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

MOTOMAN INSTRUCTIONS
MOTOMAN-□□□ INSTRUCTIONS
DX200 INSTRUCTIONS
DX200 OPERATOR'S MANUAL
DX200 MAINTENANCE MANUAL

The DX200 operator's manuals above correspond to specific usage. Be sure to use the appropriate manual.
• This instruction manual is intended to explain mainly on the laser-tracking function part of the DX200 MOTOEYE-LT for the application to the actual operation and for proper maintenance and inspection. It describes on safety and handling, details on specifications, necessary items on maintenance and inspection, to explain operating instructions and maintenance procedures. Be sure to read and understand this instruction manual thoroughly before installing and operating the manipulator.

• General items related to safety are listed in Chapter 1: Safety of the DX200 Instructions. To ensure correct and safe operation, carefully read the DX200 Instructions before reading this manual.

---

• Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure all covers and shields are replaced before operating this product.

• 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.
We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems (ANSI/RIA R15.06-2012). You can obtain this document from the Robotic Industries Association (RIA) at the following address:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338
www.roboticsonline.com

Ultimately, well-trained personnel are the best safeguard against accidents and damage that can result from improper operation of the equipment. The customer is responsible for providing adequately trained personnel to operate, program, and maintain the equipment. NEVER ALLOW UNTRAINED PERSONNEL TO OPERATE, PROGRAM, OR REPAIR THE EQUIPMENT!

We recommend approved Yaskawa training courses for all personnel involved with the operation, programming, or repair of the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Notes for Safe Operation

Read this manual carefully before maintenance or inspection of the DX100.

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

⚠️ DANGER
Indicates an imminent hazardous situation which, if not avoided, could result in death or serious injury to personnel.

⚠️ 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.

 وغير-notice. To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “DANGER”, "WARNING" and "CAUTION".
Laser-Tracking Function:
MotoEye LT

WARNING
• Before operating the manipulator, check that servo power is turned off when the emergency stop buttons on the front door of the DX200 and programing pendant are pressed. When the servo power is turned off, the SERVO ON LED on the programing pendant is turned off.

Injury or damage to machinery may result if the emergency stop circuit cannot stop the manipulator during an emergency. The manipulator should not be used if the emergency stop buttons do not function.

Figure 1: Emergency Stop Button

• Once the emergency stop button is released, clear the cell of all items which could interfere with the operation of the manipulator. Then turn the servo power ON.

Injury may result from unintentional or unexpected manipulator motion.

Figure 2: Release of EM

• Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator:
  – Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  – View the manipulator from the front whenever possible.
  – Always follow the predetermined operating procedure.
  – Ensure that you have a safe place to retreat in case of emergency.

Improper or unintended manipulator operation may result in injury.

• Confirm that no person is present in the P-point maximum envelope of the manipulator and that you are in a safe location before:
  – Turning on the power for the DX200.
  – Moving the manipulator with the programming pendant.
  – Running the system in the check mode.
  – Performing automatic operations.

Injury may result if anyone enters the working envelope of the manipulator during operation. Always press an emergency stop button immediately if there are problems.

The emergency stop button is located on the right of the front door of the DX200 and programing pendant.
WARNING

• Do not directly look at the laser beam emitted from the laser sensor.

• When the laser beam is emitted from the laser sensor onto a mirror-like surface with a high reflection ratio, such as a stainless surface or other shiny surfaces, be careful that the reflected laser beam does not make direct contact with the eyes.

• DX200 MOTOEYE-LT function uses the laser sensor manufactured by Servo-Robot, Inc. whose power is classified into Class 3B. The laser beam emitted from the laser has a high power density, and could harm the human body even in small amounts. In order to prevent injuries to operators of the laser products, guidelines based on the standard of International Electrotechnical Commission (IEC), “Safety of laser products” JIS C 6802 is specified. In JIS C 6802, the laser products are classified according to its risk evaluation and the safety actions required are specified for each class.
The outline of the classification is as follows.

<table>
<thead>
<tr>
<th>Class</th>
<th>Outline of risk evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Essentially safe in design</td>
</tr>
</tbody>
</table>
| Class 1M | Low output (wavelength: 302.5 to 4000 nm)  
           | Safe under certain conditions, including visual contact with the inside of the beam.  
           | Observation of the inside of the beam with optical manners may pose a risk. |
| Class 2 | Visible laser and low output (wavelength: 400 to 700 nm)  
           | Eyes are protected by blink reflex, including direct visual contact with the inside of the beam. |
| Class 2M | Visible laser and low output (wavelength: 400 to 700 nm)  
           | Eyes are protected by blink reflex. Visual contact with inside of the beam with optical manners may pose a risk. |
| Class 3R | In the visible laser, output is five times or less than that of Class 2 (wavelength: 400 to 700 nm). In the laser except for the visual laser, output is five times or less than that of Class 1 (wavelength: 302.5 nm or longer). The direct visual contact with the inside of the beam may pose a risk. |
| Class 3B | 0.5W or smaller output. Direct visual contact with the inside of the beam poses a risk. However, observation of pulse laser which does not connect focused points with scattered reflection is safe and it can be safely observed under certain conditions. |
| Class 4 | High output. Danger, scattered reflections may result. These can cause skin injuries and may cause fires. |

CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately, and be sure that all other necessary processing has been performed.  
  - Check for problems in manipulator movement.  
  - Check for damage to insulation and sheathing of external wires.

- Always return the programming pendant to the hook on the DX200 cabinet after use.  
  The programming pendant can be damaged if it is left in the P-point maximum envelope of the manipulator, on the floor, or near fixtures.

- Read and understand the Explanation of Warning Labels in the DX200 Instructions before operating the manipulator.
Definition of Terms Used Often in This Manual

The MOTOMAN manipulator is the YASKAWA industrial robot product.
The MOTOMAN usually consists of the controller, the programming pendant, and supply cables.
In this manual, the equipment is designated as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DX200 Controller</td>
<td>DX200</td>
</tr>
<tr>
<td>DX200 Programming Pendant</td>
<td>Programming Pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator cable</td>
</tr>
</tbody>
</table>

Descriptions of the programming pendant keys, buttons, and displays are shown as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
</table>
| Programming Pendant Keys   | The keys which have characters printed on them are denoted with [ ].
ex. [ENTER] |
| Symbol Keys                | The keys which have a symbol printed on them are not denoted with [ ] but depicted with a small picture.
ex. page key |
|                            | The cursor key is an exception, and a picture is not shown. |
| Axis Keys Numeric Keys     | “Axis Keys” and “Numeric Keys” are generic names for the keys for axis operation and number input. |
| Keys pressed simultaneously| When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them, ex. [SHIFT]+[COORD] |
| Displays                   | The menu displayed in the programming pendant is denoted with { }. 
ex. {JOB} |
Description of the Operation Procedure

In the explanation of the operation procedure, the expression "Select • • • " means that the cursor is moved to the object item and the SELECT key is pressed, or that the item is directly selected by touching the screen.

Registered Trademark

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or brand names for each company or corporation. The indications of (R) and TM are omitted.

Customer Support Information

If you need assistance with any aspect of your Laser-Tracking Function: MotoEye LT system, please contact Motoman Customer Support at the following 24-hour telephone number:

(937) 847-3200

For routine technical inquiries, you can also contact Motoman Customer Support at the following e-mail address:

techsupport@motoman.com

When using e-mail to contact Motoman Customer Support, please provide a detailed description of your issue, along with complete contact information. Please allow approximately 24 to 36 hours for a response to your inquiry.

Please use e-mail for routine inquiries only. If you have an urgent or emergency need for service, replacement parts, or information, you must contact Motoman Customer Support at the telephone number shown above.

Please have the following information ready before you call:

- System MotoEye LT
- Robots
- Primary Application
- Controller DX200
- Software Version Access this information on the Programming Pendant’s LCD display screen by selecting {MAIN MENU} - {SYSTEM INFO} - {VERSION}
- Robot Serial Number Located on the robot data plate
- Robot Sales Order Number Located on the controller data plate
# TABLE OF CONTENTS

1 Laser-tracking Function ........................................................................................................... 1-1
   1.1 Functions ....................................................................................................................... 1-3

2 Hardware Setup ...................................................................................................................... 2-1
   2.1 Connection of Laser Vision System .............................................................................. 2-1
   2.2 Settings for Cooling Air ............................................................................................... 2-2
   2.3 Emergency Stop Button on Power-BOX ....................................................................... 2-2

3 Start-up .................................................................................................................................. 3-1
   3.1 Start-up of the Power-BOX ......................................................................................... 3-1
   3.2 Start-up of the DX200 ............................................................................................... 3-1
   3.3 Start-up of the WELDCOM ...................................................................................... 3-2

4 Settings for Sensor Parameters and Job Files ....................................................................... 4-1
   4.1 Sensor Parameters ........................................................................................................ 4-1
   4.2 Required Application Job Files ................................................................................... 4-3

5 Laser Sensor Calibration ......................................................................................................... 5-1
   5.1 Workpiece for Calibration ......................................................................................... 5-1
   5.2 Tool Calibration for Reference Tool ............................................................................ 5-2
   5.3 Sensor Camera’s Mounting Position .......................................................................... 5-3
   5.4 Sensor Adjustment ...................................................................................................... 5-5
   5.5 Teaching of Calibration Job [LT-CALIB] .................................................................... 5-6
   5.6 Execution of Calibration ............................................................................................ 5-17

6 Settings for Tracking Job ....................................................................................................... 6-1
   6.1 Tracking without a Welding-start-point Search ........................................................... 6-1
   6.2 Tracking with a Welding-start-point Search ............................................................... 6-6

7 Settings for the Laser-tracking Function File ......................................................................... 7-1
   7.1 Conditions for the Laser Sensor .................................................................................. 7-2
   7.2 Conditions for Welding-start-point Search ................................................................. 7-3
   7.3 Conditions for Welding-end-point Search ................................................................. 7-5
   7.4 Conditions for Laser Tracking .................................................................................... 7-6
   7.5 Conditions for NON-detection and Error Detection .................................................. 7-8
   7.6 Conditions to Pass Over ............................................................................................ 7-9

8 Settings for Inspection Job Before Starting Operations ........................................................ 8-1
   8.1 Teaching an Inspection Job Before Starting ............................................................... 8-2
   8.2 Acquisition of Reference Data .................................................................................... 8-4

9 Tool Offset Setting ............................................................................................................... 9-1
   9.1 How to Obtain the Tool Offset Amount ..................................................................... 9-1
   9.2 How to Set the Tool Offset Amount ........................................................................... 9-3
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10.1</td>
<td>Settings for the Gap Condition File</td>
</tr>
<tr>
<td>10</td>
<td>10.2</td>
<td>Conditions for Welding</td>
</tr>
<tr>
<td>10</td>
<td>10.3</td>
<td>Conditions for Position</td>
</tr>
<tr>
<td>10</td>
<td>10.4</td>
<td>Conditions for Speed</td>
</tr>
<tr>
<td>11</td>
<td>11.1</td>
<td>Inspection Before Starting Operations</td>
</tr>
<tr>
<td>11</td>
<td>11.2</td>
<td>Manual Inspection Before Starting Operations</td>
</tr>
<tr>
<td>11</td>
<td>11.3</td>
<td>Camera Deviation Check at Welding-point Deviation Check</td>
</tr>
<tr>
<td>11</td>
<td>11.4</td>
<td>Verification of Tool Constants</td>
</tr>
<tr>
<td>11</td>
<td>11.5</td>
<td>Verification of Detected Data</td>
</tr>
<tr>
<td>12</td>
<td>12.1</td>
<td>Corrective Actions after Torch Collision</td>
</tr>
<tr>
<td>12</td>
<td>12.2</td>
<td>Corrective Actions for Target Deviation</td>
</tr>
<tr>
<td>12</td>
<td>12.3</td>
<td>Corrective Actions for Tool Deviation</td>
</tr>
<tr>
<td>12</td>
<td>12.4</td>
<td>Corrective Actions for Camera Deviation</td>
</tr>
<tr>
<td>13</td>
<td>13.1</td>
<td>Alarm List</td>
</tr>
<tr>
<td>14</td>
<td>14.1</td>
<td>Sensor Parameters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S5E Parameters</td>
</tr>
</tbody>
</table>
1 Laser-tracking Function

The laser-tracking function uses a laser sensor manufactured by ServoRobot, Inc. and is the DX200 option. This function can be used to correct the target position during welding according to the information of the target position on the welding line detected by the laser sensor.

Laser tracking includes the following control functions:

- Start point search
- Real-time tracking
- Target position offset

![Fig. 1-1 Laser Sensor Camera Appearance](image-url)
1 Laser-tracking Function

1.1 Functions

Table 1-1 Parts List

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>Power-CAM (laser sensor camera)</td>
<td>Purchased from ServoRobot Inc.</td>
</tr>
<tr>
<td>②</td>
<td>Power-BOX (image processing system)</td>
<td>Included in ①</td>
</tr>
<tr>
<td>③</td>
<td>Camera cable (5 m)</td>
<td>Included in ①</td>
</tr>
<tr>
<td>④</td>
<td>Cooling air unit (with a 5 m control signal cable)</td>
<td>Purchased from ServoRobot Inc. (option)</td>
</tr>
<tr>
<td>⑤</td>
<td>Fume purge air</td>
<td>Purchased from ServoRobot Inc. (option)</td>
</tr>
<tr>
<td>⑥</td>
<td>Cooling air (in-flow and out-flow air)</td>
<td>Included in ⑤</td>
</tr>
<tr>
<td>⑦</td>
<td>Air filter unit (oil, dry, regulator)</td>
<td>Purchased from ServoRobot Inc. (option)</td>
</tr>
<tr>
<td>⑧</td>
<td>LAN cable between personal computer for monitor and the Power-BOX (5 m)</td>
<td>Included in ①</td>
</tr>
<tr>
<td>⑨</td>
<td>LAN cable between the DX200 and the Power-BOX (5 m)</td>
<td>Included in ①</td>
</tr>
<tr>
<td>⑩</td>
<td>Sensor monitor application WELDCOM</td>
<td>Included in ① (the customer prepares a personal computer)</td>
</tr>
<tr>
<td>⑪</td>
<td>Insulation support</td>
<td>Purchased from ServoRobot Inc.</td>
</tr>
<tr>
<td>⑫</td>
<td>Sensor clamp</td>
<td>Needed to be designed and manufactured</td>
</tr>
</tbody>
</table>

System software dedicated for DX200 MOTOEYE-LT Arranged by Yaskawa (DX200 is set up)

Macro job for DX200 MOTOEYE-LT Arranged by Yaskawa (DX200 is set up)
1.1 Functions

- Start Point Search

• The laser sensor detects the start point of the welding line by an LTSRCH command.
• The difference between the detected point and the start point that is registered is calculated.

If the difference is within the allowable value, the taught welding line is shifted by an LTSFT command to compensate for this difference.

![Fig. 1-3 Welding Line Shift by the Start Point Search Function](image-url)
1 Laser-tracking Function
1.1 Functions

■ Real-time Tracking

Using the target position data from the laser sensor, the welding line data is prepared in the base coordinate system. Based on the welding line data and the taught direction of movement, the path of the center point of the manipulator’s tool is corrected. This function is carried out by an LTRCKON command and an LTRCKOF command.

■ Target Position Offset

The target position offset function shifts the target position in the tool coordinate system when the target position has deviated from the desired welding position.

---

Fig. 1-4 Correction by the Real Time Tracking Function

Fig. 1-5 Shifted Tracking Path by the Target Position Offset
2 Hardware Setup

2.1 Connection of Laser Vision System

Connect the laser vision system as shown in the following diagram.

Before installing the laser vision system of ServoRobot Inc., thoroughly read the following manuals provided by ServoRobot Inc. and fully observe the precautions:
- Power-BOX Installation and Operation Manual (ZPBXV21106E02)
- Power-CAM Installation and Operation Manual (ZPWRCAM1003E00)
2.2 Settings for Cooling Air

For cooling air, use clean and oil-free air or carbonic acid gas for the shielding gas. An air flow of 10 liter/min. (pressure: 4 bars) is required for sufficient cooling and for protection of the laser head and the work surfaces.

- Oil and dust in the cooling air may cause the sensor to malfunction.
- When using carbonic acid gas for the cooling air, be sure to use a heater to avoid condensation.

2.3 Emergency Stop Button on Power-BOX

Connect the Power-BOX emergency stop button to robot controller emergency stop loop and safety interlock circuit for work place with automatic device.

- The wiring of the emergency stop on the DX200:
  Refer to "14.5 Machine Safety I/O Logic Circuit Board (JANCD-YSF22□-E)" in the "DX200 INSTRUCTIONS" (165292-1CD).

- The wiring of the emergency stop on the Power-BOX:
  Refer to "4.4.2 Emergency Stop Alarm I/O (CN2)" in the manual "Power-BOX Installation and Operation Manual (ZPBXV21106E02)" provided with the laser vision system of ServoRobot Inc.
3 Start-up

3.1 Start-up of the Power-BOX

The following procedure describes how to start up the Power-BOX.

1: Turn ON the power switch ① in the following diagram.

=> The power lamp ② illuminates and the system status lamp ③ starts flashing.

=> After approximately one minute, the system status lamp ③ changes from flashing to illumination.

2: Turn ON the laser enable key switch ④.

=> The laser ON lamp ⑤ illuminates.

=> After two or three seconds, a laser beam is emitted from the laser sensor camera Power-CAM.

3.2 Start-up of the DX200

To start up DX200, turn ON the main power supply of the DX200.

=> When the DX200 properly starts up, the laser beam automatically goes out.

(The laser ON lamp ⑤ does not go out.)
3.3 Start-up of the WELDCOM

WELDCOM is an application software for the personal computer. WELDCOM is used for Ethernet communication with the Power-BOX, the settings for image processing, and the monitoring of the detected status. Though WELDCOM does not start up, the manipulator tracking operates properly.

The following procedure describes how to start up WinUser:
Start up the personal computer where WinUser is installed.
Click the “Start” button, point to “Programs,” and then click “WinUser” to start up WinUser.

Fig. 3-2 Laser Vision System Connection Diagram
4 Settings for Sensor Parameters and Job Files

4.1 Sensor Parameters

• Minimum interval for sampling

The minimum interval for sampling must be set using the sensor parameters. The minimum interval is the minimum value of the distance between the points detected by the sensor. Because the buffer has limited memory, set the minimum interval to limit the distance between samples so that the buffer will not overflow with an excessive amount of information.

1. The distance between the point of light emitted by the laser and the manipulator's tool center point is called a "lookahead". The minimum interval for sampling can be calculated from this "lookahead" by the following formula.

When "Lookahead" is $L \text{ [mm]}$ and the minimum interval for sampling is $I \text{ [μm]}$:

$$I = (12 \times L) \text{ [μm]} \quad \text{(Example: When L is 40 [mm], I = 12 \times 40 = 480 [μm])}$$

*Fig. 4-1 Sensor Camera Mounting and Lookahead*
2. Determine the value to be entered as a sensor parameter from the obtained minimum interval for sampling, and enter the value.

Table 4-1 Sensor Parameter S5E32 “the Minimum Interval for Sampling”

<table>
<thead>
<tr>
<th>Calculated Minimum Interval [μm]</th>
<th>0 to 1000</th>
<th>1001 to 2000</th>
<th>2001 to 4000</th>
<th>4001 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>S5E32</td>
<td>1000</td>
<td>2000</td>
<td>3000</td>
<td>5000</td>
</tr>
</tbody>
</table>
4.2 Required Application Job Files

Confirm that the following macro job files are registered in the Robot Controller.
* Set the security mode of the DX200 to “Management mode”.
* If any job is missing, load the job from the CD-ROM “DX200 MOTOEYE-LT” provided with the DX200 to the Compact Flash card or USB memory storage, and then load the job to the DX200.

4.2.1 Macro Job

Table 4-2 Macro Job List

<table>
<thead>
<tr>
<th>Macro Job Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTCLIB.JBI</td>
<td>Used in the laser sensor calibration job for the calibration detection and calculation processing.</td>
</tr>
<tr>
<td>LTSRCH.JBI</td>
<td>Obtains the detection point from the joint form by sensing.</td>
</tr>
<tr>
<td>LTSFT.JBI</td>
<td>Carries out the parallel shift with the difference between the detection point obtained by the start point search and the taught welding start point. When the shift amount is outside of the allowable range, it is judged NG.</td>
</tr>
<tr>
<td>LTRCKON.JBI</td>
<td>Used in the tracking job to start the tracking correction processing.</td>
</tr>
<tr>
<td>LTCHGJN.JBI</td>
<td>Used in the tracking job to order the sensor to change the joint file (file for the image processing parameters).</td>
</tr>
<tr>
<td>LTEDSRCH.JBI</td>
<td>Starts the end point search. The end point search is a function to end the tracking by recognizing the last detection point as the end point of the welding line when the laser sensor continuously detects no points during the tracking.</td>
</tr>
<tr>
<td>LTRCKOF.JBI</td>
<td>Used in the tracking job to end the tracking correction processing.</td>
</tr>
</tbody>
</table>
### 4.2.2 Job

**Table 4-3 Job List**

<table>
<thead>
<tr>
<th>Job File</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT-CALIB.JBI</td>
<td>Job for execution of the sensor calibration</td>
</tr>
<tr>
<td>SMPL0.JBI</td>
<td>An example of a tracking job without the search for the start point</td>
</tr>
<tr>
<td>SMPL1.JBI</td>
<td>An example of a tracking job with the search for the start point and end point search</td>
</tr>
<tr>
<td>STRTCHK.JBI</td>
<td>Job for inspection before starting an operation</td>
</tr>
<tr>
<td>CAL_OFST.JBI</td>
<td>Job for calculating the amount of the tool offset</td>
</tr>
</tbody>
</table>
5 Laser Sensor Calibration

The data obtained by the laser vision sensor is sent to the DX200 as data for a three-dimensional position in the camera coordinate system of the camera. The DX200 converts the input data to position data in the robot coordinate system. For this conversion, the manipulator’s current position in the tool coordinate system and that in the camera coordinate system relative to the tool coordinate system are required. The manipulator’s current position in the camera coordinate system relative to the tool coordinate system can be obtained by sensor calibration.

5.1 Workpiece for Calibration

- Yaskawa recommends using a workpiece with a lap joint.
- To make the teaching easier, set the workpiece so that the welding line on the workpiece is parallel to the X-axis or the Y-axis in the robot coordinate system.
5.2 Tool Calibration for Reference Tool

• Refer to "Tool Dimensions" and "Tool Calibration" of “DX200 INSTRUCTIONS" for the information about how to calibrate the tool.

<Tool Posture>
The amount of the targeted offset used for correction is adjusted with the direction of each axis in the tool coordinate system. To make the correction easier, position the tool so that the tool coordinate system’s X-axis is parallel to the welding direction (the mounting direction of the laser sensor) and the tool coordinate system’s Z-axis is parallel to the torch’s direction of ejection.

Fig. 5-2 Arc Welding Torch Tool Coordinate System
5.3 Sensor Camera’s Mounting Position

The following procedure describes how to position the sensor camera. Adjust the mounting position of the camera so that the joint of the workpiece can be detected at the center of the sensor’s field of vision when the processing posture is taken for the target workpiece.

1. Shine the laser beam.
   - Laser turn ON: Push both the Key [inter lock] and Key [5] of the programming pendant.
   - Laser turn OFF: Push both the Key [inter lock] and Key [8] of the programming pendant.

2. Connect the personal computer to the Power-BOX, and start up WELDCOM to display the graphic display.

3. Adjust the position of the sensor camera so that the image of the joint is taken in the center of the sensor’s field of vision.

Fig. 5-3 Sensor Camera Mounting

---

**Stand-off depth D: 48 mm**

**Sensor’s depth of detection H: 50 mm**

Distance: 20 mm to 100 mm (40 mm: standard)

(Consider the disturbances caused by the tool interference, welding line curvature, weld fumes, and spatters when adjusting the distance.)
For the sensor camera position adjustment, set the WELDCOM graphic display so that it will be at full range, with the horizontal and vertical scale size of 1:1.

Click icon for the display setting. Select “FOV Auto Zoom”.

<Graphic Display Adjustment>
5.4 Sensor Adjustment

The laser vision sensor can be adjusted to detect the target position on the lap joint of the workpiece.

- Using WELDCOM, adjust the Recognition Algorithm for the Power-BOX as shown in the following illustration.

(Refer to “15 WELDCOM: Application Software” for information about how to use WELDCOM.)
5.5 Teaching of Calibration Job [LT-CALIB]

- To carry out sensor calibration, a job for calibration called [LT-CALIB] must be prepared.
- The job, [LT-CALIB], includes the macro command “LTCLIB” to instruct the laser-tracking function to do calibration calculations.
- Six reference points must be taught and registered in the job [LT-CALIB].

5.5.1 Opening the Display to Register Reference Points in LT-CALIB

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move the cursor to the line of macro command “LTCLIB”.</td>
<td><img src="image" alt="Example Macro Command" /> The job number is highlighted by being shown in reverse.</td>
</tr>
<tr>
<td>Move the cursor to the right.</td>
<td><img src="image" alt="Example Macro Command" /> The “LTCLIB LT:40 LTC:0 flgB:2” is highlighted by being shown in reverse.</td>
</tr>
</tbody>
</table>
Press [SELECT].

The contents of the display change.

Press [SELECT].

The ARGUMENT SETTING display appears.

### LT-CALIB Macro Arguments

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT FUNC. FILE</td>
<td>An integer between 1 and 40</td>
<td>The tracking function file* number to be used</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The file number 40 is recommended for calibration.</td>
</tr>
<tr>
<td>CALIB. FILE</td>
<td>An integer between 0 and 23</td>
<td>The calibration file number</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enter the set teaching tool number.</td>
</tr>
<tr>
<td>TOOL REFP.</td>
<td>Teaching point</td>
<td>Refer to section “5.5.2 Teaching of Tool Reference Points” at page 5-8</td>
</tr>
<tr>
<td>sensing#1 to #4 REFP.</td>
<td>Teaching point</td>
<td>Refer to section “5.5.3 Teaching of Calibration Reference Point 1” on page 5-10 to “5.5.6 Teaching of Calibration Reference Point 4” at page 5-15.</td>
</tr>
<tr>
<td>ESCAPE REFP.</td>
<td>Teaching point</td>
<td>Refer to section “5.5.7 Teaching of Escape Position” on page 5-16.</td>
</tr>
<tr>
<td>RESULT FLAG</td>
<td>An integer between 0 and 255</td>
<td>B variable number to save the calibration results.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Calibration succeeded</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0: Calibration failed</td>
</tr>
</tbody>
</table>

* The file of the conditions to use the laser-tracking function.

(To view the file, select [OPTION] under the top menu, and select [LASER TRACKING].)
5.5.2 Teaching of Tool Reference Points

- The following procedure describes how to teach the tool reference points.
- Move the end of the tool to the end of the marked line on the lap join, and register it.

**Operation**

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move the cursor to {REGIST} of TOOL REFP., and press [MODIFY].</td>
<td>The position has been registered. The manipulator’s current position is the same as the registered position. {REGIST} stops flashing.</td>
</tr>
</tbody>
</table>
Press [ENTER] twice.

When [ENTER] is pressed the second time, the ARGUMENT SETTING display closes, and the JOB CONTENT display appears.

Press [ENTER].

When [ENTER] is pressed the third time, the settings updated on the ARGUMENT SETTING display are registered.

If [CANCEL] is pressed instead of [ENTER] to close the ARGUMENT SETTING display, the modified teaching position and numerical values are lost. To validate the modified data, be sure to press [ENTER] and close the ARGUMENT SETTING display.
### 5.5.3 Teaching of Calibration Reference Point 1

The following procedure describes how to teach the calibration reference point 1.

1. Shine the laser beam on the workpiece.
   
   * Laser turn ON: Push both the Key [inter lock] and Key [5]. (Laser turn OFF: Push both the Key [inter lock] and Key [8].)
   * Weaken the laser beam power with WELDCOM.

   **WARNING**
   
   During the calibration reference position teaching, it is necessary to visually check the scattered light (laser shined on the workpiece) of the laser beam. When the reflection ratio on the surface of the workpiece is high (mirror-like surface such as stainless workpiece), wear laser protection glasses. The mirror-like surface workpiece has a high laser power in the scattered light, and this may cause damages to the retina.

#### WELDCOM Operation: Laser Power Adjustment

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Press icon to display the TASK BAR.</td>
<td><img src="image" alt="The TASK BAR is displayed." /></td>
</tr>
<tr>
<td>Press icon to display the Task edit screen.</td>
<td><img src="image" alt="The submenu to edit is displayed." /></td>
</tr>
</tbody>
</table>
Press 🌞 icon to display the laser power adjustment screen.

The laser power adjustment screen is displayed.

After changing the control to [Manual], adjust the Manual Power to approximately 5%.

The laser beam becomes sharp and not bright.

To return the laser power to the original state after the teaching, press 🗼 icon.

The laser beam becomes bright again.
2. Register the position shown in the following figure as the calibration reference point 1.
   • Move the manipulator so that the laser beam passes through the edge of the marked line of the lap joint, and then register the manipulator's position.

![Fig. 5-9 Teaching Point of Calibration Reference Point 1](image1)

![Fig. 5-10 Calibration Reference Point 1 Graphic Display (center)](image2)

![Fig. 5-11 Calibration Reference Point 1 Registration](image3)
5.5.4 Teaching of Calibration Reference Point 2

The following procedure describes how to teach the calibration reference point 2.

1. Shine the laser beam on the workpiece.
2. Using the following procedure, register the position shown in the figure below as calibration reference point 2.
   - Move the camera downward so that the laser beam of the WELDCOM graphic display can be viewed in the upper part of the vision. ①
   - Move the manipulator so that the laser beam detects the end of the marked line. ②
   - Open the ARGUMENT SETTING display to register the manipulator’s position for calibration reference point 2.

![Diagram of teaching calibration reference point 2](image)

Fig. 5-10 Teaching Point of Calibration Reference Point 2

![Graphic display showing calibration reference point 2](image)

Fig. 5-11 Calibration Reference Point 2 Graphic Display (upper part)

![ARGUMENT SETTING display](image)

Fig. 5-12 Calibration Reference Point 2 Registration
### 5.5.5 Teaching of Calibration Reference Point 3

The following procedure describes how to teach the calibration reference point 3.

1. Shine the laser beam on the workpiece.
2. Using the following procedure, register the position shown in the figure below as calibration reference point 3.
   - Move the camera up so that the laser beam of the graphic display can be viewed in the bottom of the vision.  
   - Move the camera in a traverse direction so that the target position is viewed in the lower left of the graphic display.  
   - Move the camera so that the laser beam detects the end of the marked line.  
   - Open the ARGUMENT SETTING display to register the manipulator’s position for calibration reference point 3.

![Fig. 5-13 Teaching Point of Calibration Reference Point 3](image1)

![ARGUMENT SETTING](image2)

![Fig. 5-14 Calibration Reference Point 3 Graphic Display (lower left)](image3)

![Fig. 5-15 Calibration Reference Point 3 Registration](image4)
5.5.6 Teaching of Calibration Reference Point 4

The following procedure describes how to teach the calibration reference point 4.

1. Shine the laser beam on the workpiece.
2. Using the following procedure, register the position shown in the figure below as calibration reference point 4.
   - Move the camera in a traverse direction so that the target position can be viewed in the lower right of the graphic display.①
   - Move the camera so that the laser beam detects on the end of the marked line.
   - Open the ARGUMENT SETTING display to register the manipulator’s position for calibration reference point 4.

![Teaching Point of Calibration Reference Point 4](image1)

Fig. 5-16 Teaching Point of Calibration Reference Point 4

![Calibration Reference Point 4 Registration](image2)

Fig. 5-18 Calibration Reference Point 4 Registration

![Graphic Display (upper part)](image3)

Fig. 5-17 Calibration Reference Point 4 Graphic Display (upper part)
5.5.7 Teaching of Escape Position

1. Register the position shown in the figure below as the escape position (ESCAPE REFP.).
   • The escape position is required to avoid interference between the end of the tool and the workpiece when moving from the tool reference point to calibration reference point 1.
   • To register the manipulator’s position as the escape position, open the ARGUMENT SETTING display.

   ![Diagram of escape position registration](image)

   The laser beam must be shone about 10 mm behind the marked line.

   **Fig. 5-19 Teaching Point of Escape Position**

   **Fig. 5-20 Escape Position Registration**
5.6 Execution of Calibration

5.6.1 Execution of a Calibration Job

The following procedure describes how to carry out a calibration job.

1. Move the cursor to the beginning of the calibration job, and set the DX200 to the play mode.
2. Press [START] to execute the calibration job.
5.6.2 Confirmation of the Calibration Results

The following procedure describes how to confirm the results of the calibration.

1. Confirm that the [START] lamp is unlit and that the execution of the job has stopped.
2. Check the position of the cursor.

If the cursor is on {END}, the calibration has been successfully completed.
If the job is paused, the calibration has failed.

Corrective Actions when the Job is Paused

1. Check the sensing state.
   (1) Move the manipulator to one of the taught reference points.
   (2) Open the LASER SENSOR MONITOR display to shine the laser beam.
       The sensor detection starts.
   (3) Specify the file number 40 for the laser-tracking function that was set for the calibration job in the LASER SENSOR MONITOR display.
   (4) Check the value of the target position in the LASER SENSOR MONITOR display. If it is changing, the sensor detection is working.
   (5) Also check the target position with a red cross in the WELDCOM graphic display of the personal computer. The image of the target position should be clear and stable.
   (6) Move the manipulator to other taught reference points, and check the sensor detections in the same manner.
2. Check the file number setting.
   (1) Call up file number 40 for the laser-tracking function that was selected for the file number setting.
   (2) Check if the joint file number that is displayed is the same as the Joint file number that was set on the personal computer.
   (3) Check that the arguments of the macro command “LTCLIB” to be carried out in the calibration job [LT-CALIB] are as follows:
       • File number for the laser tracking LT: 40
       • Calibration file number LTC: (Teaching tool number)
6 Settings for Tracking Job

6.1 Tracking without a Welding-start-point Search

This section explains how to make settings for tracking without a search for the start point of the welding. Those settings can be used when the deviation of the start point of the welding is so small that the laser beam always shines on the welding line while the manipulator is approaching the start point of the welding. The sample job, “SMPL0”, is used as an example.
### 6.1.1 Teaching of Sample Job “SMPL0”

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOP</td>
<td></td>
</tr>
<tr>
<td>SFTOF</td>
<td></td>
</tr>
<tr>
<td>SFTOF3D</td>
<td></td>
</tr>
<tr>
<td>`-- TL mode [B000]-------</td>
<td></td>
</tr>
<tr>
<td>` 0:W/O TRACKING, 1:TRACKING - -</td>
<td></td>
</tr>
<tr>
<td>SET B000 1</td>
<td></td>
</tr>
<tr>
<td>SPEED V=16.7</td>
<td></td>
</tr>
<tr>
<td>MOVL V=500 (Standby position)</td>
<td></td>
</tr>
<tr>
<td>MOVJ V=500 (Standby position)</td>
<td></td>
</tr>
<tr>
<td>LTRCKON SW=B000 LT:1 V=100</td>
<td></td>
</tr>
<tr>
<td>'arcon</td>
<td></td>
</tr>
<tr>
<td>MOVL</td>
<td></td>
</tr>
<tr>
<td>LTEDSRCH SW=B000 LT:1</td>
<td></td>
</tr>
<tr>
<td>MOV</td>
<td></td>
</tr>
<tr>
<td>'arcof</td>
<td></td>
</tr>
<tr>
<td>LTRCKOF SW=B000</td>
<td></td>
</tr>
<tr>
<td>MOVL V=500</td>
<td></td>
</tr>
<tr>
<td>MOVJ VJ=10.0 (Standby position)</td>
<td></td>
</tr>
<tr>
<td>END</td>
<td></td>
</tr>
</tbody>
</table>

- **Approach point**: Set the approach point so that the laser beam is shone 5 mm to 10 mm before the start point of the welding.
- **Start point of the welding**: Teach the start point of the welding, and register it as an argument of the macro command, "LTRCKON".
- **Mid-way point to start the search for the end point of the welding**: Teach a point to specify the start position to carry out the macro command, “LTEDSRCH”.
- **End point of the welding**: Teach a point that is 20 mm to 30 mm away from the actual end point of the welding of the reference workpiece.
- **Escape point**: Teach a point to specify the tool’s escape motion after welding.

Teach the points ① to ⑤ as shown in the following diagram.

![Fig. 6-1 Teaching Points of Job “SMPL0”](image)

Teach the approach point ① so that the laser beam is shone 5 mm to 10 mm before the start point of the welding.

Teach the end point of the welding ④ 20 mm to 30 mm away from the actual end point of the welding of the reference workpiece.
6.1.2 Settings for Macro Commands

**LTRCKON**

With moving the manipulator to the start point of the welding registered in the LTRCKON command, the DX200 starts the laser tracking.

```
NOP
SFTOF
SFTOF3D
'-- TL mode [B000]------------------------
' 0:W/O TRACKING, 1:TRACKING - -
'-------------------------------------------------
SET B000 1
SPEED V=16.7
MOVL V=500
MOVL V=500
LTRCKON SW=B000 LT:1 V=100
'arcon
MOVL
LTEDSRCH SW=B000 LT:1
MOVL
'arcof
LTRCKOF SW=B000
MOVL V=500
MOVJ VJ=10.0
END
```

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>①LT MODE(B var.)</td>
<td>B000</td>
<td>B000 to B099 Excluding B030</td>
<td>B variable number to specify whether to carry out or skip the macro command.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1: Carries out the macro command</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0: Skips the macro command</td>
</tr>
<tr>
<td>②LT FUNC.FILE#</td>
<td>1</td>
<td>1 to 40</td>
<td>Specifies the tracking function file to be used for detection during the approach to the start point of the welding.</td>
</tr>
<tr>
<td>③APPROACH SPEED</td>
<td>50</td>
<td>(Approx. the same speed as welding speed)</td>
<td>Specifies the motion speed for the approach to the start point of the welding.</td>
</tr>
<tr>
<td>④WELD START REFP.</td>
<td>(Teaching point)</td>
<td>(Teaching point)</td>
<td>Teach the start point of the welding of the reference workpiece.</td>
</tr>
</tbody>
</table>
The LTEDSRCH command starts the search for the end point of the welding. The search automatically ends at the last detected point when the DX200 recognizes the welding end in the section that was continuously undetected.

```
NOP
SFTOF
SFTOF3D
'-- TL mode [B000]------------------------
' 0:W/O TRACKING, 1:TRACKING - -
'-------------------------------------------------
SET B000 1
SPEED V=16.7
MOVL V=500
MOVL V=500
LTRCKON SW=B000 LT:1 V=100
 'arcon
MOVL
LTEDSRCH SW=B000 LT:1
MOVL
 'arcof
LTRCKOF SW=B000
MOVL V=500
MOVJ VJ=10.0
END
```

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ LT MODE(B var.)</td>
<td>B000</td>
<td>B000 to B099 Excluding B030</td>
<td>B variable number to specify whether to carry out or skip the macro command. 1: Carries out the macro command 0: Skips the macro command</td>
</tr>
<tr>
<td>☐ LT FUNC. FILE#</td>
<td>1</td>
<td>1 to 40</td>
<td>Specifies the tracking function file to be used for the search for the end point of the welding.</td>
</tr>
</tbody>
</table>
## LTRCKOF

The LTRCKOF command ends the tracking.

```
NOP
SFTOF
SFTOF3D
'-- TL mode [B000]
' 0:W/O TRACKING, 1:TRACKING - -
----------------------------------
SET B000 1
SPEED V=16.7
MOVL V=500
MOVL V=500
LTRCKON SW=B000 LT:1 V=100
'arcon
MOVL
LTEDSRCH SW=B000 LT:1
MOVL
'arcof
LTRCKOF SW=B000
MOVL V=500
MOVJ VJ=10.0
END
```

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT MODE (B var.)</td>
<td>B000</td>
<td>B000 to B099</td>
<td>B variable number to specify whether to carry out or skip the macro command.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excluding B030</td>
<td>1: Carries out the macro command</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0: Skips the macro command</td>
</tr>
</tbody>
</table>

### 6.1.3 Settings for the Laser-tracking Function File

Refer to chapter 7 “Settings for the Laser-tracking Function File” to set the number of each tracking function file which was specified for a macro command.
6.2 Tracking with a Welding-start-point Search

This section explains how to make settings for tracking with a search for the start point of the welding. The sample job, “SMPL1”, is used as an example in the search for the start point, OK→NG.

6.2.1 Teaching of Sample Job “SMPL1”

<table>
<thead>
<tr>
<th>NOP</th>
<th>SFTOF</th>
<th>SFTOF3D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>‘--TL mode [B000]------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>’0:W/O TRACKING, 1:TRACKING –</td>
<td></td>
</tr>
<tr>
<td></td>
<td>‘------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>SET B000 1</td>
<td>SPEED V=16.7</td>
<td></td>
</tr>
<tr>
<td>MOV V=500</td>
<td>MOVVDV=500</td>
<td>①</td>
</tr>
<tr>
<td>*retry</td>
<td>LTSRCH SW=B000 LT:1 V=60 snsP:10</td>
<td>② ③</td>
</tr>
<tr>
<td>JUMP *retry IF B002=0</td>
<td>LTSFT SW=B000 sns=P010 flgB:2</td>
<td>④</td>
</tr>
<tr>
<td>PAUSE IF B002=0</td>
<td>LTRCKON SW=B000 LT:1 V=100</td>
<td>⑤</td>
</tr>
<tr>
<td>‘arcon</td>
<td>MOVL</td>
<td>⑥</td>
</tr>
<tr>
<td>MOVL</td>
<td>LTEDSRCH SW=B000 LT:1</td>
<td></td>
</tr>
<tr>
<td>‘arcof</td>
<td>MOV V=500</td>
<td>⑦</td>
</tr>
<tr>
<td>LTRCKOF SW=B000</td>
<td>MOV V=500</td>
<td>⑧</td>
</tr>
<tr>
<td>MOVJ VJ=10.0</td>
<td>END</td>
<td></td>
</tr>
</tbody>
</table>

① Approach point
If there is no risk of interference, assign the same point as the start point of the search.

② Start point for the welding-start point search
Teach the start point of the search, and register it as an argument of the macro command, “LTSRCH”.

③ End point for the welding-start-point search
Teach the end point of the search, and register it as an argument of the macro command, “LTSRCH”.

④ Reference point for the start point of the welding
Teach the same point as the start point of the welding, and register it as an argument of the macro command, “LTSFT”.

⑤ Start point of the welding
Teach the start point of the welding and register it as an argument of the macro command, “LTRCKON”.

⑥ Mid-way point to start the search for the end point of the welding
Teach a point to specify the start position to carry out the macro command, “LTEDSRCH”.

⑦ End point of the welding
Teach a point that is 20 mm to 30 mm away from the actual end point of the welding of the reference workpiece.

⑧ Escape point
Teach a point to specify the tool’s escape motion after welding.
Teach the points ① to ⑧ as shown in the following diagram.

Fig. 6-2 Teaching Points of Job “SMPL1”
6.2.2 Settings for Macro Commands

**LTSRCH**

The LTSRCH command starts the search for the start point of the welding.

```plaintext
NOP
SFTOF
SFTOF3D
'-- TL mode [B000]-------------------------
' 0:W/O TRACKING, 1:TRACKING --
'------------------------------------------------
SET B000 1
SPEED V=16.7
MOVL V=500
MOVL V=500
*retry
LTSRCH SW=B000 LT:1 V=60 snsP:10
JUMP *retry IF B002=0
LTSFT SW=B000 sns=P10 flgB:2
PAUSE IF B002=0
LTRCKON SW=B000 LT:1 V=50
 'arcon
MOVL
LTEDSRCH SW=B000 LT:1
MOVL
 'arcof
LTRCKOF SW=B000
MOVL V=500
MOVJ VJ=10.0
END
```

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| ①LT MODE(B var.)  | B000          | B000 to B099 Excluding B030 | B variable number to specify whether to carry out or skip the macro command.  
|                    |               |                        | 1: Carries out the macro command                                          |
|                    |               |                        | 0: Skips the macro command                                                |
| ②LT FUNC. FILE#   | 1             | 1 to 40                | Specifies the tracking function file to be used for detection during the approach to the start point of the welding. |
| ③SEARCH START REF | (Teaching point) | (Teaching point) | The point to end the search.                                             |
6.2 Tracking with a Welding-start-point Search

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>① SEARCH END REFP.</td>
<td>(Teaching point) (Teaching point) The point to end the search.</td>
</tr>
<tr>
<td>② SEARCH SPEED</td>
<td>50 20 to 80 The motion speed during the search.</td>
</tr>
<tr>
<td>③ DETECT POS.(P#)</td>
<td>10 0 to 127 Specifies the P variable number to save the start point of the welding obtained by the search function.</td>
</tr>
<tr>
<td>④ SEARCH RESULT(B#)</td>
<td>2 0 to 99 Excluding 30 Specifies the B variable number to save the search results. 1: Detected 0: Not detected</td>
</tr>
</tbody>
</table>

### LTSFT

The LTSFT command calculates the amount of parallel shift based on the detected point obtained by the welding-start-point search and the start point of the welding taught in the LTSFT command, and then carries out a parallel shift.

```plaintext
NOP
SFTOF
SFTOF3D
'-- TL mode [B000]------------------------
' 0:W/O TRACKING, 1:TRACKING --
'------------------------------------------------
SET B000 1
SPEED V=16.7
MOVL V=500
MOVL V=500
*retry
LTSRCH SW=B000 LT:1 V=60 snsP:10
JUMP *retry IF B002=0
LTSFT SW=B000 sns=P010 flgB:2
PAUSE IF B002=0
LTRCKON SW=B000 LT:1 V=50 'arcon
MOVL
LTEDSRCH SW=B000 LT:1
MOVL 'arcof
LTRCKOF SW=B000
MOVL V=500
MOVJ VJ=10.0
END
```

ARGUMENT SETTING

<table>
<thead>
<tr>
<th>No.</th>
<th>Argument</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LT MODE</td>
<td>B000</td>
</tr>
<tr>
<td>2</td>
<td>DETECT POS.(P#)</td>
<td>P010</td>
</tr>
<tr>
<td>3</td>
<td>MELD START REFP.</td>
<td>REGIST</td>
</tr>
<tr>
<td>4</td>
<td>SHIFT RESULT(B#)</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>SFT MOV.PARNJT.R</td>
<td>15</td>
</tr>
</tbody>
</table>
## 6.2 Tracking with a Welding-start-point Search

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| LT MODE(B var.)                | B000          | B000 to B099 Excluding B030 | B variable number to specify whether to carry out or skip the macro command.  
1: Carries out the macro command  
0: Skips the macro command |
| DETECT POS.(P#)                | 10            | 0 to 127                     | Specifies the P variable number to save the detected point for calculating the shift amount. |
| WELD START REFP. (Teaching point) | (Teaching point) |                             | Sets the same point as the start point of the welding to be used for calculating the shift amount. |
| SHIFT RESULT(B#)               | 2             | 0 to 99 Excluding 30         | Judgment of the calculated amount of shifting.  
1: Acceptable  
0: Outside the allowable range |
| SFT MOV.PARMIT R               | 15            | 0 to                         | Allowable range of shift amount (unit: mm) |
### LTRCKON

Moving the manipulator to the start point of the welding taught in the LTRCKON command, the DX200 starts the laser tracking.

```
NOP
SFTOF
SFTOF3D
'-- TL mode [B000]------------------------
' 0:W/O TRACKING, 1:TRACKING --
'------------------------------------------------
SET B000 1
SPEED V=16.7
MOVL V=500
MOVL V=500
*retry
LTSRCH SW=B000 LT:1 V=60 snsP:10
JUMP *retry IF B002=0
LTSFT SW=B000 sns=P010 flgB:2
PAUSE IF B002=0
LTRCKON SW=B000 LT:1 V=50
'arcon
MOVL
LTEDSRCH SW=B000 LT:1
MOVL
'arcof
LTRCKOF SW=B000
MOVL V=500
MOVJ VJ=10.0
END
```

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| ⊗LT MODE(B var.)   | B000          | B000 to B099 Excluding B030    | B variable number to specify whether to carry out or skip the macro command.  
                              |               |                               | 1: Carries out the macro command                                      |
|                    |               |                               | 0: Skips the macro command                                              |
| ⊗LT FUNC.FILE#     | 1             | 1 to 40                        | Specifies the tracking function file to be used for detection during the approach to the start point of the welding. |
| ⊗APPROACH SPEED    | 50            | (Approx. the same speed as welding speed) | Specifies the motion speed for the approach to the start point of the welding. |
### 6.2 Tracking with a Welding-start-point Search

<table>
<thead>
<tr>
<th>WELD START REFP.</th>
<th>(Teaching point)</th>
<th>(Teaching point)</th>
<th>Teaches the start point of the welding of the reference workpiece.</th>
</tr>
</thead>
</table>

#### LTEDSRCH

The LTEDSRCH command starts the search for the end point of the welding. The search automatically ends at the last detected point when the DX200 recognizes the welding end in the section that was continuously undetected.

```diagram
<table>
<thead>
<tr>
<th>Argument Setting LTEDSRCH</th>
<th>1. LT MODE(B var.)</th>
<th>2. LT FUNC. FILTER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B000</td>
<td>1</td>
</tr>
</tbody>
</table>
```

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>LT MODE(B var.)</td>
<td>B000</td>
<td>B000 to B099 Excluding B030</td>
<td>B variable number to specify whether to carry out or skip the macro command. 1: Carries out the macro command 0: Skips the macro command</td>
</tr>
</tbody>
</table>
### 6.2 Tracking with a Welding-start-point Search

**LT FUNC.FILE#**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>1 to 40</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Setting</strong></td>
<td>Specifies the tracking function file to be used for the search for the end point of the welding.</td>
<td></td>
</tr>
</tbody>
</table>

---

**LTRCKOF**

The LTRCKOF command ends the tracking.

```
NOP
SFTOF
SFTOF3D
 ' -- TL mode [B000]------------------------
 ' 0:W/O TRACKING, 1:TRACKING --
 '------------------------------------------------
SET B000 1
SPEED V=16.7
MOVL V=500
MOVL V=500
*retry
LTSRCH SW=B000 LT:1 V=60 snsP:10
JUMP *retry IF B002=0
LTSFT SW=B000 sns=P010 flgB:2
PAUSE IF B002=0
LTRCKON SW=B000 LT:1 V=50
 'arcon
MOVL
LTEDSRCH SW=B000 LT:1
MOVL
 'arcof
LTRCKOF SW=B000
MOVL V=500
MOVJ VJ=10.0
END
```

---

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>①LT MODE (B var.)</td>
<td>B000</td>
<td>B000 to B099 Excluding B030</td>
<td>B variable number to specify whether to carry out or skip the macro command. 1: Carries out the macro command 0: Skips the macro command</td>
</tr>
</tbody>
</table>
6.2.3 Settings for the Laser-tracking Function File

Refer to chapter 7 “Settings for the Laser-tracking Function File” to set the number of each tracking function file which was specified for each macro command.
7 Settings for the Laser-tracking Function File

The laser-tracking function file includes the conditions for each process in laser tracking.

- File Components
7.1 Conditions for the Laser Sensor

1. **JOINT FILE NO.**
   Selects one of the joint files stored in the SMART-BOX of the laser vision sensor. The joint file includes the conditions to specify the processing method for detection.
   - Setting range: 0 to 100
   - Initial setting: 0

2. **WORK ORIENTATION BREAKPOINT**
   Selects one of the breakpoints transmitted from the laser vision system to get the information on the inclination of the joint.
   - Setting range: 0 to 7
   - Initial setting: 0

3. **TARGET PT Y(Z)-SHIFT (SENSOR)**
   Shifts the target in the direction of the Y-axis and Z-axis in the camera coordinate system of the laser vision sensor.
   - Setting range: -10.0 to 10.0
   - Initial setting: 0
7.2 Conditions for Welding-start-point Search

SEARCH TYPE
Specifies the search type.
- Setting range: NG→OK; OK→NG; STOP
- Initial setting: OK→NG

Three search types are available:
Type NG→OK and type OK→NG: Searches for the transition point to and from the section that is continuously detected to and from the section that is continuously undetected, and recognizes this point as the start point.
Type STOP: Recognizes the first detected point as the start point.

- Type NG→OK
  Searches for the transition point from the section that is continuously undetected to the section that is continuously detected.
  Teach the motion for the search to be done from a section away from the welding line to the welding line.
• Type OK→NG
Searches for the transition point from the section that is continuously detected to the section that is continuously undetected.
Teach the motion for the search to be done from the welding line to a section away from the welding line.

• Type STOP
The first detected point after the start of the search is recognized as the start point.

©OVERLAP DISTANCE
Shifts the start point of the search towards the welding line. Searches for the start point on the bead end on the welding line and uses this point as the start point of the welding when welding on the bead end. This function is invalid when “STOP” is selected as the search type.
• Setting range: 0 to 10
• Initial setting: 0
7.3 Conditions for Welding-end-point Search

\( \odot \) **WELD DETECTION OVERLAP**
For the search type, NG → OK, specifies the length of the section that is continuously detected to be recognized as the welding line.
- Setting range: 5 to 50
- Standard setting: 10

\( \odot \) **NON-WELD DETECTION OVERLAP**
For the search type, OK → NG, specifies the length of the section that is continuously undetected to be recognized that the torch is away from the welding line.
- Setting range: 5 to 50
- Initial setting: 10

\( \odot \) **OVERLAP DISTANCE**
Shifts the end point of the search towards the welding line. Searches for the end point on the bead end on the welding line and uses this point as the end point of the welding when welding on the bead end. This function is invalid when “STOP” is selected as the search type.
- Setting range: -10 to 10
- Initial setting: 10

\( \odot \) **NON-WELD DETECTION OVERLAP**
For the search type, OK → NG, specifies the length of the section that is continuously undetected to be recognized that the torch is away from the welding line.
- Setting range: 5 to 50
- Initial setting: 10
### 7.4 Conditions for Laser Tracking

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **XYZ CORRECTION**
   - Turns the output of the path correctional amount ON/OFF.
   - Setting range: ON or OFF
   - Initial setting: ON

2. **RxRyRz CORRECTION**
   - For future use. Do not change the initial setting.

3. **SENSING POSITION CORRECTION**
   - For future use. Do not change the initial setting.

4. **GAP COND FILE NO.**
   - Specifies the gap condition file number. This file includes the data to correct the welding condition according to the gap obtained by the sensor.
   - Setting range: 1 to 30
   - Initial setting: 1

5. **TCP X-SHIFT (TOOL FRAME)**
   - TCP Y-SHIFT (TOOL FRAME)
   - TCP Z-SHIFT (TOOL FRAME)
   - Shifts the target point in the tool coordinate system if the target point has deviated from the desired welding point.
   - Setting range: -99.9 to 99.9
   - Initial setting: 0.0
TCP Rx-SHIFT (TOOL FRAME)
For future use. Do not change the initial setting.

TCP Ry-SHIFT (TOOL FRAME)
For future use. Do not change the initial setting.

TCP Rz-SHIFT (TOOL FRAME)
For future use. Do not change the initial setting.
7.5 Conditions for NON-detection and Error Detection

1. **ACTION AFTER NON-DETECTION**
   Specifies the manipulator motion when nothing is detected in the specified distance.
   - **NO ACTION**
     The manipulator continues moving in the taught direction without stopping even if data is no longer sent from the sensor because nothing has been detected. Tracking is restarted when the sensor detects the data again.
   - **STOP**
     An alarm occurs, and the manipulator stops when data is no longer sent from the sensor because nothing has been detected.
   - Setting range: NO ACTION, STOP
   - Initial setting: NO ACTION

2. **NON-DETECTION DISTANCE**
   Specifies the distance to be checked. Specify approximately half the distance of the "lookahead".
   If the detecting ratio is low, specify a longer distance.
   If the detecting ratio is high, specify a shorter distance.
   - Setting range: 5 to 100
   - Initial setting: 10

3. **DATA ACQUISITION LENGTH**
   Specifies the length of the approximate line to be used for judgment of error detection. Specify approximately half the distance of the "lookahead".
   If the curvature 1/R of the welding line is large, specify a shorter distance.
   If the curvature 1/R of the welding line is small, specify a longer distance.
   - Setting range: 5 to 100
   - Initial setting: 10

4. **DETECT ERR LIMIT (START/END, MIDDLE)**
   Specifies the distance to judge whether the point to be checked is mistakenly detected or not.
   **START/END:** The distance to be used to judge the points detected during the approach to the start point of the welding and during the search for the end point.
   **MIDDLE:** The distance to be used to judge the points detected in the tracking sections other than those in the START/END.
   - Setting range: 0.0 to 50.0
7.6 Conditions to Pass Over

For future use. Do not set.
8 Settings for Inspection Job Before Starting Operations

When the sensor mounted onto the manipulator is displaced, the tracking deviation occurs. The inspection job before starting checks the deviation of the sensor before the actual operation by tracking. This is also used to check the sensor deviation and torch deviation when the target deviation occurs.

If the inspection job before starting fails to be properly set, the sensor may fail to be properly checked.

After the tool calibration and sensor calibration, be sure to set the inspection job again before starting.
8.1 Teaching an Inspection Job Before Starting

NOP
'AUTO/MANUAL switching flag [0: AUTO, 1: MANUAL]
SET LB000 0
'Initial setting flag [0: Normal, 1: Initial setting]
SET LB001 0

'Standby position
MOVJ VJ=5.0
'Approach motion====
MOVJ VJ=5.0
MOVJ VJ=5.0
MOVL V=100
'==============

'Position for checking the welding point deviation
REFP 1
'Posture 1 for checking the welding point deviation
REFP 2
'Posture 2 for checking the welding point deviation
REFP 3
'Position for checking the camera deviation
REFP 4
'Posture 1 for checking the camera deviation (start)
REFP 5
'Posture 1 for checking the camera deviation (end)
REFP 6
'Posture 2 for checking the camera deviation (start)
REFP 7
'Posture 2 for checking the camera deviation (end)
REFP 8

:
8.1 Teaching an Inspection Job Before Starting

NOP
'AUTO/MANUAL switching flag [0: AUTO, 1: MANUAL]
SET LB000 0
'Initial setting flag [0: Normal, 1: Initial setting]
SET LB001 0

'Standby position
MOVJ VJ=5.0

'Approach motion====
MOVJ VJ=5.0
MOVJ VJ=5.0
MOVJ VJ=5.0

'Position for checking the welding point deviation
REFP 1

'Posture 1 for checking the welding point deviation
REFP 2

'Posture 2 for checking the welding point deviation
REFP 3

'Position for checking the camera deviation
REFP 4

'Posture 1 for checking the camera deviation (start)
REFP 5

'Posture 1 for checking the camera deviation (end)
REFP 6

'Posture 2 for checking the camera deviation (start)
REFP 7

'Posture 2 for checking the camera deviation (end)
REFP 8

---

Position for checking the camera deviation

Posture 1 for checking the camera deviation
(Tilt the tool five more degrees.)

Posture 2 for checking the camera deviation
(Tilt the tool five more degrees. (to the other side))
8.2 Acquisition of Reference Data

The following procedure describes how to get the reference data.

1. Set [1] (initial setting) to the initial setting flag.
2. Set [0] (AUTO) to the AUTO/MANUAL switching flag.
3. Carry out the inspection job before starting an operation in auto or test mode.

   The data of the target point and the actual data which was detected are obtained at the position for checking the camera deviation, the posture 1 for checking the camera deviation, and the posture 2 for checking the camera deviation to store as the position data of the user variables.
9 Tool Offset Setting

If the tool center point (TCP) always deviates from the target in one direction, the deviation can be corrected by using the tool offset function.

### 9.1 How to Obtain the Tool Offset Amount

The following procedure describes how to obtain the amount of the tool offset.

1. Carry out tracking in a test run.
2. When a deviation is found, stop the manipulator.
   - To obtain the exact amount of the deviation, keep the servo power supply ON.
3. Select the job for offset calculation, “CAL OFFSET”.
4. Set the number of the tool used for tracking as the teaching tool.
5. Register the TCP position when the manipulator is stopped as the reference point, “Deviated Position”.

   **NOP**
   - 'Deviated Position
   - REFP 1
   - 'Corrected Position
   - REFP 2

6. Correct the TCP's position in the direction perpendicular to the tracking direction in the JOG operation.
7. Register the corrected position of the TCP as the reference point, “Corrected Position”.

8. Move the cursor to the beginning of the job, and carry out the test run.

9. The calculated amount of the tool offset is stored as the position data of the user variable [P 088]. Take note of the values for the X-, Y-, and Z-axes.
9.2 How to Set the Tool Offset Amount

1. Open the tracking function file used for tracking, and add the values obtained in Step 9 of section 9.1 “How to Obtain the Tool Offset Amount” to the offset settings.

   <Example>
   When the offset “0.0, 0.3, -0.1” has been set, add the obtained offset (0.0, 0.1, -0.2) to the offset settings.
   The offset values to be reset are:
   X: 0.0 mm
   Y: 0.3 + 0.1 = 0.4 mm
   Z: -0.1 + (-0.2) = -0.3 mm
9.2 How to Set the Tool Offset Amount

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>TRACKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>XYZ CORRECTION</td>
<td>ON</td>
</tr>
<tr>
<td>Rx/Ry/Rz CORRECTION</td>
<td>OFF</td>
</tr>
<tr>
<td>SENSING POSITION CORRECTION</td>
<td>FF</td>
</tr>
<tr>
<td>GAP COND FILE NO.</td>
<td>1</td>
</tr>
<tr>
<td>TCP X-SHIFT(TOOL FRAME)</td>
<td>0.0 mm</td>
</tr>
<tr>
<td>TCP Y-SHIFT(TOOL FRAME)</td>
<td>0.3 mm</td>
</tr>
<tr>
<td>TCP Z-SHIFT(TOOL FRAME)</td>
<td>-0.1 mm</td>
</tr>
<tr>
<td>TCP Rx-SHIFT(TOOL FRAME)</td>
<td>0 deg.</td>
</tr>
<tr>
<td>TCP Ry-SHIFT(TOOL FRAME)</td>
<td>0 deg.</td>
</tr>
<tr>
<td>TCP Rz-SHIFT(TOOL FRAME)</td>
<td>0 deg.</td>
</tr>
</tbody>
</table>
10 Settings for the Gap Adaptation Function

This chapter explains the function to adapt the welding condition (current, voltage, analog 3ch. 4ch., target position and speed) to the gap value.

• The user sets the change value of the welding condition which adapts to the gap into GAP CONDITION FILE.

```
GAP CONDITION FILE

GAP CONDITION: 1

GAP VOLT CURR 3ch 4ch x y z SPEED
ON ON OFF OFF OFF ON ON
0.1 100 100 0 0 0.0 0.0 0.0 100
0.2 110 105 0 0 0.0 0.0 -0.2 90
0.4 120 110 0 0 0.0 0.0 -0.5 85
0.6 125 113 0 0 0.0 0.0 -0.7 80
0.7 130 115 0 0 0.0 0.0 -0.9 70
```

• The DX200 makes linear functions from the first ‘GAP CONDITION FILE’.

The controller calculates the correction values which adapts to GAP by using the function.
10.1 Settings for the Gap Condition File

The Gap Condition file includes the conditions for each gap value.

- **File Components**
10.2 Conditions for Welding

① SWITCH of FUNCTION
• ON: Enable of adaptive control. / OFF: Disable of adaptive control.
• Initial setting: OFF

② GAP VALUE
The gap value to make the condition correspond. It is possible to set gap by ten stages.
The same data is displayed in POSITION and SPEED.
• Setting range: 0.1 to 99.9 [mm]
• Initial setting: 0 [mm]

③ VOLTAGE RATIO
Analog 1ch. which controls the welding voltage is corrected in proportion to gap.
Set ratio of changing analog 1ch. output, which is programed by AOUT (1) in the JOB.
Analog channel No. is changeable by sensor parameter S5E040.
• Setting range: 0 to 200 [%]
• Initial setting: 0 [%]

④ CURRENT RATIO
Analog 2ch. which controls the welding current is corrected in proportion to gap.
Set ratio of changing analog 2ch. output, which is programed by AOUT (2) in the JOB.
Analog channel No. is changeable by sensor parameter S5E041.
• Setting range: 0 to 200 [%]
• Initial setting: 0 [%]

⑤ ANALOG 3ch. RATIO
Analog 3ch. is corrected in proportion to gap.
Set ratio of changing analog 3ch. output, which is programed by AOUT (3) in the JOB.
Analog channel No. is changeable by sensor parameter S5E042.
• Setting range: 0 to 200 [%]
• Initial setting: 0 [%]
**ANALOG 4ch. RATIO**

Analog 4ch. is corrected in proportion to gap. Set ratio of changing analog 4ch. output, which is programmed by AOUT (4) in the JOB. Analog channel No. is changeable by sensor parameter S5E043.

- Setting range: 0 to 200 [%]
- Initial setting: 0 [%]
10.3 Conditions for Position

1. **SWITCH of FUNCTION**
   - ON: Enable of adaptive control. / OFF: Disable of adaptive control.
   - Initial setting: OFF

2. **GAP VALUE**
   The gap value to make the condition correspond. It is possible to set gap by ten stages.
   The same data is displayed in WELD and SPEED.
   - Setting range: 0.1 to 99.9 [mm]
   - Initial setting: 0 [mm]

3. **SHIFT VALUE of TARGET POSITION (X, Y, Z)**
   It is possible to shift the tool central point (TCP) axially of the tool coordinate system in proportion to gap value.
   Set shift values of each axially of the tool coordinate system.
   - Setting range: -99.9 to 99.9 [mm]
   - Initial setting: 0 [mm]

4. **CHANGE VALUE of TOOL POSTURE (Rx, Ry, Rz).**
   - Setting range: -90 to 90 [degree]
   - Initial setting: 0 [degree]
   * For future use. Do not change the initial setting.
10.4 Conditions for Speed

① SWITCH of FUNCTION
- ON: Enable of adaptive control. / OFF: Disable of adaptive control.
- Initial setting: OFF

② GAP VALUE
The gap value to make the condition correspond. It is possible to set gap by ten stages.
The same data is displayed in WELD and POSITION.
- Setting range: 0.1 to 99.9 [mm]
- Initial setting: 0 [mm]

③ CHANGE RATIO of SPEED
Adjust the welding speed, which specified by the job, by overriding the speed with the specified value.
- Setting range: 1 to 200 [%]
- Initial setting: 0 [%]
1. When using gap adaptation function of analog output, ensure to add INSTRUCTION (ARCSET) set by analog output before starting the tracking.
2. Changing analog output by INSTRUCTION is invalid during the tracking, when using gap adaptation function of analog output.
3. When using gap adaptation function of speed control, speed can be changed by INSTRUCTION.
   - When the speed decreases to 80% by gap adaptation function, changing the speed by INSTRUCTION from 100 to 150 [cm/min], the actual speed becomes $150 \times 0.8 = 120$ [cm/min].
4. It is possible to change analog channel by setting the sensor parameters (S5E040 to 043).

<table>
<thead>
<tr>
<th>Initial setting</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>S5E040: 1</td>
<td>1 to 12 ch. that are not specified by S5E040 to 043</td>
</tr>
<tr>
<td>S5E041: 2</td>
<td>1 to 12 ch. that are not specified by S5E040, 042, 043</td>
</tr>
<tr>
<td>S5E042: 3</td>
<td>1 to 12 ch. that are not specified by S5E040, 041, 043</td>
</tr>
<tr>
<td>S5E043: 4</td>
<td>1 to 12 ch. that are not specified by S5E040 to 042</td>
</tr>
</tbody>
</table>
11 Inspection Before Starting Operations

11.1 Automatic Inspection Before Starting Operations

For the best performance of the laser-tracking function, perform the inspection before starting operations.
11.2 Manual Inspection Before Starting Operations

Procedure of Manual Inspection Before Starting Operations

Assign "1" to the auto/manual flag at the beginning of the job.

Attach a tip for teaching.

Set the DX100 to teaching mode, and start a test run.

Restart the manipulator in the test run.

Restart the manipulator in the test run.

In all of the three postures, does the tip for teaching point to the tip for checking?

No

Restart the manipulator in the test run to move the manipulator to posture 1 for checking the welding point deviation.

Select the tool number of the teaching tool for tracking, and change the posture by pressing the X, Y, and Z keys in the JOG operation.

After changing the posture, does the tip for teaching still point to the tip for checking?

No

Refer to "11.3 Camera Deviation Check at Welding-point Deviation Check."

Yes

Move the manipulator to the posture 1 for checking the welding point deviation, and temporarily stop the manipulator.

Move the manipulator to the posture 2 for checking the welding point deviation, and temporarily stop the manipulator.

Move the manipulator to the posture 3 for checking the welding point deviation, and temporarily stop the manipulator.

Yes

Move the manipulator to the posture 1 for checking the welding point deviation, and temporarily stop the manipulator.

Refer to "11.4 Verification of Tool Constants."

Refer to "11.5 Verification of Detected Data."
11.3 Camera Deviation Check at Welding-point Deviation Check

1. Move the manipulator to the standby position.
2. Move the cursor to the beginning of the job.
3. Assign "0" to auto/manual flag.
4. Start the test run.

Is the tip for teaching or the tip for checking deformed?

The entire tool has not deviated, but the surface around the welding point may be deformed. Correct the deformation on the surface.

Is the deviation less than 1 mm?

Check for target deviation by carrying out a tracking job in a test run.

Any deviation?

Correct the target deviation by setting the amount of offset. Refer to "9 Tool Offset Setting."

Resetting after tool calibration is necessary. Refer to "12.3 Corrective Actions for Tool Deviation."

Replace the tip and restart the procedure described in "11.2 Manual Inspection Before Starting Operations."

Refer to "12.3 Corrective Action for Tool Deviation."

Key:

Refer to the section for more information.

Comment
11.4 Verification of Tool Constants

Verification of Tool Constants

Tool constant has been changed.

Is there a record of the previously registered tool constants?

Yes

Assign the original values to the tool constants.

Press the BWD button to move the manipulator to the posture 1 for checking the torch deviation, and restart the jog operation to check if the settings are correct.

After changing the posture, does the tip for teaching still point to the tip for checking?

Yes

Carry out tool calibration.

Carry out the sensor calibration again. Refer to "5. Laser Sensor Calibration."

No

End

End

Refer to the section for more information.

Comment
11.5 Verification of Detected Data

Verification of Detected Data

Carry out the automatic inspection before starting operations.
1. Move the manipulator to the standby position.
2. Move the cursor to the beginning of the job.
3. Assign "0" to auto/manual flag.

Start the test run.

[Error 1]
Has the manipulator stopped due to camera deviation?

Yes

No

[Errors 2 and 3]
Has the manipulator stopped due to camera deviation when changing the posture?

Yes

No

Is 10 μm assigned to the X-, Y-, and Z-axes parameters in "Robot Setting"?

Yes

No

Assign 10 μm to the X-, Y-, and Z-axes parameters in "Robot Setting."

End
12 Troubleshooting

12.1 Corrective Actions after Torch Collision

Take corrective actions following the flowchart.

- Torch Collision
- Any target deviation?
  - Yes: Check for tool deviation and camera deviation by carrying out the inspection job before starting operations. Refer to "11.2 Manual Inspection Before Starting Operations."
  - No: Any target deviation?
    - Yes: Contact your Yaskawa representative.
    - No: End
12.2 Corrective Actions for Target Deviation

Take corrective actions following the flowchart.

Target Deviation

Check the status of the detection on the WinUser graphic display.

Is the target point (a red cross) unstable?

No  

Has an offset been applied to the target position?

Yes

Assign "0" to "TARGET PT Y- and Z-SHIFT (SENSOR)" in the CONDITION for the "LASER SENSOR" in the LASER TRACKING display.

No

Check for tool deviation and camera deviation by carrying out the inspection job before starting operations. Refer to “11.2 Manual Inspection Before Starting Operations.”

Adjust the parameters with WinUser.

No

Has the target position offset been cancelled?

Yes

Contact your Yaskawa representative.

No

Any target deviation?

Yes

End
12.3 Corrective Actions for Tool Deviation

Take corrective actions following the flowchart.

1. Change the tool with the tip for teaching.
2. Carry out the manual inspection job before starting operations, and move the manipulator to the position for checking the welding point deviation.
3. Check if the tip end for teaching points to the tip end for checking.

Check if the flange and the torch are attached and fixed securely. Tighten the screws if necessary.

Check if the torch or sensor cables have been stretched too much that the torch has been moved. Adjust the stretching tension of the connection cable if necessary.

Has the tool deviation been corrected?

Yes

Correct the tool deviation, and tighten the mounting screws.

Carry out tool calibration.

Carry out the sensor calibration again. Refer to “5. Laser Sensor Calibration.”

Redo the initial settings for the inspection job before restarting operations. Refer to “8. Settings for Inspection Job Before Starting Operations.”

No

End
12.4 Corrective Actions for Camera Deviation

Take corrective actions following the flowchart.

1. **Camera Deviation**
   - The mounting position of the sensor's camera may have deviated.

2. Move the manipulator to the position for checking the camera deviation of the inspection job before starting operations.
   - If the manipulator is at the position for the detection test when changing the posture, press the [BWD] button to return the manipulator to the previous position.

3. Adjust the mounting position of the camera so that the laser beam shines on the marked line on the joint of the workpiece for the detection test.

4. Tighten the mounting screws.

5. Carry out the sensor calibration again.
   - Refer to "5. Laser Sensor Calibration."

6. Redo the initial settings for the inspection before restarting operations.
   - Refer to "8. Settings for Inspection Job Before Starting Operations."

End
# 13 Alarm List

## 13.1 Alarm List

<table>
<thead>
<tr>
<th>Alarm No.</th>
<th>Data</th>
<th>Message</th>
<th>Cause</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>5020</td>
<td>0 to 199</td>
<td>Parameter error [decimal data]</td>
<td>Set values for the sensor parameter are incorrect. The decimal data indicates the number of the sensor parameter whose setting is incorrect.</td>
<td>Set the sensor parameter to a value within the setting range described in the parameter list.</td>
</tr>
<tr>
<td>5050</td>
<td>1 to 233</td>
<td>Motion extension processing error, [decimal data]</td>
<td>An interface error between the tracking processing system and the operating section for the laser-tracking function. The decimal data indicates the type of error.</td>
<td>Requires investigation at Yaskawa. Contact your Yaskawa representative, stating the situation, the alarm number, and the decimal data of the alarm.</td>
</tr>
<tr>
<td>5051</td>
<td>1 to 201</td>
<td>Skill command processing error, [decimal data]</td>
<td>An error occurred in a macro command. The decimal data indicates the type of error.</td>
<td>Requires investigation at Yaskawa. Contact your Yaskawa representative, stating the alarm number, decimal data, and the macro command where the error occurred.</td>
</tr>
<tr>
<td>5052</td>
<td>0 to 19</td>
<td>System error (Laser tracking), [decimal data]</td>
<td>An error occurred in the tracking processing system of the laser-tracking function. The decimal data indicates the type of error.</td>
<td>Requires investigation at Yaskawa. Contact your Yaskawa representative, stating the situation, the alarm number, and the decimal data of the alarm.</td>
</tr>
<tr>
<td>5053</td>
<td>*</td>
<td>Laser tracking processing error, [decimal data]</td>
<td>The decimal data indicates the type of error</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 to 9</td>
<td>Laser tracking processing error, [decimal data]</td>
<td>An error occurred in the corresponding process of the laser-tracking function.</td>
<td>Requires investigation at Yaskawa. Contact your Yaskawa representative, stating the situation, the alarm number, and the decimal data of the alarm.</td>
</tr>
<tr>
<td>No.</td>
<td>Laser Tracking Processing Error, [Decimal Data]</td>
<td>Description</td>
<td>Action</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------</td>
<td>-------------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>An error occurred in the sensing mode.</td>
<td>Return the manipulator to its standby position, and restart the job for tracking from the beginning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>The Coordinate/Independent attribute of a move instruction has been changed in the middle of tracking.</td>
<td>Use either coordinate move instructions or independent move instructions for the teaching in the tracking section.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>A tool change error</td>
<td>Use the same teaching tool throughout the tracking section.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>The control group has been changed in the middle of tracking.</td>
<td>Use either coordinate move instructions or independent move instructions for the teaching in the tracking section.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>The external reference point has not been registered.</td>
<td>Register the external reference point.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>An error occurred in the gap condition data setting.</td>
<td>The same gap amounts are defined. Change either of the gap amount settings.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 16  | The laser sensor has continuously detected no points. | Increase the detecting frequency of the sensor.  
• Remove the polish on the workpiece’s surface.  
• Correct the teaching posture so that the laser beam can be shown on the welding line of the reference workpiece.  
• Adjust the image processing parameter in WELDCOM. |
<p>| 17  | The manipulator cannot move to the position that was corrected during tracking. | Correct the taught position for the reference workpiece, considering the posture of the L- and U-axes. |
| 18  | The correction amount exceeds the allowable value. | For teaching, minimize the posture change so that the manipulator can move in a smooth motion. |</p>
<table>
<thead>
<tr>
<th>Alarm List</th>
<th>Alarm List</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 to 27</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>32</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>34</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>40</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>41</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>42</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>43</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>50 to 56</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>60</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>5054 *</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>0 to 9</td>
<td>Laser tracking processing error, [decimal data]</td>
</tr>
<tr>
<td>Alarm Number</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>98</td>
<td>An error occurred in data check from the DX200.</td>
</tr>
<tr>
<td>103</td>
<td>No response has been received from the DX200.</td>
</tr>
<tr>
<td>104</td>
<td>Camera failure.</td>
</tr>
<tr>
<td>107</td>
<td>An error occurred in the final processing for tracking.</td>
</tr>
<tr>
<td>112</td>
<td>The parameter instructed from the DX200 does not exist.</td>
</tr>
<tr>
<td>115</td>
<td>An error occurred at the setup.</td>
</tr>
<tr>
<td>116</td>
<td>The operating temperature exceeds the allowable range.</td>
</tr>
<tr>
<td>118</td>
<td>The value instructed from the DX200 is out of the allowable range.</td>
</tr>
</tbody>
</table>
# 14 Sensor Parameters

## 14.1 S5E Parameters

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Initial Value</th>
<th>Setting Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Real-time data delay time (* when using MOTOMAN-UP6) [ms]</td>
<td>* 286</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Updated angle for seam frame reference [0.01 deg.]</td>
<td>6000</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Updated distance for seam frame reference [μm]</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Average number of travels for stabilizing workpiece direction vector [number of travels]</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Maximum correction distance [μm]</td>
<td>5000</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Buffer size for judging OK and NG [amount of memory]</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>OK judging level [%]</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>NG judging level [%]</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Pixel → μm conversion [conversion constant]</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Sampling minimum cycle [ms]</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Sampling minimum interval [μm]</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Number of stop-search sampling times [number of times]</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Target offset parameter unit (μm)</td>
<td>0</td>
<td>0 to 1000</td>
</tr>
<tr>
<td>40</td>
<td>Analog output channel for gap adaptation function</td>
<td>1</td>
<td>1 to 12</td>
</tr>
<tr>
<td>41</td>
<td>Analog output channel for gap adaptation function</td>
<td>2</td>
<td>1 to 12</td>
</tr>
<tr>
<td>42</td>
<td>Analog output channel for gap adaptation function</td>
<td>3</td>
<td>1 to 12</td>
</tr>
<tr>
<td>43</td>
<td>Analog output channel for gap adaptation function</td>
<td>4</td>
<td>1 to 12</td>
</tr>
<tr>
<td>44</td>
<td>Min. of speed ratio for gap adaptation function [0.01%]</td>
<td>0</td>
<td>0 to 20000</td>
</tr>
<tr>
<td>51</td>
<td>Reserved for system</td>
<td>0</td>
<td>Do not change.</td>
</tr>
<tr>
<td>58</td>
<td>Reserved for system</td>
<td>20</td>
<td>Do not change.</td>
</tr>
<tr>
<td>60</td>
<td>Reserved for system</td>
<td>0</td>
<td>Do not change.</td>
</tr>
<tr>
<td>90</td>
<td>Reserved for system</td>
<td>100</td>
<td>Do not change.</td>
</tr>
<tr>
<td>91</td>
<td>Reserved for system</td>
<td>20</td>
<td>Do not change.</td>
</tr>
</tbody>
</table>

Note: The reserved parameters (51 to 57, 58, 60 to 89, 90, 91) are not to be changed.
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Initial</th>
<th>Setting Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td>Sensor IP address 1</td>
<td>192</td>
<td>Do not change.</td>
</tr>
<tr>
<td>161</td>
<td>Sensor IP address 2</td>
<td>168</td>
<td>Do not change.</td>
</tr>
<tr>
<td>162</td>
<td>Sensor IP address 3</td>
<td>2</td>
<td>Do not change.</td>
</tr>
<tr>
<td>163</td>
<td>Sensor IP address 4</td>
<td>3</td>
<td>Do not change.</td>
</tr>
<tr>
<td>164</td>
<td>Sensor Ethernet port</td>
<td>6344</td>
<td>Do not change.</td>
</tr>
<tr>
<td>190</td>
<td>Reserved for system</td>
<td>0</td>
<td>Do not change.</td>
</tr>
<tr>
<td>199</td>
<td>Reserved for system</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
DX200 OPTIONS
INSTRUCTIONS
FOR LASER-TRACKING FUNCTION: MOTOEYE-LT

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for ongoing product modifications and improvements.