

**MotoSoft®**

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# **Laser Seam Finding User's Manual**

for Meta Vision Systems

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## Chapter 1

# Introduction

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Laser Seam Finding is Motoman's solution for non-contact detection and identification of weld seams. Laser Seam Finding can improve the speed and accuracy of your welding process and increase productivity by locating a weld joint and shifting the robot to the correct position in a fraction of a second. One of the biggest merits for using the Laser Seam Finding system is its ability to detect weld seams that are either not detectable, or very difficult to detect using a wire touch sensing system. Thin material lap joints, non-electrically conductive material, narrow gap butt joints, curved surfaces, etc., are all detectable when using the Laser Seam Finding system.

A laser camera measures the weld joint using a line-type laser. The resulting 2D image is used to identify the weld seam by comparing it with a series of pre-defined seam profiles. Once the weld seam has been identified, the processor calculates a two dimensional shift amount (Y, and Z) based on where the weld joint is located in the camera's field of view relative to a pre-taught reference point. This 2D shift amount is then translated into a three dimensional shift amount which is used by the robot controller to correct for part deviation and positioning.

## 1.1 About This Document

Please read this manual for safety precautions, installation instructions, and other important information before using the Laser Seam Finding system. This manual is intended as an introduction and system integration overview for personnel who are familiar with the operation of their Motoman robot model, and Microsoft® Windows®/ PC usage. This manual contains the following chapters:

### **CHAPTER 1 – INTRODUCTION**

Provides general information about Laser Seam Finding, a list of reference documents, and customer service information.

### **CHAPTER 2 – SAFETY**

Provides general information regarding the safe use and operation of the Laser Seam Finding system.

### **CHAPTER 3 – INSTALLATION**

Provides instructions for installation of the Laser Seam Finding system, and first time use.

### **CHAPTER 4 – OPERATION**

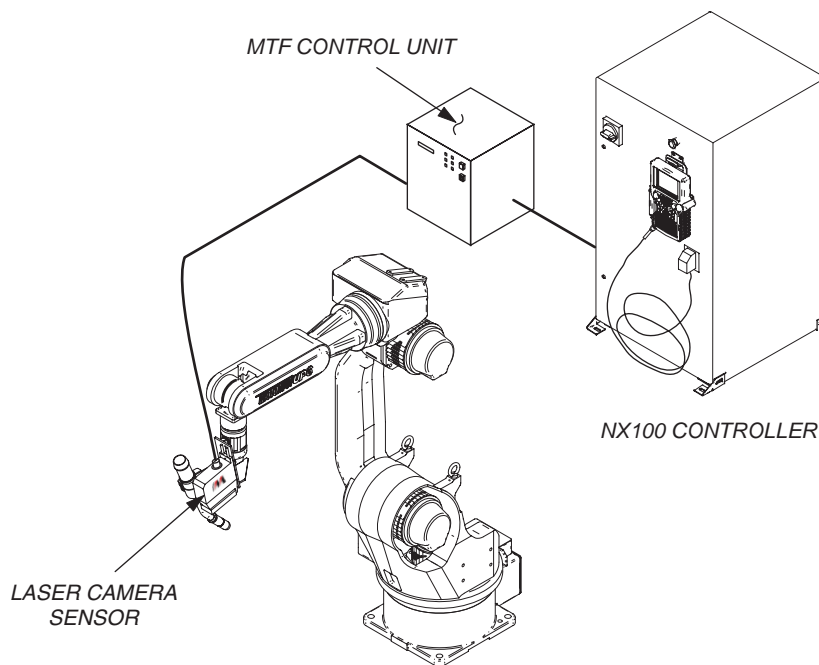
Provides step by step instructions and examples for using the Laser Seam Finding system.

## 1.2 System Overview

This Motoman Laser Seam Finding system is designed around the Meta Vision Systems, Laser Pilot MTF system. It features a rugged laser camera unit, separate control unit, and PC-based software.

### 1.2.1 System Layout

The laser camera is mounted to the robot weld torch. A camera cable is run to the MTF control unit. A communication cable (digital I/O) runs between the MTF Control unit and the robot controller.



The Motoman Laser Seam Finding system includes the following major components:

- Laser Camera
- Laser Camera Cable
- Torch Mounting Bracket
- MTF Control Unit
- MTF Control Unit Serial Cable (PC Communications)
- Laser Camera Software
- Motoman Laser Seam Finding User's manual
- MVS vendor manuals
- Analog to Digital convertor (two)
- MTF to Robot Controller Interface Cable

## 1.2.2 System Requirements

Laser Seam Finding runs well with the XRC and NX controllers. However, the ERC and MRC controllers may require some modifications. Three external input groups (8 sequential bits each) and eight sequential external outputs (1 byte) are required so that the robot controller can communicate with the vision system. Because of this, the Laser Seam Finding system is compatible with all Motoman robot controllers. The XRC and NX controllers use Macro Jobs to provide an easy-to-use and flexible interface. However, pre-XRC controllers do not offer the Macro Job, therefore, the interface (robot programming) will be more complex.

## 1.3 Specifications

- Robot Controller XRC, NX (ERC & MRC require setup modification)
- Camera Models ServoRobot Mini-i, SF, and MX
- Camera 580g
- Sensing Resolution 0.2mm, 0.4mm, or 0.6mm
- lateral field of view +/-6.4mm, +/-12.8mm, or +/-19.2mm
- depth of view 60 - 80mm
- sensing time 1.5 to 5.5 sec
- camera orientation beam parallel to Y or X direction of Tool Frame
- camera position 69 - 97mm stand-off

## 1.4 Reference to Other Documentation

For additional information, refer to the following:

- Operator's Manual for Welding (P/N 149231-1)
- Manipulator Manual for your robot model
- Laser Camera vendor manual

## 1.5 Customer Service

If you need technical assistance, contact the Motoman service staff at (937) 847-3200. Please have the following information ready before you call:

- Laser Seam Finding version
- Operating system (Microsoft® Windows® 95/98/NT/2000/XP)
- System configuration (hard disk capacity, memory, software, etc.)
- List of all software installed after shipment from Motoman
- Description of difficulty (make note of any error messages)
- Application specific information including robot jobs, process details etc...

# Notes



## Chapter 2

# Safety

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### 2.1 Introduction

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**It is the purchaser's responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.**

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We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems. This information can be obtained from the Robotic Industries Association by requesting ANSI/RIA R15.06-1999. The address is as follows:

**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](http://www.roboticsonline.com)

Ultimately, the best safeguard is trained personnel. The user is responsible for providing personnel who are adequately trained to operate, program, and maintain the robot cell. **THE ROBOT MUST NOT BE OPERATED BY PERSONNEL WHO HAVE NOT BEEN TRAINED!**

We recommend that all personnel who intend to operate, program, repair, or use the robot system be trained in an approved Motoman training course and become familiar with the proper operation of the system.

This safety chapter addresses the following –

- Standard Conventions (Section 2.2)
- General Safeguarding Tips (Section 2.3)
- Mechanical Safety Devices (Section 2.4)
- Installation Safety (Section 2.5)
- Programming, Operation, and Maintenance Safety (Section 2.6)

## 2.2 Standard Conventions

This manual includes the following alerts – in descending order of severity – that are essential to the safety of personnel and equipment. As you read this manual, pay close attention to these alerts to insure safety when installing, operating, programming, and maintaining this equipment.



### **DANGER!**

**Information appearing in a DANGER concerns the protection of personnel from the immediate and imminent hazards that, if not avoided, will result in immediate, serious personal injury or loss of life in addition to equipment damage.**



### **WARNING!**

**Information appearing in a WARNING concerns the protection of personnel and equipment from potential hazards that can result in personal injury or loss of life in addition to equipment damage.**



### **CAUTION!**

**Information appearing in a CAUTION concerns the protection of personnel and equipment, software, and data from hazards that can result in minor personal injury or equipment damage.**



*Note: Information appearing in a Note provides additional information which is helpful in understanding the item being explained.*

## 2.3 General Safeguarding Tips

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows –

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the robot cell.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
- The robot must be placed in Emergency Stop (E-Stop) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06-1999, section 4.2.5, Sources of Energy, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

## 2.4 Mechanical Safety Devices

The safe operation of the robot, positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06-1999 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location.

The following safety equipment is provided as standard –

- Safety fences and barriers
- Light curtains and/or safety mats
- Door interlocks
- Emergency stop palm buttons located on operator station, robot controller, and programming pendant

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.

## 2.5 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. Installation tips are as follows –

- Be sure that only qualified personnel familiar with national codes, local codes, and ANSI/RIA R15.06-1999 safety standards are permitted to install the equipment.
- Identify the work envelope of each robot with floor markings, signs, and barriers.
- Position all controllers outside the robot work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

## 2.6 Programming, Operation, and Maintenance Safety

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to program, operate, and maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Do not enter the robot cell while it is in automatic operation. Be sure that only the person holding the programming pendant enters the workcell.
- Check the E-Stop button on the programming pendant for proper operation before programming. The robot must be placed in Emergency Stop (E-Stop) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.
- Any modifications to PART 1, System Section, of the robot controller concurrent I/O program can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1, System Section. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!
- Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.
- The robot controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to controller parameters for maximum robot performance. Great care must be taken when making these modifications. All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot and other parts of the system. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations.
- Check and test any new or modified program at low speed for at least one full cycle.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Use proper replacement parts.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).

## Chapter 3

# Installation

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This chapter provides instructions for installing the Laser Seam Finding system including: software installation, hardware installation, and first time use.



### **CAUTION!**

**Installation of the Motoman Laser Seam Finding System is not a task for the novice. The system is not fragile, but it is a highly sophisticated vision system. Handle components with care. Rough handling can damage system electronic components.**



### **DANGER!**

**The laser camera is a Class 3B device, according to EN60825:1992. Never look directly into the laser beam. It is the user's responsibility to ensure that suitable safety precautions are taken to avoid viewing the beam directly or from a mirror reflection.**

## **3.1 Hardware Installation**

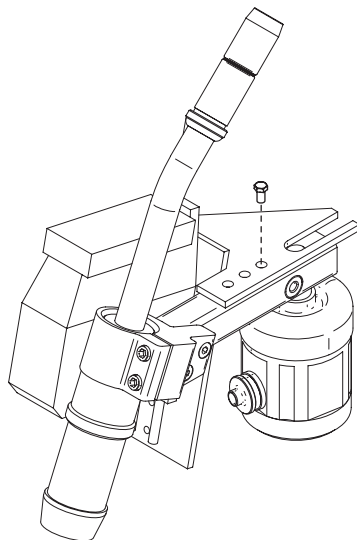
### **3.1.1 Required Material**

All system components and most hardware required for installation of the Laser Seam Finding system are included with your shipment. There are, however, some required items that the customer must supply (hand tools, special anchor bolts, etc.). These are not included with your shipment.

- Local electrical service
- Clean, dry air supply (13 to 17 cfh/ 6 to 8 l/min)
- Hand tools and other equipment and necessary

### 3.1.2 Mounting the Laser Camera

Carefully mount the laser camera to the robot torch using the bracket and hardware provided.



### 3.1.3 Connecting the Cables

1. Locate the camera cable.
2. Plug the camera cable into the connector on the back of the camera.



**CAUTION!**

**Route wires and cables away from hazardous work areas to avoid wire breakage and unnecessary interruption of system operation.**

3. Route camera cable to MTF Control Unit.
4. Plug other end of camera cable into Camera connection on back of MTF Control Unit.
5. Refer to system prints for connections between the MTF Control Unit and the robot controller.



**WARNING!**

**All power must be disconnected from the robot controller before beginning internal wiring. Failure to disconnect power can result in serious personal injury, loss of life, or equipment damage. Be sure to follow all Lockout/Tagout procedures.**

### 3.1.4 Connecting Power to MTF Control Unit

The Laser Pilot MTF control unit runs off of 24V DC power. The Motoman Laser Seam Finding system start-up kit contains a 24V DC power supply. However, 24V DC power can be obtained from an alternate source (i.e. the robot controller). To connect power to the MTF control unit, proceed as follows:

1. Locate the AC power cord and AC adapter.
2. Plug the AC adapter cord into the back of the MTF Control Unit marked 24VDC.
3. Plug one end of the power cord into the AC adapter.
4. Plug the other end of the power cord into a standard AC outlet.

### 3.1.5 Connecting the Monitor (Optional)

A video monitor may be required during installation to allow laser brightness to be adjusted correctly, and to verify that the sensor is getting a clear image of the part.

1. Locate AC power cord for your monitor.
2. If not already connected to back of monitor, plug one end to AC power connection on back of monitor.
3. Connect other end to properly grounded three-prong AC outlet.
4. Locate signal cable.
5. With power off, connect one end of signal cable to DB9-15P receptacle on back of monitor.
6. Route other end of signal cable to MTF control unit.
7. Connect signal cable to DB9-15P connector marked VGA on back of MTF control unit.

### 3.1.6 Connecting the Air

1. Route air line to camera and connect to connector on top of camera.

## 3.2 Software Installation

### 3.2.1 Robot Controller Software

Both the NX and XRC controller must have the Macro Job function installed. The Macro Job function must be initialized by a trained Motoman technician. Re-initialization of the NX controller by a non-Motoman employee may void your warranty. If the Macro Job function option has not been installed, please contact the Motoman service staff at (937) 847-3200.

### 3.2.2 PC Software

Load LP (Laser Pilot) Tools software on your PC. Please refer to the laser camera vendor instructions for detailed installation instructions.

## 3.3 System Setup

Once the laser camera has been mounted, software installed, and all connections made, the system must be properly calibrated.

### 3.3.1 Macro Job Configuration

1. Load the LASERR1.JBI, HALT.JBI, and MACRO.DAT files onto the controller.



*Note: The LASERR1, LASERR2, HALTR1, HALTR2, and MACRO.DAT files are used for the DRC, Dual Robot Controller.*

2. Configure the LASERR1 and HALT macro jobs for the Universal Inputs/Outputs to be used with the Laser Seam Finding system.
3. Open each macro job and locate the “setup section” at the beginning of the job.

```

NOP
'***Set Up Section***** / Verify the values in the Set Up Section
'IN SeamFound
SET LI004 6 / Input Number for SEAM FOUND signal
'IN System OK
SET LI005 5 / Input Number for SYSTEM OK signal
'IN Error
SET LI006 7 / Input Number for ERROR NOTIFICATION signal
'INGroup Error
SET LI014 1 / Input Group Number for ERROR CODE signals
'OT Laser On
SET LI009 6 / Output Number for LASER ON signal
'OT Measure
SET LI010 7 / Output Number for MEASUREMENT MODE ON signal
'OTGroupH SeamSelection
SET LI003 1 / Output Group Number for SEAM NUMBER signals
'OTGroupH IO Message Bits
```



```
SET LI011 43          / Output Group Number for I/O MESSAGE BITS
'***Set Up completed*** / This is the end of the Set Up Section. Do not
                        modify code beyond this point
```

4. Set each input (IN) and output (OT) number to match those in your system documentation.

### 3.3.2 Concurrent I/O Configuration

Laser Seam Finding uses five user messages during operation. The concurrent I/O ladder is modified at the factory for all new systems shipped with the Laser Seam Finding system. However, if you are installing Laser Seam Finding to an existing system, you will need to modify your concurrent I/O ladder to add the following user I/O messages:

<u>Binary Value</u>	<u>Message</u>
1	Modify Ref.P. in LASRFIND macro
2	No Joint Recognized
3	Shift Amount too Large
4	Off-setting to find seam
5	Re-execute Macro Command



#### **CAUTION!**

**Modification of the concurrent I/O ladder should only be done by personnel familiar with this advanced operation. Please refer to the Motoman Concurrent I/O manual (P/N 149230-1) or contact your the Motoman service staff at (937) 847-3200, for more information.**

### 3.3.3 Camera Alignment

#### Define Tool Data

The robot tool file data must be modified so that the Y- and Z-coordinates of the robot tool are parallel to the Y- and Z-coordinates of the laser/camera sensor.



*Note: If it is not possible to align the system with the Y-Axis, the system can be reconfigured so the laser stripe is parallel with the X-direction of Tool Frame.*

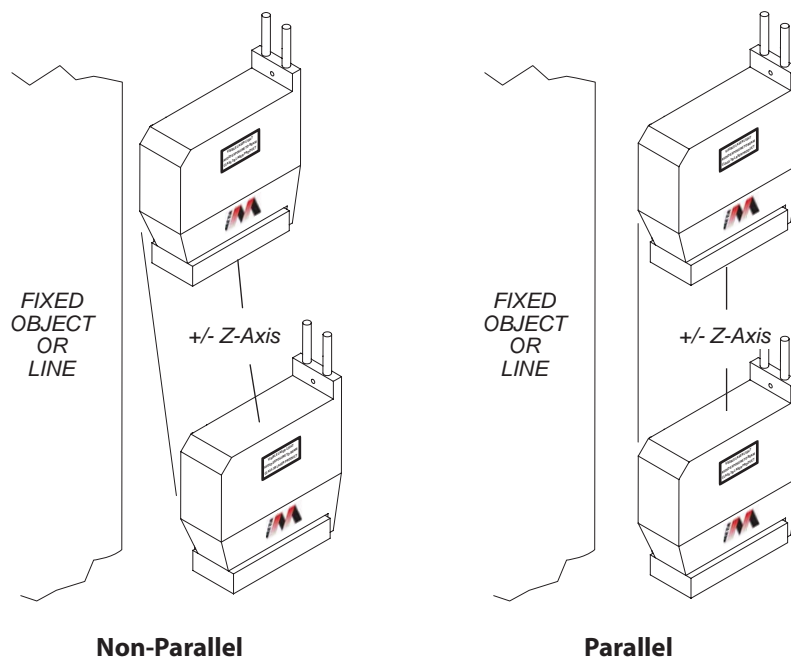


#### CAUTION!

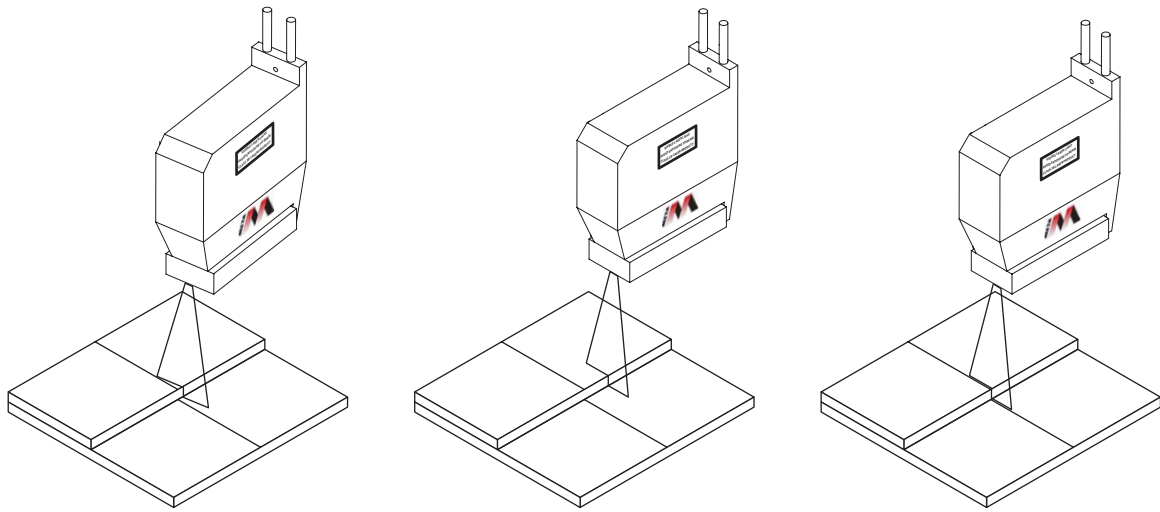
**Each robot has its own unique Tool Data file. Make certain you are modifying the correct corresponding Tool Data file for the robot you are using.**

To modify the Tool Data file, proceed as follows:

1. Press [ROBOT] > [TOOL]. The Tool Data screen appears.
2. Jog the robot so that the camera is parallel to a fixed object or line.



3. Press the [COORD.] key until Tool Frame is selected.
4. Jog the robot in the +/- Z axis of the Tool Frame. The camera chassis should remain parallel to the fixed line. If not, modify the Rx and Ry data in the Tool Data file until the camera tracks exactly parallel with the fixed object or line.
5. Mount a small weld coupon onto a fixed position inside the robot work cell.
6. Scribe/draw a very thin line across the weld joint as shown below.



**Non-Parallel**

**Parallel**

**Aligned**

7. Position the camera so that the weld joint is visible to the vision system.
8. Turn the laser ON so the laser stripe is projected onto the weld joint. (refer to the I/O list in your system prints to determine Universal Output used).
9. Using the robot programming pendant, jog the robot so that the camera is perpendicular to the part surface.
10. Once the camera is perpendicular to the part surface, jog the robot until the laser beam is projected directly onto the scribed line.
11. Press [ROBOT] > [TOOL]. The Tool Data screen appears.
12. Select Tool Coordinates and jog the robot in the +/- Y direction. The laser beam should track directly along the scribed line. If not, adjust the Tool File data (by adjusting the Rx, Ry, and Rz data) until the laser beam tracks the scribed line.



*Note: At this point the Tool File data is set so that the Y- and Z-coordinates of the robot Tool are parallel to the Y- and Z-coordinates of the laser/camera sensor.*

### Setup Alignment Job

1. Create a job to be used to verify laser/camera sensor alignment. E.g. ALIGN-R1, ALIGN-R2, etc.
2. Move the robot so that the laser/camera sensor is in position to project the laser line exactly onto the scribed line.
3. Using the LP tools software, setup the seam profile for your alignment coupon.
4. Save these settings and note the seam number used.



### CAUTION!

**Once you have assigned a seam number for this weld coupon, do not modify this seam number or you will lose the ability to verify camera alignment.**

5. Insert the LASERR1 macro instruction into the job.  
LASERR1 Joint=25 Cal=0 Pvar=82 Flag=B82
6. Modify macro arguments as follows:
  - a. Cursor to the Instruction side (right side) of the LASERR1 macro and press [SELECT] twice. The Argument Setting screen appears.

JOINT NUMBER	0-99	Seam number defined in LP Tools software
CALIBRATION MODE	0	0=OFF, 1=ON
REF. POSITION	--	Taught position, zero shift amount
P VARIABLE	0-127	Pvariable used to store shift amount
MAX SHIFT AMOUNT	0-	Error message occurs if Shift amount exceeds this value
RESULT FLAG BVAR	0-99	
  - b. Set JOINT NUMBER to the Seam Number defined in Step 3.
  - c. Verify that CALIBRATION MODE is set to 1 (Calibration mode ON).
  - d. Define the P-variable to be used to store the shift amount.
  - e. Cursor to REF. POSITION and press [MODIFY] > [ENTER] to record the current robot position.
  - f. Press [ENTER] twice to save the Argument Setting data into the robot job.
7. Press [INT] + [TEST START] to execute the macro. This centers the camera directly over the seam. "Modify Ref. P. in LASERR1 macro" message appears at the bottom of the screen.
8. Cursor to the Instruction side (right side) of the LASERR1 macro and press [SELECT] twice. The Argument Setting screen appears.



*Note: Verify that the laser stripe is still projected exactly on the scribed line before recording the new robot reference position. If not, adjust the robot position, and repeat steps 6, 7, and 8 as necessary.*

9. Cursor to REF. POSITION and press [MODIFY] > [ENTER] to record the new robot position.
10. Press [ENTER] twice to save the Argument Setting data into the robot job.
11. Verify that the laser line is still projected exactly onto the scribed line.

### Execute Alignment Job

1. Open the alignment job created above (e.g. ALIGN-R1).
2. Turn the laser ON (refer to the I/O list in your system prints to determine Universal Output used).
3. Cursor to the Laser Seam Finding macro instruction (LASERR1).
4. Cursor to the Instruction side of the macro and press [SELECT] twice.
5. Cursor to the Ref. Position and press [FWD]. Camera moves to Reference position.
6. Verify alignment of the sensor by observing the orientation and location of the laser line relative to the scribed line. Laser line should be projected exactly on the scribe line.
7. Press [CANCEL] twice.

8. Set CALIBRATION MODE to 0 (Calibration mode OFF).
9. From the LASERR1 macro, press [INT + TEST START] to execute the Laser Seam Finding macro in this job. Upon successful execution of the macro, a shift amount is written to the defined P variable. Look at the value of this P variable. If the amount is close to zero for X, Y, and Z, the sensor is properly aligned to the robot.
10. If a substantial shift amount is recorded in the P variable, adjust the mounting position of the camera to fine-tune the alignment and repeat this alignment sequence.

# Notes

## Chapter 4

# Operation

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### WARNING!

To ensure safe and reliable operation of this system, all operators must properly trained on the correct operation and safety procedures for this system. Please refer to the vendor documentation shipped with your system, for detailed operation information.

To measure variations in part placement, the laser camera captures offset amounts and sends these to the robot controller for path correction. The laser camera sensor uses a two dimensional, fan-shaped laser projection to calculate the part location through triangulation between the laser projector, the reflection of the laser stripe from the part, and the camera sensor.

The robot moves to a pre-programmed reference position over the seam to be welded. With the laser camera located over where seam is expected to be, the robot sends a signal to the laser camera to perform a measurement. The laser camera turns its laser ON and measures the location of the seam. This measurement is then compared to a reference position and the offset difference is calculated. The laser camera then sends this measurement to the robot controller, and the robot controller moves the robot this amount, positioning the laser camera over the seam. This process may be repeated to verify that the sensor has moved to the correct position.

If the seam cannot be located within the sensor field of view, the controller can be programmed to move the sensor to other positions, create an error report, or alert the operator, depending on what is appropriate for the application.

## 4.1 Programming Setup

### 4.1.1 Defining Seam Profile

A seam profile must be created for each weld type that varies in size or type (i.e. 2mm lap joint, 3 mm lap joint, T joint, etc.). Seam profiles can then be reused for repeating seam types. Using the LP Tools software, define the vision system parameters for proper image acquisition of each weldment in your job. For detailed instructions, refer to the vendor supplied Laser Pilot MTF Tools manual.



*Note: It is helpful to write down the assigned seam numbers for each weld type, as these numbers will be used to setup the robot weld job.*

1. Jog the robot so that the laser camera is within range of the weld seam.
2. Using the LP Tools software, setup the seam profile for each weld joint.
3. Save these settings and note the seam numbers used.

### 4.1.2 Calibration

Each LASERR1 macro instruction used in your job must be calibrated. If you have 10 different regions that you are seam finding, you must have 10 different LASERR1 macros in your job, and each must be calibrated separately. To calibrate the LASERR1 macro, proceed as follows:

1. Turn the robot controller power ON.
2. Using the programming pendant, open the robot job used for seam finding.
3. Insert the LASERR1 macro into the robot job before moving to the weld position.

```
MOVJ VJ=100.0
LASERR1 Joint=25 Cal=0 Pvar=82 Flag=B82
MOVJ VJ=100.0
MOVJ VJ=100.0
SFTON P082
MOVJ VJ=100.0
```
4. Set the macro arguments for calibration as follows:
  - a. Cursor to the Instruction side (right side) of the LASERR1 macro and press [SELECT] twice. The Argument Setting screen appears.

JOINT NUMBER	0-99	Seam number defined in LP Tools software
CALIBRATION MODE	0	0=OFF, 1=ON
REF. POSITION	--	Taught position, zero shift amount
P VARIABLE	0-127	Pvariable used to store shift amount
MAX SHIFT AMOUNT	0-	Error message occurs if Shift amount exceeds this value
RESULT FLAG BVAR	0-99	
  - b. Set JOINT NUMBER to the appropriate Seam Number defined in Section 4.1.1.
  - c. Cursor to REF. POSITION and record. Press [MODIFY] > [ENTER] to record the current robot position.
  - d. Press [ENTER] twice to save the Argument Setting data into the robot job.
5. Execute the Calibration routine as follows:
  - a. Verify that CALIBRATION MODE is set to 1 (Calibration mode ON).
  - b. From the LASERR1 macro, press [INT + TEST START] to calibrate the reference position to the vision system's seam profile. The robot moves to the Zero Shift Amount position with the camera centered directly over the seam.
  - c. An error message appears at the bottom of the display if Calibration is unsuccessful.
  - d. If calibration is successful, the "Modify Ref. P. in LASERR1 macro" message appears at the bottom of the screen.



- e. Cursor to the Instruction side (right side) of the LASERR1 macro and press [SELECT] twice. The Argument Setting screen appears.
- f. Cursor to REF. POSITION and press [MODIFY] > [ENTER] to record the new robot position.
- g. Press [ENTER] twice to save the Argument Setting data into the robot job.

*Note: With Calibration mode OFF, the macro instruction is set for normal playback mode. Execution of the macro with Calibration mode OFF, allows the LASRFIND macro to save the shift amount to the defined P-variable.*

6. Once calibration is successful, set the LASERR1 macro for normal operation as follows. This allows the LASERR1 macro to record the shift amount to the defined P-variable.
  - a. Cursor to the Instruction side (right side) of the LASERR1 macro and press [SELECT] twice.
  - b. Set Calibration mode to 0 (Cal=0).
  - c. Set the destination P-variable number (Pvar=?) to store the shift amount.
  - d. Set the Max Shift Amount. If the calculated shift amount exceeds this value, a “Shift Amount too Large” error message appears and the Result Flag Bvar is set to 0.
  - e. Set the Result Flag Bvar (0-99). This B variable stores the search routine results (0 - unsuccessful search, or 1 - successful search).
  - f. Press [ENTER] twice to save the Argument Setting data into the robot job.

### 4.1.3 Seam Finding Job Integration

Insert a LASERR1 macro and modify the reference position for each seam finding event in your job. Follow the Setup procedures above for *each* seam finding location. A different Seam profile must be used for each different type of weld seam.

The P-variable used in the LASERR1 macro is used with the SFTON command to shift the motion steps in the robot weld job.

**Table 1** Weld/Seam Finding Job: Single Seam Finding Event

Instruction	Description
NOP	
MOVJ VJ=100.0	
LASERR1 Joint=25 Cal=0 Pvar=82 Flag=B82	LASERR1 macro using the following: Seam Number 25 as defined in LP Tools software Calibration Mode OFF for normal operation P variable #82 used to store shift amount B variable #82 used to store success results
MOVJ VJ=100.0	
MOVJ VJ=100.0	

**Table 1** Weld/Seam Finding Job: Single Seam Finding Event

Instruction	Description
SFTON P082	Shift robot position by amount stored in P variable #82
MOVJ VJ=100.0	Move to weld position with shift amount
ARCON ASF#(14)	Begin welding
MOVL V=100	Move along weld seam with shift amount
ARCOF	End welding
MOVJ VJ=100.0	
SFTOF	Turn Shift OFF
MOVJ VJ=100.0	Move to safe position without shift amount
END	

**Table 2** Weld/Seam Finding Job: Start Point and End Point detection

Instruction	Description
NOP	
MOVJ VJ=100.0	
LASRFIND Joint=25 Cal=0 Pvar=44 Flag=B44	LASERR1 macro using the following: Seam Number 25 as defined in LP Tools software Calibration Mode OFF for normal operation P variable #44 used to store shift amount B variable #44 used to store success results
MOVJ VJ=100.0	
LASRFIND Joint=25 Cal=0 Pvar=45 Flag=B45	
MOVJ VJ=100.0	
MOVJ VJ=100.0	
SFTON P044	Shift robot position by amount stored in P variable #44
MOVJ VJ=100.0	Move to weld position with shift amount
ARCON ASF#(14)	Begin welding
MOVL V=100	Move along weld seam with start shift amount
SFTON P045	Shift robot position by amount stored in P variable #45
MOVL V=100	Move along weld seam with end shift amount
ARCOF	End welding

**Table 2** Weld/Seam Finding Job: Start Point and End Point detection

Instruction	Description
MOVJ VJ=100.0	
SFTOF	Turn Shift OFF
MOVJ VJ=100.0	Move to safe position without shift amount
END	

**Table 3** Skipping a weld based on success search flag (B variable)

Instruction	Description
NOP	
MOVJ VJ=100.0	
LASRFIND Joint=25 Cal=0 Pvar=45 Flag=B45	LASERR1 macro using the following: Seam Number 25 as defined in LP Tools software Calibration Mode OFF for normal operation P variable #45 used to store shift amount B variable #45 used to store success results
MOVJ VJ=100.0	
MOVJ VJ=100.0	
SFTON P045	Shift robot position by amount stored in P variable #45
MOVJ VJ=100.0	Move to weld position with shift amount
JUMP *45 IF B045=0	Jump to line 45 if search is unsuccessful
ARCON ASF#(14)	Begin welding
*45	Line 45
MOVL V=100	Move along weld seam with shift amount
ARCOF	End welding
MOVJ VJ=100.0	
SFTOF	Turn Shift OFF
MOVJ VJ=100.0	Move to safe position without shift amount
END	

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