GE Fanuc Automation Europe

Computer Numerical Controls

Laser-Model C1000*i*A

Operator's Manual

B-70254EN/01

FANUC

TECHNOLOGY AND MORE

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In this manual we have tried as much as possible to describe all the various matters.
However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.
Therefore, matters which are not especially described as possible in this manual should be regarded as "impossible".

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1 OVERVIEW

This manual describes how to handle the FANUC LASER-MODEL C1000*i*A for those users who operate laser oscillators.
In this manual, we have tried as for as possible to address all issues. However, space restrictions prevent us from describing everything that must not be done,
or which cannot be done, because there are so many possibilities.
Therefore, all matters which are not specifically described as being possible should be regarded as being "impossible".

1.1 MANUAL CONTENTS

This manual consists of the following chapters and appendixes:

1. OVERVIEW
   Chapter 1 covers the configuration of the manual, applicable models, related manuals, and provides notes on reading the manual.

2. SAFETY
   Chapter 2 covers the warnings and precautions related to laser beams, high voltages, high temperatures, and a toxic substances. To ensure safe operation, read this chapter first.

3. FUNCTIONS
   Chapter 3 describes the structure and operation of the laser oscillator.

4. MAINTENANCE
   Chapter 4 describes the periodic maintenance of the laser oscillator.

5. TROUBLESHOOTING
   Chapter 5 describes the actions to be taken if the oscillator malfunctions.

APPENDIX
A. EXTERNAL VIEW
B. FANUC LASER C SERIES SPECIFICATIONS
C. ERROR CODE LIST
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1.2 APPLICABLE MODELS

This manual covers the following models:

Model	Abbreviation
FANUC LASER-MODEL C1000*i*A	C1000*i*A

1.3 RELATED MANUALS

The following manuals are available for the FANUC LASER-MODEL C1000*i*A:

FANUC Series 16*i*-LA	DESCRIPTIONS	B-63192EN
	CONNECTION MANUAL	B-63193EN
	OPERATOR'S MANUAL	B-63194EN
	MAINTENANCE MANUAL	B-63195EN
	PARAMETER MANUAL	B-63200EN
FANUC LASER-MODEL C1000*i*A	DESCRIPTIONS	B-70252EN
	OPERATOR'S MANUAL (This manual)	B-70254EN
	MAINTENANCE MANUAL	B-70255EN

1.4 FOR SAFE OPERATION

This manual contains precautions which must be observed during operation of the laser oscillator, to ensure the operator's safety and prevent damage to the oscillator. Each precaution is indicated by "Warning" or "Caution" according to its severity.
Supplementary information is indicated by "Note".
Read the contents of each "Warning", "Caution", and "Note" before attempting to use the oscillator.

WARNING
Precautions to be applied in those situations where there is a danger of the operator being killed or seriously injured.

CAUTION
Precautions to be applied in those situations where there is a danger of the operator being slightly injured or the oscillator being damaged.

NOTE
Supplementary information other than precautions.

The functions of a laser machining system depend not only on the laser oscillator, but also on the machine, power magnetics cabinet, servo system, CNC, and operator's panel. This manual describes only the laser oscillator. For a description of the other components, refer to the corresponding manuals, supplied by the machine tool builder.

- Read this manual thoroughly and store it in a safe place.

2 SAFETY

This chapter describes precautions to be observed to ensure the safe operation of the laser oscillator.
Read this chapter thoroughly before attempting to use the laser oscillator.
Also, read the safety precautions in the operator's manual supplied by the machine tool builder.
The laser oscillator may present a danger not only to the operator but also to other people working around the oscillator, up to a considerable distance away. The laser oscillator must, therefore, be operated only by a person who has received appropriate training.
Only persons who have understood the internal structure of the laser oscillator and have received appropriate training can maintain the laser oscillator.
A warning label is put on each dangerous position of the laser oscillator. Be extremely careful about the labeled positions.

2.1 WARNING

(1) It is extremely dangerous to expose your eyes to direct, scattered, or reflected CO_2 laser light. Always wear protective glasses while the laser is operating.
Exposure to laser light can cause blindness. If your eyes are accidentally exposed, seek medical advice immediately.

(2) Do not turn on the laser oscillator while a panel is removed or a door is open.
Operating the laser with a door open or panel removed may result in the operator being directly exposed to CO_2 laser radiation. Exposure to laser light can cause blindness and/or severe burns. If your eyes are accidentally exposed to laser light, seek medical advice immediately.
Before turning on the power during maintenance if absolutely necessary, wear protective glasses and clothing to prevent accidents.

(3) If the laser oscillator is operated with a panel open, ultraviolet radiation is emitted from the high-frequency discharge section. Gazing the discharge section for a long time can cause visual disturbances such as impaired eyesight.
Always wear protective glasses during work. If you feel trouble with your eyes, seek medical advice immediately.

(4) Surround the laser machining tool with a fence made of a material which absorbs laser light well (such as acrylic). Place appropriate warning notices on the fence.
The door in the safety fence shall be fitted with an interlock switch such that opening the door stops the laser.
Failure to provide such a fence exposes persons in the vicinity of the machine tool to the danger of being exposed to CO_2 laser radiation and the associated risk of blindness. If a person is accidentally exposed to laser light, seek medical advice immediately.

(5) The laser beam shall be no higher than average eye height. Enclose the path of the laser beam with covers. Do not leave the end of the beam path open. Place laser- absorbing material at the end of the beam path to absorb the beam's energy.
A CO_2 laser beam is directional and has a high energy density. Exposure to laser light can cause blindness. Flammable material may burn or explode if exposed to the laser beam. If your eyes are accidentally exposed to laser light, seek medical advice immediately.

(6) A high voltage of 3 to 4 kV_{0-p} is applied to some places in the laser oscillator cabinet. Therefore, do not turn the power to the oscillator on or operate the oscillator when an oscillator panel is open. Operating the laser oscillator with a panel open can cause a touch on a high-voltage place, resulting in electric shock. Before turning on the power during maintenance if absolutely necessary, take measures against accidents.

(7) Before daily inspection, the replacement of a maintenance part or maintenance, open the main circuit breaker and turn the power supply off (double power-off).
To prevent the power from being inadvertently turned on, lock the circuit breaker open, and affix an indication of work in progress.
Failure to turn off the power during inspection or replacement exposes the operator to the danger of electric shock.
Before turning on the power during maintenance if absolutely necessary, take measures against accidents.

(8) The oscillator output mirror and focusing lens on the machining head both have a substrate made of ZnSe (zinc selenide), a toxic substance. Therefore, do not touch the mirror or lens with your bare hands.
Inhaling ZnSe dust may cause difficulty in breathing, completely stopping the breathing of the victim in the worst case.
If you accidentally touch the mirror or lens with your bare hands, wash your hands well under running water.
If you accidentally inhale ZnSe dust or debris, seek medical advice immediately.

(9) Do not look at the machining point without eye protection. Otherwise, your eyes may be exposed to reflected laser light, resulting in blindness.
If your eyes are accidentally exposed to laser light, seek medical advice immediately.

(10) Before attempting to machine any material for the first time, consult with the manufacturer of the material.
Some materials generate toxic gases when cut or drilled by a laser beam.
Should you accidentally inhale any toxic gas, seek medical advice immediately.

(11) If the laser oscillator must be moved, entrust the work to the machine tool builder whenever possible. If performed by inexperienced personnel, the oscillator may topple or be dropped, resulting in a potentially fatal accident.
When the machine tool builder is not available to move the oscillator, follow the procedure described on the hanging method label. While moving the oscillator, stand well clear and never pass under the oscillator.

(12) Do not allow any dangerous or high-pressure gas to get into the oscillator housing. The oscillator cabinet has a hermetic structure (dustproof and dripproof), it cannot be ventilated easily.
Flammable gases such as oxygen can cause a fire or explosion.
Toxic gases can harm operators during maintenance. Organic gases can degrade machining performance. High-pressure gases can damage a panel or the cabinet, resulting in injury from flying matters.
If such a gas accidentally gets into the oscillator housing, remove a panel for ventilation. The installation room must be also well ventilated.
To purge the oscillator housing, use purified, low-pressure air or nitrogen.

2.2 CAUTION

(1) If there is a possibility of being exposed to CO_2 laser radiation exceeding the maximum permissible exposure (MPE) level for skin, wear protective clothing.
Otherwise, there is a danger of being burnt.

(2) FANUC LASER-MODEL C1000*i*A is fitted with a red semiconductor laser to indicate the approximate position of invisible CO_2 laser beam. Do not look directly at the semiconductor laser beam. Otherwise, your eyes may be injured.

(3) The gas circulating system in the oscillator becomes very hot.
Do not touch the gas pipes, turbo blower, heat exchanger, or exhaust pump, until they have cooled down sufficiently after the oscillator has been turned off. Otherwise, you may be burnt.

(4) Do not pass your hand in the optical path of the laser machine or under the laser head when the shutter of the oscillator is open. When the shutter is open, a laser beam may be emitted from the oscillator accidentally. Before work in the optical path or under the laser head, confirm that the shutter is closed.

(5) The workpiece becomes very hot during machining. Never touch the workpiece with your bare hands. Otherwise, you may be burnt.

(6) During machining, extremely hot chips are likely to be generated.
Unless sufficient caution is exercised, there is a danger of the operator being burnt, or of a fire being started.

(7) Some materials may burn or explode when laser machined. Before attempting to machine any material for the first time, consult with the manufacturer of the material, to prevent the danger of fire of or the possibility of operator injury.

(8) The oscillator contains cooling fan units. Although the fan units are fitted with a finger guard, to prevent injury, keep your hands well away from the fans.

(9) The oscillator is controlled according to the CNC internal parameter settings. If a numeric value different from a setting is entered and the oscillator is operated, the oscillator may malfunction. In the worst case, the oscillator may be damaged.

2.3 NOTE

(1) During installation or maintenance necessitating the opening of an oscillator door or the removal of a panel, only persons who have undergone maintenance training should operate the laser. In such a case, extreme caution must be exercised.

(2) Warning labels are affixed to those parts of the oscillator where there is a danger of exposure to laser radiation. Observe the precautions given on the labels. (Section 2.4 shows the warning labels.)

(3) Laser products shall conform to the regulations laid down in the laser safety standard, including that stipulating control using a key.
The oscillator start signal (RUN ON) shall be controlled with a key switch such that the oscillator cannot be turned on without a specific key.
Control using a key ensures that other than the authorized personnel cannot operate the laser oscillator. It is extremely dangerous if a person who is unfamiliar with the equipment attempts to operate the laser oscillator.

(4) The shutter shall be unlocked only while a beam is being output. Otherwise, keep the shutter locked to provide protection should the laser accidentally be turned on.

(5) Do not discard a used output mirror or focusing lens together with regular waste. If the output mirror or focusing lens is replaced, return the original to the supplier or entrust it to a specialized disposal company.

(6) Do not place any flammable material (such as paper, cloth, or wood) near the workpiece table.

(7) Keep a fire extinguisher beside the unit.

(8) The FANUC LASER-MODEL C1000*i*A is equipped with an alarm lamp. The alarm lamp blinks while discharge is in progress or whenever laser radiation is possible.
While the alarm lamp is blinking, pay careful attention to laser radiation and high voltages.

2.4 WARNING LABELS

The oscillator uses high voltages and laser beam radiation. Such hazards are indicated with warning labels attached to the positions shown in Fig. 2.4 (a) to (b).

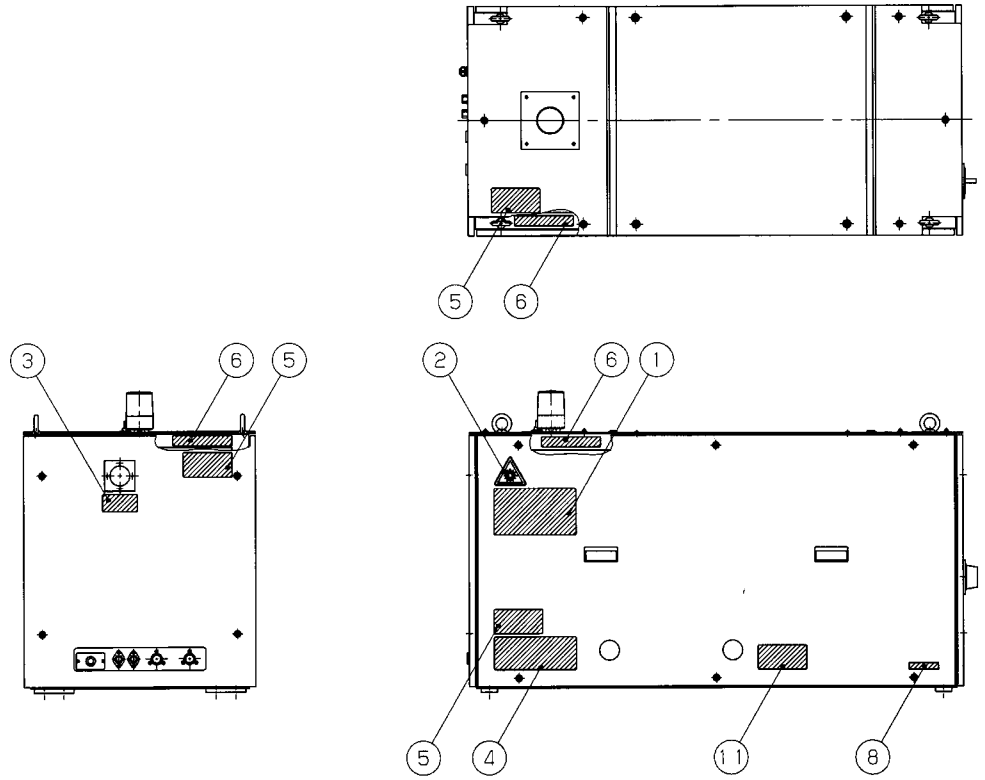


Fig. 2.4 (a) Warning label positions (C1000*i*A : front view)

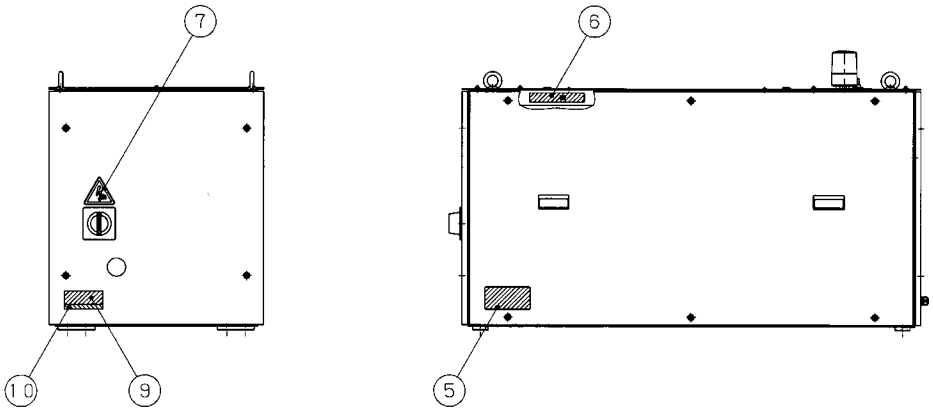
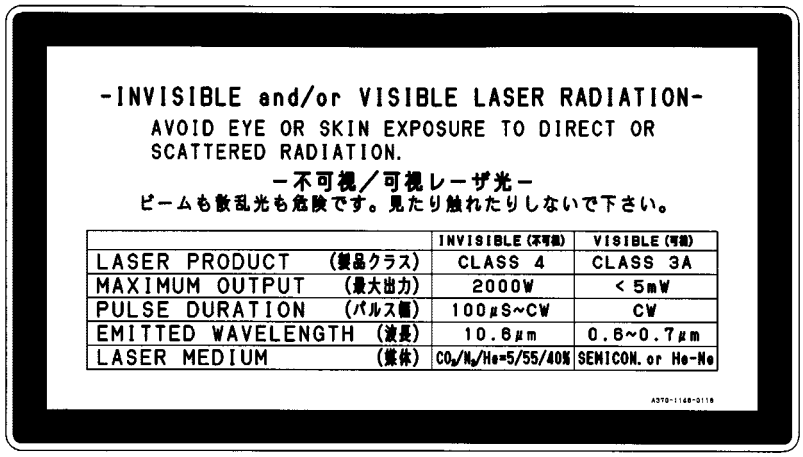
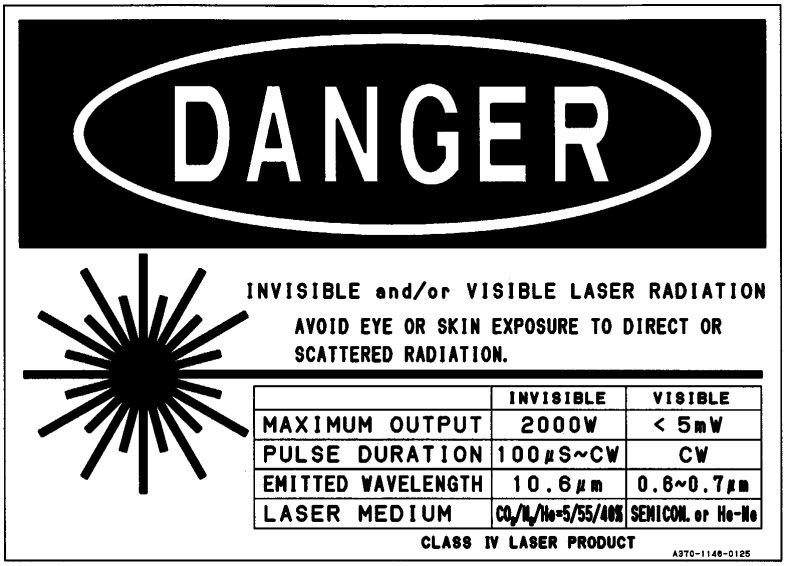


Fig. 2.4 (a) Warning label positions (C1000*i*A : rear view)

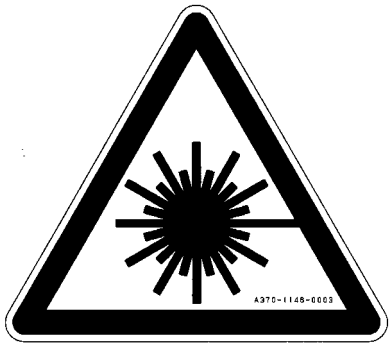
(1) Class indication label (JPN)



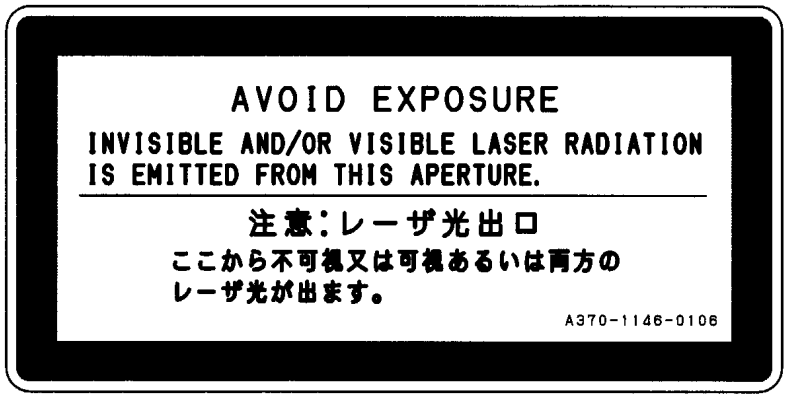
(1) Class indication label (FDA)



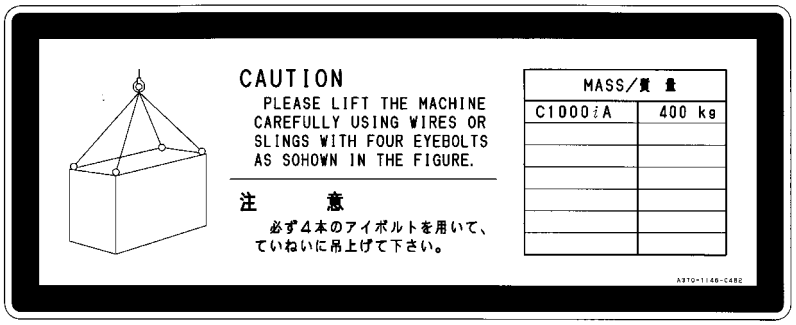
(2) Warning label



(3) Aperture label



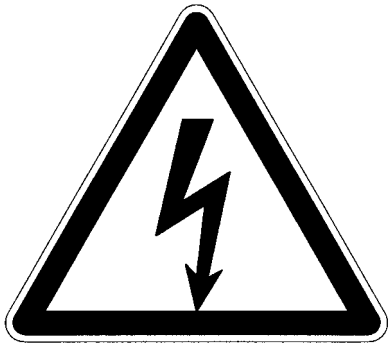
(4) Suspension method label



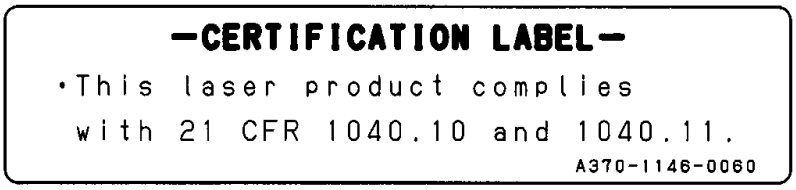
(5) Access panel

(6) Label inside the access panel

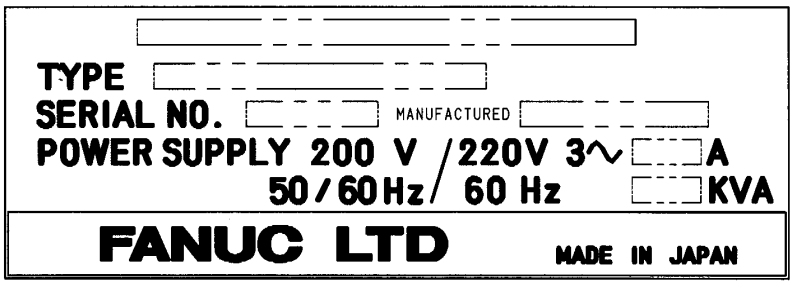
(7) Discharge section label



(8) Certification label

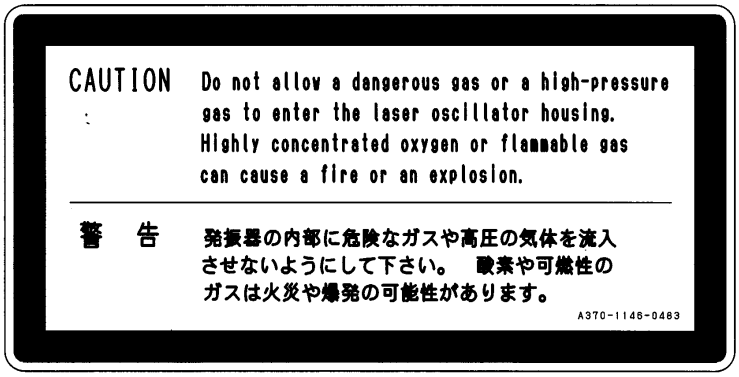


(9) Equipment nameplate



(10) Manufacturer's address label

(11) Label for regulating the atmospheric gases in the oscillator housing



3 INTERNAL STRUCTURE

3.1 OUTLINE

Fig. 3.1 show the internal structure of the laser oscillator.
The C1000*i*A consists of a laser resonator, discharge drive unit, forced gas circulating system, pressure controller, CNC interface, and a protective housing.

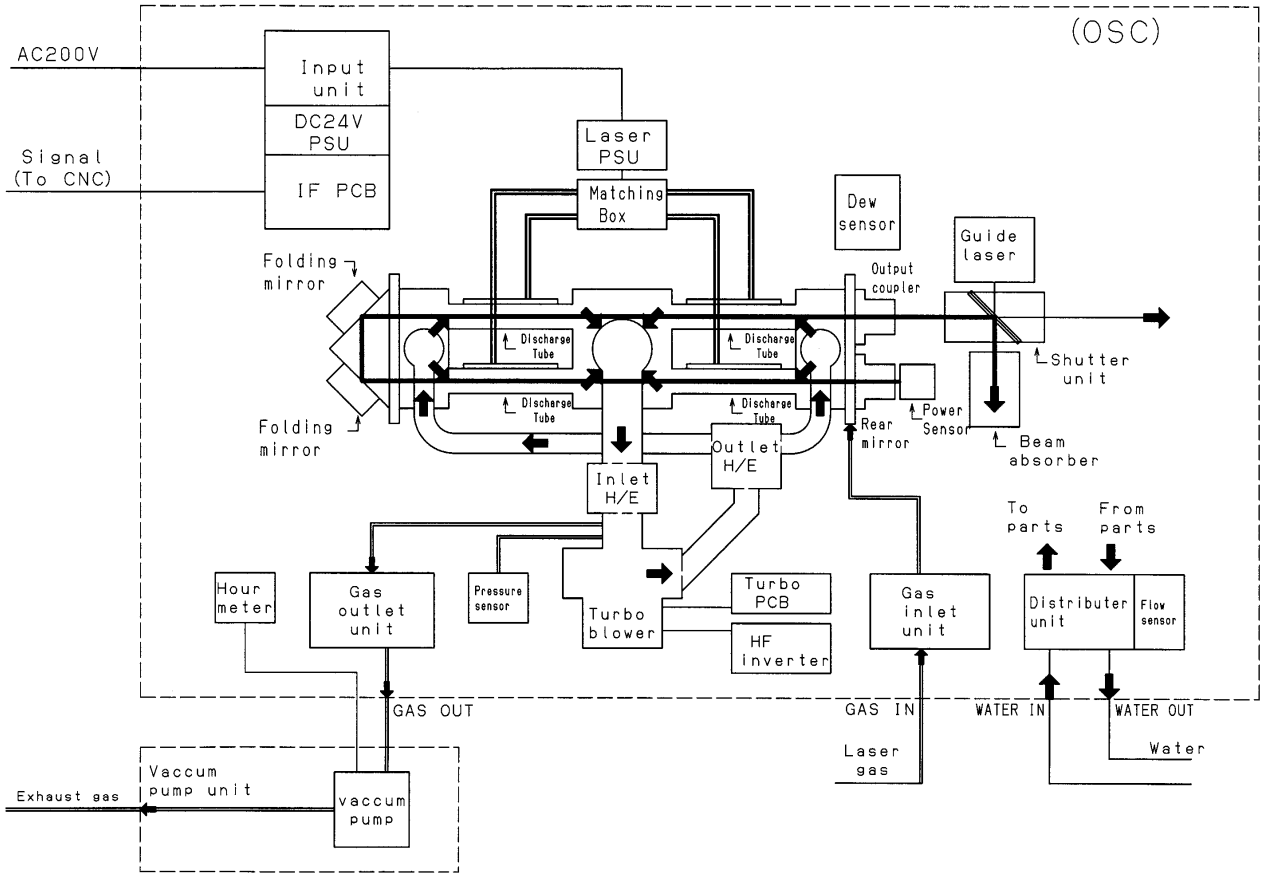


Fig. 3.1 C1000*i*A internal structure

(1) Laser resonator

The laser resonator consists of several discharge tubes, connected in series using folding mirrors, with a rear mirror and output mirror placed at the open ends of the discharge tubes, thus sealing the tubes. The resonator is fitted with a gas pipe connecting port through which laser gas is fed into the discharge tubes.

A discharge from the electrodes of the discharge tube energizes CO_2 molecules, which emit light. This light is amplified by stimulated emission, repeated between the rear mirror and output mirror, a laser beam being emitted from the output mirror.

(2) Discharge drive unit
The discharge drive unit consists of a laser power supply, matching box, and discharge tubes. High-frequency output of 2 MHz that is controlled by the CNC discharges the laser gas flows through discharge tubes to energize CO_2 molecules.

(3) Forced gas circulating system
A gas circulating system is configured by connecting the resonator and turbo blower with a circulating pipe. Laser gas is forced through the discharge tubes at a speed of 200 m/s or higher.
A water-cooled heat exchanger, used to cool the high-temperature gas from the discharge tubes, is provided at the inlet side of the turbo blower. At the outlet side of the turbo blower, another water-cooled heat exchanger dissipates the compression heat.

(4) Pressure controller
The laser gas pressure within the forced gas circulating system is controlled by commands issued from the CNC, thus ensuring stable laser output.

(5) CNC interface
Interface used to connect a FANUC Series 16*i*-L. CNC commands that, control the operation of the laser oscillator, such as start/stop and laser output, are input via this interface.

(6) Protective housing
An enclosure that houses the above components. The housing, consisting of metal panels, completely encloses the laser oscillator, thus protecting the operator from exposure to laser radiation and from high voltages. All panels are screw-fixed and cannot be removed without an appropriate tool.

3.2 COMPONENT DETAILS

This section describes the internal structure of the C1000*i*A more specifically. Fig. 3.2 is an internal structural drawing.

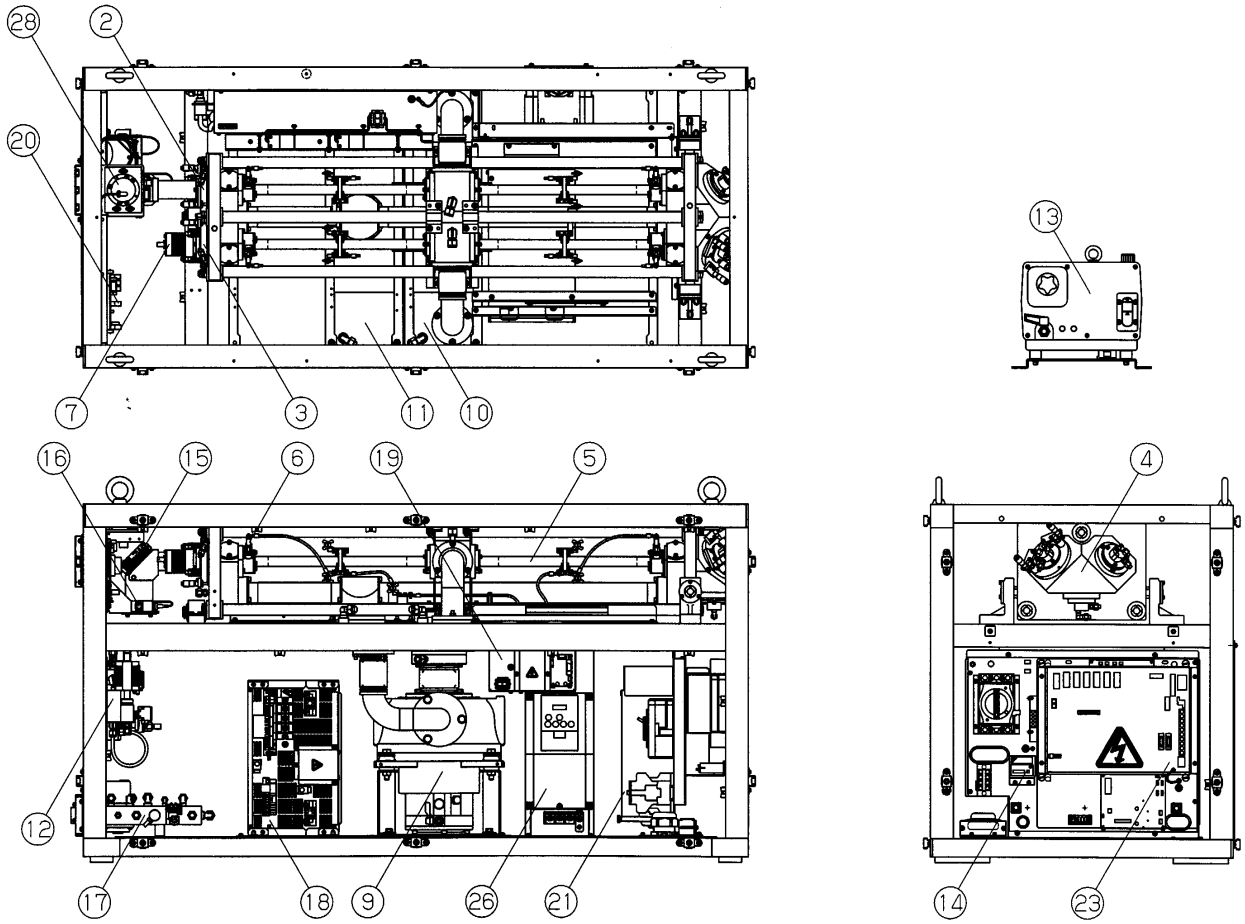


Fig. 3.2 C1000*i*A structural drawing

(1) Resonator
The resonator consists of an output mirror, rear mirror, folding mirrors, discharge tubes, power sensor unit, etc. It converts electrical energy first to laser gas, then to optical energy (10.6-μm single-wavelength laser beam).

(2) Output mirror
A transmitting/reflecting mirror which outputs the laser beam after it has been amplified. The output mirror consists of a ZnSe (zinc selenide) substrate, coated with dielectric. ZnSe is tightly toxic. Be particularly careful, therefore, when handling the output mirror.

(3) Rear mirror
A reflecting mirror consisting of a Ge (germanium) substrate, coated with dielectric.
Having a high reflectance of 99.5%, the rear mirror is used to reflect the laser beam within the resonator while transmitting 0.5% of the laser light so that the beam can be monitored externally.

(4) Folding mirror
A mirror unit which reflects the laser beam at a 90-degree angle.
The folding mirror consists of a block with a surface tilting to a 45-degree angle and an Si (silicon) substrate, coated with multilayer dielectric film.

(5) Discharge tube
A pair of Ag (silver) electrodes are metallized on the surface of a hollow quartz glass pipe. A high-frequency discharge between these electrodes injects electrical energy into the laser gas. Each electrode is coated with ceramic, preventing it from degrading and thus improving system reliability.

(6) Trigger electrode
A predischarge placed outside the laser oscillation area can facilitate the start of the main discharge. With it, the laser output is completely zero when the beam is off.

(7) Power sensor
An optical sensor which detects the intensity of the laser beam, transmitted through the rear mirror, thus enabling monitoring of the laser output level.

(8) Gas circulating system
A gas circulating path including a turbo blower, heat exchangers, and circulating pipes, which circulates laser gas in the discharge tubes at high speed.

(9) Turbo blower
During laser oscillation, the laser gas pressure is 1330 – 9310 Pa. The turbo blower circulates this rough-vacuum gas at high speed without contaminating the gas.

(10) Heat exchanger (inlet)
Water-cooled heat exchanger used to cool the laser gas that has been heated by discharge, before it is drawn into the turbo blower.

(11) Heat exchanger (outlet)
Water-cooled heat exchanger used to cool the laser gas that has been heated by compression in the turbo blower, before being forced into the discharge tubes.

(12) Gas controller

The gas controller always monitors the gas pressure in each discharge tube and supplies the fresh laser gas to the circulating system to keep the pressure constant. It also monitors the supply status of the laser gas, purge check for the circulating system, and other items and has a function of adjusting the amount of flow of the gas to be exhausted.

(13) Exhaust pump unit

This unit is used to vacuum-exhaust laser gas from the gas circulating system such that its pressure falls to that used for laser oscillation. Also, within this unit, a small amount of circulating gas is constantly being exchanged, to prevent degradation of the circulating gas.

(14) Hour meter

The hour meter indicates the total number of hours that the laser oscillator has operated (how many hours the exhaust pump has operated), to indicate whether maintenance or inspection is necessary.

(15) Shutter

The shutter has a rotary arm operated by a rotary solenoid and an Au (gold)-evaporated reflecting mirror attached to the arm.
It can be opened and closed by CNC commands. It also has a position sensor and a temperature sensor for safety and always monitors the open/close status and shutter temperature.

(16) Beam absorber

While the laser oscillator is operating with the shutter closed, the laser beam is guided into the beam absorber. The beam absorber absorbs nearly 100% of laser beam and is water-cooled, allowing it to safely absorb the beam for relatively long periods. For safety, the beam absorber is equipped with a temperature sensor which allows the system to monitor the temperature of the beam absorber.

(17) Distribution unit

This unit distributes cooling water, supplied from either a chiller unit or a temperature-regulated external water supply, to each unit in the laser oscillator.
For safety, the water distribution unit is equipped with a flow sensor which allows the system to monitor the flow rate of the cooling water.

(18) Laser power supply
A power supply for generating a discharge in each discharge tube. The laser power supply receives the three-phase AC input at 200/220V and outputs 2-MHz high-frequency power controlled with stability by commands from the CNC.
The RF inverter converts DC power to 3 to 4 kVPO-P high-frequency (2 MHz) power, then outputs it to the matching box.

(19) Matching box
The matching box contains a matching circuit, consisting of coils and capacitors, which ensures that power is effectively input to the discharge tubes.

(20) Intermediate PCB B
This PCB transmits signals output by the shutter section, such as those from the limit switch, absorber temperature sensor, power sensor, and condensation sensor, to the interface PCB.

(21) Input unit
The power magnetics cabinet distributes power, supplied from an external unit, to each unit in the laser oscillator. It also protects each unit from overcurrents.

(22) Input unit control PCB
This PCB has functions of transmitting the contactor open/close signals according to CNC commands and of notifying the CNC of the open/close status of the circuit breaker in the input unit.

(23) Interface PCB
Transfers signals to and from the CNC via the FANUC I/O Link (serial interface).

(24) Stabilized power supply
This unit converts the 200/220 VAC power source to DC power for the interface PCB and other units.

(25) Condensation sensor
The condensation sensor is mounted above the output mirror holder. If condensation occurs on this sensor, the resistance changes, an alarm (abnormal water temperature) occurs, and the oscillator is stopped. It prevents faults in each unit from occurring due to condensation.

(26) High-frequency inverter
This inverter drives the turbo blower. It is responsible for acceleration/deceleration control during start and stop of the blower.

(27) Turbo PCB
This PCB monitors overheating, the oil level, and frequency reached signal of the turbo blower.

(28) Guide laser (diode laser)

A diode laser is overlaid on the same optical axis as a guide beam for checking the optical axis because the CO_2 laser beam is invisible to the unaided eye. The guide beam is emitted in synchronization with the mechanical shutter only when the shutter is closed. The guide laser can be used for roughly adjusting the optical path of an external optical system and for obtaining a guide for the machining point.

4 MAINTENANCE

In FANUC LASER C1000*i*A, periodic inspection items have been reduced, and adjustments have been made easy. To keep the oscillator in a satisfactory operating condition over a long period, however, it is necessary to carry out periodic maintenance (including daily maintenance) described in this chapter. The oscillator is designed to maintain the same performance and reliability as it has when it is installed, provided that maintenance is carried out as prescribed.

4.1 DAILY INSPECTION

Table 4.1 lists daily inspection items. Inspect the FANUC LASER C1000*i*A according to this table. When parts (including oil) have been used for a prescribed period, replace them quickly.

Table 4.1 Daily inspection items for FANUC LASER C series

	Item	Period	Content and instruction
1	Residual laser gas	Daily	Check to see if the primary pressure is 1MPa or less as measured at the regulator on the laser gas cylinder. If the primary pressure is 1MPa or lower, replace the gas cylinder.
2	Exhaust pump oil	Weekly	Make sure that the oil level is between L (lower limit) and H (higher limit). If the oil level is below L, supply oil. Be sure to replace the oil periodically, every 1500 hours of operation, whichever is earlier.
3	Exhaust pump oil leak	Weekly	Make sure that no oil is leaking from the exhaust pump main body, drain valve and their periphery. If oil is leaking, immediately replace the exhaust filter, because it is likely to have been clogged. Be sure to replace the exhaust filter periodically, every 3000 hours of operation, whichever is earlier.
4	Turbo blower oil	Weekly	Make sure that the oil level is between L (lower limit) and H (higher limit). If the oil level is below L, supply oil. Be sure to replace the oil periodically, every 1000 hours of operation, whichever is earlier.
5	Turbo blower oil leak	Weekly	Make sure that no oil is leaking from the turbo blower main body, oil inlet, cock, and their periphery. If oil leaks for any reason other than a cock being open, call FANUC.
6	Laser output	Weekly	If the laser output decreases within the oscillator, warning message No. 4085 is issued. If this message appears, clean or replace the mirror in the oscillator quickly.
7	Cooling water	Daily	Make sure that the chiller discharge output is 5 kgf/cm^2 or less. At the start of the oscillator, also make sure that the water temperature is 20°C or higher.
		Weekly	Check the quality of cooling water in the chiller. Be sure to replace the cooling water every two months. Adding an anticorrosive to cooling water can decrease the replacement frequency.

4.2 PERIODIC MAINTENANCE

The FANUC LASER C1000*i*A contains consumables that must be replaced periodically. Table 4.2(a) or (b) lists such consumables and the related periodic maintenance work.
Perform periodic maintenance as well as daily inspection described in Section 4.1 by using the listed periods as guidelines.
Note, however, that the replacement and maintenance intervals are not guaranteed values but standard values based on field records.

Table 4.2(a) Periodic maintenance items and periods

	Item	Period of maintenance (operation hour)
1	Output mirror change	Every 3000 to 4000 hours, or when the quality has degraded
2	Rear mirror change	Every 3000 to 4000 hours, or when the quality has degraded
3	Folding mirror change	Every 3000 to 4000 hours, or when the quality has degraded
4	Exhaust pump oil change	Every 1500, or when the exhaust power has degraded
5	Exhaust pump filter change	Every 3000, or when the exhaust power has degraded
6	Exhaust pump overhaul	Every 10000, or when the exhaust power has degraded
7	Turbo blower oil change	Every 1000, or when oil properties have changed
8	Turbo blower overhaul	Every 12000, or when the power has degraded
9	Pressure controller gas filter change	Every 12000, or when a pressure failure occurs
10	Discharge tube O-ring change	Every 6000, or internal leakage occurs
11	Gas pipe O-ring replacement	Every 6000, or internal leakage occurs
12	Cooling water	Every 1500, or when cooling water properties have changed
13	Water tubing cleaning	Every 3000, or when the water pipe has clogged
14	Alarm lamp replacement	Every 3000, or when the lamp fails to light

Table 4.2(b) Mirror cleaning periods

Item	Period of maintenance (operation hour)
Cleaning of output and rear mirrors only	None
Cleaning of all internal mirrors	Every 3000 to 4000 hours

4.3 DETAILS OF MAINTENANCE

When opening the panels and doors during maintenance, keep the power turned off. Before replacing oil, be sure to check that purging is completed.

4.3.1 Changing the Turbo Blower Oil

(1) Check method
Check the amount of oil in the turbo blower while referring to the figure below. The oil level should be between graduations H and L.
This check should be made when the oscillator is at a rest. When the turbo blower is running, it is impossible to check the amount of oil correctly.

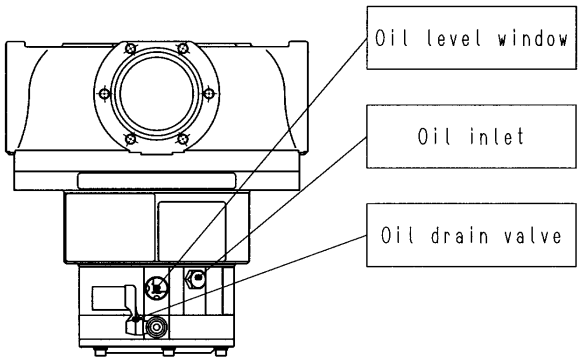


Fig. 4.3.1 Turbo blower oil gauge

(2) Replenishment method
1 Remove the hexagonal-head screw from the oil inlet with a 17 mm wrench.
Be careful not to lose the O-ring on the screw.
Before supplying turbo oil, stop the oscillator according to the correct procedure and turn off the power.

CAUTION
If the oscillator is not stopped by the correct procedure, the pressure in the turbo blower becomes negative. Opening the oil inlet under such a condition lets a large amount of air get in the turbo blower. This flow of air causes oil mist to get into the oscillator housing, resulting in contamination of internal mirrors.

2 Take out a bottle of oil from an oil kit (A04B-0800-K326). Remove the nozzle from the bottle, and take off the inner lid, then put the nozzle back on the bottle.
Put the supplied tube into the nozzle, insert the tube into the oil inlet, pour oil being careful to cause no foreign matters to get into oil.
Pour oil while checking the oil level from the oil level window until the oil level reaches the three-quarter position from L between L and H. Either superfluous or insufficient oil can be a cause of trouble.

3 Lightly wipe the area around the oil inlet, hexagonal-head screw on the oil inlet, and O-ring with a clean cloth or paper, then check that there are no foreign matters. Foreign matters getting into oil may cause a turbo blower fault. Check that the O-ring is fit to the hexagonal-head screw on the oil inlet, then tighten the screw (recommended torque: 7.85Nm)

4 If oil has spilled over, wipe it up. Otherwise, the peripheral equipment may be affected adversely.

5 If there is oil left over, put the inner lid back on the bottle, and keep the bottle in a dark, cool place.

(3) Replacement method

1 Get a container for oil drain on hand, and put the tip of the drain tube into the container.

2 Turn the oil drain cock through 90 degrees, and the oil will start draining. Opening the oil inlet during draining can drain oil fast.

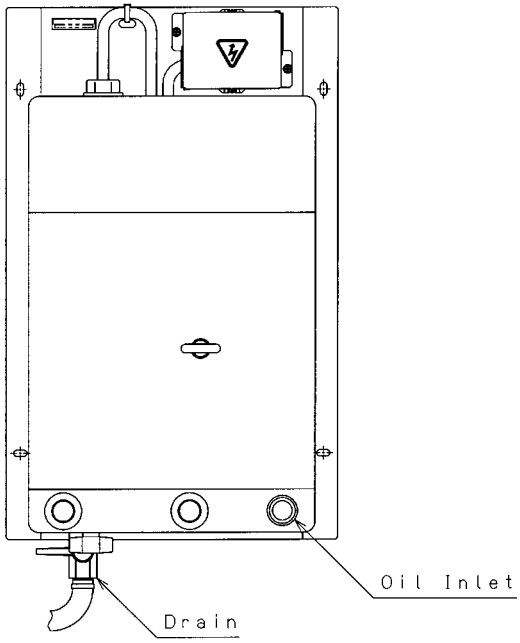
3 After all the oil has been drained, close the oil drain cock by setting it back in the initial place.

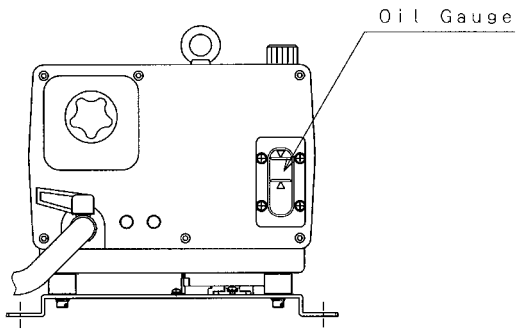
4 Supply oil by following the same procedure as for replenishment.

CAUTION
After replacing the turbo blower oil, perform discharge aging.

4.3.2 Changing the Exhaust Pump Oil

(1) Check method
Watch the oil gauge, and check that the oil level is between graduations L and H. Also check whether the oil is dark.
If the oil level is below L, add oil to the turbo blower or replace the oil in it. If the oil level is above H, drain until the oil level becomes below H.



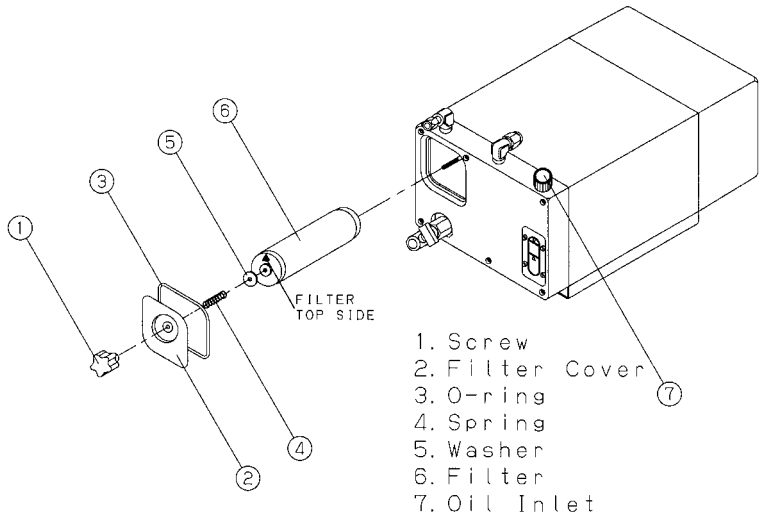


The exhaust of the turbo blower contains oil mist. The exhaust pump will capture oil mist, and the amount of exhaust pump oil increases with time. When the oil has increased too much, the filter gets immersed in the oil, possibly causing white mist to come out from the pump, or oil to leak. Furthermore, the exhaust capacity may get lowered, or the pump may be damaged.

(2) Replacement method
1 Stop the oscillator, and turn off the power.
2 Remove the oil inlet plug. There is an O-ring on it. Be careful not to damage it. A missing or damaged O-ring can lower the exhaust capacity of the pump.
3 Insert the drain tube into a drain oil vessel then open the drain cock.
4 After the oil has been drained up, close the cock.
5 Supply 1.8 liters of new oil through the oil inlet, while watching the oil gauge.
6 Attach the oil inlet plug.

4.3.3 Replacing the Exhaust Pump Filter

When the operation time reaches 3000 hours or the exhaust capacity gets lowered, replace the filter. A clogged filter may cause a whitish smoke of oil mist to come out of the pump or lower the exhaust capacity.



1 Stop the oscillator, and turn off the power.
2 Remove the black screw from the exhaust pump unit, then remove the filter cover and O-ring.
3 Remove the spring and washer.
4 Pull out the filter element.
5 Check the mounting orientation of a new filter element, then insert the filter. A filter mounted improperly may cause oil mist (whitish smoke) to come out of the exhaust pump gas outlet. Therefore, check again that the filter is mounted properly.

Replacement work is now complete.

4.4 MAINTENANCE PARTS

The following table lists maintenance parts.
Order a consumable from the machine tool builder or FANUC service center by the corresponding specification number listed below.

	Name	Specification
1	Turbo blower oil	A04B-0800-K326
2	Exhaust pump oil	SA-H (Manufactured by Matumura Sekiyu Co. Ltd.) A98L-0040-0093/1.0L6
3	Exhaust pump filter	A98L-0001-0911

4.5 COOLING WATER

4.5.1 Cooling Water Specification

The quality of cooling water is specified in the table below. If tap water is used, it should be treated in an ion exchanger.

Refrigerator/air-conditioner cooling water quality standard (JRA-9001-1980)

Standard item	pH (25°C)	6.0 to 8.0
	Conductivity (25°C)	200μs/cm or less
	Chlorine ion Cl^-	20ppm or less
	Sulfate ion SO_4^{2-} @@	50ppm or less
	M alkalinity $CaCO_3$ @ @ @	50ppm or less
	Total hardness $CaCO_3$ @ @ @	50ppm or less
Reference item	Iron Fe @ @ @	0.3ppm or less
	Sulfur ion S^{2-} @@	Not to be detected
	Ammonia ion NH_4^+ @ @ @	0.2ppm or less
	Ionic silica SiO_2 @ @	30ppm or less

4.5.2 Anticorrosive

Add the following anticorrosive to cooling water immediately after installation to prevent problems due to corroding cooling water and to decrease the frequency of replacement of cooling water.
Consult the chiller manufacturer for use of the anticorrosive.
Product name:

CONTLIME K-6000

Manufacturer:

MITSUBISHI GAS CHEMICAL. ISC

Use:

Add the anticorrosive to cooling water in concentration of 1000 ppm (100 cc/100 liters). Monthly check the concentration of the anticorrosive using concentration check paper dedicated to anticorrosives and add the anticorrosive to cooling water until the concentration reaches about 1000 ppm.

Concentration check paper:

Purchase a concentration check set (50 sheets of check paper, a dropping pipette, etc.) together with CONTLIME K-6000 (manufactured by Mitsubishi Gas Chemical ISC).

If the above anticorrosive is added to cooling water and the concentration is controlled, also be sure to replace the cooling water every year.

[Reference] Cooling water capacity of the oscillator

Model	Water capacity
C1000*i*A	About 5 liters

4.5.3 Cleaning Agent

To remove foreign matters such as fur that have adhered to the inside of the cooling water circulating path, wash the cooling water circulating path using the following detergent. Consult the chiller manufacturer for use of the detergent.

Product name:

DESLIME

Manufacturer:

MITSUBISHI GAS CHEMICAL ISC

Use:

Add the detergent of 10% of the amount of cooling water, circulate the water for an hour, then drain the water. After that, rinse the cooling water circulating path thoroughly. Do not touch a stock solution of DESLIME with your bare hands because the solution is a strong chemical. If a stock solution accidentally contacts your skin, wash the stock solution off your skin well under running water.

If waste water used for washing is left standing, the main ingredient, hydrogen peroxide, is decomposed. Wait until hydrogen peroxide is decomposed, or dilute waste water with water to reduce the concentration, then flush the waste water down the drain.

4.5.4 Antifreezing Solution

If the chiller is used in a cold district, it should be provided with an antifreezing function. When it is extremely cold, the chiller should be kept running.

If it is necessary to use an antifreezing solution for lack of an alternative, he following antifreezing solution should be used. Its concentration should be 30% (usually) or 40% (in an extremely cold district). Use of an antifreezing solution should be restricted within four months in winter. Do not use antifreezing solution together with an anticorrosive. The following antifreezing solution is already added with an anticorrosive.

Product name:

AURORA BRINE

Manufacturer:

TOKYO FINE CHEMICAL Co.

Use:

Refer to the description indicated on the product.

4.5.5 Pure Water Supply Unit

It is recommended that a pure water supply unit (ion-exchange resin) be installed at the water inlet of the chiller. The pure water supply unit can prevent problems with the oscillator from occurring due to corrosion or a clogged pipe. Replace the water periodically because the quality of the circulating cooling water is lowered.

Product name:
Pure Water Supply Cartridge
Manufacturer:
ORUGANO Co. Ltd.
Use:
Refer to the description indicated on the product.

4.6 LASER GAS

4.6.1 Laser Gas Specification

Supply the laser oscillator with a mixture of gases that satisfy the conditions listed below.

(1) Composition ratio and accuracy
CO_2 : 5±0.25%
He : 40±2.00%
N_2 : 55±2.75% (N_2 balance)
(2) Water (H_2O): 5 ppm or less
(3) Hydrocarbon (CnHm): 1 ppm or less
(4) Gas purity: 99.99% or higher

4.6.2 Gas Pipe

Observe the following cautions for piping between the laser gas cylinder and laser oscillator.

(1) Use nylon tube having an inside diameter of 8 mm or larger (Junlon AS1 manufactured by Junkousha, or equivalent). Do not use a rubber or urethane tube.
(2) Use a swage-lock vacuum joint. Do not use a one-touch coupler, quick coupler, or hose-band joint.
(3) Minimize the length of tubing. It should be kept within 5 m. Never exceed 15 m. For a length of 15 m or greater, use stainless pipe.
(4) If it is necessary to use metal pipe for lack of an alternative, use stainless bright annealed pipe. Minimize the number of joints used. Connect pipes, if necessary, using a swage-lock vacuum joint or by TIG welding. Do not use silver soldering or copper piping. Piping should be installed by a vacuum piping specialist. Do not extend metal piping over 30 m.
(5) Always keep the piping materials clean. Do not allow foreign matter to get in the pipe.
(6) Use a pressure reducer that is free from gas leakage.
(7) After installing the pipe, check it for gas leakage, using a liquid leak checker (Gyupoflex : A98L-0001-0856, detecting bubbles caused by leaking gas) or a clamp test1).

Clamp test

Open the valve of the gas cylinder to pressurize the inside of the pipe, then close the valve. Check to see if the pressure in the pipe becomes low with time. Monitor the primary pressure of the gas reducer for over 8 hours. If the gas pressure becomes lower by 10% within 8 hours, gas is likely to be leaking. Take an appropriate measure.

5 TROUBLESHOOTING

5.1 TROUBLESHOOTING PROCEDURE

If an alarm occurs, the alarm number and message are displayed on the CNC screen.

CHECKING ON FAULTS

After identifying the following items, call the FANUC service center. In some cases, a symptom is not actually a fault in the oscillator, although it looks like a fault. So, check it with the following sections.

(1) Symptoms
  (a) State of operation
  (machining in progress, oscillator being started, etc.)
  (b) Timing of a fault (alarm)
  (c) Alarm number
  (d) How often the fault occurs
  (e) Oscillator serial number

(2) Other information
  (a) Software system and edition indicated on the CNC screen when power is turned on
  (b) Parameter settings;
  check the current parameter settings with the corresponding values indicated on the unit, and report your finding to the FANUC service center.

5.2 ALARM MESSAGE LIST

Alarm number	Contents
4061	A/D CONVERTER \ P
4062	A/D CONVERTER \ Q
4063	RF POWER SUPPLY
4065	SHUTTER ACTION
4066	DISCHARGING
4067	LASER CABINET OH
4068	BEAM REFLECTION
4069	LASER IF PCB
4070	CHILLER NOT READY
4071	ASSIST GAS NOT READY
4072	CHILL FLOW
4073	LASER GAS PRES.
4075	CHILL TEMP.
4076	LASER POWER DOWN
4077	ABSORBER TEMP.
4078	LASER TUBE PRES.
4079	PUSH RESET KEY
4080	LASER TUBE EXHAUST
4081	GAS PRES. CONTROL
4082	TUBE PRES.SENSOR
4085	MIRROR CLEANING
4087	SHUTTER OH
4088	LASER VOLTAGE DOWN
4089	ASSIST GAS NO SELECT
4090	LASER NOT GENERATE
4094	VANE PUMP
4099	GAS PRES.NOT REACH

5.3 RESPONDING TO ALARM MESSAGES ON THE SCREEN

ALM No.4061

AD converter 1 is not normal.

No.	Cause of trouble	Solution
1	Anomaly of AD converter 1	It is necessary to replace AD converter 1 mounted on B8 on A16B-2100-0141. Call the FANUC service center.
2	Anomaly of IF PCB	I It is necessary to replace the IF PCB (A16B-2100-0141). Call the FANUC service center.

ALM No.4062

AD converter 2 is not normal.

No.	Cause of trouble	Solution
1	Anomaly of AD converter 2	It is necessary to replace AD converter 2 mounted on D7 on A16B-2100-0141. Call the FANUC service center.
2	Anomaly of IF PCB	Replace the IF PCB (A16B-2100-0141).

ALM No.4063

Anomaly of laser power supply unit

This alarm is displayed if an error occurs in the laser power supply unit or the power supply unit performs protective operation. Fully check the cause of the error because the power supply unit also performs protective operation if an error occurs in other than the power supply unit itself. This alarm will recur after replacement of the power supply alone without eliminating the root cause.

(1) Preliminary inquiry

	Check item	Solution
1	Checking parameters	Confirm that all the parameters described in the attached parameter sheets are correctly set. In case there exists any error, correct it.
2	Checking the discharge tubes	1) Check whether the mounting bracket of a discharge tube are loose or missing. 2) Check whether the electrode has separated. 3) Check whether the inside and outside of a discharge tube is dirty. 4) Check the discharge tubes for a crack. 5) Check the O-ring of each discharge tube for damage.
3	Checking the trigger electrode	Check whether the trigger electrode is dirty.
4	Checking the matching box	1) Check whether the matching box fan stops. 2) Check whether any coil in the matching box becomes black.

	Check item	Solution
5	Checking cooling water temperature	Confirm that the cooling water temperature is in the range of 20°C to 30°C.
6	Checking cable connectors	Check the cables and connectors connected to the power supply for looseness.
7	Insufficient discharge aging	Perform aging operation.

(2). Confirming operation and investigating the cause of a fault

	Phenomenon	Presumption cause
1	An alarm is issued when the LED of a laser power supply unit is not turned on.	The IF PCB is faulty. Poor cable contact
2	An alarm occurs before discharge begins. An instantaneous HVON alarm occurs.	The laser power supply is defective.
3	The RF current is small in comparison with other power supply units and the discharge tends to disappear.	The laser power supply is maladjusted.
4	The RF discharge current is large in comparison with other units. The alarm is DCV alarm.	
5	The RF voltage of all the units is high during discharge and the laser power is low. The discharge tends to disappear. When the purge is repeatedly performed, the RF voltage gradually decreases and the laser power recovers. This phenomenon often appears after the laser was not used for a long period.	The external laser gas pipe is abnormal. The gas composition is not normal due to leakage of a gas.
6	The RF voltage of all the units is high during discharge and the laser power is low. The discharge is tends to disappear. Even though the purge is repeatedly performed, the situation does not recover.	Internal leakage of oscillator Internal leakage of water of the oscillator
7	The RF voltage of all the units is high during discharge but the laser power is normal. The discharge is tends to disappear. The output is high for the high output command, and it is lower than the standard for the low output command.	The intra-tube pressure of the laser gas is high or the gas composition is not normal (excessive amount of N_2).
8	The RF voltage of all the units is low during discharge and the laser power is low. The discharge is widely spread. In the high laser power region, the power is low but in the low power region, it is higher than the normal value. The alarm is DCV alarm.	The intra-tube pressure of the laser gas is high or the gas composition is not normal (excessive amount of He).
9	Although the RFV, RFI, and output are normal, an alarm may occur.	Anomaly of the Laser power-supply unit itself (anomaly of alarm circuit).

(3).Solution

	Cause of trouble	Solution
1	External laser gas pipe abnormal	Check the faulty sections, then improve external piping.
2	Laser gas composition ratio abnormal	Replace the laser gas with one that satisfies the specification. If there is a leakage in external piping, the gas composition in the gas cylinder connected to the piping for a long time may change.
3	Discharge tube abnormal	It is necessary to replace or adjust the part. Call the FANUC service center.
3	IF PCB abnormal	
4	Laser power supply abnormal	
5	Laser power supply maladjusted	
6	Pressure sensor abnormal	
7	Internal leakage, leakage of water, or faulty O-ring	

ALM No.4065

Shutter anomaly

This alarm occurs when the shutter does not operate normally for the shutter open/close commands. The table below lists the causes of the fault and the corresponding countermeasures.

No.	Cause of trouble	Solution
1	Shutter clamp not removed.	Remove the shutter clamp.
2	Anomaly of position detector	It is necessary to replace or adjust the part. Call the FANUC service center.
3	Shutter cam loosened.	
4	Shutter arm caught.	
5	Relay PCB B abnormal	
6	Anomaly of cables connecting PCB.	

ALM No.4066

Discharge anomaly

After HV is turned on, the discharge starts. This alarm occurs when at least one discharge tube discharges hard and causes high voltage.

No.	Cause of trouble	Solution
1	Anomaly of parameter setting	Check whether the numeric values in the parameter list supplied with the unit are set.
2	Anomaly of laser gas composition	Use the laser gas with the specified composition and purity.

No.	Cause of trouble	Solution
3	Loose fixing parts of electrode	It is necessary to replace or adjust the part. Call the FANUC service center.
4	Leakage in the vacuum system or leakage of water	
5	The gas flow control value is closed	
6	Anomaly of matching box	
7	Crack or pinhole in discharge tube	

ALM No.4067

Overheating laser oscillator housing

The temperature of the input side of the electrode cooling fan is monitored and sends alarm when it exceeds 60°C. When the temperature decreases, the alarm state is solved automatically. Before that it cannot be reset. (The C1000*i*A does not have the sensor.)

No.	Cause of trouble	Solution
1	Excessive environmental temperature	Lower the ambient temperature by ventilation (5 to 30)
2	Excessive cooling water temperature	Set the temperature of the cooling water to within an appropriate range (20 to 30).
3	Anomaly of cooling fan motor	It is necessary to replace or adjust the part. Call the FANUC service center.
4	Anomaly of temperature sensor	
5	Anomaly of oscillator IF PCB(A16B-2100-0141)	
6	Anomaly of connecting cables between the PCBs.	

ALM No.4068

Too much incident laser beam back to the resonator..

This alarm is issued, if a workpiece reflects laser beam more than the rating to the laser oscillator. This can happen when the laser beam is used to drill, cut, or weld materials (such as copper, brass, and aluminum) having a high reflectivity to the laser beam (10.6 μm).

	Cause of trouble	Solution
1	Excessive returning beam back into the resonator	Lower the output specified in the command, or take an action to reduce the reflected laser beam.
2	Anomaly of parameter for alarm detection	Check the settings of parameter Nos. 15265 and 15266 with the corresponding values in the parameter table attached to the unit.
3	Anomaly of parameter for output power table	Check the settings of parameter Nos.15280 to 15308 with the corresponding values in the parameter table attached to the unit.

	Cause of trouble	Solution
4	Anomaly of parameter for input calibration coefficient	Set the parameter PRM. No.15215 to be the values as shown in the attached table. After replacing the rear mirror or power sensor, it is necessary to change this parameter setting. Call the FANUC service center.

ALM No.4069

Anomaly of power supply unit voltage of IF PCB

This alarm appears when there occurs the anomaly in the stabilized power unit voltage +5, ±15, +24V of IF PCB for NC interface.

No.	Cause of trouble	Solution
1	Fuse blowing	It is necessary to replace or adjust the part. Call the FANUC service center.
2	Anomaly of stabilized power source unit	
3	Anomaly of power unit of IF PCB	
4	Laser oscillator main circuit breaker abnormal	Check whether the main circuit breaker is in the complete continuity (ON) state.

ALM No.4070

Anomaly of chiller unit

Setting the RUN ON switch to ON causes the CNC to output a chiller unit start signal to the machine, which will respond with a chiller unit ready signal. The CNC monitors this signal. If the chiller ready signal stops, the CNC issues this alarm. Check the operation of the chiller.

ALM No.4071

Anomaly of assist gas

When starting machining, the CNC monitors for a ready signal from the assist gas supply unit in the machine. If this signal is not sent normally, the CNC issues this alarm.

Check the operation of the assist gas supply unit. Also check whether there is the assist gas.

This alarm is issued also when in G32PαQβ, α is not 0 to 3, or β is not 1 to 7 during program execution.

ALM No.4072

Shortage of cooling water

This alarm appears when the water shortage takes place.

No.	Cause of trouble	Solution
1	Shortage of cooling water	1 The capacity of the chiller unit is insufficient, or the water flow rate is reduced due to a clogged pipe. Use a chiller unit having sufficient capacity, or clean the piping. 2 Check whether the cooling water is distributed normally throughout between the external optical system and the laser oscillator. Ensure that cooling water is supplied to the laser oscillator at the specified flow rate. This alarm is issued if cooling water is supplied at a flow rate even slightly below the specified value.
2	Anomaly of sensor cable	It is necessary to replace or adjust the part. Call the FANUC service center.
3	Anomaly of water flow rate sensor	

ALM No.4073

Decrease of laser gas pressure

The pressure of the laser gas supplied to the laser oscillator is monitored.

This alarm is issued, if this pressure becomes lower than the permissible level.

No.	Cause of trouble	Solution
1	Tool low supply pressure of laser gas	Adjust the secondary pressure at the regulator on the gas cylinder so that the pressure of laser gas supplied to the laser oscillator is 0.15MPa (rating) as measured at the entry of the oscillator. If the distance between the gas cylinder and the oscillator is larger than 5 m, it is necessary to set the pressure slightly higher.
2	No laser gas.	Check whether the gas cylinder is empty or whether the connection valve is closed. If empty, replace the gas cylinder.
3	Leakage from the gas tube leading to the oscillator	Check that the gas pipe joint is secure. Also check whether the tube or pipe is broken. If so, replace it.
4	Gas supply pressure sensor or cable abnormal	It is necessary to replace or adjust the part. Call the FANUC service center.

ALM No.4075

Condensation

A condensation sensor is mounted near the output mirror holder in the oscillator. This alarm occurs when the sensor detects condensation. After this alarm occurs, the alarm status cannot be reset until the condensation status is released. Do not blow hot air of 60°C or higher on the condensation sensor. Flowing dry air in the oscillator is effective.

No.	Cause of trouble	Solution
1	Tool low cooling water temperature	Set the water temperature near the room temperature (plus about 1°C).
2	Connecting anomaly of condensation sensor cable	It is necessary to replace or adjust the part. Call the FANUC service center.
3	Anomaly of condensation sensor	

ALM No.4076

Laser gas pressure decrease

This alarm is issued, if the monitored laser output is much lower than the specified laser output, that is the monitored laser output is lower than the specified output by a value specified in parameter No. 15271.

No.	Cause of trouble	Solution
1	Lack of output from laser power sensor unit	It is necessary to replace or adjust the part. Call the FANUC service center.
2	Connecting anomaly of the cable of laser power sensor unit.	
3	Anomaly of intermediate PCB B A16B-1600-0361	

ALM No.4077

Overheat of beam absorber

Laser beam is introduced into the beam absorber, when the oscillation takes place with shutter closed. This absorber is water-cooled and sends alarm when the temperature of the absorber exceeds a critical one. In the usual operation, the irradiation of the absorber takes place only during the calibration after the oscillator start.

No.	Cause of trouble	Solution
1	Insufficient cooling water	It is necessary to replace the part. Call the FANUC service center.
2	Temperature sensor wired incorrectly	
3	Temperature sensor abnormal	
4	Absorber abnormal	

ALM No.4078

Gas pressure anomaly in discharge tube

The gas pressure is monitored after the discharge start ready condition (LRDY) is established. This alarm is issued, if the monitored gas pressure deviates by ±100 (1330Pa) from the set gas pressure.

No.	Cause of trouble	Solution
1	Anomaly of parameter setting of gas pressure control	Check whether the values of PRM NO. 15000/bit1,15244,15245,15246 are set as indicated in the attached data sheets. If a different value is set, set the value specified in the data sheets.
2	Abnormal supply laser gas pressure setting	Adjust the secondary pressure at the regulator on the gas cylinder so that the pressure of laser gas supplied to the laser oscillator is 0.1 to 0.2 MPa (rating) as measured at the entry of the oscillator. If the distance between the gas cylinder and the oscillator is larger than 5 m, it is necessary to set the pressure slightly higher.
3	Leakage in circulating system	It is necessary to replace or adjust the part. Call the FANUC service center.
4	Stopped turbo blower	
5	Anomaly of pressure sensor	
6	The gas flow control valve is closed.	
7	Anomaly of gas control unit	

ALM No.4079

Press the RESET key

The emergency stop button was pressed.

If the emergency stop button is pressed after the discharge start ready condition (LRDY) is set up, the shutter is closed, discharge stops, and the LRDY condition is resumed, then this alarm is displayed. To reset the alarm, remove the cause of trouble, release the emergency stop button, and press the reset key on the operator's panel.

ALM No.4080

Leakage of gas tube/anomaly of exhaust pump

When the RUN ON switch is turned on, the exhaust pump starts evacuating the gas in the circulating system to place the oscillator in the low-pressure state. This alarm occurs when the pressure does not reach the exhaust completion pressure specified for parameter No. 15240 until the specified time (default: 10 minutes) has elapsed after the start of exhaust.

No.	Cause of trouble	Solution
1	Incorrect gas pressure control parameter setting	Check if the value of PRM No. 15240 is set as indicated in the attached data sheets. If a different value is set, set the value specified in the data sheets

No.	Cause of trouble	Solution
2	Anomaly of IF PCB A16B-2100-0141	It is necessary to replace or adjust the part. Call the FANUC service center.
3	Gas leakage from piping	
4	Anomaly of gas connection of exhaust pump	
5	Anomaly of exhaust pump	

ALM No.4081

Anomaly of gas pressure control

When the RUN ON switch is turned on, the vacuum pump starts evacuation. After the pressure is lowered to the specified value, the laser gas is introduced into the pipe, and gas pressure control starts.

Whether the pressure is within ±20 (266 Pa) of the pressure specified for parameter No.15241 is checked, 45 seconds after the start of gas pressure control. This alarm occurs when the pressure does not fall within this range. When no error occurs, the turbo blower rotates and the discharge start ready condition (LRDY) is established.

No.	Cause of trouble	Solution
1	Anomaly of parameter setting of gas pressure control	Check whether the values of PRM Nos. 15000#1, 15244, 15245, 15246 are set as indicated in the attached data sheets. If a different value is set, set the value specified in the data sheets.
2	Anomaly of supply laser gas pressure	Adjust the secondary pressure at the regulator on the gas cylinder so that the pressure of laser gas supplied to the laser oscillator is 0.1 to 0.2 MPa (rating) as measured at the entry of the oscillator. If the distance between the gas cylinder and the oscillator is larger than 5 m, it is necessary to set the pressure slightly higher.
3	Gas leakage from piping	It is necessary to replace or adjust the part. Call the FANUC service center.
4	Anomaly of IF PCB A16B-2100-0141	
5	Anomaly of pressure sensor	
6	Anomaly of pressure control valve	

ALM No.4082

Anomaly of pressure sensor

This alarm appears when the signal of the pressure sensor used vanishes.

No.	Cause of trouble	Solution
1	Open or poor contact in connection cable between pressure sensor and IF PCB	It is necessary to replace or adjust the part. Call the FANUC service center.
2	Anomaly of IF PCB	
3	Anomaly of pressure sensor	

ALM No.4083

Shutter failure to open

This alarm occurs when the shutter does not reach the correct position at a certain time (pre-flow time of assist gas) after the shutter open command.

No.	Cause of trouble	Solution
1	The pre-flow time of assist gas is too short for the shutter to open.	Adjust the pre-flow time on setting screen. It should be longer than 0.6 sec.
2	When beam output was specified, other alarm was issued.	Check the cause of occurred alarm, then take appropriate action.
3	Movable part caught	It is necessary to replace or clean the part. Call the FANUC service center.

ALM No.4085

Decrease of laser output power

This alarm appears when the laser output power decreases and takes an abnormally higher calibration coefficient.

No.	Cause of trouble	Solution
1	An optical part in the laser resonator is out of position.	It is necessary to align the laser resonator or to clean or replace an optical part. Call the FANUC service center.
2	An optical part in the laser resonator is dirty.	
3	The supplied laser gas is not the one specified.	Replace the laser gas with the specified one, that is CO_2:N2:He = 5:55:40% (volume ratio) with a composition ratio accuracy of ±5%.
4	Cooling water temperature out of specified range	Check whether the temperature of cooling water falls within the range of 20 to 30°C.
5	Laser oscillator ambient temperature out of specified range	Check whether the ambient temperature falls within the range of 5 to 30°C.

ALM No.4087

Shutter temperature abnormal

This alarm is issued when the temperature of the shutter mirror exceeds a preset maximum. The table below lists the causes of faults and the corresponding countermeasures.

No.	Cause of trouble	Solution
1	Contamination of shutter mirror	Clean the shutter mirror. If this alarm recurs after the shutter mirror is cleaned, it is necessary to replace the mirror. Call the FANUC service center.
2	Anomaly of temperature sensor	It is necessary to replace the part. Call the FANUC service center.
3	Temperature sensor cable broken	
4	Relay PCB B (A16B-1600-0361) or IF PCB (A16B-2100-0141) is faulty.	
5	Anomaly of PCB connection cables	

ALM No.4088

Discharge tube voltage drop

This alarm is issued, if the voltage applied to the discharge tube drops largely.

More specific, the discharge tube voltage for reference discharge is set up automatically to parameter No. 15270 each time the RUN button is pressed.

This alarm is issued, if the automatically set discharge tube voltage is lower than the discharge voltage specified at the previous RUN time, by at least the amount specified in parameter No. 15272.

No.	Cause of trouble	Solution
1	The laser gas composition is not as specified.	Replace the laser gas with the specified one, that is CO_2:N2:He = 5:55:40% (volume ratio) with a composition ratio accuracy of ±5%.
2	Anomaly of discharge tube voltage detection system	It is necessary to replace the part. Call the FANUC service center.
3	Reduced blowing capacity of turbo blower or anomaly of inverter	

ALM No.4089

Assist gas not output

This alarm is issued, if an attempt is made to radiate a laser beam, when no assist gas is selected, or an assist gas condition is not set up.

ALM No.4090

Laser beam not generated

This alarm is issued, if an attempt is made to radiate a laser beam, when the laser oscillator is not in the LSTR state (discharging state).

ALM No.4094

Vacuum pump operation abnormal

This alarm occurs when the thermal switch of the magnetic contactor for the exhaust pump is tripped.

No.	Cause of trouble	Solution
1	Clogged exhaust pump filter	Replace the exhaust pump filter.
2	Clogged exhaust pump air outlet	Clean the outlet and remove the foreign matters with which the outlet is clogged.
3	Anomaly of thermal switch	It is necessary to replace the part. Call the FANUC service center.
4	Anomaly of IF PCB	
5	Signal cable broken	

ALM No.4099

Gas pressure not reached

This alarm is issued, if the discharge tube gas pressure does not reach [specified discharge tube gas pressure during oscillation - tolerance] after HV is set to ON.

No.	Cause of trouble	Solution
1	Invalid parameter setting	Check whether the values of PRM Nos. 15001/bit3, 15247, and 15248 are set as indicated in the attached data sheets. If a different value is set, set the value specified in the data sheets.
2	Gas leakage from internal piping	It is necessary to locate the leakage and replace the related part. Call the FANUC service center.
3	Pressure sensor abnormal	

ALM No.4100

Inverter abnormal

If the inverter used to power the turbo blower is abnormal, this alarm is issued.

When this alarm is issued, check that the alarm LED on the LED indicator section of the inverter is lit. At this time, do not turn off the power to the inverter because the alarm will be reset if the power is turned off.

For an explanation of faults and corresponding countermeasures, see the Maintenance Manual (B-70255EN)

No.	Cause of trouble	Solution
1	Excessive intake pressure	Check whether the values of PRM Nos. 15240, 15241, and 15242 are set according to the attached data sheets.

No.	Cause of trouble	Solution
2	Turbo blower rotor locked	It is necessary to replace or adjust the part. Call the FANUC service center.
3	Failed bearing in turbo blower	
4	Invalid inverter setting	

ALM No.4101

Inverter frequency reached signal abnormal

This alarm is issued, if a frequency reached signal is not received within 120 seconds after the turbo blower is started.

No.	Cause of trouble	Solution
1	Cable connection abnormal	It is necessary to replace or adjust the part. Call the FANUC service center.
2	Faulty turbo blower	
3	Inverter abnormal	
4	Invalid inverter setting	

ALM No.4105

Turbo blower temperature abnormal

This alarm is issued, if the temperature of the turbo blower motor winding becomes higher than the permissible level.

No.	Cause of trouble	Solution
1	Cooling water temperature high	Reduce the temperature of the cooling water.
2	Insufficient cooling water	The amount of cooling water supplied to the turbo blower may be insufficient. Check whether the cooling water tube between the water branch unit and blower is twisted or clogged. If the tube is twisted or clogged, replace the tube. If a tube in the turbo blower is clogged, clean the tube.
3	Anomaly of temperature sensor	It is necessary to replace or adjust the part. Call the FANUC service center.
4	Anomaly of temperature sensor cable connection	
5	Anomaly of turbo blower	

ALM No.4106

Low turbo blower oil

This alarm is issued if the signal from the turbo blower oil sensor indicates that the oil level has fallen below the setting.

No.	Cause of trouble	Solution
1	The oil level is lower than specified.	Replenish the turbo blower with oil until the oil level on the oil gauge is between H and L. Replace the oil every 1000 hours of operation.
2	Insufficient turbo blower cooling	When the temperature of the turbo blower motor section is high, check whether the cooling water path is clogged. If the cooling water path is clogged, wash the turbo blower.

No.	Cause of trouble	Solution
3	Invalid sensor setting	It is necessary to replace or adjust the part.
4	Sensor abnormal	Call the FANUC service center.

ALM No.4107

External reflecting mirror not installed

This alarm is issued, if the beam reflecting unit is not attached with a mirror or mirror holder. (The C1000*i*A has no beam folding unit.)

No.	Cause of trouble	Solution
1	Mirror not mounted	Mount a mirror.
2	Sensor abnormal	It is necessary to replace or adjust the part.
3	Cable abnormal	Call the FANUC service center.

ALM No.4132

Parameter changed (warning)

Press the RESET key to release this alarm.

APPENDIX

A EXTERNAL VIEW OF LASER OSCILLATOR

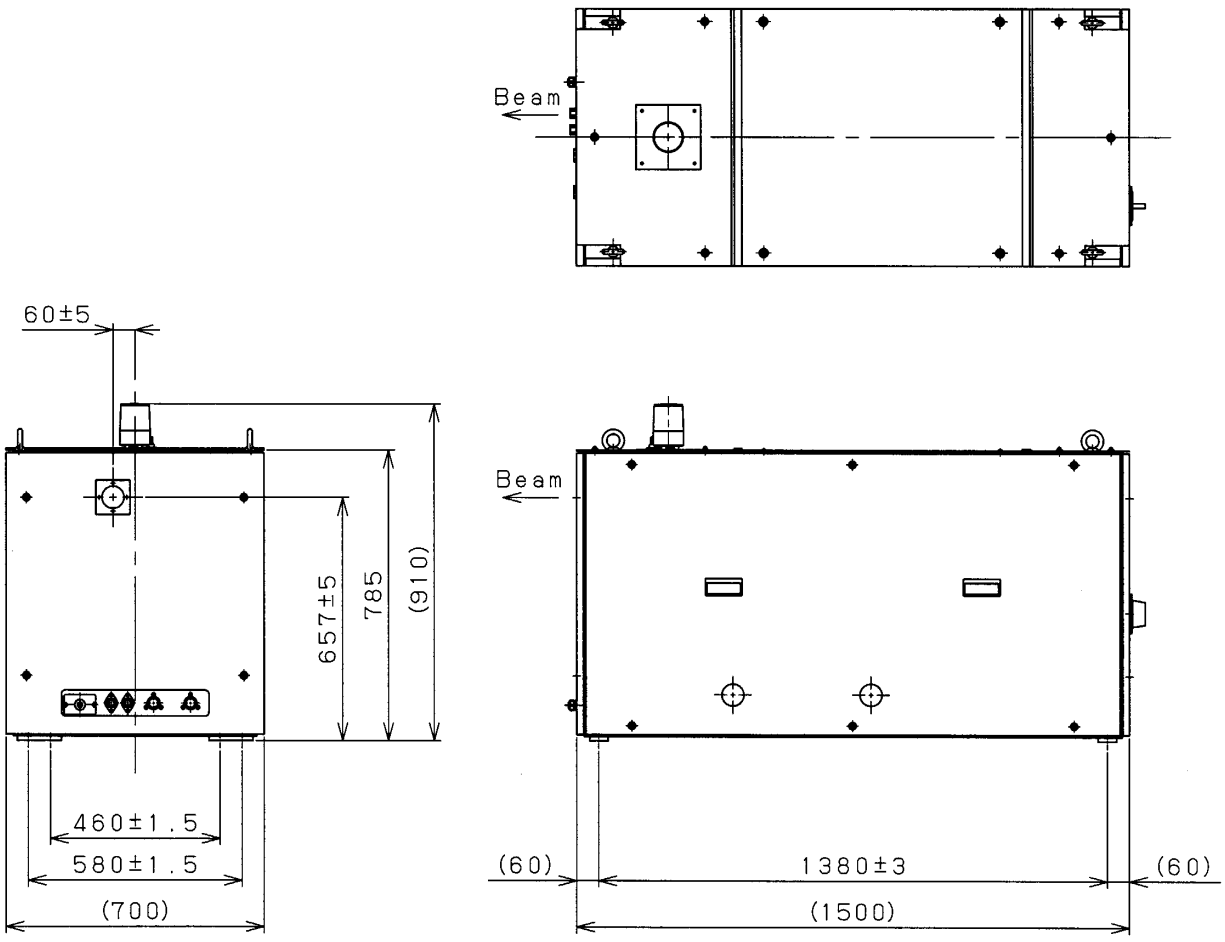


Fig. A EXTERNAL VIEW OF LASER OSCILLATOR

B SPECIFICATIONS

Item		Contents
Type		**FANUC LASER MODEL-C1000*i*A**
Method		High-speed axial carbon dioxide gas laser by high-frequency discharge excitation
Structure		Combination resonator/power supply type (separate exhaust pump)
Rated laser output		1,000 W
Maximum laser output		1,000 W (continuously variable output range of 100 W or greater)
Pulse peak value		1,000 W
Output stability		±1% (for 8-hour rated output under output feedback control)
Laser wavelength		10.6μm
Beam mode		Low-order mode
Beam diameter(at oscillator outlet)		Approximately ϕ20 mm or less
Polarization		45° polarization
Angle of beam divergence(full angle)		2 mrad or less
Pulse output command frequency		5 to 2,000 Hz
Pulse output command duty factor		0 to 100%
Laser gas	Composition	Mixture of CO_2:He:N_2 = 5:40:55% (volume ratio with N_2 balance) with a composition ratio accuracy of ±5%.
	Gas pressure	0.175±0.025 MPa (0.15 to 0.20 MPa) measured on a gauge
	Consumption	About 10 liters/h
Cooling water	Amount	40 liters/min or more
	Temperature / Temperature stability	20°C to 30°C/±1°C (for laser output stability of ±1%)
	Circulating water pressure	0.5MPa or less on a gauge
	Recommended cooling capacity of chiller unit	11 kW or more
Power requirements		200VAC +10%, -15% 50/60 Hz±1Hz or 220VAC +10%, -15% 60 Hz±1Hz
Required input power		18 kVA
Maximum current		60 A
Hour meter		Total operation hours of the exhaust pump
Door interlock		No
Warning lamp		Blinks while discharge is in progress.
Weight		Main oscillator unit: About 350 kg Exhaust pump unit: About 30 kg

C PARAMTER LIST

This appendix describes the parameters for the Series 16*i*-L.
Many parameters depend on the laser oscillator model and unit.
Check the parameter list in the data sheet supplied with each unit, then set parameters.

C.1 PARAMETERS FOR ENABLING/DISABLING VARIOUS FUNCTIONS

	#7	#6	#5	#4	#3	#2	#1	#0
15000			FLT	CLB	BMO	AGA	LGC	LPC

Data type: Bit

LPC Power control function
- 0: Invalid (standard)
- 1: Valid

LGC Two stage gain selection of intra-tube pressure control
- 0: Invalid
- 1: Valid (standard)

(When this bit is 1, PRM No. 15245 becomes valid.)

AGA Assist gas preparation check with beam on
- 0: Valid (standard)
- 1: Invalid (for maintenance)

BMO Beam on only with beam off
- 0: Invalid (standard)
- 1: Valid (for manual only and maintenance)

CLB Power compensation
- 0: Disabled
- 1: Enabled (standard)

FLT Filter in power control
- 0: Invalid
- 1: Valid (standard)

	#7	#6	#5	#4	#3	#2	#1	#0
15001		LHC		PC8	NGC	PES	G0B	EXA

Data type: Bit

EXA Selection of assist gas
- 0: 3 types (standard)
- 1: 7 types

G0B When G00 is specified, a beam
- 0: Outputs (standard).
- 1: Does not output.

PES Piercing time during machine lock or dry run
- 0: Enabled (standard)
- 1: Disabled

NGC
- 0: Presets an integral gas pressure control value.
- 1: Does not preset an integral gas pressure control value.

PC8 The power compensation function
- 0: Specifies a fixed value for the power.
- 1: Increases the power in eight levels.

LHC

0: Does not control the oscillator with external signals (standard).
1: Controls the oscillator with external signals.
In the automatic operation mode, external signals are used to turn on and off the shutter and beam output.

	#7	#6	#5	#4	#3	#2	#1	#0
15002		PSH					ADC	BMA

Data type: Bit

BMA

0: Disables beam output with the shutter closed in the automatic operation mode (standard).
1: Enables beam output with the shutter closed in the automatic operation mode (for maintenance).

ADC

0: Uses the select signal to determine AD converter 2 data.
1: the DI signal to determine AD converter 2 data. (standard)

PSH

0: Uses all discharge tubes.
1: Uses half of the discharge tubes.

	#7	#6	#5	#4	#3	#2	#1	#0
15003						GVW	HPT	TIV

Data type: Bit

TIV

0: Inverts the sign (+/-) of the amount of tracing displacement.
1: Does not invert the sign (+/-) of the amount of tracing displacement.

HPT

0: Rewrites parameter settings for extending or shortening piercing.
1: Does not rewrite parameter settings for extending or shortening piercing.

GVW

0: Disables evacuation when RUN is turned off.
1: Enables evacuation when RUN is turned off.

	#7	#6	#5	#4	#3	#2	#1	#0
15004	CWY	ECH		EDG		SPB	STC	AGC

Data type: Bit

AGC

0: Uses the "G32 P_;" command (when Q, T, and R are not specified) as the flow pattern command.
1: Uses the "G32 P_;" command (when Q, T, and R are not specified) as the gas pressure control direct command.

STC

0: Controls the shutter with a G code.
1: Controls the shutter with an external signal.

SPB

0: Outputs a beam in skip operation.
1: Outputs no beam in skip operation.

EDG

0: Turns the beam off when switching the assist gas during edge machining.
1: Does not turn the beam off when switching the assist gas during edge machining.

ECH

0: Does not clear the active E number upon reset.
1: Clears the active E number upon reset.

CWY

0: A CO_2 laser oscillator is used.
1: A CW-YAG laser oscillator is used.

	#7	#6	#5	#4	#3	#2	#1	#0
15005	DLY	ITR		GNS	BPV	TTD		INB

Data type: Bit

INB

0: Stops beam output upon completion of pulse distribution.
1: Stops beam output upon completion of in-position check.

TTD

0: Each laser power supply drives only one discharge tube.
1: Each laser power supply drives two discharge tubes.

BPV

0: Opens the bypass valve during power calibration.
1: Closes the bypass valve during power calibration.

GNS

0: Stops the assist gas output during assist gas switching by the assist gas direct command. (standard)
1: Does not stop assist gas output during assist gas switching by the assist gas direct command.

ITR

0: Disables the tracing control interlock signal (G227#6 *TRIL).
1: Enables the tracing control interlock signal (G227#6 *TRIL).

DLY

0: Disables the beam output condition delay function.
1: Enables the beam output condition delay function.

	#7	#6	#5	#4	#3	#2	#1	#0
15006			PCN	PCL		PIN	TRM	NCC

Data type: Bit

NCC

0: Displays the processing condition setting screen.
1: Does not display the processing condition setting screen.

TRM

0: Enables the zero-point, start-point and end-point soft keys for the trace setting screen.
1: Disables the zero-point, start-point and end-point soft keys for the trace setting screen.

PIN

0: Specifies a G13 address P using metric input.
1: Specifies a G13 address P using inch input.

PCL

0: On-screen pressure display of assist gas in kg/cm^2.
1: On-screen pressure display of assist gas in MPa.

PCN

0: Rewrites the power compensation factor with 1024 when power compensation is not performed.
1: Does not rewrite the power compensation factor and retains the previous value when power compensation is not performed.

	#7	#6	#5	#4	#3	#2	#1	#0
15007			STO	XSC	ECK	ESE		

Data type: Bit

ESE

0: After completion of distribution, executes piercing during edge machining.
1: After completion of distribution, checks the smoothing errors, then executes piercing during edge machining.

ECK

0: Determines the angle on the actual processing path during edge machining.
1: Determines the angle on the path in the machining program during edge machining.

XSC

0: Does not operate the edge machining function in the exact stop mode.
1: Operates the edge machining function in the exact stop mode.

STO

0: Does not execute the after-flow and pre-flow when the assist gas command is issued with the same type and same flow pattern.
1: Executes the after-flow and pre-flow when the assist gas command is issued with the same type and same flow pattern.

	#7	#6	#5	#4	#3	#2	#1	#0
15008	RMP	EGE	DCW		SOC	TAL	GPC	MST

Data type: Bit

MST

0: When a reference displacement amount is specified with a plus sign (+) in the trace command, the nozzle approaches the workpiece. When a reference displacement amount is specified with a minus sign (-), the nozzle moves away from the workpiece.

1: When a reference displacement amount is specified with a plus sign (+) in the trace command, the nozzle moves away from the workpiece. When a reference displacement amount is specified with a minus sign (-), the nozzle approaches the workpiece.

GPC

0: Exercises tracing control according to the reference displacement amount.

1: Exercises tracing control according to the gap amount (distance between the nozzle and workpiece).

TAL

0: Invalidates the "out-of-tracing-range alarm" when the trace check mode signal (G225#2 TRCKM) is set to "1."

1: Invalidates both of the "out-of-tracing-range alarm" and "excess tracing displacement alarm" when the trace check mode signal (G225#2 TRCKM) is set to "1."

SOC

0: Uses the reference displacement amount for piercing as that for tracing control not during processing when the processing condition setting function is used.

1: Uses the reference displacement amount for piercing as that for tracing control only during piercing when the processing condition setting function is used.

DCW

0: Does not display the DCV, DCI, and DCW values on the diagnostic display.

1: Displays the DCV, DCI, and DCW values on the diagnostic display.

EGE

0: Disables the automatic aging function.

1: Enables the automatic aging function.

RMP

0: The step function uses only the up/down step distances to measure the travel distance.

1: The step function uses the up/down step distances and feedrate setting to measure the travel distance.

	#7	#6	#5	#4	#3	#2	#1	#0
15009	TEM	BCG	BEM	AFZ	BS2	BS1	AS2	AS1

Data type: Bit

AS1,AS2,BS1,BS2 Parameters for the laser gas mixing function.
This function stores and monitors the operating status of the mixer.
These parameters need not be set manually because they are automatically set.

AS2,AS1 Indicates the status of tank A.

AS2	AS1	Status
0	0	Filling gases in tank A
0	1	Mixing gases in tank A
1	0	Supplying gases in tank A
1	1	Setup for filling gases in tank A in progress

BS2	BS1	Status
0	0	Filling gases in tank B
0	1	Mixing gases in tank B
1	0	Supplying gases in tank B
1	1	Setup for filling gases in tank B in progress

AFZ

1: Does not include the Z-axis in calculation for actual cutting feedrate display.
0: Includes the Z-axis in calculation for actual cutting feedrate display.

BEM

1: The supply pressure of the three-gas cylinder is normal.
0: The supply pressure of the three-gas cylinder is low.

BCG

1: The three-gas cylinder is not replaced.
0: The three-gas cylinder is replaced.

TEM

1: The tank supply pressure is normal.
0: The tank supply pressure is low.

	#7	#6	#5	#4	#3	#2	#1	#0
15010	OVE		TRG					

Data type: Bit

TRG

0: Disables the trigger pulse command control function.
1: Enables the trigger pulse command control function.

OVE

0: Does not allow edge machining and feedrate clamp based on arc radius to be used together.
1: Allows edge machining and feedrate clamp based on arc radius to be used together.

	#7	#6	#5	#4	#3	#2	#1	#0
15011	OPV		CSC		LVE			EDS

Data type: Bit

EDS

0: Uses the conventional conditions as the cutting conditions during execution of edge machining or start-up processing for a return.

1: Uses the piercing operating conditions in edge machining for the laser power, assist gas type, and assist gas pressure as cutting conditions during execution of edge machining or start-up processing for a return.

LVE

0: Performs assist gas switching according to the conventional specifications at the start of edge machining and at the start of cutting for the return distance after that.

1: Ignores the time setting when the gas type and pressure do not change for assist gas switching at the start of edge machining and at the start of cutting for the return distance after that.

CSC When the following four values, S, P, Q, and F, are concurrently specified in the first G01, G02, or G03 block following G24 in the start-up processing mode,

0: Executes conventional start-up processing without using the specified S, P, Q, and F values.

1: Cancels operation of start-up processing and performs cutting using the specified S, P, Q, and F values.

OPV

0: The external piping exhaust valve operates only once after power-on.

1: The external piping exhaust valve always operates when RUN is turned on.

C.2 PARAMETERS FOR DISCHARGE TUBE SELECTION

	#7	#6	#5	#4	#3	#2	#1	#0
15025	PS8	PS7	PS6	PS5	PS4	PS3	PS2	PS1
15026	PS16	PS15	PS14	PS13	PS12	PS11	PS10	PS9

Data type: Bit

PS1 to PS16 Discharge tube selection when half of the discharge tubes are used
Set the bit for each discharge tube to be used to 1, and set the other bits to 0.

NOTE
Parameter No. 15026 is provided for future addition of discharge tubes. In the current specifications, this parameter is not used. Set all bits to 0.

	#7	#6	#5	#4	#3	#2	#1	#0
15027	PS8	PS7	PS6	PS5	PS4	PS3	PS2	PS1
15028	PS16	PS15	PS14	PS13	PS12	PS11	PS10	PS9

Data type: Bit

PS1 to PS16 Discharge tube selection when all discharge tubes are used
Set the bit for each discharge tube to be used to 1, and set the other bits to 0.

NOTE
Parameter No. 15028 is provided for future addition of discharge tubes. In the current specifications, this parameter is not used. Set all bits to 0.

C.3 PARAMETERS FOR CONTOURING CONDITIONS

15040	Power output setting

Data type: Word
Unit of data: W
Range of data: 0 to 7000

15041	Pulse frequency setting

Data type: Word
Unit of data: Hz
Range of data: 5 to 2000

15042	Pulse duty ratio setting

Data type: Word
Unit of data: %%
Range of data: 0 to 100

C.4 PARAMETERS FOR EDGE MACHINING CONDITIONS

15050	Edge detection angle

Data type: Word
Unit of data: deg
Range of data: 0 to 180
A corner is assumed to be present when the angle formed by two blocks is smaller than the specified angle.

15051	Peak piercing power value

Data type: Word
Unit of data: W
Range of data: 0 to 7000
Set a peak power value for piercing to be performed at the top of a corner.

15052	Piercing pulse frequency

Data type: Word
Unit of data: Hz
Range of data: 5 to 2000
Set a pulse frequency for piercing to be performed at the top of a corner.

15053	Piercing pulse duty ratio

Data type: Word
Unit of data: %
Range of data: 0 to 100
Set a pulse duty ratio for piercing to be performed at the top of a corner.

15054	Piercing time

Data type: Two-word
Unit of data: msec
Range of data: 0 to 99999999
Set a piercing time used for piercing to be performed at the top of a corner.

15055	Piercing assist gas pressure

Data type: Word
Unit of data: 0.01Mpa or 0.1 kg/cm^2
Range of data: 0 to 255
Set an assist gas pressure for piercing to be performed at the top of a corner.

15056 **Type of piercing assist gas**

Data type: Word
Unit of data:
Range of data: 0 to 7
Set a type of assist gas to be used for piercing.

15057 **Return distance**

Data type: Two-word
Unit of data:

Setting range	IS-A	IS-B	IS-C	Unit
Metric input	0.01	0.001	0.0001	mm
Inch input	0.001	0.0001	0.00001	inch

Range of data: 0 to 65000
Set a return distance from the top of a corner to the next block.

15058 **Return feedrate**

Data type: Word
Unit of data: mm/min
Range of data: 0 to 9999
Set a return feedrate to be used for movement from the top of a corner to the next block.

15059 **Peak return power value**

Data type: Word
Unit of data: W
Range of data: 0 to 7000
Set a peak return power value to be used for movement from the top of a corner to the next block.

15060 **Return frequency**

Data type: Word
Unit of data: Hz
Range of data: 5 to 2000
Set a return frequency to be used for movement from the top of a corner to the next block.

15061 **Return duty ratio**

Data type: Word
Unit of data: %
Range of data: 0 to 100
Set a return duty ratio to be applied to movement from the top of a corner to the next block.

C.5 PARAMETERS FOR PIERCING CONDITIONS

15080	Piercing power

Data type: Word
Unit of data: W
Range of data: 0 to 7000
Set the piercing power.

15081	Initial piercing frequency

Data type: Word
Unit of data: Hz
Range of data: 5 to 2000
Set the initial piercing frequency.

15082	Incremental piercing frequency

Data type: Word
Unit of data: Hz
Range of data: 0 to 2000
Set the incremental piercing frequency.

15083	Initial piercing duty ratio

Data type: Byte
Unit of data: %
Range of data: 0 to 100
Set the initial piercing duty ratio.

15084	Incremental piercing duty ratio

Data type: Byte
Unit of data: %
Range of data: 0 to 100
Set the incremental piercing duty ratio.

15085	piercing step time

Data type: Word
Unit of data: msec
Range of data: 0 to 32767
Set the piercing step time.

15086	Number of piercing steps

Data type: Word
Unit of data:
Range of data: 0 to 32767
Set the number of piercing steps

15087	Piercing end time

Data type: Two-word
Unit of data: msec
Range of data: 0 to 99999999
Set the piercing end time

C.6 PARAMETERS FOR POWER CONTROL

	#7	#6	#5	#4	#3	#2	#1	#0
15089	LP8	LP7	LP6	LP5	LP4	LPZ	LPY	LPX

Data type: Bit

LP*

0: Does not use the *-axis for speed calculation for the power control function.

1: Uses the *-axis for speed calculation for the power control function.

If no bit is specified, the power control function operates, assuming the first axis (LPX) and second axis (LPY) to be specified.

Ordinarily, specify each axis to be used for interpolation. Do not specify a synchronously controlled axis for simple synchronous control or PMC axis.

15090	Minimum output power

Data type: Word
Unit of data: W
Range of data: 0 to 7000

15091	Minimum pulse frequency

Data type: Word
Unit of data: Hz
Range of data: 5 to 2000

15092	Minimum pulse duty ratio

Data type: Word
Unit of data: %
Range of data: 0 to 100

Set the minimum pulse duty ratio.

15093	Power control constant

Data type: Word
Unit of data: %
Range of data: 0 to 100

Set the power control constant.

15094	Power control filter time constant

Data type: Word
Unit of data: msec
Range of data: 0 to 32767

Set the power control filter time constant.

15095	Allowable variation in power control speed

Data type: Byte
Unit of data: mm/min (specified increment for B8F1-08 or earlier) or %
Range of data: 0 to 255
Standard setting: 4

Set the amount by which the power control speed is allowed to vary.
This parameter is valid when parameter No. 15450 is set to 0.
To set a value of 256 or greater, use parameter No. 15450.
Set this parameter according to the setting of bit 6 of parameter No. 15096 (SDB) as follows.

	#7	#6	#5	#4	#3	#2	#1	#0
15096	EGM					PCD	PCF	PCP

Data type: Bit

PCP

0: Does not control the output according to the feedrate in power control.
1: Controls the output according to the feedrate in power control.

PCF

0: Does not control the frequency according to the feedrate in power control.
1: Controls the frequency according to the feedrate in power control.

PCD

0: Does not control the duty ratio according to the feedrate in power control.
1: Controls the duty ratio according to the feedrate in power control.

EGM

0: Cancels the power control mode in the edge machining or start-up processing mode.
1: Stops power control only during return distance movement in the edge machining or start-up processing mode.

In the edge machining or start-up processing mode, the E number for specifying conditions for edge machining or start-up processing is selected.

15097	Parameter for calculating the displacement of the output (output at a speed of F = 0)

Data type: Word
Unit of data: V
Range of data: 0 to 7000

15098	**Parameter for calculating the displacement of the frequency (frequency at a speed of F = 0)**

Data type: Word
Unit of data: Hz
Range of data: 5 to 2000

15099	**Parameter for calculating the displacement of the duty ratio (duty ratio at a speed of F = 0)**

Data type: Word
Unit of data:
Range of data: 0 to 100

C.7 PARAMETERS FOR ASSIST GAS PRESSURE AND TIME SETTING

15100	Selection of assist gas

Data type: Word
Unit of data:
Range of data: 0 to 7
Select a type of assist gas.

15101	Selection of flow pattern

Data type: Word
Unit of data:
Range of data: 1 to 3
Select a assist gas flow pattern.

15102	Pre-flow time 1
15103	Pre-flow time 2
15104	Pre-flow time 3

Data type: Word
Unit of data: 10msec
Range of data: 0 to 32767
Set the assist gas pre-flow time.

15108	After-flow time 1
15109	After-flow time 2
15110	After-flow time 3

Data type: Word
Unit of data: 10msec
Range of data: 0 to 32767
Set the assist gas after-flow time.

15114	Pre-flow pressure 1
15115	Pre-flow pressure 2
15116	Pre-flow pressure 3

Data type: Word
Unit of data: 0.01Mpa or 0.1 kg/cm^2
Range of data: 0 to 255
Set the assist gas pre-flow pressure.

15120	Processing flow pressure 1
15121	Processing flow pressure 2
15122	Processing flow pressure 3

Data type: Word
Unit of data: 0.01Mpa or 0.1 kg/cm^2
Range of data: 0 to 255
Set the assist gas processing flow pressure.

15126	After flow pressure 1
15127	After flow pressure 2
15128	After flow pressure 3

Data type: Word
Unit of data: 0.01Mpa or 0.1 kg/cm^2
Range of data: 0 to 255
Set the assist gas after-flow pressure.

15132	Maximum assist gas pressure

Data type: Word
Unit of data: 0.01Mpa or 0.1 kg/cm^2
Range of data: 0 to 255
Set an assist gas pressure (kg/cm^2 (Mpa)) at which 10V is output in analog output.

15135	Assist gas pressure set time

Data type: Word
Unit of data: 10msec
Range of data: 0 to 32767
Set a desired assist gas pressure set time.

15136	Assist gas pressure

Data type: Word
Unit of data: 0.01Mpa or 0.1 kg/cm^2
Range of data: 0 to 255
Set a desired assist gas pressure.

15137	Assist gas pressure set time for piercing

Data type: Word
Unit of data: 10msec
Range of data: 0 to 32767
Set a desired assist gas pressure set time for piercing.

15138	Assist gas pressure for piercing

Data type: Word
Unit of data: 0.01Mpa or 0.1 kg/cm^2
Range of data: 0 to 255
Set a desired assist gas pressure for piercing.

15139	Assist gas stop time

Data type: Word
Unit of data: 10msec
Range of data: 0 to 32767
Set the wait time when the assist gas stops.

C.8 PARAMETERS FOR LASER MAINTENANCE TIMING INDICATION FUNCTIONS

15150	Laser RUN ON time

Data type: Two-word
Unit of data: 0.1hour
Range of data: 0 to 99999999
A cumulative RUN ON time is automatically set.

15151	Vacuum pump operation time

Data type: Two-word
Unit of data: 0.1hour
Range of data: 0 to 99999999
A cumulative vacuum pump operation time is automatically set.

15152	Shutter alarm mask time

Data type: Word
Unit of data: msec
Range of data: 0 to 32767
Set a time from when shutter operation is directed until shutter alarm monitoring starts.

	#7	#6	#5	#4	#3	#2	#1	#0
15153								LCK

Data type: Bit
LCK
0: Disables the leakage check function.
1: Enables the leakage check function.

15154	Leakage judgment time

Data type: Word
Unit of data: sec
Range of data: 3 to 65535
Set the time during which the valve is closed and the internal pressure of a discharge tube is kept for leakage check. The internal pressure of a discharge tube is measured four times within the specified time. If a value of 0 to 2 is set, the leakage check function does not operate.

	#7	#6	#5	#4	#3	#2	#1	#0
15160							MDS	MNT

Data type: Bit

MNT

0: Does not display the laser maintenance screen.
1: Displays the laser maintenance screen.

When the value indicating that the laser maintenance screen is not displayed is specified, the compensation factor is also stored and the cumulative operating time is also set. You can display the laser maintenance screen to check the data when required.

MDS

0: Disables data input on the laser maintenance screen.
1: Enables data input on the laser maintenance screen.

Data input on the laser maintenance screen is disabled to prevent the end user from entering data such as the operating time unintentionally. (The data can only be referenced.)
Setting this parameter to 1 enables data input.

C.9 PARAMETERS FOR THE OSCILLATOR

15200	Power used for power compensation factor determination when half of the discharge tubes are used

Data type: Word
Unit of data: W
Range of data: 0 to 32767
Set a power to find the power compensation factor when half of the discharge tubes are used.

15201	Power used for power compensation factor determination when all discharge tubes are used

Data type: Word
Unit of data: W
Range of data: 0 to 32767
Set a power to find the power compensation factor when all discharge tubes are used.

15203	Power calibration limit

Data type: Word
Unit of data:
Range of data: 0 to 32767
If the power compensation factor exceeds this value, the low output alarm signal (F220#6 MWRN) is output to notify the user of the time to clean or replace the mirror.

15204	Power calibration coefficient

Data type: Word
Unit of data:
Range of data: 0 to 32767
This is to calibrate command power for real power. This parameter is automatically set at power compensation after the oscillator start signal (G222#6 RUN) is turned on.

15205	Power compensation time

Data type: Word
Unit of data: sec
Range of data: 0 to 32767
Set a power compensation time.

15206	Time constant for the power sensor input filter

Data type: Word
Unit of data: msec
Range of data: 8 to 32767
This time constant is used when the laser power monitor value input from the power sensor is multiplied by the primary delay filter.

15207	Maximum specifiable power

Data type: Word
Unit of data: W
Range of data: 0 to 32767
If the power setting after power compensation or power feedback addition exceeds this value, the power output is clamped to this value.

15208	Laser power feedback gain

Data type: Word
Unit of data:
Range of data: 0 to 32767
Set the laser power feedback gain.

15209	Power feedback clamp

Data type: Word
Unit of data:
Range of data: 0 to 32767
This clamp value is used to prevent the excess power setting from being made during power feedback.

15210	Maximum command power

Data type: Word
Unit of data: W
Range of data: 0 to 7000
This is power clamp when power command is greater than this value.

15211	Minimum command power

Data type: Word
Unit of data: W
Range of data: 0 to 7000
This is power clamp when power command is smaller than this value.

15212 **Maximum specifiable power when the duty ratio is not clamped**

Data type: Word
Unit of data: W
Range of data: 0 to 32767
If PRM No. 15213 does not clamp the duty ratio to 50%, and a specified power after power compensation and power feedback processing exceeds the setting in this parameter, the power is clamped to the setting.
If a value of 0 is set, the setting of parameter No. 15207 is set.

15213 **Duty ratio clamp criterion**

Data type: Word
Unit of data: W
Range of data: 0 to 7000
When a specified power multiplied by an override value exceeds the value set in this parameter, the duty ratio is clamped to 50% (fixed value), and the peak value is clamped to the value set in PRM No. 15210.0, the setting of parameter No. 15210 is set.

15214 **Maximum setting for the CW-YAG laser frequency**

Data type: Word
Unit of data: Hz
Range of data: 0 to 32767
For a CW-YAG laser oscillator, the frequency setting is clamped to this value.

15215 **Power input calibration coefficient**

Data type: Word
Unit of data: W
Range of data: 102 (0.1×2^{10}) to 10240 (10×2^{10})
(If 0 is specified, 1024 (10×2^{10}) is assumed.)
Set the power input compensation factor.

15216 **Power display filter time constant**

Data type: Word
Unit of data: msec
Range of data: 0 to 32767
This is the filter time constant with which fluctuation in power display is suppressed.

15217	Beam stop delay time

Data type: Word
Unit of data: msec
Range of data: 0 to 32767
Set the time between the in-position check and stop of the beam.

15218	Maximum setting for the CW-YAG duty clamp output

Data type: Word
Unit of data: W
Range of data: 0 to 32767
If the specified laser output, Pc, for a CW-YAG laser exceeds this setting, the duty limit is clamped to $\frac{PRM.15218}{Pc} \times 100(\%)$.
If a value of 0 is set, 500 W is assumed.

15219	Beam output condition delay time

Data type: Byte
Unit of data: 8msec
Range of data: 0 to 8

C.10 PARAMETERS FOR DISCHARGE

15220	Maximum bias command at discharge start

Data type: Word
Unit of data: mV
Range of data: 0 to 32767
Set the maximum bias setting at the start of discharge.

15221	Voltage for conforming discharge

Data type: Word
Unit of data: V
Range of data: 0 to 32767
Set the discharge starting voltage.

15222	Discharge waiting time

Data type: Word
Unit of data: 10msec
Range of data: 0 to 32767
Specifies the waiting time until the discharge is checked after the maximum bias setting is specified at the start of discharge.

15223	Bias command

Data type: Word
Unit of data: mV
Range of data: 0 to 32767
Specify the bias setting.

15224	Modulation voltage

Data type: Word
Unit of data: mV
Range of data: 0 to 3000
Set the voltage to which the normal bias value is lowered during modulation by the base modulation function.

15225	Modulation time

Data type: Word
Unit of data: 10msec
Range of data: 0 to 32767
Set the time during which the bias setting is lowered.

C.11 PARAMETERS FOR GAS CONTROL (1)

15240 **Negative pressure in exhaust completion**

Data type: Word
Unit of data: (1=13Pa)
Range This pressure is used for evacuating the discharge tubes in laser start-up sequence.

15241 **Intra-tube pressure in discharge start**

Data type: Word
Unit of data: (1=13Pa)
Range of data: 0 to 32767
Internal gas pressure of the discharge tubes at the start of discharge

15242 **Tube pressure for oscillation (50Hz)**

Data type: Word
Unit of data: (1=13Pa)
Range of data: 0 to 32767
Internal gas pressure of the discharge tubes during laser oscillation. (at 50 Hz)

15243 **Tube pressure for oscillation (60Hz)**

Data type: Word
Unit of data: (1=13Pa)
Range of data: 0 to 32767
Internal gas pressure of the discharge tubes during laser oscillation. (at 60 Hz)

15244 **Gas pressure control gain**

Data type: Word
Unit of data:
Range of data: 0 to 32767
This is the gain to feedback control the intra-tube laser gas pressure.

15245 **Intratube pressure control gain 2**

Data type: Word
Unit of data:
Range of data: 0 to 32767
Set the gas pressure control gain during base discharge.
When bit 1 of parameter No.15000 is 1, this parameter is valid.

15246 **Pressure control integration gain**

Data type: Word
Unit of data:
Range of data: 0 to 32767
This is feedback integration gain for gas pressure control.

15247 **Pressure control integral element preset value**

Data type: Word
Unit of data:
Range of data: -32768 to 32767
Integral element preset value for gas pressure control

15248 **Allowable gas pressure insufficiency**

Data type: Word
Unit of data: (1=13Pa)
Range of data: 0 to 32767
Allowable value used to determine to issue no alarm if the gas pressure does not reach the setting

15249 **Gas pressure rising time**

Data type: Word
Unit of data: sec
Range of data: 0 to 60
Set the gas pressure rising time in sequence 27.

15255 **RUN ON evacuation time**

Data type: Word
Unit of data: sec
Range of data: 0 to 32767
Set the evacuation time at the RUN start.

15256 **RUN OFF evacuation time**

Data type: Word
Unit of data: sec
Range of data: 600 to 32767
When bit 2 of parameter No. 15003 (GVW) is set 1 and the oscillator start signal (G222#6 RUN) is set to "0," evacuation is performed according to this time setting.

15257	Number of abnormal vibrations detected

Data type: Word
Unit of data:
Range of data: 0 to 32767
If the number of abnormal vibrations detected exceeds the value specified in this parameter, an alarm is issued.

15258	Time constant of the filter used for laser gas pressure variation suppression

Data type: Word
Unit of data: msec
Range of data: 17to 32767 (If a value less than 16 is specified, the filter does not function.)

15259	Exhaust time when RUN is ON

Data type: Word
Unit of data: sec
Range of data: 0 to 32767
Set a desired evacuation time when RUN is ON.

15260	Period when the exhaust value of the external pipe is open

Data type: Byte
Unit of data: sec
Range of data: 0 to 60 (When a time beyond 60 sec is specified, the time is clamped to 60 sec.)
Set the time the exhaust valve of the external pipe is open.

C.12 PARAMETERS FOR HIGHLY REFLECTIVE MATERIAL ALARMS

15265	Maximum allowable power increase

Data type: Word
Unit of data: W
Range of data: 0 to 32767
If the difference between the specified power and actual output power is greater than this value, beam reflection error alarm 4068 is issued.

15266	Maximum allowable power

Data type: Word
Unit of data: W
Range of data: 0 to 32767
If the actual output exceeds this value, beam reflection error alarm 4068 is issued.

C.13 PARAMETERS FOR LASER POWER/VOLTAGE DROP

15270	Discharge tube voltage in normal operation

Data type: Word
Unit of data: V
Range of data: 0 to 32767
Set the discharge tube voltage during normal base discharge.
This parameter is automatically rewritten after the discharge start signal (G222#7 HVON) is turned on.

15271	Power decrease limit

Data type: Word
Unit of data: W
Range of data: 0 to 32767
If the difference between the specified output and actual output is greater than this setting, low output alarm 4076 is issued.

15272	Discharge tube voltage decrease limit

Data type: Word
Unit of data: V
Range of data: 0 to 32767
If the difference between the discharge tube voltage during use of the laser and that at the start-up of the laser is greater than this setting, low voltage alarm 4088 is issued.

15276	Laser gas replacement time

Data type: Word
Unit of data: sec
Range of data: 0 to 32767
Time during which a new laser gas is filled in the internal piping system after RUN is turned on

C.14 PARAMETERS FOR POWER TABLE SETTING

15280	Table interval when half of the discharge tubes are used
15281	Table interval when all discharge tubes are used

Data type: Word
Unit of data:
Range of data: 0 to 32767
Standard setting: Refer to the parameter data sheet delivered with the machine.
Set the increment in watts used for the setting in the output command.

15290	Power command 0 when half of the discharge tubes are used
15291	Power command 1 when half of the discharge tubes are used
15292	Power command 2 when half of the discharge tubes are used
15293	Power command 3 when half of the discharge tubes are used
15294	Power command 4 when half of the discharge tubes are used
15295	Power command 5 when half of the discharge tubes are used
15296	Power command 6 when half of the discharge tubes are used
15297	Power command 7 when half of the discharge tubes are used
15298	Power command 8 when half of the discharge tubes are used

Data type: Word
Unit of data: W
Range of data: 0 to 32767
Standard setting: Refer to the parameter data sheet delivered with the machine.
Sequentially set the output setting starting from 0 for each table interval when half of the discharge tubes are used.

15300	**Power command 0 when all discharge tubes are used**
15301	**Power command 1 when all discharge tubes are used**
15302	**Power command 2 when all discharge tubes are used**
15303	**Power command 3 when all discharge tubes are used**
15304	**Power command 4 when all discharge tubes are used**
15305	**Power command 5 when all discharge tubes are used**
15306	**Power command 6 when all discharge tubes are used**
15307	**Power command 7 when all discharge tubes are used**
15308	**Power command 8 when all discharge tubes are used**

Data type: Word
Unit of data: W
Range of data: 0 to 32767
Standard setting: Refer to the parameter data sheet delivered with the machine.
Sequentially set the output setting starting from 0 for each table interval when all discharge tubes are used.

C.15 AUTOMATIC AGING FUNCTION

15320	Command power for power compensation coefficient calculation

Data type: Word
Unit of data: V
Range of data: 0 to 7000

15321	Oscillation frequency command for power compensation coefficient

Data type: Word
Unit of data: Hz
Range of data: 5 to 2000

15322	Pulse duty cycle command for power compensation coefficient

Data type: Word
Unit of data: %
Range of data: 0 to 100

15323	Command time for power compensation coefficient calculation

Data type: Word
Unit of data: sec
Range of data: 0 to 32767

15324	Gas pressure setting for normal compensation (50Hz)

Data type: Word
Unit of data: (1=13Pa)
Range of data: 0 to 32767

15325	Gas pressure setting for normal compensation (50Hz)

Data type: Word
Unit of data: (1=13Pa)
Range of data: 0 to 32767

15326	Power command when aging is performed with the automatic aging

Data type: Word
Unit of data: V
Range of data: 0 to 7000

15327	Oscillation frequency command for aging

Data type: Word
Unit of data: Hz
Range of data: 5 to 2000

15328 **Pulse duty cycle command for aging**

Data type: Word
Unit of data: %
Range of data: 0 to 100

15329 **Power command time for aging**

Data type: Word
Unit of data: sec
Range of data: 0 to 32767

15330 **Gas pressure setting (50 Hz) for aging**

Data type: Word
Unit of data: (1=13Pa)
Range of data: 0 to 32767

15331 **Gas pressure setting (60 Hz) for aging**

Data type: Word
Unit of data: (1=13Pa)
Range of data: 0 to 32767

15332 **Oscillation frequency command value for power compensation**

Data type: Word
Unit of data: Hz
Range of data: 5 to 2000

15333 **Pulse duty cycle command during power compensation**

Data type: Word
Unit of data: %
Range of data: 0 to 100

15334 **Number of aging operations**

Data type: Word
Unit of data:
Range of data: 0 to 32767 (Automatically set by the CNC)

15335 **Time data 1 when the HV is turned off after LSTR**

Data type: Two-word
Unit of data: Year
Range of data: 0 to 99999999 (Automatically set by the CNC)

15336	Time data 2 when the HV is turned off after LSTR

Data type: Two-word
Unit of data: Month
Range of data: 1 to 12 (0 to 99999999) (Automatically set by the CNC)

15337	Time data 3 when the HV is turned off after LSTR

Data type: Two-word
Unit of data: Day
Range of data: 1 to 31 (0 to 99999999) (Automatically set by the CNC)

15338	Time data 4 when the HV is turned off after LSTR

Data type: Two-word
Unit of data: Hour
Range of data: 0 to 24 (0 to 99999999) (Automatically set by the CNC)

15339	Stop time for the oscillator requiring aging operation

Data type: Word
Unit of data: hour
Range of data: 0 to 32767 (range of valid settings: 30 to 120)
If the setting is less than 30, internal processing assumes the value to be 60.

C.16 POWER CONTROL (2)

15450	Allowable variation in power control speed

Data type: Word
Unit of data: mm/min
Range of data: 0 to 32767
Standard setting: 4

Set the amount by which the power control speed is allowed to vary. When this parameter is set to 0, parameter No. 15095 is valid. Parameter No. 15095 and this parameter differ in the range of valid settings.
For details of setting, see the explanation of parameter No. 15095.

C.17 LASER GAS MIXER FUNCTION

15710 **Wait time for checking the remaining amount in the gas cylinder**

Data type: Word
Unit of data: sec
Range of data: 0 to 32767
Standard setting:

Wait time when the remaining amount in the gas cylinder is checked

15711 **Gas mixture wait time**

Data type: Word
Unit of data: min
Range of data: 0 to 32767
Standard setting: 60

Time required until gas mixture is complete and the mixed gas can be supplied after gases are filled in the tank.

15712 **Gas mixer evacuation time**

Data type: Word
Unit of data: min
Range of data: 0 to 32767
Standard setting: 30

Set the time required for evacuating the mixer. This value is also used for the time required for evaluation for leakage check.

15713 **Helium exhaust time**

Data type: Word
Unit of data: msec
Range of data: 0 to 32767
Standard setting:

Time required for exhausting the Helium gas from piping before the next gas is filled after the helium gas is filled

15714 **Nitrogen and CO_2 exhaust time**

Data type: Word
Unit of data: msec
Range of data: 0 to 32767
Standard setting:

Time required for exhausting the nitrogen gas or carbon dioxide gas from the piping before the next gas is filled after that gas is filled

15715	Vacuum criteria gas pressure

Data type: Word
Unit of data: (1=13Pa)
Range of data: 0 to 32767
Standard setting:

This value is used for determining the degree of vacuum of the laser gas pressure in the gas mixer.
If the laser gas pressure does not reach this value, an alarm is issued.

15716	Evacuation wait time

Data type: Word
Unit of data: min
Range of data: 0 to 32767
Standard setting: Wait time for evacuation. If the setting is 0, a value of 30 is input.

C.18 PARAMETERS FOR GAS PRESSURE CONTROL (2)

	#7	#6	#5	#4	#3	#2	#1	#0	
15800									TPC

Data type: Bit

TPC The control function of driving the turbo blower with a constant power
0: Invalid
1: Valid

15801	Maximum internal pressure when the control function of driving the turbo blower with a constant power is enabled

Data type: Word
Unit of data: (1=13Pa)
Range of data: 1 to 32767

Maximum setting for the internal laser pressure. If the internal laser pressure setting calculated from the laser power setting exceeds the setting of this parameter, the internal laser pressure is clamped to this value.

15802	Laser power setting used as the maximum internal pressure when the control function of driving the turbo blower at a constant power is enabled

Data type: Word
Unit of data: W
Range of data: 1 to 32767

Laser power setting used when the setting of parameter No. 15801 is used as the internal laser pressure setting. The proportional constant for the internal laser gas pressure setting and laser power setting is determined using this parameter and parameter No. 15801.

15803	Compensation factor for the internal pressure setting when the control function of driving the turbo blower at a constant power is enabled

Data type: Word
Unit of data: 1/1024
Range of data: 0 to 32767

Compensation factor by which the internal laser pressure setting is multiplied. When the parameter setting is 1024, compensation factor 1.0 is used for multiplication.

15804	Maximum exhaust valve open time for internal pressure control during oscillation

Data type: Word
Unit of data: msec
Range of data: 0 to 3000

Set the maximum open time for exhaust valve PCV.

D GLOSSARY

Name	Meaning
<A>	
Access panel	That protective component of a housing or enclosure which, when removed or shifted, can cause exposure to laser radiation.
AEL Accessible emission level	Maximum accessible emission level set up for each class of laser products
Alignment	Optical axis adjustment
Aperture	Iris, or stop
<B>	
Beam	Aggregate of unidirectional, diverging, or conversing rays
Beam diameter	Distance between two symmetrical points in a cross section of a beam where the power per unit area is 1/e as high as the maximum power per unit area
Beam divergence	Angle through which a beam spreads
Burn pattern	Laser beam mode pattern generated on a plate such as an acrylic plate for confirmation purposes
<C>	
Circular Polarization	Polarization in which a plane of polarization rotates about the axis along which the light progresses and does not have directivity; an electric or magnetic field based on circular polarization has a constant intensity.
CO_2 laser	Laser that uses a carbon dioxide gas as a laser medium
CW Continuous wave	Continuously radiated laser output
<D>	
Discharge excitation	Realization of inverted population by means of discharge
<E>	
Enhanced pulse	Greatly amplified peak output of a pulse
Excitation	Transition of atoms or molecules to a higher energy level by supplying them with external energy
Exposure time	Duration through which laser radiation is emitted
<F>	
Fast axial flow laser	Laser in which gas flows rapidly in the same direction as the laser beam
Feedback	Corrective action in which a quantity to be controlled is compared with a target value generated by feeding part of an output signal to the input through a specially created closed loop so that the quantity to be controlled matches the target value.
<L>	
Laser	Device for generating light by stimulated emission
Laser controlled area	Area in which activities are controlled or monitored for protection from hazards resulting from laser radiation
Laser mirror	Reflecting mirror used in a laser resonator
Laser safety officer	Person having sufficient knowledge about evaluation and management of hazards of lasers and in charge of safety management of lasers
Laser safety standard	Standard to protect human bodies from hazards resulting from laser beams in view of use of lasers and about laser products for sale
Linear Polarization	Polarization in which a plain of polarization is at a constant angle with the axis along which the light progresses
<M>	
Maintenance	Action taken by a user to preserve normal operation of a product, such as adjustment or other measures specified in documents created by the manufacturer for users

Name	Meaning
Maximum output	Maximum radiation power or maximum radiation energy per pulse that a laser product outputs in all directions where there is a hazard of exposure in view of operational capacity in every area at any point of time after the production of the laser product
Mode	State of a resonant system in which an electromagnetic field has a specific distribution
MPE Maximum permissible exposure	Maximum laser radiation level that can be radiated onto human bodies without harmful influence to them in an ordinary environment
<O>	
Operation	Laser product's action covering all intended functions, not including maintenance or service.
Optical resonator	Device in which stimulated emission of light is used for a laser and which consists of a pair of reflecting mirrors facing each other
<P>	
Parameter	Variable that is assigned a given value for a specific purpose and indicates that purpose
Phase	Amount representing a positional relationship between two adjacent highest or lowest points on a wave
Power density	Energy per unit area
Protective housing	Laser product housing or its part designed to protect humans from exposure to a laser beam exceeding an accessible emission level or strong collateral radiation
Pulse duration	Time interval between the points at which an instantaneous value on the leading and trailing edges is half the peak pulse amplitude
Pulse duty	Ratio (%) of a duration in which a pulsating laser output is on, to its entire cycle
Pulse frequency	Repetition frequency at which pulsating laser beams are radiated from an oscillator
Pulse laser	Laser that outputs energy in the form of a single pulse or a pulse train
Pulse output	Laser output radiated in the form of a pulse train
<R>	
Radian	Measurement unit of angle; 1 radian equals $360°/2\pi$
Radiant energy	Energy emitted, transmitted, or received (measured in joules, or J)
<S>	
Safety interlock	Device combined with the protective housing of a laser product to stop its operation automatically when part of the housing is removed
Semiconductor laser	Laser that uses a semiconductor as an exciting medium
Sequence	A succession of steps carried out in a prescribed order
Stimulated emission	Emission of an electromagnetic wave from a material in proportion to the strength of the incident electromagnetic field
<T>	
Target	Jig used to radiate and position a laser beam
Threshold	Physical quantity necessary to generate laser beams

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Revision Record

FANUC LASER-MODEL C1000*i*A OPERATOR'S MANUAL (B-70254EN)

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