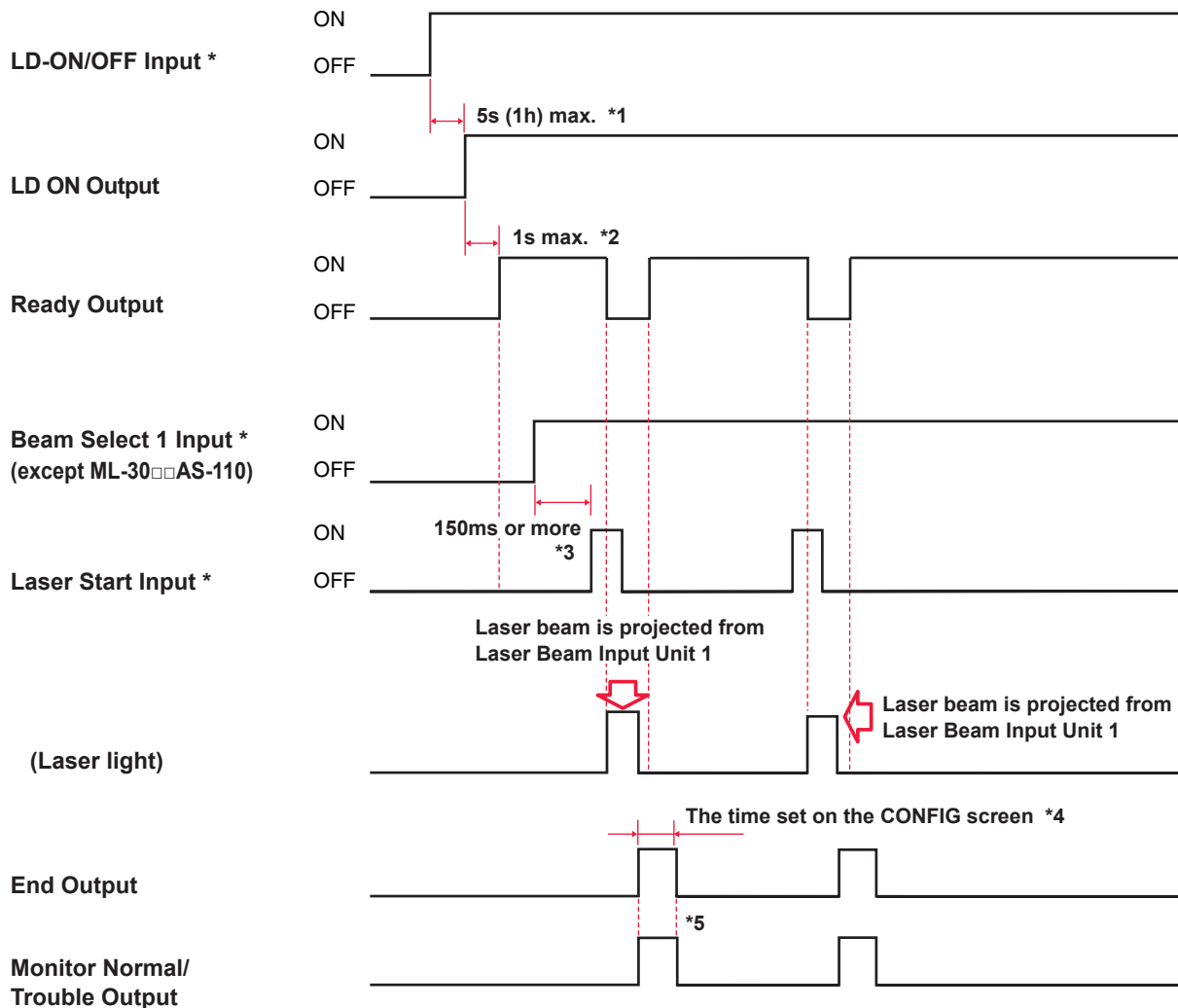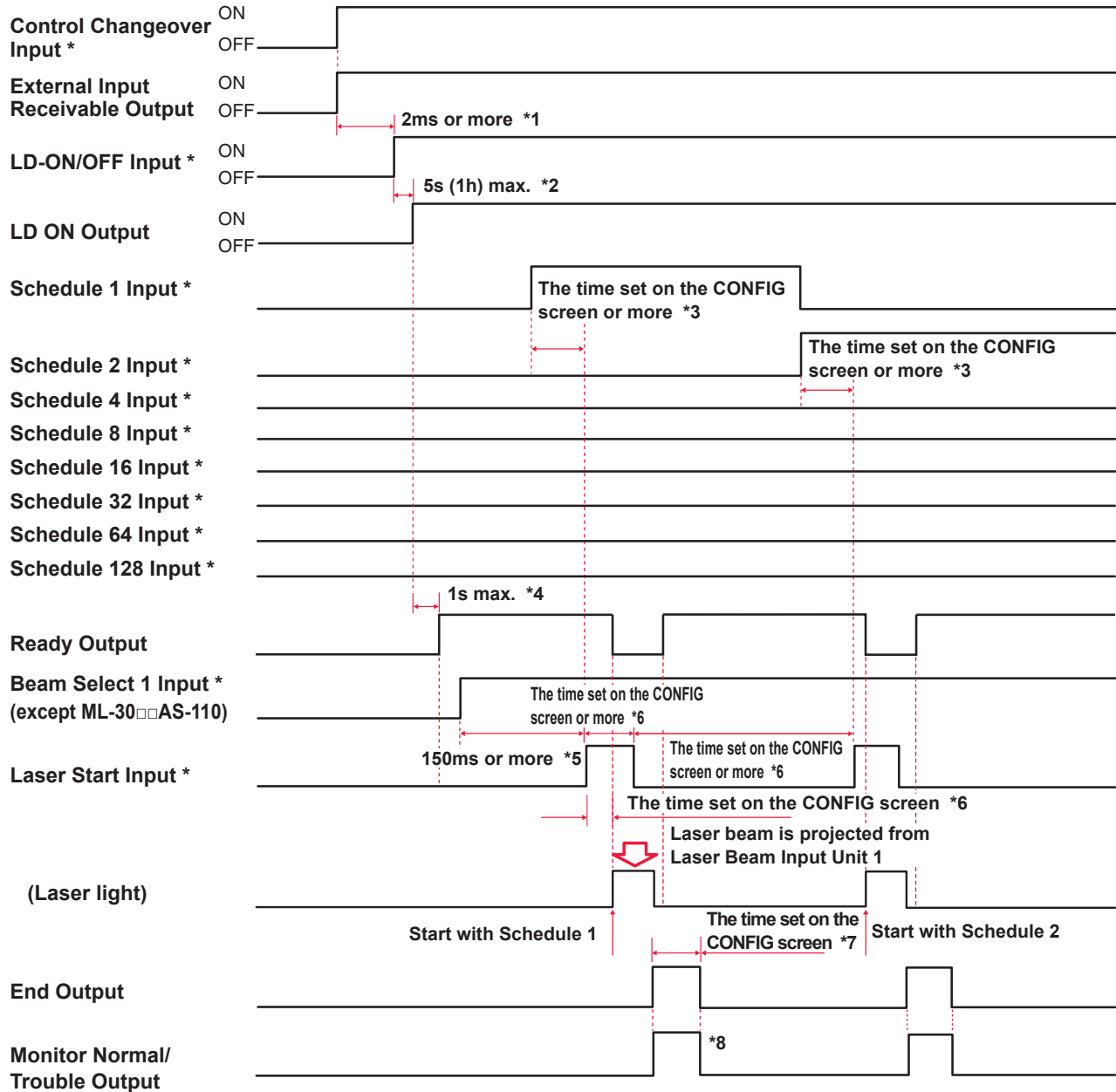

*1	5s (1h) max.	LD on time. When the temperature of fiber laser module is 10°C or more, the time is 5 seconds max. The signal is not output until the temperature of fiber laser module becomes 10°C. (1 hour max.)
*2	1s max.	LD output preparation time. In the REPEAT mode, the signal is kept turned off 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	150ms or more	Shutter operation time. After BEAM selection, a laser start input signal is input after the lapse of certain time for shutter operation.
*4		Time required for the end signal to be output after a laser output
*5		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 *4 and *5, the output time is 20 ms but can be changed to 30 or 40 ms on the CONFIG screen.

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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, BEAM1 is selected, and then laser light is output from input unit 1.

(*: Operation on the user side)

*1	2ms or more	Control changeover time
*2	5s (1h) max.	LD on time
*3		Schedule signal acceptance time (time from a schedule signal input till establishment of schedules)
*4	1s max.	LD output preparation time
*5	150ms or more	Shutter operation time
*6		Laser start signal acceptance time (time from a signal input till an output). Time from the laser start signal till oscillation is 50 to 100 µs after the time set on the CONFIG screen.
*7		Time required for the end signal to be output after a laser output
*8		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 *6, the acceptance time is 4 ms but can be changed to 0.1, 1, 2, 8 or 16 ms on the CONFIG screen.

In *7 and *8, 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, BEAM1 and 2 are selected and laser light is output from input unit 1 and 2 respectively with a time difference.

(*: Operation on the user side)

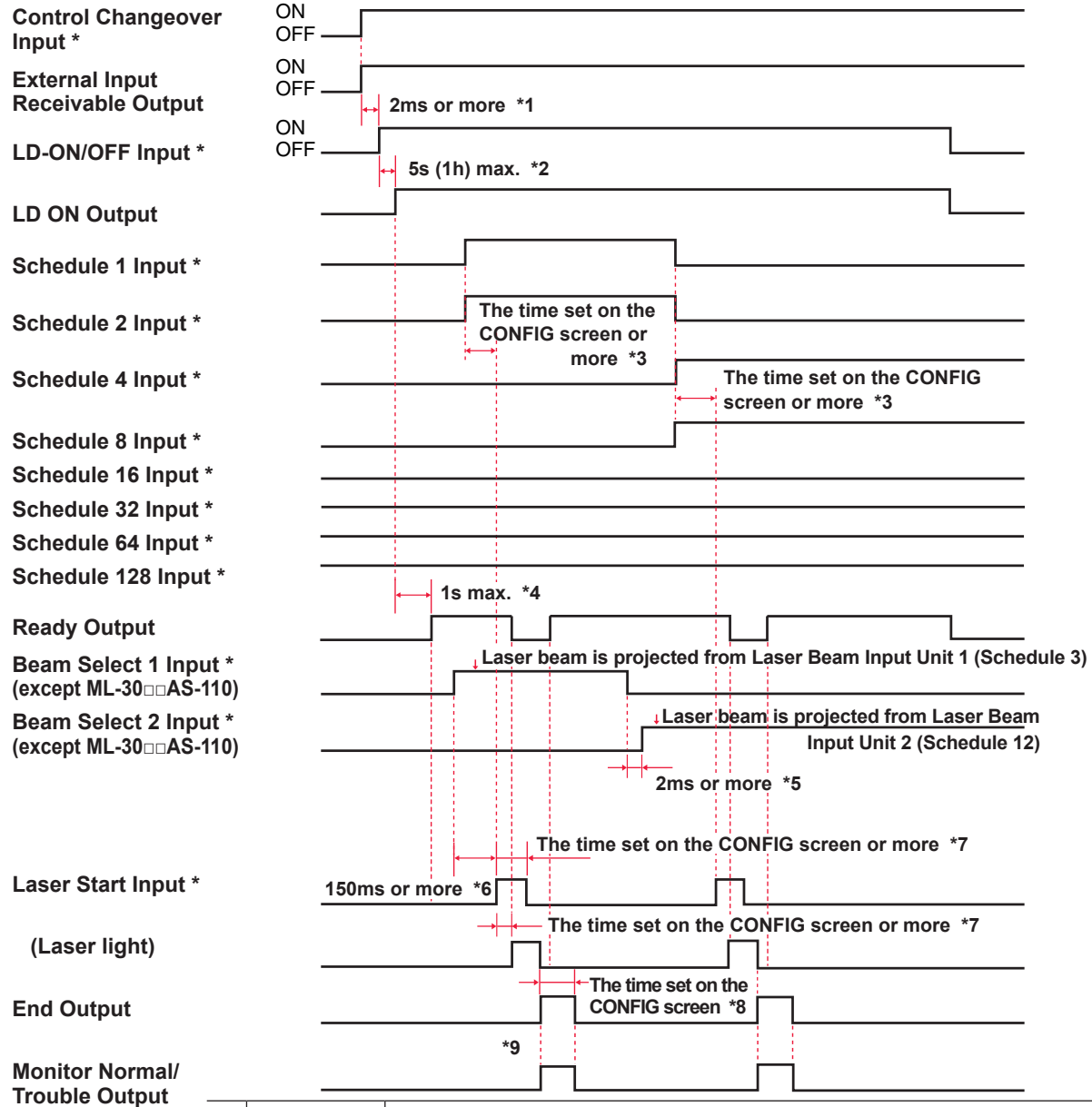| *1	2ms or more	Control changeover time
*2	5s (1h) max.	LD on time
*3		Schedule signal acceptance time (time from a schedule signal input till establishment of schedules)
*4	1s max.	LD output preparation time
*5	2ms or more	Shutter operation changeover time
*6	150ms or more	Shutter operation time
*7		Laser start signal acceptance time (time from a signal input till an output)
*8		Time required for the end signal to be output after a laser output
*9		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 *7, the acceptance time is 4 ms but can be changed to 0.1, 1, 2, 8 or 16 ms on the CONFIG screen.

In *4 does not output a ready signal unless a value is entered in the specified conditional input.

In *8 and *9, the output time is 16 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, BEAM1 is selected, and then laser light is output from input unit 1.

(*: Operation on the user side)

LD ON Output

Schedule 1 Input *

Schedule 2 Input *

Schedule 4 Input *

Schedule 8 Input *
Schedule 16 Input *
Schedule 32 Input *
Schedule 64 Input *
Schedule 128 Input *

1s max. *1

Ready Output

Beam Select 1 Input *
(except ML-30□□AS-110)

The time set on the CONFIG screen or more

150ms or more *2

Laser Start Input *

Continuous output from input unit 1

(Laser light)

1ms or more

Laser Stop Input *

The time set on the CONFIG screen *3

End Output

*4

**Monitor Normal/
Trouble Output**

Laser beam is output repeatedly
according to Schedule 7

The laser repetition stops when
Laser Stop signal is input

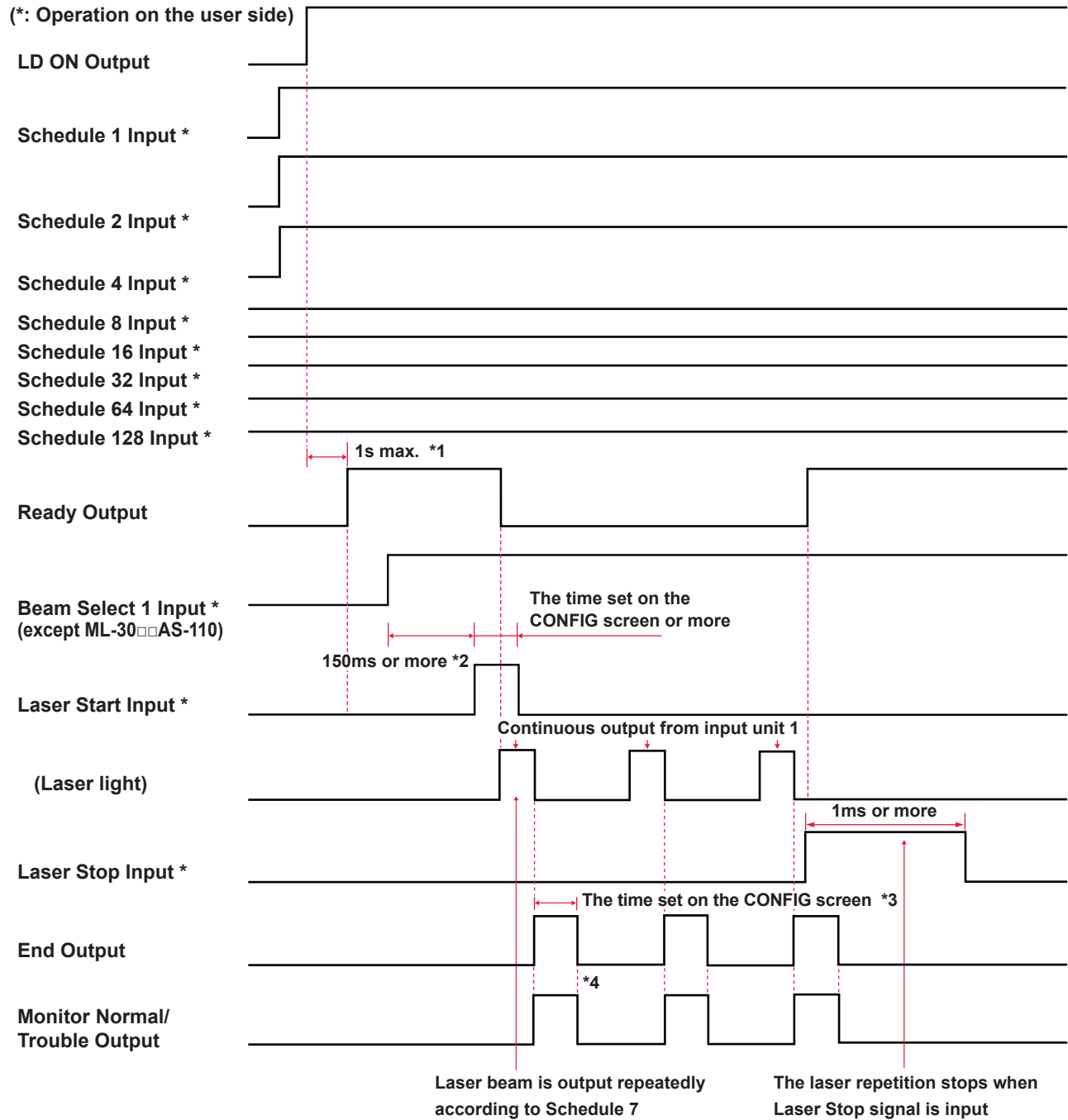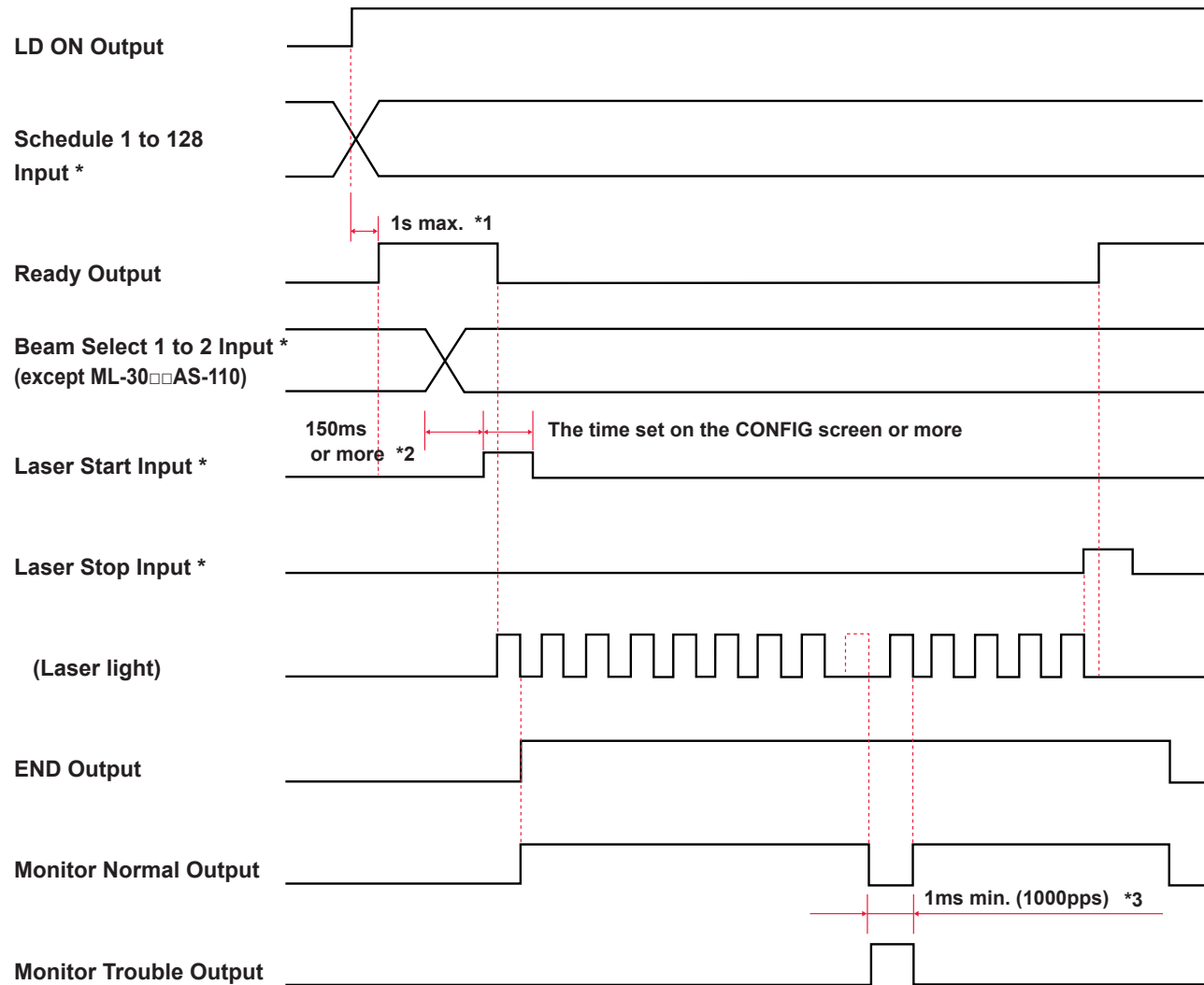| *1	1s max.	LD output preparation time
*2	150ms or more	Shutter operation time
*3		Time required for the end signal to be output after a laser output
*4		Time required for outputting a signal to indicate whether the laser energy is within the set upper limit value (HIGH) and lower limit value (LOW) 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.

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

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

(*: Operation on the user side)

Signal	Timing
LD ON Output	
Schedule 1 to 128 Input *	
Ready Output	1s max. *1
Beam Select 1 to 2 Input * (except ML-30□□AS-110)	
Laser Start Input *	150ms or more *2 The time set on the CONFIG screen or more
Laser Stop Input *	
(Laser light)	
END Output	
Monitor Normal Output	
Monitor Trouble Output	1ms min. (1000pps) *3

*1	1s max.	LD output preparation time
*2	150ms or more	Shutter operation time
*3	1ms min.	Monitor error output time. Minimum error output time for 1000 pps.

Explanation of Terminology

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

A	
ACK	Control code that is used for communication between computers. Affirmative response that is sent from the computer of transmission destination to the transmission source. Abbreviation of acknowledgement (affirmative response). → P.143
Asynchronous system	Communication system in which the transmitting timing is not matched with the receiving timing. In the synchronous system, timing information is transmitted at data transmission and the receiving side receive the data by using this timing information. In the asynchronous system, the receiving side receives only data.
B	
BCC	Control code that is used for communication between computers. Error check character that is added to check a transmission error for each block of the communication text. Abbreviation of Block Check Character. → P.143
Beamsplitter	Mirror to reflect laser light, which is incorporated in the laser oscillator section. → P.106
C	
COM (Common)	Common line. This means a connecting point where the multiple points are connected to the same common point. The electric circuit includes an A contact, B contact, and Common. The common contact is connected to the A contact and B contact commonly. Abbreviation of Common.
Common	Common line. This means a connecting point where multiple points are commonly connected to the same point in the circuit or wiring. The electric circuit includes an A contact, B contact, and Common. The common contact is connected to the A contact and B contact commonly. This is abbreviated as COM.
D	
Data bit	Bit to indicate one-character data that is used for asynchronous communication. → P.141
Diode laser	Package that mounts the LD bar in a heat sink.
E	
ETX	Control code that is used for communication between computers. → P.143
Excitation	Phenomenon in which the electrons around an atom proceed from the ground status to a one-upper status. In the case of laser, excitation means that the atoms or molecules in the laser medium proceed from a low energy status to a high energy status when energy is given from the outside.
F	
FC-LD	Unit that permits diode laser light to be emitted from the fiber by using a special optical system. Abbreviation of Fiber Coupling Laser Diode.
FIX	Fixed waveform that is a laser light output means to be used by this laser. Laser light with a fixed waveform by up to 3 divisions in the case where output time and the output value are set in the range of the first laser and the third laser. → P.83
Fixed waveform	Laser output method by this laser. This is called FIX. Laser light with a fixed waveform by up to 3 divisions in the case where output time and the output value of each point are set in the range of the first laser and the third laser. → P.83

FLEX	Flexible waveform of pulse oscillation that is a laser light output means to be used by this laser. Laser light with a flexible waveform in the case where output time and the output value of each point are set in the range of POINT 01 and POINT 20. → P.85
Flexible waveform	Laser light output method of this laser. This is called FLEX or CW. Laser light with a flexible waveform in the case where output time and the output value of each point are set in the range of POINT 01 and POINT 20. → P.85 and P.87
Full duplex	Communication system in which data can be send and received simultaneously from both sides in two-way communication. The data transfer system of this laser is an asynchronous full duplex system. → P.141

G

Grounding	Electrical connection between an electric device and the ground. This is also called earth or ground.
Grounding work	Specified in Article 18 "Interpretation of Technical Standard of Electric Equipment." The grounding work for device connected to a low-voltage circuit of 300 V or less is performed in compliance with class D, and that of more than 300 V is performed in compliance with class C. → P.39
Guide light	Auxiliary light to check the laser light irradiating position and make a positional adjustment. Light with a wavelength of 380 nm to 780 nm that can be seen by man. This is also called visible laser. In this laser, diode laser for guide light is output. → P.60

H

Harmonic	Waveform having 3 to 40 times of frequency of the basic frequency (50/60 Hz). → P.43

I

Input unit	Unit to transmit laser light to the optical fiber. → P.24
Interlock	Circuit to prevent hazards, which stops the machine operation when a material comes close to a place where a hazardous unit or equipment is provided.

L

L	Line terminal. This is a terminal to be connected to a line conductor of the external circuit. Abbreviation of Live. → P.43
Laser	LASER is an abbreviation of Light Amplification by Stimulated Emission of Radiation, which is light artificially generated by laser oscillator. Laser is classified into solid laser, liquid laser, and gas laser by medium.
Laser light	Light artificially generated by laser oscillator. This laser light is widely used for electronic devices, optical communication, medial treatment, metal working, and other fields. As a matter of feature, laser light goes straight, its wavelength is fixed and the phase (wave peak and hollow) is the same, so high energy can be obtained by concentrating light to one point.
Laser power feedback	Control function that is adopted for this laser. The measured value and average power of output laser energy is retuned to the input side so that they can be checked immediately after a laser output.
Laser safety supervisor	Person who is responsible for laser safety management, having an enough knowledge to execute laser hazard assessment and safety management. For the facilities or places where a laser product exceeding Class 3B in JIS C 6802 "Safety Standards for Laser Products", it is necessary to appoint a laser safety supervisor and provide a management area. Since most laser welder comes under class 4 of the highest hazard, the laser safety supervisor must be appointed. → P.9
LD	General term for diode laser and FC-LD.
LD chip	Semiconductor laser device.

Leakage breaker	Safety device to shut off the circuit at detection of a leakage current that flows from the power supply to the ground.

N

N	Neutral point terminal. This is a terminal to be connected a neutral point of the circuit. Abbreviation of Neutral. → P.43
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.143

O

Optical fiber	Cable to transmit light that is made of quarts glass or thin plastic fiber. This cable consists of a core of the center and a clad covering the surroundings, and light is propagated in the core. The mode is classified into 2 types, namely, multi mode and single mode by the number of light propagation modes, and the multi-mode optical fiber is divided into step index (SI) and graded index (GI) by refractive index distribution of the core.
Oscillator	In the laser welder, the oscillator means a unit to amplify and oscillate laser light. This unit consists of a laser medium, excitation source, amplifier, etc. Laser is amplified and oscillated when the laser medium is excited by excitation source.
Output unit	Unit to output the laser light transmitted by optical fiber to the workpiece. The optical fiber connected to the input unit is connected. → P.24 and P.44

P

Parity	Method to check whether data is correctly transmitted or received in data communication. A data error is detected by using bit information or parity bit that is added to the data. Parity means Odd and Even.
Parity bit	Data that is added to the source data to detect an error in data communication. The receiving side collates with the parity bit by checking whether the number of 0s or 1s in the obtained bit train is odd or even. When an error is found, data is retransmitted or processing is interrupted. → P.141
PE	Protective earthing terminal. This is a terminal that is provided to ground a device. Abbreviation of Protective Earth. → P.43
Peak power	At laser welding, the peak power means the energy amount per time (value resulting from dividing the pulse energy by pulse width) and its unit is kilowatt (kW) in the REPEAT mode or watt (W) in the CW mode.
Peak value	Laser output peak value. "PEAK POWER" value (FIX/FLEX) or "POWER" value (CW) that is set on the SCHEDULE screen in this laser. → P.83
Photo MOS relay	Full solid relay that adopts a light emitting diode on the driving side and MOS (Metal-Oxide Semi-conductor) FET (Field-Effect Transistor) for the contact. → P.123
PLC	Device that exerts sequence control by executing the programmed contents of control in sequence. This is often called Sequencer (product name of Mitsubishi Electric Corporation). Abbreviation of Programmable Logic Controller.
Powersharing	Laser light delivery specification. Single laser light is split into multiple beams by beamsplitter so that laser light is output simultaneously to multiple optical fibers. → P.106
pps	Number of pulses per second. Abbreviation of pulse per second.
Protective glasses	Protective glasses that the operator puts on to protect the eyes from laser light. The protective glasses are divided into some types by wavelength of laser light.
Pulse width	Time during which laser light is irradiated.

R

Rated current	Maximum effective current value when a current can be continuously output. This value indicates that it is prohibited to cause a current to continuously flow exceeding this level.
Remote interlock	Interlock function to shut off the laser output in an emergency as a means for using the laser device safely. In this laser, the E-STOP connector (the REM. I/L connector when replacing our old products) is connected to the door of the room so that laser light may be shut off when the door is opened. → P.127 and P.128
Resistivity	Electric resistance generally used as a scale to indicate the hardness of current flow for a material. Its unit is ohm (Ω). The value that indicates this resistance by unit volume (1 cm x 1 cm x 1 cm) is volume resistivity and its unit is ohm centimeter (Ωcm).
RS-232C	Serial communication standard that is standardized by Electric Industries Alliance (EIA) of the United States. This is used for a connection between a data line terminator such as MODEM and a data terminal unit such as PC. Many different devices are based on this standard, so that this standard is used for various fields. Abbreviation of Recommended Standard-232C. → P.140
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.140
RxD	Pin for received data out of signal lines of the communication connector. → P.140

S

Safety shutter	Shutter to cut off laser light, which is incorporated in the laser oscillator section. When the shutter is set to open, laser light is output. → P.106
SCHEDULE	This word means a laser light output schedule in this laser. 256 types of SCHEDULE can be set and each schedule can be registered with a SCHEDULE number. → P.83
Sequencer	A type of PLC (Programmable Logic Controller) that exerts sequence control by executing the programmed contents of control, being a product name of Mitsubishi Electric Corporation.
Single phase	Electric current whose magnitude and direction change periodically, having the same phase. This single phase is used as a 100 V power supply for electric lamps and plug sockets.
sq (square)	Unit that represents a sectional area of cable. Square millimeter. → P.43
Start bit	Bit to indicate the beginning of data in the asynchronous communication mode in which synchronization is performed for each data such as control character and symbol. The bit to indicate a separation between characters is called stop bit. → P.141
STX	Control code that is used for communication between computers. → P.143
Surge	Abnormal overvoltage or overcurrent applied momentarily to the electric circuit. → P.43

T

Timesharing	Laser light delivery specification. When the incorporated timesharing unit is operated, laser light is output to a single optical fiber. This function is provided in the timesharing specification of this laser. → P.106
Timesharing unit	Unit that mounts mirrors to reflect laser light. Laser light is output to the selected optical fiber when the mirror is operated. This unit is incorporated in the laser oscillator section according to the timesharing specification of this laser. → P.10
TxD	Pin for send data out of signal lines of communication connector. → P.140

W

Work distance	Distance from the laser light output position to the target workpiece for laser welding.

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

ITEM		SETTING RANGE	UNIT	SCHEDULE (Enter No. optionally.)												
			No.													
↑SLOPE	TIME	00.0 - 50.0	ms													
FLASH1	TIME	00.2 - 50.0	ms													
	POWER	000.0 - 200.0	%													
COOL1	TIME	00.0 - 50.0	ms													
FLASH2	TIME	00.0 - 50.0	ms													
	POWER	000.0 - 200.0	%													
COOL2	TIME	00.0 - 50.0	ms													
FLASH3	TIME	00.0 - 50.0	ms													
	POWER	000.0 - 200.0	%													
↓SLOPE	TIME	00.0 - 50.0	ms													
PEAK POWER **ML-3030AS:**		1.000 - 2.700	kW													
ML-3015AS:		1.000 - 1.350														
REPEAT		0001 - 1000	pps													
SHOT		0001 - 9999														
ENERGY	HIGH	00.000 - 99.999	J													
	LOW	00.000 - 99.999	J													

NETWORK #

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

SCHEDULE (Enter No. optionally.)

ITEM		SETTING RANGE	No./UNIT																
↑SLOPE	TIME	00.0 - 50.0	ms																
FLASH1	TIME	00.2 - 50.0	ms																
FLASH1	POWER	000.0 - 200.0	%																
COOL1	TIME	00.0 - 50.0	ms																
FLASH2	TIME	00.0 - 50.0	ms																
FLASH2	POWER	000.0 - 200.0	%																
COOL2	TIME	00.0 - 50.0	ms																
FLASH3	TIME	00.0 - 50.0	ms																
FLASH3	POWER	000.0 - 200.0	%																
↓SLOPE	TIME	00.0 - 50.0	ms																
PEAK POWER **ML-3030AS:**		1.000 - 2.700	kW																
ML-3015AS:		1.000 - 1.350																	
REPEAT		0001 - 1000	pps																
SHOT		0001 - 9999																	
ENERGY	HIGH	00.000 - 99.999	J																
ENERGY	LOW	00.000 - 99.999	J																

NETWORK #

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

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

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

ITEM		SETTING RANGE	UNIT	No. SCHEDULE (Enter No. optionally.)
POINT 16	TIME	00.0 - 50.0	ms	
	POWER	000.0 - 200.0	%	
POINT 17	TIME	00.0 - 50.0	ms	
	POWER	000.0 - 200.0	%	
POINT 18	TIME	00.0 - 50.0	ms	
	POWER	000.0 - 200.0	%	
POINT 19	TIME	00.0 - 50.0	ms	
	POWER	000.0 - 200.0	%	
POINT 20	TIME	00.0 - 50.0	ms	
	POWER	000.0 - 200.0	%	
PEAK POWER	ML-3030AS:	1.000 - 2.700	kW	
	ML-3015AS:	1.000 - 1.350		
REPEAT		0000 - 1000	pps	
SHOT		0001 - 9999		
ENERGY	HIGH	00.000 - 99.999	J	
	LOW	00.000 - 99.999	J	

NETWORK # _____

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

ITEM		SETTING RANGE	UNIT	SCHEDULE (Enter No. optionally.)
POINT 01	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 02	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 03	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 04	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 05	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 06	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 07	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 08	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 09	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 10	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 11	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 12	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 13	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 14	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 15	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	

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

ITEM		SETTING RANGE	UNIT	No. / SCHEDULE (Enter No. optionally.)
POINT 16	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 17	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 18	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 19	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
POINT 20	TIME	00.0 - 99.9	sec	
	POWER	000.0 - 200.0	%	
PEAK POWER	ML-3030AS:	100 - 270	W	
	ML-3015AS:	100 - 135		
POWER	HIGH	000 - 999	%	
	LOW	000 - 999	%	

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