MLX300 SOFTWARE OPTIONS USERS MANUAL
FOR: MULTIPLE ROBOT CONTROLLERS

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

For Your Safety

Robots generally have requirements which are different from other manufacturing equipment, such as larger working areas, high-speed operation, rapid arm movements, etc., which can pose safety hazards.

Read and understand the instruction manuals and related documents, and observe all precautions in order to avoid the risk of injury to personnel and damage to equipment.

Carelessness contributes to serious accidents in the work area.

It is the user’s responsibility to ensure that all local, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions are met and followed.

DANGER

• Teaching, operations, and maintenance of the Robot must conform to:
  – Industrial Safety and Health Law
  – Order for Enforcement of the Industrial Safety and Health Law
  – Industrial Safety and Health Regulations
  – Technical Standards for Electrical Facilities

Other related laws and regulations are:
  – Occupational Safety and Health Act in USA
  – Factory Act (Gewerbeordnung) in Germany
  – Health and Safety at Work, etc. Act in UK
  – EC Machinery Directive 2006/42/EC

• Prepare:
  – SAFETY WORK REGULATIONS
    based on concrete policies for safety management complying with related laws and regulations.

• Observe:
  – JIS B 8433-1: 2015 “Robots for industrial environments-Safety requirements” (ISO 10218-1: 2011) for safe operation of the robot. (JIS B 8433 is for Japan only)

• Reinforce:
  – SAFETY MANAGEMENT SYSTEM
    by designating authorized operators and safety managers for the Robot, as well as giving continuing safety education and training.

• Teaching, operation, and maintenance of the Robot are specified as “Hazardous Operations” in the Industrial Safety and Health Act (for Japan only). Personnel engaged in these operations must receive special training offered by YASKAWA.
DANGER

- Personnel engaged in operation, maintenance, or management of the Robot must receive required training before using the Robot.
  For more information on training, contact Customer Support.
- Make sure to have and follow all manuals, read them thoroughly and understand the contents of them.
  Confirm that you have all required manuals. If any of the manuals are missing, contact Customer Support.
- Read and understand these instructions thoroughly before installing, operating, or maintaining the Robot.

Any matter not described in this manual must be regarded as “prohibited” or “improper”.

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.

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.
**WARNING**

- Safe operation of this equipment is 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 R15.06-2012 safety standards, and other local codes that may pertain to the installation and use of this equipment.

Not following all national codes, safety standards, and local codes can result in death or serious injury.

- Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location.

Not providing additional safety measures as required can result in death or serious injury.

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

If safety equipment does not operate properly, death or serious injury can result.

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**CAUTION**

- Only trained personnel familiar with the operation, manuals, electrical design, and interconnections of this equipment should program, or maintain the system.

Any personnel involved with the operation of the equipment must understand potential dangers of operation.

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**NOTICE**

- The drawings and photos in this manual are examples. Differences may exist between them and the delivered product.

- YASKAWA may modify this model without notice due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.

- Some operations require standard passwords and while others require special passwords.

- If a manual is damaged or lost, contact Customer Support to order a new copy. Make sure to tell Customer Support the Part Number listed on the front cover.
Safety Notes for Safe Operation

Read this manual carefully before installing, operating, maintaining, or inspecting the system.

In this instruction, Safe Operations are classified as “DANGER”, “WARNING”, “CAUTION” or “NOTICE”.

**DANGER**
Indicates an imminently hazardous situation which, if not avoided, **WILL result in death or serious injury**.

**WARNING**
Indicates a potentially hazardous situation which, if not avoided, **MAY result in death or serious injury**.

**CAUTION**
Indicates a hazardous situation, which if not avoided, **MAY result in minor to moderate injury**.

**CAUTION**
Indicate a situation which if not avoided **may result in equipment damage**.

**NOTICE**
Indicates **practices not related to personal injury**.

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


Installation and Wiring Safety

Review the Manipulator and Controller Instructions for details on installation and wiring.

In planning installation, adapt an easy to observe arrangement to ensure safety. Take safety into consideration when planning the installation.

Ensure Safety

- When the power supplies of the Manipulator and Controller are turned ON at start-up, be sure to confirm the following:
  - Safety protection devices such as the E-STOP circuit, door interlocks, etc. operate normally.
  - Each axis operates normally in MANUAL mode.
  - Robot operates normally at the speed limit or less in the MANUAL mode.(Speed limit: 250 mm/s at the TCP or the flange)
  - The manual function and the playback function operate normally.

- Make sure to clearly indicate when the Robot is in operation:
  - Use a pilot lamp and/or an audible alert or
  - The Robot stops operation if the operator comes close.
Safety
Ensure Safety

All personnel working with the Robot (safety administration, installation, operation, and maintenance personnel) must always be prepared and "Safety First" minded, to ensure the safety of all personnel.

**WARNING**

- In the vicinity of the area where the Manipulator is installed, avoid any dangerous actions, such as entering the Robot's operating range without due care.

Failure to observe this instruction may cause contact with the Robot or peripheral equipment, which may result in death or serious injury.

- Strictly observe the safety precautions and signs in the factory, such as “Flammable”, “High Voltage”, “Danger”, “Off-limits to Unauthorized Personnel”.

Failure to observe this instruction may result in death or serious injury do to fire, electric shock, caused by contact with the Robot or other equipment.

- Strictly observe the following precautions about clothing:
  - Always wear approved work clothes (no loose-fitting clothes).
  - To prevent mis-operation, do not wear gloves when operating the Robot.
  - Do not allow underwear, shirts, or neckties hang out from the work clothes.
  - Do not wear accessories, such as earrings, rings, or necklaces.
  - Always wear protective safety equipment, such as hard hats, safety shoes (with slip-proof soles), face shields, safety glasses, and gloves as necessary.

Failure to observe this instruction may result in death or serious injury.

- The following must be understood and strictly observed by all personnel as rules:
  - Unauthorized personnel other than the operator must not approach the area where the Manipulator is installed.

Failure to observe this instruction may cause contact with the Manipulator, Controller, control panel, workpiece, or Positioner, etc., may result in death or serious injury.
Safety
Ensure Safety

WARNING

• Turn OFF servo power before operating.
  – Press the EMERGENCY STOP button to turn off SERVO POWER. When servo power is OFF, the “Servos Off Ready” displays on the Pendant.

If the EMERGENCY STOP button(s) do not work correctly, death or serious injury may result. Do not use if the EMERGENCY STOP button does not perform correctly.

Fig. : EMERGENCY STOP Button

• Clear the cell of all items which could interfere with the operation before releasing the EMERGENCY STOP button.

Death or serious injury may result from unintentional or unexpected motion.

Fig. : Release of EMERGENCY STOP Button

• Make sure no person is in the operating range and the operator is in a safe location before:
  – Turning ON power to the Controller
  – Moving the Robot with the Pendant
  – Running the system in MANUAL mode
  – Performing automatic operations

Death or serious injury may result if a person enters the operating range during operation. Immediately press an EMERGENCY STOP button whenever there is a problem.
Safety
Ensure Safety

CAUTION

- All operators, programmers, maintenance personnel, supervisors, and anyone working near the system must be 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:
  - Place system in E-STOP mode whenever it is not in use.
  - Use lockout/tagout procedures during equipment maintenance in accordance with ANSI/RIA R15.06-2012, section 4.2.5, Sources of Energy. Refer also to Section 1910.147 (29 CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).
  - Only trained personnel familiar with the operation of this equipment, the operator's manuals, the system equipment, and options and accessories can operate equipment.

Improper operation can result in personal injury and/or damage to the equipment.

- If the light in the operator's working space is not bright enough, provide the space with appropriate lighting.

CAUTION

- Store industrial tools, etc. in a safe location outside the Robot's operating range.

If an industrial tool, etc. is left unattended on the Robot, on a fixture, or on the floor, etc., the Robot may come in contact with the industrial tool left unattended, which may result in damage to the Robot and/or the fixture.
Operation Safety

DANGER

- Personnel engaged in teaching or inspection, etc. of the Robot must receive special training required by applicable laws and regulations.

- While performing inspection and maintenance, wiring, or attaching a tool to the Manipulator, etc., make sure to turn OFF the power supply of the Controller and the tool, and keep the switch of the power supply locked so that unauthorized personnel cannot turn ON the power supply.

  In addition, display a warning sign stating “Energizing Prohibited”.

  Turning ON the power supply without due care during inspection and maintenance, etc., may cause electric shock or unexpected movement of the Robot, which may result in personal injury.

- Use the Robot only within the specifications described in the manuals supplied with the Robot.

  Failure to observe this instruction may result in personal injury and/or equipment damage.

- Observe the following precautions when performing a teaching operation within the Robot's operating range:
  - Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
  - View the Robot from the front whenever possible.
  - Always follow the predetermined operating procedure.
  - Always keep in mind emergency response measures against the Robot's unexpected movement toward a person.
  - Ensure a safe place to retreat in case of emergency.

  Failure to observe this instruction may cause improper or unintended movement of the Robot, which may result in personal injury.
WARNING

• Read “Safety” of the Controller instructions before operating.
  Not reading and understanding chapter 1 of the Controller instruction can result in death or serious injury.

• Read and understand all Warning Labels before operating.
  Not reading and understanding all Warning Labels can result in death or serious injury.

• Confirm that no person is present in the P-point maximum envelope of the Robot before:
  – Turning on power to the Controller.
  – Moving the Robot with a Pendant.
  – Running the system in MANUAL mode.
  – Performing automatic operations.

  Injury may result if anyone enters the working envelope of the Robot during operation. Always press an EMERGENCY STOP button immediately if there are problems.

• Observe the following when performing teaching operation within the operating range:
  – Lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence.
  – Display a sign that operations are being performed so no other person closes the safety fence.
  – View from the front whenever possible.
  – Always follow the predetermined operating procedure.
  – Always keep in mind emergency response measures against unexpected movement toward a person.
  – Ensure a safe place to retreat in case of emergency.

  Failure to observe this precautions may cause improper or unintended movement, which may result in personal injury.
Maintenance Safety

WARNING

• Use care when modifying software.
  – The equipment allows modifications to the software for maximum performance.

  All modifications made to the software will change the way the equipment operates and may cause death or serious injury, as well as damage parts of the system.

• Make sure all modifications did not make create a hazardous or dangerous condition in all modes.

  All modifications made to the software will change the way the equipment operates and may cause death or serious injury, as well as damage parts of the system.

• Disconnect and lockout/tagout all sources of energy before making modifications or connections.

  Not disconnecting and doing lockout/tagout of all sources of energy can result in death or serious injury.

CAUTION

• Do not modify the Robot Controller.

  Making modifications without written permission from YASKAWA voids the warranty.

• 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.

• All connections must be made within the standard voltage and current ratings of the equipment.

  Improper connections can damage the equipment.
Definition of Terms Used Often in This Manual

The Robot is the YASKAWA industrial robot product.

The Robot usually consists of a Manipulator, Controller, Programming Pendant, and Robot 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>MLX300 Controller</td>
<td>Robot Controller</td>
</tr>
<tr>
<td>DX200 or YRC1000 Programming Pendant</td>
<td>Programming Pendant</td>
</tr>
<tr>
<td>Proface or AllenBradlyMobileView Pendant</td>
<td>MLX Pendant</td>
</tr>
<tr>
<td>Manipulator</td>
<td>Manipulator</td>
</tr>
<tr>
<td>Cable between the Robot and the Controller</td>
<td>Robot cable</td>
</tr>
<tr>
<td>Positioner</td>
<td>Positioner</td>
</tr>
</tbody>
</table>

Registered Trademark

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or bland names for each company or corporation. The indications of ® and ™ are omitted.

Customer Support Information

If you need assistance with any aspect of the Multiple Robot Controllers contact Customer Support at the following 24-hour telephone number:

(937) 847-3200

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

techsupport@motoman.com

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

NOTICE

Use e-mail for routine inquiries only. If there is an urgent or emergency need for service, replacement parts, or information, contact Customer Support at the telephone number shown above.
Customer Support Information
Registered Trademark

Have the following information ready before calling:

- **System**: MLX300
- **Robots**
- **Positioner**
- **Primary Application**
- **Software Version**

Access this information on the Status Display screen of the Control Module.

- **Robot Serial Number**
  - Located on the robot data plate
- **Robot Sales Order Number**
  - Located on the Control Module data plate
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<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
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<td>7-1</td>
</tr>
<tr>
<td>8 Safety Relay Board (Optional)</td>
<td>8-1</td>
</tr>
</tbody>
</table>
### 1 Introduction

This manual describes setting up and operating multiple Robot Controllers with a single Programmable Logic Controller (PLC). Four manipulators can be configured to a single Robot Controller. To increase the number of manipulators per Robot Controller. The Robot Controller must be configured at YASKAWA for a DR2C, TR3C, or QR4C integration.

**NOTICE**

Four devices can be configured to a single Robot Controller. The four devices can be any combination of Manipulators, Positioners, and/or Transporters.

- For example, a Robot Controller can control two Manipulators and two transporters at a maximum.

*Fig. 1-1: PLC Connected to Four Robot Controllers*

### 1.1 Manual References

There may be a requirement for the following manuals when configuring for Multiple Robot Controllers.

**Table 1-1: Reference Manuals**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>180952-1CD</td>
<td>MLX300 Hardware Installation, Software Upgrade and Options</td>
</tr>
<tr>
<td>180247-1CD</td>
<td>MLX300 Software and Operating User's</td>
</tr>
<tr>
<td>188423-1CD</td>
<td>Ethernet/IP-Safe Configuration, MLX300 Controller as Adapter Supplement</td>
</tr>
</tbody>
</table>
2 Configuring Multiple Robot Controllers for MLX300

This section explains how to modify a standard MLX300 PLC program to talk with multiple Robot Controllers.

NOTICE

This section uses CompactLogix PLC software and can be used as a reference for modifying the ControlLogix PLC software.

2.1 Creating a New Ethernet Module for Each Additional Controller

1. Right-click on “Ethernet” and select “New Module”, in the Controller Organizer.

![Fig. 2-1: Adding New Controller Ethernet Module](image1)

2. Navigate to “ETHERNET-MODULE” and press {Create}.
   - Use check boxes at the top to narrow down the choices to make the navigation quicker.

![Fig. 2-2: Selecting Ethernet Module](image2)
3. Enter the following information for the new module
   - Name: Robot_Controller_1
   - Comm Format: Data - SINT
   - IP Address: 196.168.1.32
   - Connection Parameters
     | Assembly Instance | Size |
     |-------------------|------|
     | Input             | 200  | 436  |
     | Output            | 201  | 400  |
     | Configuration     | 202  | 10   |

   ![Fig. 2-3: Setting Controller Data Size and IP Address](image)

   NOTICE
   The default IP address for the second robot controller is 192.168.1.32. The address can be changed if it matches the IP address set inside the Robot Controller.

4. Press {OK} then {Close} on the next screen.
Configuring Multiple Robot Controllers for MLX300

2.1 Creating a New Ethernet Module for Each Additional Controller

5. Right-Click on the new module, “ETHERNET-MODULE Generic Ethernet Module”, that was just created and select “Properties”.

Fig. 2-4: Changing Ethernet Properties

6. Select the “Connection” tab and:
   – set the “Requested Packet Interval (RPI)” to 4 ms.
   – uncheck the “Use Unicast Connection over EtherNet/IP” box.
   – press {OK}.

Fig. 2-5: Setting Controller Requested Packet Interval

7. Change the Robot Controller IP address to match the IP address in step 3.
   – Refer to the “MLX300 SOFTWARE AND OPERATING USER’S MANUAL” (180247-1CD) section 5.1.1 “Changing the Communication Settings of the Controller”

NOTICE

One of the Robot Controllers has a tag attached to it that states it is “Controller 0”. This is the only Robot Controller that has the Multiple Controller license parameter set. Therefore, it must be configured in the PLC as Robot_Controller_0.
Multiple Robot Controllers

2 Configuring Multiple Robot Controllers for MLX300

2.2 Addition of PLC Controller Tags for Multiple Controllers

8. Repeat section 2.1 “Creating a New Ethernet Module for Each Additional Controller” for each Robot Controller to be added.

– For example, the third controller module is named “Robot_Controller_2”, and the default IP address is 192.168.1.33. Fig. 2-6 shows a ladder configured for three Robot Controllers.

Fig. 2-6: Setting Robot Controller Requested Packet Interval

2.2 Addition of PLC Controller Tags for Multiple Controllers

This section shows an example of adding tags for two additional Robot Controllers.

1. Set the NumberOfRobotController = 3, in the Controller Tags.

Fig. 2-7: Number Of Robot Controllers Tag

2. Increase the MLX tag array size to the number of robots.

– For this example, change its data type to “MLxData[3]”.

Fig. 2-8: Changing MLX Tag Array Size

3. Create new tags per Table 2-1

Table 2-1: Tags

<table>
<thead>
<tr>
<th>Name</th>
<th>Alias For</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller_1_Inputs</td>
<td>MLX[1].InternalData.ReadPacket.digitalInputs[0]</td>
</tr>
<tr>
<td>Controller_1_Outputs</td>
<td>MLX[1].InternalData.WritePacket.digitalOutputs[0]</td>
</tr>
</tbody>
</table>

4. Repeat step 3 for each additional Robot Controller.

– Refer to Fig. 2-11 for an example tag of changes for three Robot Controllers.
2.3 Importing Communication Program for Each Additional Robot Controller

1. Right-click on “MLX_Task” → “Add” → “Import Program”, in the Controller Organizer.

Fig. 2-9: Importing Communication Program For Each Controller

2. Select MLX300 software CD → PLC → Multiple Robot Controllers → “MLX_Communications_1.L5X” and then press {OK}
   – Creates the program.

3. Repeat section 2.3 for each additional Robot Controller.

   • Refer to Fig. 2-10 for an example for adding a communication program for three Robot Controllers.

   • Refer to Fig. 2-11 for an example of the tags that should have been created for three Robot Controllers.

Fig. 2-10: Communication Programs Setup for Three Robot Controllers
### Configuring Multiple Robot Controllers for MLX300

#### 2.3 Importing Communication Program for Each Additional Robot Controller

#### Fig. 2-11: PLC Tag Additions for Three Robot Controllers

<table>
<thead>
<tr>
<th>Scope</th>
<th>(MLX300)</th>
<th>(MLX300)</th>
<th>(MLX300)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>01Ctrl_0 Inputs</td>
<td>01Ctrl_1 Inputs</td>
<td>01Ctrl_2 Inputs</td>
</tr>
<tr>
<td>Notice</td>
<td>For explanation of the input and output tags:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- the “MLX_1_Input” tag array is for data received from Robot Controller 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| | - the “Controller_1_Inputs” tag array is the digital input status of the I/O at the breakout board.
2.4 Task Period and Jog Timer Adjustments

The complete configuration of the PLC network needs to be considered. The addition of robots, and other network devices could cause Ethernet communication issues with the Robot Controllers. Depending on the actual load of the PLC, the settings in this section might need to be changed.

2.4.1 Adjusting Task Periods

The default MLX_HMITask Period is set to 16 ms. For large PLC programs the period may need to be increased to allow more processing time for other devices. YASKAWA recommends keeping the 16 ms setting, unless there are issues.

Change the MLX_Task Period to 8 ms

1. Right-click on “MLX_Task”, and select “Properties”

![Fig. 2-12: Changing MLX_Task Properties](image)

2. Select the “Configuration” tab.

![Fig. 2-13: Increasing Period of MLX_Task](image)

3. Increase the “Period” from 4.000 ms to 8.000 ms and press {OK}. 

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4. Select the “Program / Phase Schedule” tab.

*Fig. 2-14: Setting Order of Scheduled MLX_Task Programs*

![Task Properties - MLX_Task](image)

5. Use the up and down arrow buttons to change the scheduled order and press {OK}.

### NOTICE

When robot programs are developed, they need to be placed in the MLX_Task. At a later time, return to this screen and make sure the robot programs are scheduled below all the communication programs, as shown in *Fig. 2-14*.

#### 2.4.2 Adjusting Jog Timer

There are two Jog Delay timer tags in the HMIUpdates program. When executing the MLxRobotJogTCP AOI from the HMI, the jog motion completes after a short move. Afterwards, there is a short timer and the AOI executes again. While pressing the HMI {JOG}, it continues to execute multiple occurrence of this AOI.

When there is a single robot on a controller, the “JogDelayTime_Single_Robot” timer is automatically used. When a controller has multiple robots, the “JogDelayTime_Multiple_Robot” timer is automatically used. If there is a hesitation while jogging the robot, increase the timer value that corresponds to the number of robots.

*Fig. 2-15: Jog Delay Timer Settings*
3 HMI Interface for Multiple Robot Controllers

3.1 Selecting Multiple Robot Controllers

When the Robot Controller option for multiple Robot Controllers is turned ON, all HMI screens will include a new entry for changing the Controller Number. After changing the controller number, the robot number connected to that controller can be changed.

Fig. 3-1: HMI Screens For Multiple Controllers

3.2 ABOUT MLX

Selecting the “ABOUT MLX” screen from (Menu) displays the status of the Robot Controller options that were purchased and enabled.

Fig. 3-2: About MLX Screen with Options Enabled Status
3.3 Multiple Controller Enabled

The Multiple Controller license is only turned on for “Robot_Controller_0”. When the Robot Controllers are shipped, the Robot Controller 0 is identified with an attached tag. Only this Robot Controller can be setup as “Robot_Controller_0”. Refer to chapter 2 “Configuring Multiple Robot Controllers for MLX300”.

3.4 Proper Control of Robot with Multiple Controllers

For proper control of robots with multiple Robot Controllers, there is a requirement that all Robot Controllers communicate with the PLC. If one of the Robot Controllers is not communicating, the PLC disables controls to the other Robot Controllers. For example, if the cell is configured for three Robot Controllers and only two are communicating, the robot programs will not execute. The one exception is for Robot Controller 0. This Robot Controller will always function as long as it is communicating, since it's the master. The Main screen shows an alarm message if one of the Robot Controllers does not communicate.

Fig. 3-3: All Controllers Not Connected Alarm
3.5 Robot Controller Needs Repaired

It is possible to disconnect (detach) a Robot Controller to continue operation with other Robot Controllers.

1. Place the Robot Controller in MANUAL mode.
2. Select the “Robot Configuration” from {Menu}.
3. Set the controller number to the one that needs to be detached.
4. Press {Detach Controller}.
   - After detaching, this button's text changes to “Attach Controller”.
     - Pressing the button again re-attaches the Robot Controller.

Fig. 3-4: Detaching a Controller

NOTICE

- {Detach Controller} does not display in AUTOMATIC Mode or if the Controller number is 0.
- Controller 0 is the master and can not be detached.
- Entering the controller number on the Main screen will cause a notice that the controller is detached.
3.6 Multiple Controller License Not Activated

If the `NumberOfRobotControllers` in the controller tags is greater than one, and Controller 0 does not have the Multiple Controller option turned on, a "Multiple Controller License Not Activated" alarm displays.

Fig. 3-5: Multiple Controller License Not Activated Alarm

![Diagram showing the Multiple Controller License Not Activated alarm]
4 PLC Programming for Multiple Robot Controllers

4.1 Add-On Instructions (AOI)

All the AOIs in the previous MLX300 software releases already have an entry for multiple controllers. None of the AOIs are changed for the multiple controller option. Referring to Fig. 4-1, the MLX number at the bottom of each AOI is the Robot Controller number. For example, MLX[2] sends a command to Robot Controller number 2.

Fig. 4-1: AOIs to Send Commands to Controller 2

![AOIs to Send Commands to Controller 2](image)

**NOTICE**

A single PLC rung should not have commands for more than one controller.

4.2 Writing a PLC Program

A PLC program can be written for each Robot Controller, or a single program can be written for all Robot Controllers. All robot programs need to be placed in the MLX_Task.

Fig. 4-2: Task List for Multiple Controllers

![Task List for Multiple Controllers](image)
5 Cell Configurations

The cell configuration can consist of a PLC operating multiple Robot Controllers in a single cell or in multiple cells. There are multiple interface options for the MLX Pendant. There can be a MLX Pendant interface installed on a single Robot Controller, or a MLX Pendant interface installed on each Robot Controller.

### NOTICE

A Robot Controller can be ordered from YASKAWA as a DR2C, TR3C, or QR4C Controller. These setups are for controlling multiple robots from a single Robot Controller. For example the TR3C has three controllers, but only one Robot Controller CPU is used. Only the first controller (R1) is used to operate all three robots. When the TR3C Controller interfaces with the multiple controller option, it is equivalent to a single Robot Controller with three robots.

5.1 Configuring All Robot Controllers in the Same Cell

*Fig. 5-1: Configuration of a Single Cell*

1. Wire one Auto/Manual key switch between the multiple controllers for each cell.
2. Wire the E-Stop circuitry to all controllers.
   - This can be accomplished with the controller safety IO breakout boards. As an option, a Safety PLC can be interfaced with this wiring.
     - FSU Safety IO Connections - XINs/XOUTs
     - Machine Safety IO Connections - GSINs/GSOUTs
5. Cell Configurations
5.1 Configuring All Robot Controllers in the Same Cell

3. Wire Safety Gate interlocks to all controllers.

**CAUTION**

- Only one MLX Pendant can be connected in a cell to meet the ANSI RIA Single Point of Control specification.
  - The reason for this is the MLX Pendant can select any of the Robot Controllers. If two people are programming at the same time, one person is able to select the other person's robot. Two MLX Pendants connected at the same time in a cell will cause an alarm on the main screen.

4. Install the MLX Pendant, there are two options:
  - Install a MLX Pendant interface adapter in each Robot Controller.
  - Install a MLX Pendant interface adapter in one Robot Controller and wire an enabling switch (DSW) signal from this Robot Controller to all other Robot Controllers in that cell.
    - Refer to chapter 7 “Pendant Safety Wiring Between Robot Controllers”.

**NOTICE**

Each cell should have at least one MLX interface adapter.
5.2 Configuring Robot Controllers in Different Cells

Fig. 5-2: Configuration of a Multiple Cells

1. Wire one Auto/Manual keyswitch to all Robot Controllers inside a cell.

2. Wire the E-Stop circuitry to all controllers inside a cell.
   - This can be accomplished with the Robot Controller safety IO wiring.
     - FSU Safety IO Connection - XINs/XOUTs
     - Machine Safety IO Connection - GSINs/GSOUTs

3. Wire Safety Gate interlocks to all Robot Controllers.

4. Install the MLX Pendant, there are two options:
   - Install a Pendant interface adapter in each Robot Controller.
   - Install a MLX Pendant interface adapter in one Robot Controller and wire an enabling switch (DSW) signal from this Robot Controller to all other Robot Controllers.

   Refer to chapter 7 “Pendant Safety Wiring Between Robot Controllers”.

NOTICE

Use the robot controller IO for all cases. The Safety PLC is an option for connecting to the robot controller IO

CAUTION

- Only one MLX Pendant can be connected at a time to meet the ANSI RIA Single Point of Control specification for a specific cell.
  - The reason for this is the MLX Pendant can select any of the Robot Controllers. If two people are programming at the same time, one person is able to select the other persons robot.

Two MLX Pendants connected at the same time will cause an alarm on the main screen.
5.3 Modifications for Robot Controller with No MLX Pendant Port (option)

This section explains modifications that can eliminate unused hardware on the Robot Controllers that do not have a MLX Pendant port. It will also explain using only machine safety I/O for interfacing this Robot Controller, without requiring an FSU.

### 5.3.1 Removing MLX Pendant Patch Cable (Option)

If the Robot Controller does not have a MLX Pendant port installed, the patch cable that comes out the side of the Robot Controller and connects to the Programming Pendant connector on the front of the cabinet can be removed. For this, a Pendant, Bypass, YRC1000 will need to be purchased and installed for jogging operations. YASKAWA Part number: 186310-1, Pendant, Bypass, YRC1000

**NOTICE**

The Pendant, Bypass, YRC1000 is different than the standard Programming Pendant connector, because of jumpers for the enabling signals.

### 5.3.2 No Pendant Port Tag

A PLC controller tag can be changed to free up the GSIN_1 safety input. This input checks that the MLX pendant bypass plug is installed.

If there is a desire to use GSIN_1 input for another safety interlock, change the ControllerWithNoMLxPendantPort[x] tag to “1”, where “x” is the controller number.

*Fig. 5-3: Setting tag for a Controller with No Pendant Port*

**NOTICE**

For the YRC1000, if the FSU is not purchased, this change is required, because the GS1N_1 signal needs to be used for pendant safety interface wiring between controllers. Refer to chapter 7 “Pendant Safety Wiring Between Robot Controllers”. The DX200 has an extra safety input on the terminal block called “EXDSW” that can be used to free up the GSIN_1 input.
6 Safety I/O Logic Setup on a MLX Pendant

### 6.1 For Slave Controllers Only, Enable Servo On Signal

This section explains how to setup the safety logic circuit on the MLX Pendant.

In some sections, it will explain the option where only one Robot Controller has a MLX Pendant interface adapter. The MLX Pendant is able to select any of the Robot Controllers inside that cell to jog the robots and teach positions. For this case, the Robot Controller that has the MLX Pendant connection is called the “master” controller, and the other Robot Controllers are called the “slave” controllers.

#### 6.1 For Slave Controllers Only, Enable Servo On Signal

Execute this section only for cases when one Robot Controller in the cell has a MLX Pendant interface adapter (port).

1. Enable the Servo On Signal to allow the master controllers MLX Pendant's enabling switch to turn on servo power for each slave controller.
2. Press and hold the [Main Menu] and turn on the slave controller.
   - The controller boots up into maintenance mode.
3. Login to Safety Mode
4. Select “SYSTEM” → “SECURITY”
5. Press (Select), highlight “SAFETY MODE” and press [ENTER].
6. Enter the safety mode password.
   - The default password is sixteen “5”s.
6 Safety I/O Logic Setup on a MLX Pendant

6.1 For Slave Controllers Only, Enable Servo On Signal

7. Select “SYSTEM” → “SETUP” → “OPTION FUNCTION”

Fig. 6-1: Selection OPTION FUNCTION

8. Arrow down to highlight:
   • YRC1000 - “SAFETY LOGICAL CIRCUIT SETTING” and press {Select}
   • DX200 - “SAFETY LOGICAL EXPANSION” and press {Select}.

Fig. 6-2: Selecting Safety Logical Circuit Settings

9. Highlight “SERVO ON ENABLE SIGNAL” and press {Select} to change the setting to “ENABLE”.

Fig. 6-3: Enabling Servo On Signal

10. Press [ENTER] and choose “Yes” to Modify.
Multiple Robot Controllers

6 Safety I/O Logic Setup on a MLX Pendant

6.1 For Slave Controllers Only, Enable Servo On Signal

11. Reset the Safety Flash, if using FSU.
   a) Press “File” → “Initialize”
   b) Highlight
      • **YRC1000** - “Safety Board FLASH Reset” and press “Yes” at the “Reset?” question.
      • **DX200** - “Functional Safety Board FLASH Reset” and press “Yes” at the “Reset question?”

**Fig. 6-4: Resetting Safety Flash**

12. Repeat section 6.1 for each slave Robot Controller with no MLX Pendant port.
6.2 Setup Safety Logic Circuit on Each Robot Controller

This section needs to be completed for each Robot Controller.

1. Cycle power.
2. Login to the Safety Mode
3. Press “SYSTEM INFO” → “SECURITY”
4. Press {Select}, highlight “SAFETY MODE” and press [ENTER].
5. Enter the safety mode password.
   • The default password is sixteen “5”s.
6. If:
   • Using FSU (FSBOUTs/FSBINs) - for safety interlocking between controllers continue to step 7.
   • Using machine safety I/O (GSOUTs/GSINs), go to step 8
7. Set Safety Logic Circuit
   a) Select “SAFETY FUNC.” → “F-SAFETY SIGNAL ALLOC”.
   
   ![Fig. 6-5: Selecting F-Safety Signal Allocation](image)

   b) Set FSBOUT01 and FSBOUT02 to “M-SAFE”
   
   ![Fig. 6-6: Setting FSU Outputs to M-SAFE](image)

c) Press {WRITE} at the bottom corner of the screen.
6.2 Setup Safety Logic Circuit on Each Robot Controller

8. Select “SAFETY FUNC.” → “SAFETY LOGIC CIRCUIT”

**Fig. 6-7: Selecting Safety Logic Circuit**

**6.2.1 Choosing A Safety IO**

When performing the following steps, press on an entry box to choose a safety I/O item.

**Fig. 6-8: Selecting Safety I/O Items**
1. Setup three logic statements for the Master and Slave controllers.
   - **Machine Safety IO**: setup Fig. 6-9
   - **FSU safety IO**: setup Fig. 6-10.

   • The following examples are for a cell with two controllers, and only the master controller has a MLX Pendant port. If each controller has a MLX Pendant port, do not enter the third line of Safety Logic Circuit tables.
   • The first two logic statements will E-Stop the other controller when pressing any EMERGENCY STOP. The third logic statement allows the MLX Pendant enabling switch on the master controller to turn on servo power of the slave controller.
   • This format can be copied for more slave controllers. A FSU is required when using more than two controllers. The safety IO numbers (FSBIN/FSBOUT) will need to change for each controller added.

*Fig. 6-9: Safety Logic Circuit with Machine Safety IO*

*Fig. 6-10: Safety Logic Circuit with FSU Safety IO*

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**NOTICE**

Fig. 6-9 shows the machine safety setup only for a DX200 Controller. The YRC1000 Controller does not have a “EXDSW” safety input, so the GSIN1 input will need to be used. To use this input, section 5.3.2 “No Pendant Port Tag” on page 5-4 needs to be executed.

2. Press {WRITE} at the bottom corner of the screen after changing items in the SAFETY LOGIC CIRCUIT screen.
3. Make sure that the safety logic circuit is correct, and then press {CONFIRM} at the bottom corner of the screen.
4. Press “Yes” to the “Update the Files?” question.
5. Repeat chapter 6 "Safety I/O Logic Setup on a MLX Pendant" for each Robot Controller.
7 Pendant Safety Wiring Between Robot Controllers

This section shows an example wiring for the case when just one Robot Controller in the cell has a MLX Pendant interface adapter (port). If each Robot Controller has a MLX Pendant port, disregard the wiring for the Robot Controller “PP DSW OUTPUT”.

Fig. 7-1: MLX Pendant Safety Wiring with Machine Safety I/O
Fig. 7.2: MLX Pendant Safety Wiring with FSU I/O

Multiple Robot Controllers

Pendant Safety Wiring Between Robot Controllers
NOTICE

- Fig. 7-1 shows the machine safety setup only for a DX200 controller. The YRC1000 Controller does not have a “EXDSW” safety input, so the GSIN1 input will need to be used. To use this input, section 5.3.2 “No Pendant Port Tag” on page 5-4 needs to be executed.
- The FSBOUT01/FSBIN01 in the Safety Logic Circuit corresponds to the XOUT1/XIN1 hardware connections.
8 Safety Relay Board (Optional)

YASKAWA offers an optional safety relay board that can reduce a lot of the safety I/O wiring. This board provides relays for four safety inputs and outputs. The installation of the relay board requires standoffs mounted to a control panel. YASKAWA part number: 183372-1, Board Assy, FSU Relay Bd.

Fig. 8-1: Optional Safety Relay Board
Fig. 8-2: Safety Relay Board Schematic