

Remote Laser FUNCTION

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

Part Number: 157302-1CD
Revision: 0



YASKAWA

MANUAL NO.

HW0485495



 **MANDATORY**

- In order to secure safety, installation, maintenance/inspection and repairing of the welder shall be carried out by a well trained person who has a good knowledge about welder, or a qualified person.
- In order to secure safety, the operation of the welder shall be operated by a knowledgeable and skilled person who can understand very well about the contents of the instruction manual and can handle the welder safety.
- Perform the safety education.
- After reading this instruction manual, please keep it valuably as well as the warranty certificate in a handy place to read easily for the related person and read it again when needed.

 **CAUTION**

- The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.
- YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.
- If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.
- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product's warranty.

Notes for Safe Operation

In this manual, the Notes for Safe Operation are classified as “WARNING,” “CAUTION,” “MANDATORY,” or “PROHIBITED.”



WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.



CAUTION

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to personnel and damage to equipment. It may also be used to alert against unsafe practices.



MANDATORY

Always be sure to follow explicitly the items listed under this heading.



PROHIBITED

Must never be performed.

Even items described as “CAUTION” may result in a serious accident in some situations. At any rate, be sure to follow these important items.



To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “CAUTION” and “WARNING.”



DANGER

In order to avoid an electric shock, be sure to observe the followings.



Touching the electrically charged portion may result in a fatal electric shock or burns.

1. Do not touch the live parts.
2. Be sure to turn off all power sources on the input side by the switch in the distribution box before performing installation or maintenance/inspection operation.
3. Do not use damaged cables, those of small capacity or of which the conductors are exposed.
4. Be sure to fasten the connections of cable and insulate them.
5. Do not use the welder without its case or cover.
6. Do not use broken or wet gloves. Be sure to always use insulated gloves.
7. When working at a high position, use a life rope.
8. Perform maintenance and inspection periodically. If a damaged portion is found, repair it at once before the machine. (Never use a damaged machine.)
9. When the welder is not used, turn off the power on the input side of all devices.



DANGER

In order to prevent fire, explosion and burst, be sure to observe the followings.



- Spatter and heated base metal just after welding may cause fire.
- If these are incomplete connections of cable or incomplete contacts in the current flow passage on the base metal side such as steel frame, these may result in fire due to the heat generation by electrification.
- Welding a sealed tank or pipe may result in burst.

1. Remove flammable materials to avoid contacting with scattering spatter. When not removable, enclose the flammable materials with a non-flammable cover.
2. Do not perform welding when there is flammable gas nearby.
3. Do not bring the hot base metal just after welding nearer to the flammable materials.
4. Regarding the welding for ceiling and floor, wall, remove the hidden flammable materials.
5. Be sure to fasten the connections of cable and insulate them.
6. The cable on the base metal side shall be connected close to the welded section as much as possible.
7. Do not weld a gas pipe with gas inside, a sealed tank or pipe.
8. Please keep a fire extinguisher near the welding work place and prepare for fire.



DANGER

In order to protect you and other persons from fumes or gas generated by welding, use an exhaust system and protective tools.



- Welding work at a narrow place may result in danger of suffocation due to the occurrence of air shortage.
- When breathing in fumes or gas generated at the time of welding, it may cause a harm of health.

1. In order to prevent gas poisoning or suffocation, in a place specified by regulations (such as Industrial Safety and Health Law, etc.), provide good ventilation or effective tools for breathing shall be used.
2. In case of welding at a narrow place, be sure to provide good ventilation or wear a protective tool for breathing. Also carry out the welding work under a well trained supervisor.



WARNING

As the rotating section may cause an injury, be sure to observe the followings.



- When bringing hands, fingers, hair or cloth nearer to a rotating section such as cooling fan, it may result in injuries by being rolled in.

1. Do not use the welder without its case or cover attached.
2. When taking out the case or cover for maintenance/inspection, the work shall be carried out by a knowledgeable, well trained person who can understand very well about the

welder or a ququalified person. Install a screen in the surroundings of welder lest the other person makes an access carelessly.

3. Do not bring hands, fingers, hair or cloth nearer to the cooling fan in rotation.

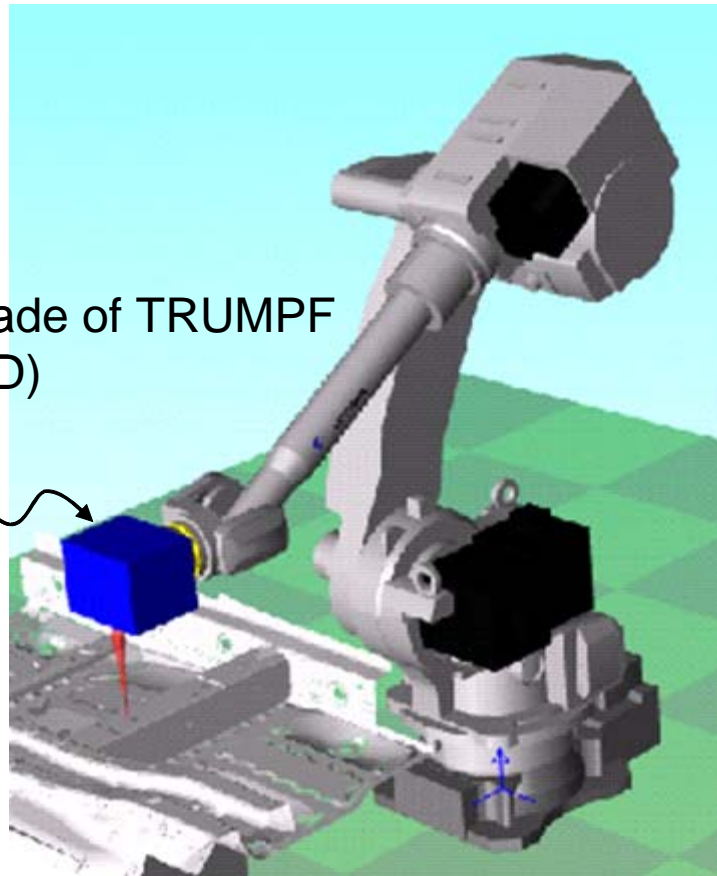
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1 Outline of Remote Laser

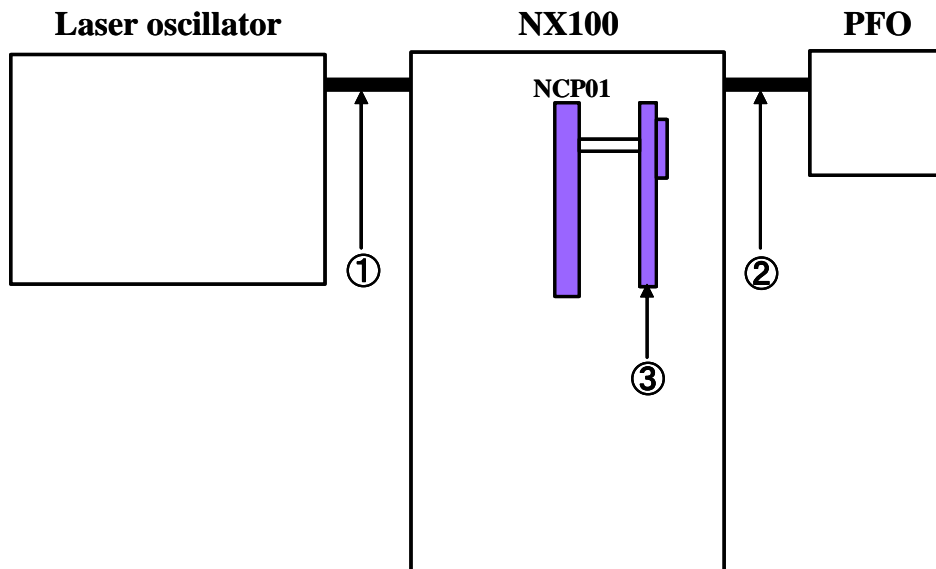
1.1 Outline of Remote Laser System

The remote laser system (On The Fly) is a laser welding system by controlling the position of the laser head (PFO made by TRUMPF) while the robot is moving.

Laser Head made of TRUMPF
PFO3D/33(2D)



1.2 Structure of Remote Laser System

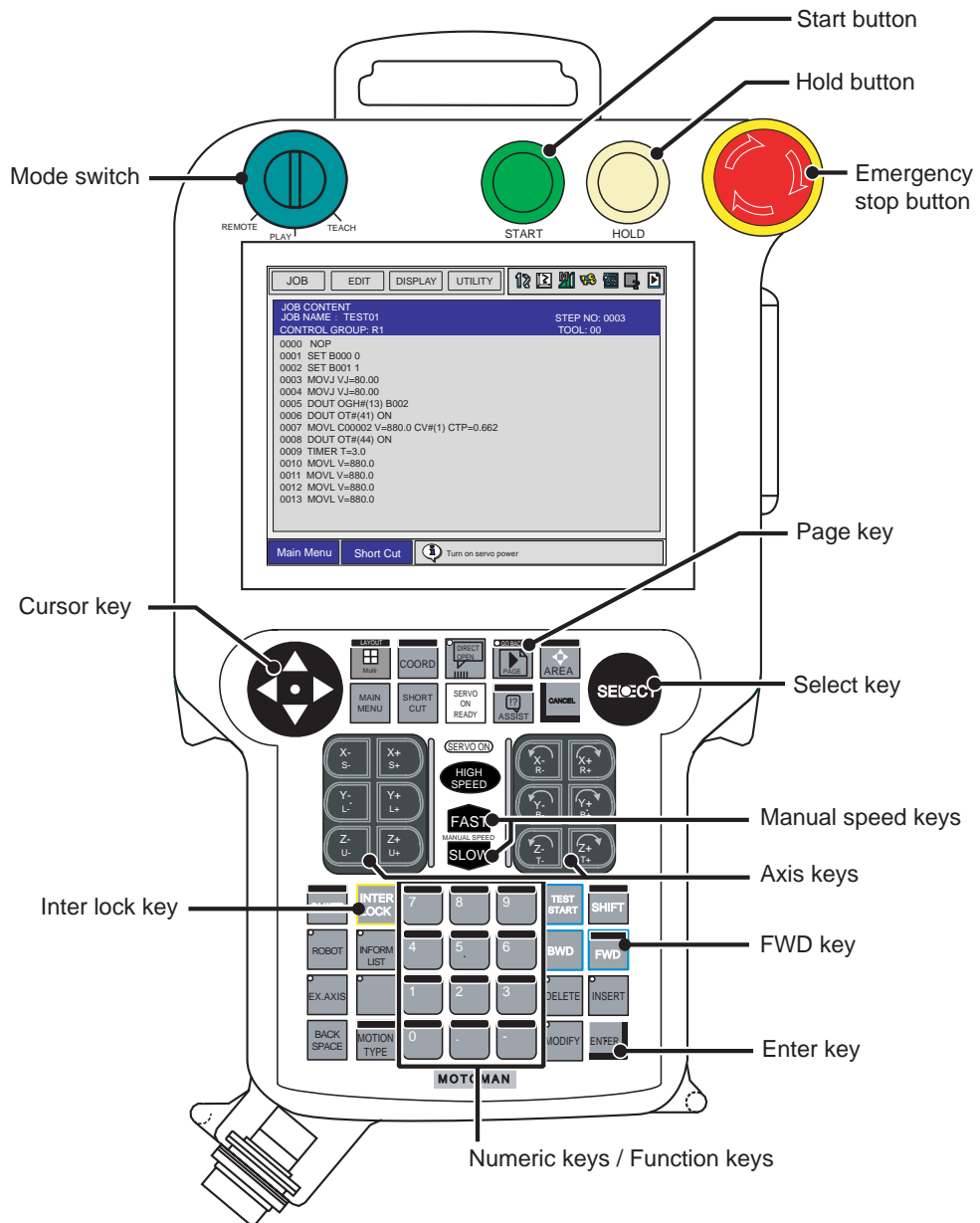


- ① I/O or Device Net
- ② CAN (Controller Area Network) communication cable
- ③ NCP02 (for remote laser) + NSL03

Software: NS4.56.00A-81
1.10(Remote Laser ROM)

2 Operation of Remote Laser with Pendant

2.1 Name of Pendant Each Part



2.2 Kind of Laser

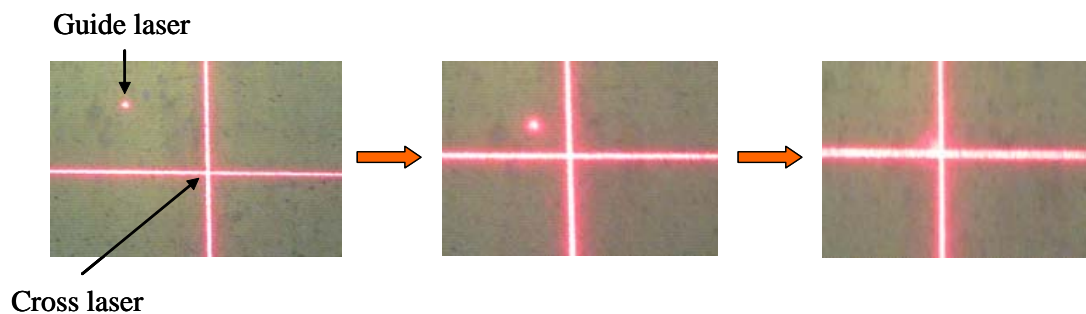
2.2 Kind of Laser

There are some kinds of lasers used by this function.

- Guide light: It is visible light used when the teaching is done. The welding start point and the welding end point are taught by using the guide light.

- Cross laser: It is visible light used when focusing it on work. The focal length is adjusted by making the robot go up and down Z axially and matching Guide laser to the intersection of Cross laser.

The cross laser can be turned on with [INTER LOCK] and [5] key to the pendant, and turned off with [INTER LOCK] and [8] key of the pendant.



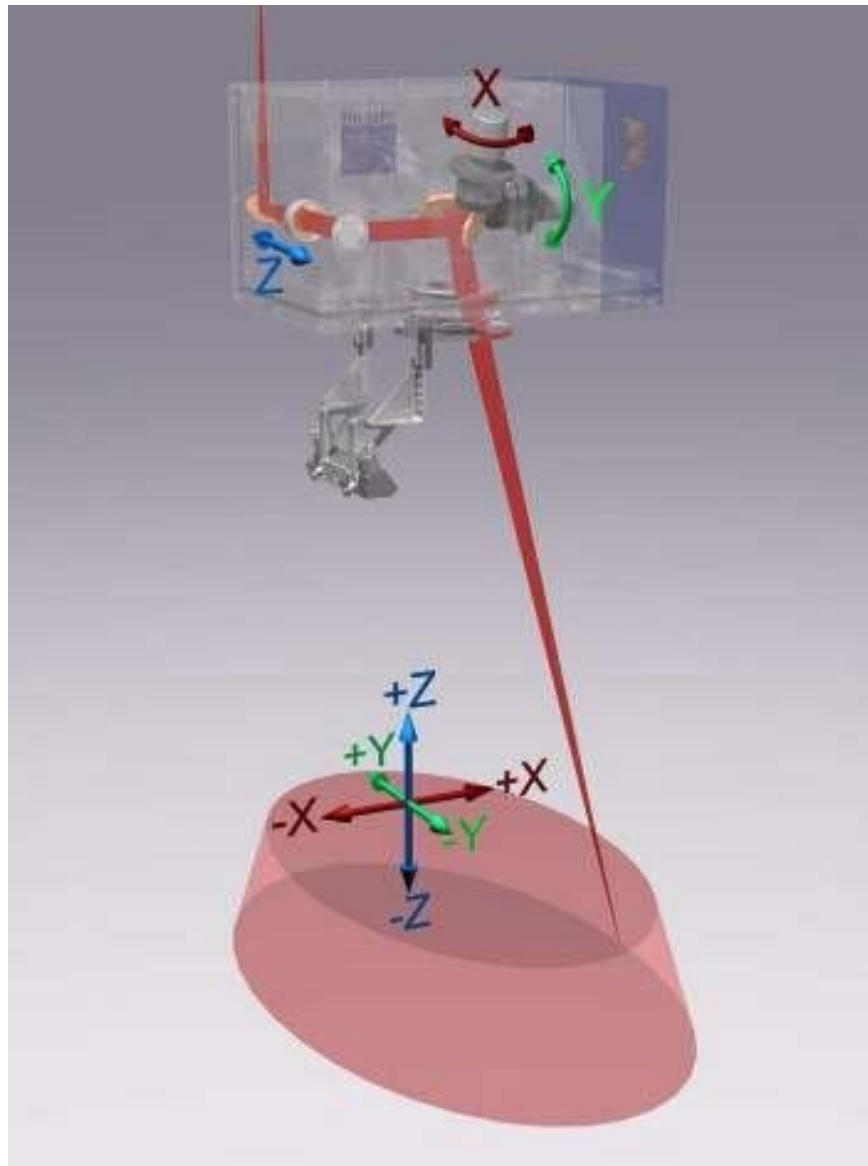
- Welding laser: It is a laser irradiated when actually welding.

※ To shirk away from risk, please do not approach the flash coverage of the laser, and look straight at the laser.

※ Please shade when you weld.

2.3 Coordinate System of Laser Head

Figure of the coordinate system of the laser head is shown.



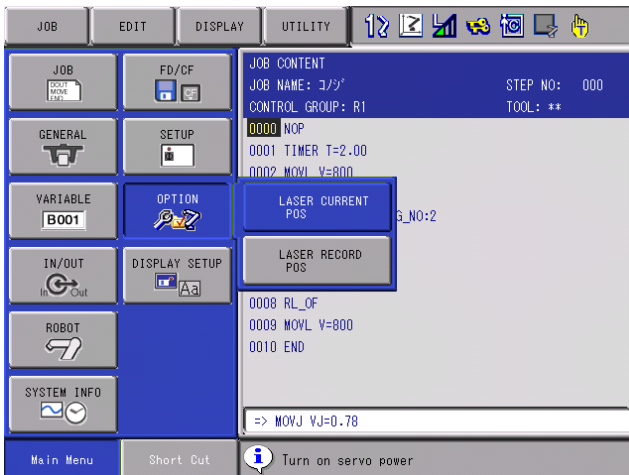
※ Figure shows the coordinate system of PFO3D. There is no Z axis in PFO33.

2.4 Operation

2.4 Operation

The guide light of a remote laser is irradiated to work, and the guide light can be moved with robot controller's programming pendant.

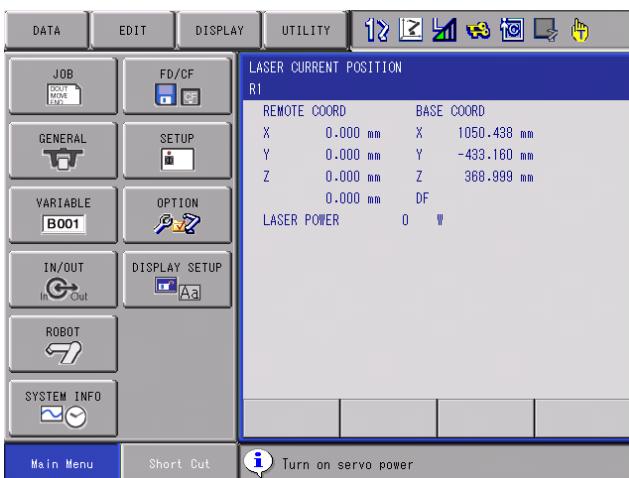
You should be opening the laser current position screen or the laser record position screen to move a remote laser.



(i) [OPTION]→[LASER CURRENT POSITION] is selected.

Remote axis coordinates display the coordinate value of a peculiar coordinate system of laser head (PFO-3D or PFO-33) .

Base axis coordinates display the focus position of a remote laser by the coordinate value of the base coordinate system for the robot.



The guide light of a remote laser can be moved with [INTER LOCK] and [+X], [-X], [+Y], [-Y], [+Z], [-Z] key of the pendant.

※ The operation by [+Z],[-Z] key is only PFO-3D.

※ The range of the operation limit of a remote laser is described to Chapter 6.

For PFO-3D, DF(defocus) of a remote laser can be operated with [INTER LOCK] and [+B], [-B] key of the pendant.

DF(defocus) is a function to adjust the focal length in the direction of an optical axis of the laser.

The laser light can be returned to the starting point with [INTER LOCK] and [6] key of the pendant.

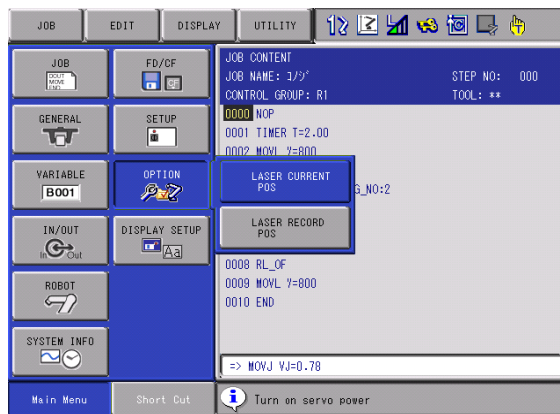
3 Remote Laser Welding Position Registration File

The remote laser welding position registration file is for registering welding positions. The laser refer to the remote laser welding position registration file specified by the RL_ON instruction while the robot is moving.

The number of remote laser welding position registration file is 100.

40 or less welding lines can be registered in one remote laser welding position registration file.

3.1 Setting of File



(i) [OPTION] → [LASER RECORD POS] is selected.

SELECT REMDTE LASER FILE		
No	ROBOT	RECORD STATUS
001	RT	REGIST
002	RT	REGIST
003	RT	REGIST
004	RT	REGIST
005	RT	UNREGIST
006	RT	UNREGIST
007	RT	UNREGIST
008	RT	UNREGIST
009	RT	UNREGIST
010	RT	UNREGIST
011	RT	UNREGIST
012	RT	UNREGIST
013	RT	UNREGIST

(i) The welding position registration file is selected. The welding position registration file is from No.001 to No.100.

(ii) When the cursor is moved to the registered part with [Cursor key], and [SELECT] key is pressed, the welding position registration screen is displayed.

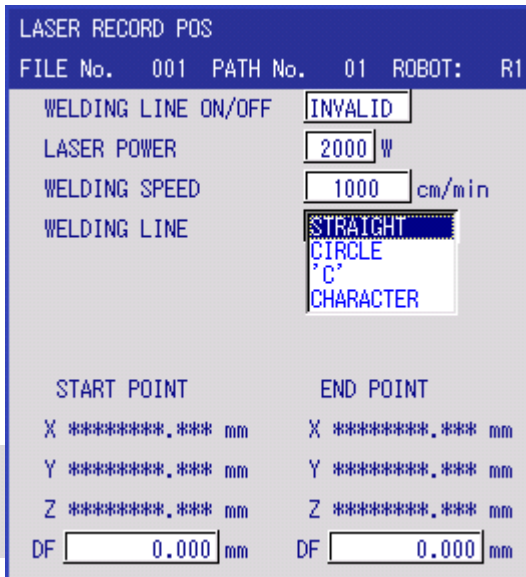
When at least one welding path is registered, registration status becomes [REGIST].

- When searching for the file number
When the cursor is moved to the part of No. on this screen, and the [SELECT] key is pressed, the box where the file number is input is displayed.

- When you clear the registered file
Please refer to "3.8 Deletion of File".

3.2 Type of Welding Line

3.2 Type of Welding Line



40 or less welding lines can be registered in one remote laser welding position registration file.

Please register the welding position from welding path No.01 to a small path numerical order.

[WELDING LINE] VALID/INVALID: This welding path is not executed when invalidating it.

[LASER POWER]: The laser output [W] is set.

[WELDING SPEED]: The welding speed is set.

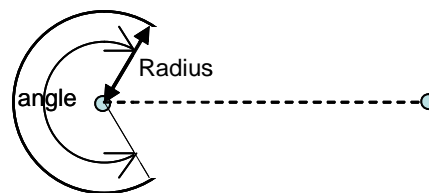
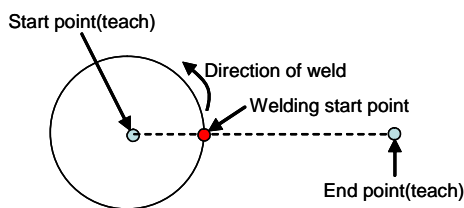
[DF(defocus)]: The focal length is adjusted in the direction of an optical axis of the laser.

[Kind of WELDING LINE]:

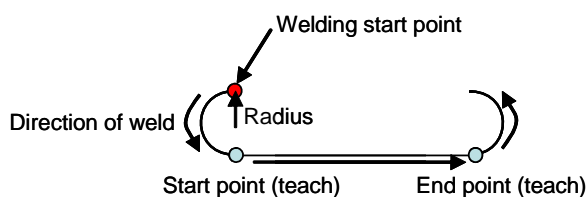
STRAIGHT: The welding start point and the welding end point are welded in the straight line.



CIRCLE: The position of the start point (teach) is assumed to be a center of a circle, and circle is welded by the specified radius. The welding start position is on the straight line that connects the welding end point from the welding start point. If a positive numerical value is input to [RADIUS], the direction of the welding becomes direction of counterclockwise. If a negative numerical value is input to [RADIUS], the direction of the welding becomes direction of clockwise. Moreover, a circular arc angle can be specified.



'C': The straight line with the semicircle of the specified radius are added to the straight line from the start point (teach) to the end point (teach).

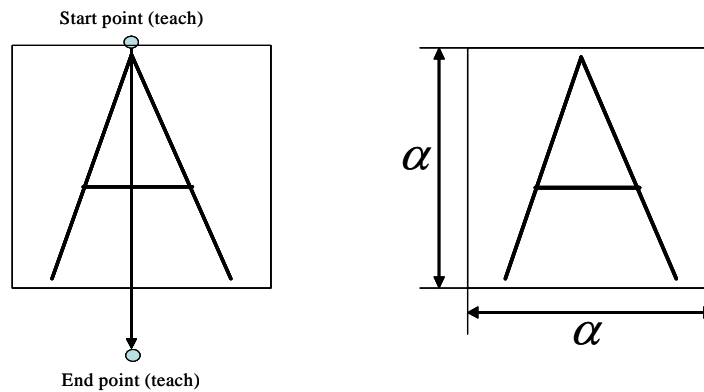


※ C that reversed left figure can be drawn by putting a negative figure in the radius.



CHARACTER: The alphabet (Capitals A~Z) and the figure (1~9) are specified. If the cursor is matched to CHARACTER and [SELECT] key is pushed, it becomes the screen of the keyboard. Then select one arbitrary character and push [ENTER] key.

The direction of the character is set by the start point (teach) and the end point (teach), and the size of the character is set by LENGTH.



3.3 Registration of Welding Position

START POINT		END POINT	
X	867.244 mm	X	867.264 mm
Y	-195.929 mm	Y	-157.372 mm
Z	370.601 mm	Z	371.072 mm
DF	0.000 mm	DF	0.000 mm

The robot and the laser can be moved to the registered position by pressing [FWD] key of the pendant when the cursor is on 「START POINT」 or 「END POINT」.

(i) The cursor is moved to the welding start point and the guide light of a remote laser is moved to the welding beginning point with [INTER LOCK] key and [+X], [-X], [+Y], [-Y], [+Z], [-Z] key.

(ii) Afterwards, the position is registered with [MODIFY] key and [ENTER] key.

(iii) The welding end point is registered as well as (i) (ii).

The displayed position is an orthogonalization value of the base coordinate system for the robot.

3.4 Registration of Timer and Slope Control

3.4 Registration of Timer and Slope Control

START TIMER	<input type="text" value="0.010"/> sec	END TIMER	<input type="text" value="0.000"/> sec
LASER POWER SLOPE CONTROL			
WELD ST. ON/OFF	<input checked="" type="checkbox"/> ON	WELD ED. ON/OFF	<input type="checkbox"/> OFF
START POWER	<input type="text" value="10"/> W	END POWER	<input type="text" value="10"/> W
SLOPE TIME	<input type="text" value="0.050"/> sec	SLOPE TIME	<input type="text" value="0.050"/> sec

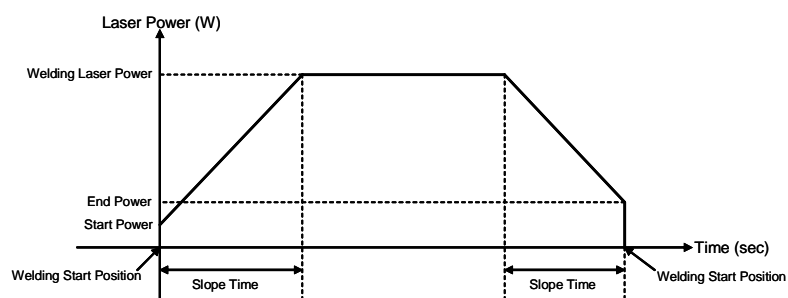
[START TIMER]: The laser position is maintained during the specified time at the start position like laser power OFF, and the welding begins after time passes.

[END TIMER]: The laser position is maintained during the specified time at the end position like laser power ON, and after time passes, it moves to the next start point.

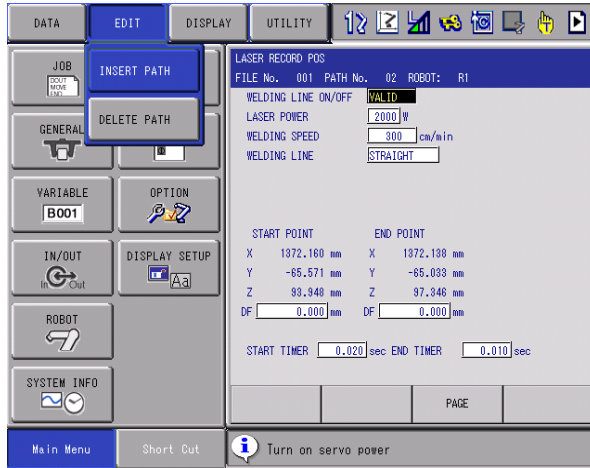
[WELD ST. SLOPE]: It welds in specified slope time while raising the laser power from specified start power to specified laser power.

[WELD ED. SLOPE]: The welding is ended by spending the specified slope time, and decreasing the laser power from specified laser power to specified end power.

Please press the [SELECT] key to the pendant and make [WELD ST.(ED) ON/OFF] [ON] to do the slope control effectively.



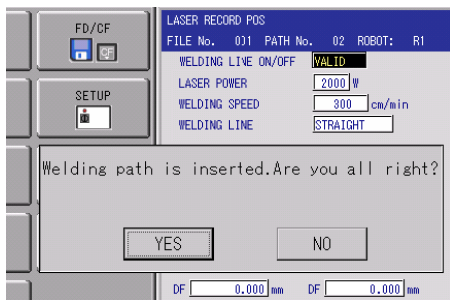
3.5 Addition of PATH



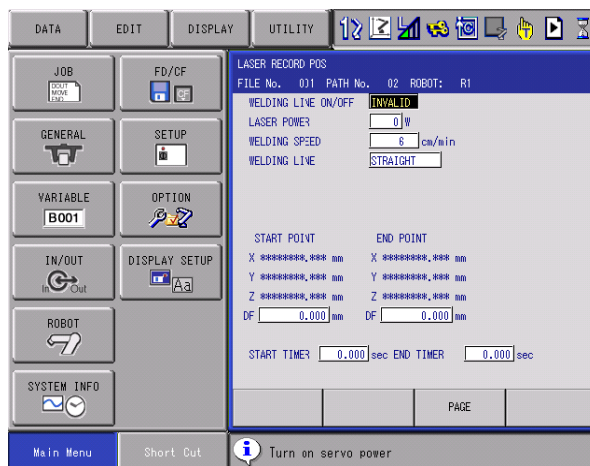
(1) When you add a new path before the displayed path, [EDIT] → [INSERT PATH] is selected on the screen of the displayed path.

(2) When the message of "Welding path is inserted.Are you all right?" appears in the dialog box, [YES] is selected.

(3)A new path is added before the displayed path.

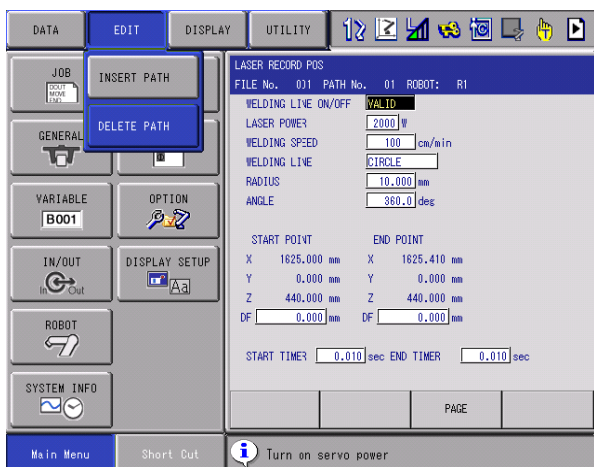


※ Because path that can be registered in one file is 40, when a new path is added, information on 40th is annulled.



3.6 Deletion of Path

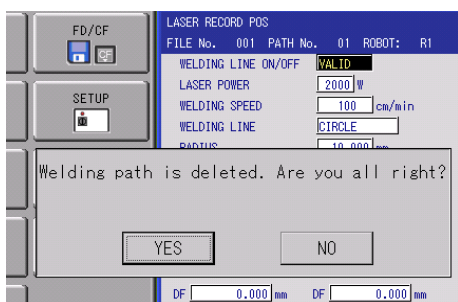
3.6 Deletion of Path



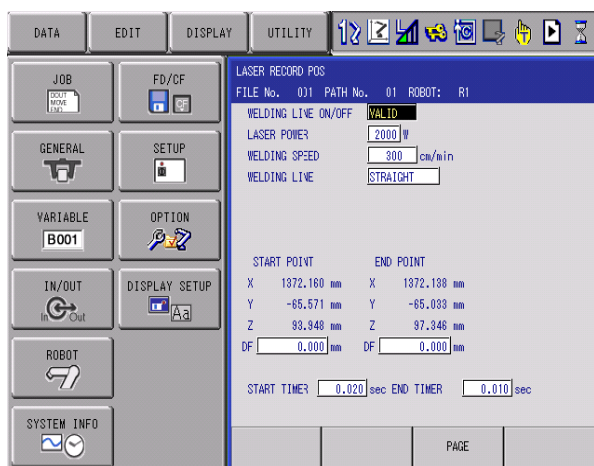
(1) When you delete the displayed path, [EDIT] → [DELETE PATH] is selected on the screen of the displayed path.

(2) When the message of "Welding path is deleted. Are you all right?" appears in the dialog box, [YES] is selected.

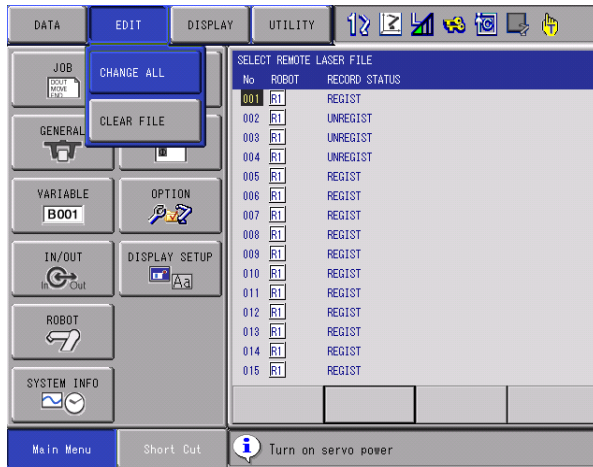
(3) The displayed path is deleted, and the following path advances one by one. (Ex. PATH No.02 → PATH No.01, PATH No.03 → PATH No.02)



※ Because path that can be registered in one file is 40, when a path is deleted, a new path is added to 40th. .



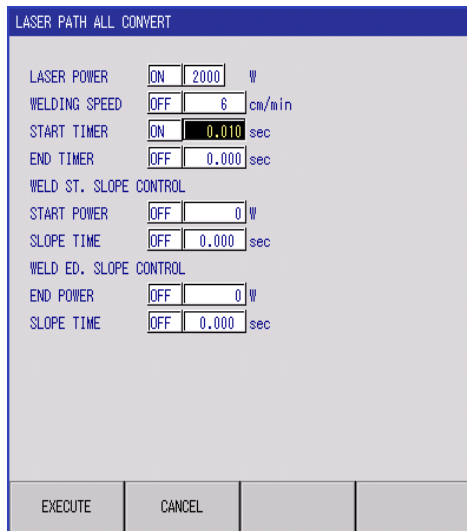
3.7 Batch Change of Welding Condition



(1) On the screen of SELECT REMOTE LASER FILE, the cursor is matched to the file that changes the welded condition, then [EDIT] → [CHANGE ALL] is selected.

(2) The condition that changes is made “OFF” → “ON”, and the numerical value is changed. Only the condition that is “ON” can change the numerical value.

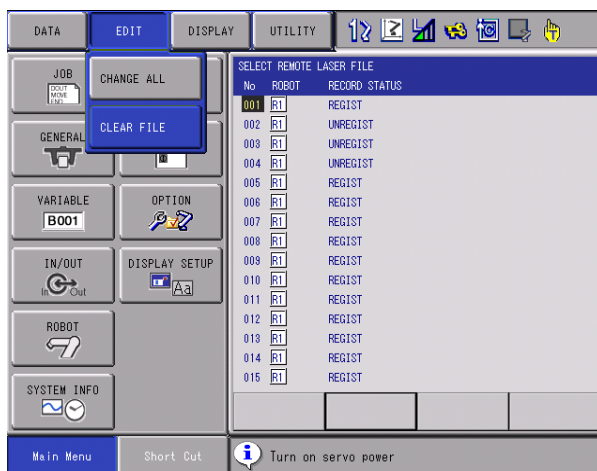
(3) When the numerical value is input, [EXECUTE] is pushed. It automatically returns to the screen of SELECT REMOTE LASER FILE after the numerical value is changed. At this time, the condition that is “OFF” is not changed.



※ It returns to the screen of SELECT REMOTE LASER FILE without doing anything when “CANCEL” is pushed.

3.8 Deletion of File

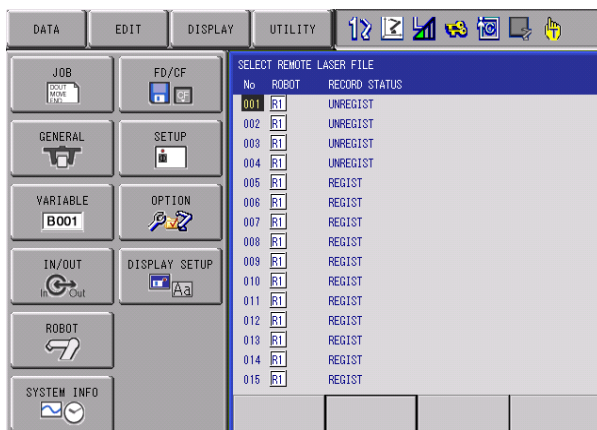
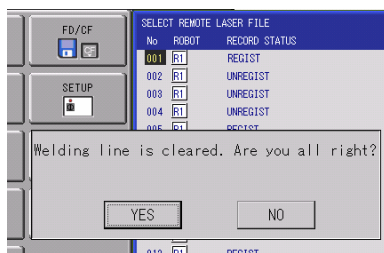
3.8 Deletion of File



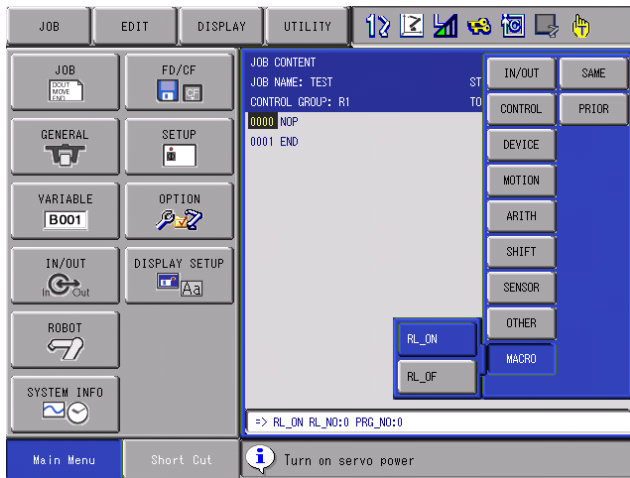
(1) On the screen of SELECT REMOTE LASER FILE, the cursor is matched to the file to be deleted, then [EDIT] → [CLEAR FILE] is selected.

(2) When the message of "Welding line is cleared. Are you all right?" appears in the dialog box, [YES] is selected.

(3) The content of the file is cleared, and RECORD STATUS becomes "UNREGIST" → "REGIST".



4 Remote Laser Welding Instruction

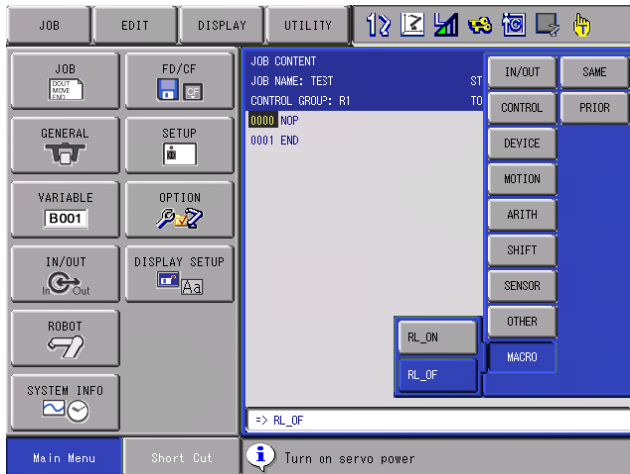
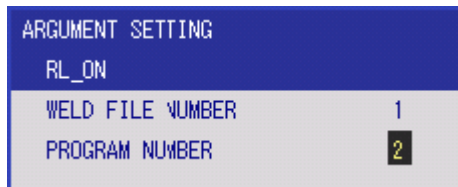


The [RL_ON] instruction is registered in path that welds a remote laser.

- (i) [MACRO] → [RL_ON] is selected.
- (ii) On the macro argument setting screen,

WELD FILE NUMBER: The file number used is specified.

PROGRAM NUMBER: The program number for the laser controller is specified.



To end path that welds a remote laser, the [RL_OF] instruction is registered.

[MACRO] → [RL_OF] is selected.

5 Means to Solve Error

(i) For attention at playback

This function generates a positional instruction of laser head synchronizing with the robot motion. Therefore, it may not be able to control laser head at the laser irradiation position when the running speed of the robot is enlarged.

When laser head doesn't reach the irradiation position, the laser power should be adjusted to '0W'.

In this case, please set the running speed of the robot small.

(ii) Holding stop during welding section, Restart after emergency stops

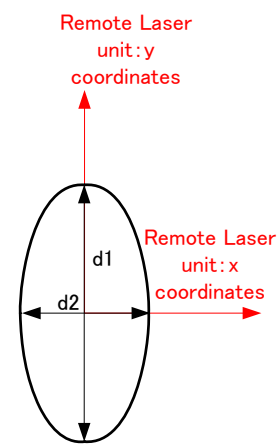
About the start afterwards when it stops temporarily (holding stop, emergency stop) on the way of the welding section (when it has not ended the welding file),

- The restart at the stop position continues welding from where the robot stopped.
- When the robot is moved by operating it from the stop position with JOG, it also becomes continuance processing.

However, when the laser doesn't reach the welding section because of moving the robot, it becomes laser power '0W'.

6 SxE Parameter Explanation

SxE	contents	unit
10	Servo delay time	[msec]
20	Remote unit Range of welding beginning: d1	[micron]
21	Remote unit Range of welding beginning: d2	[micron]
22	Remote unit Range of welding beginning Z+	[micron]
23	Remote unit Range of welding beginning Z-	[micron]
24	Remote unit Operation limit: d1	[micron]
25	Remote unit Operation limit: d2	[micron]
26	Remote unit Operation limitZ+	[micron]
27	Remote unit Operation limit Z-	[micron]
28	JOG Feed distance	[micron]
29	JOG Low distance	[micron/sec]
30	JOG Middle distance	[micron/sec]
31	JOG High distance	[micron/sec]
32	JOG High-speed distance	[micron/sec]
33	System reservation	
34	System reservation	
35	System reservation	
36	System reservation	
39	PFO 2D/3D specification	0:3D 1:2D
40	Stop welding use specification	Use general purpose output number
99	Starting point operation specification when welding ends	0:No operation 1:Starting point operation



※ Please set the value of SxE parameter according to the laser head.

	Focal length[mm]	Operation limit d1 × d2[mm]	Operation limit of Z axis[mm]
PFO3D f345	345	240 × 140	± 40
PFO3D f450	450	320 × 190	± 70
PFO33	255	180 × 104	
PFO33 E	345	240 × 140	
PFO33 C	450	320 × 190	

In the case of PFO3D, the space is smaller on top. And larger on bottom.(Refer to 2-3)

Example : In the case of PFO3D f450

Field size on top (z-Position + 70 mm) : d1 × d2 = 288 × 174 (mm)

Field size on bottom (z-Position - 70 mm) : d1 × d2 = 352 × 206 (mm)

Field size in middle (z position = 0mm) : d1 × d2 = 320 × 190 (mm)

※① Please set a value that [Remote unit Range of welding beginning] is smaller than [Remote unit Operation limit].

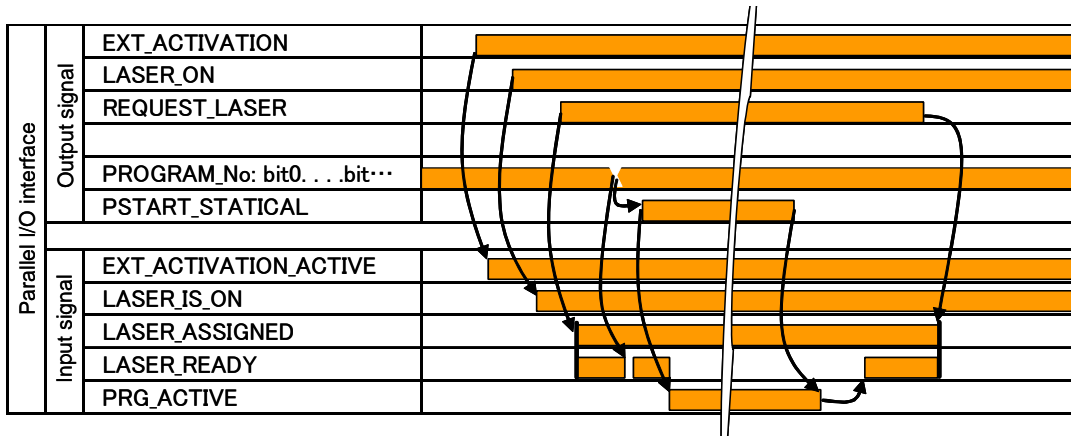
※② The stop welding which does a laser welding without moving the robot can be done when a general-purpose output of the number specified by SxE parameter#40 is adjusted to. However, the stop welding can be done only one path in one welding file.

7 Example with I/O Assignment

The example with the I/O assignment and the timing diagram (the laser oscillator made of TRUMPF and NX100) are shown. Please apply to the system that constructs it referring to the following example.

Please refer to the manual of the laser oscillator made of TRUMPF for details.

Logic	Signal No	Name·Use	State	Connector	Terminal	Logic	Signal No	Name·Use	State	Connector	Terminal
20050	IN017	EX_ACTIVATE_ACT1	Level	8-B1	2	30050	OT017	EX_ACTIVE	Level	8-AB8	15,16
20051	IN018	LASER_IS_ON	Level	8-A1	1	30051	OT018	LASER_ON	Level	8-AB9	17,18
20052	IN019	LASER_READY	Level	8-B2	4	30052	OT019	REQ LASER	Level	8-AB10	19,20
20053	IN020	LASER_ASSIGNED	Level	8-A2	3	30053	OT020	PSTART_STATICAL	Level	8-AB11	21,22
20054	IN021	PRG_ACTIVE	Level	8-B3	6	30054	OT021	PRG.No(bit0)	Level	8-AB12	23,24
20055	IN022		Level	8-A3	5	30055	OT022	PRG.No(bit1)	Level	8-AB13	25,26
20056	IN023		Level	8-B4	8	30056	OT023		Level	8-AB14	27,28
20057	IN024		Level	8-A4	7	30057	OT024		Level	8-AB15	29,30



Remote Laser FUNCTION

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