Motoman XRC 2001 Controller

MotoRail
System Manual

Part Number: 147734-1CD
Revision: 0
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Chapter 1

Introduction

MotoRail is a pre-engineered, overhead linear track solution that allows a Motoman robot to service multiple workstations, maximizing productivity and use of capital equipment. MotoRail is available in both dual, and single-robot configurations to provide increased throughput. Independent or truly coordinated operation is possible. MotoRail can be used for identical or progressive operations at multiple machining cells and is fully supported by Motoman, Inc.

1.1 About This Document

This manual is intended as an introduction and overview for personnel who have received operator training from Motoman, and who are familiar with the operation of this Motoman robot model. For more detailed information, refer to the manuals listed in Section 1.3. This manual contains the following sections:

SECTION 1 - INTRODUCTION
This section provides general information about the MotoRail system and its components, a list of reference documents, and customer service information.

SECTION 2 - SAFETY
This section provides information regarding the safe use and operation of the MotoRail system.

SECTION 3 - DESCRIPTION OF EQUIPMENT
This section provides a detailed description of the major components of the MotoRail system. This section also includes a table of component specifications.

SECTION 4 - INSTALLATION
This section provides instructions for set up and installation of the MotoRail system.

SECTION 5 - OPERATION
This section provides instructions for basic operation of the MotoRail system. This section also provides procedures for start-up, normal operation, fault recovery, and shutdown.

SECTION 6 - MAINTENANCE
This section contains a table listing periodic maintenance requirements for the components of the MotoRail system.
1.2 System Overview

The MotoRail system features a ceiling mounted (inverted) or wall mounted UP20, UP50, or UP130T robot (ceiling mount only) and is designed for applications requiring extended reach and high throughput. These applications include machine loading, material handling, welding, deburring, trimming, deflashing, load/unload of injection molding machines, and dispensing. Various configurations are available, with rail lengths between 4 and 20 meters. Figure 1-1 shows the naming convention for standard system configurations.

![NAMING CONVENTION:](image)

**Figure 1** Naming Convention

1.2.1 System Layout

The standard MotoRail system is designed to provide linear transport of UP20, UP50, or UP130T robot. Robot base to floor height is approximately 2650 mm (104.3 in.) for the UP20 and UP50, and 3500 mm (137.8 in.) for the UP130T. Standard rail lengths are 4, 6, and 8 meters, with a travel distance of 3, 5, and 7 meters respectively.

Rail lengths greater than 8 meters are available by coupling multiple rail segments together. Additional leg supports are required at each rail joint. Rail lengths greater than 20 meters are possible, depending on controller location, height of rail, and orientation of robot. For rail designs greater than 8 meters, contact Motoman Applications Engineering.

The standard configuration includes a linear rail, 5:1 gear ratio carriage for UP20 and UP50 models, 6:1 gear ration for UP130T, two legs, lateral brace, external axis kit for carriage, 1/2-inch air hose, and robot cables. See Figure 2 for system layout.
Note: This manual is for a standard Motoman system. If your system is a custom or modified system, please use the drawing and Bill of Material (BOM) provided with the system for troubleshooting and spares provisioning.

1.2.2 Major Components

The MotoRail system includes the following major components:

- A Motoman UP20, UP50, or UP130T manipulator and XRC 2001 controller
- Linear module
- Lateral brace
- Safety equipment, including the following:
  - S-axis hard stops
1.2.3 Optional Equipment

The following optional equipment is available for use with the MotoRail system:

- 90-degree bracket for vertical mounting of robot (not available for UP130T)
- Limit switch kit
- Automatic lubricator kit

1.3 Reference to Other Documentation

For additional information refer to the following:

- Motoman UP20 Manipulator Manual (P/N 145965-1)
- Motoman UP50 Manipulator Manual (P/N 145964-1)
- Motoman UP130T Manipulator Manual
- Motoman Concurrent I/O Parameter Manual (P/N 147626-1)
- Vendor manuals for system components not manufactured by Motoman

1.4 Customer Service Information

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

- Robot Type (UP20, UP50, or UP130T)
- Application Type (material handling, arc welding, etc.)
- System Type (MotoRail)
- Software Version (access using TOP MENU > SYSTEM INFO > VERSION > SYSTEM on the programming pendant)
- Robot Serial Number (located on back side of robot arm)
- Robot Sales Order Number (located on front door of XRC 2001 controller)
Chapter 2
Safety

2.1 Introduction

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.

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. The address is as follows:

RoboticIndustriesAssociation
900VictorsWay
P.O.Box3724
AnnArbor,Michigan48106
TEL:(734)994-6088
FAX:(734)994-3338

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 section 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 Safety (Section 2.6)
- Operation Safety (Section 2.7)
- Maintenance Safety (Section 2.8)

### 2.2 Standard Conventions

This manual includes information essential to the safety of personnel and equipment. As you read through this manual, be alert to the four signal words:

**DANGER!**

**WARNING!**

**CAUTION!**

**NOTE:**

Pay particular attention to the information provided under these headings which are defined below (in descending order of severity).

⚠️ **DANGER!**

Information appearing under the DANGER caption 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 under the WARNING caption 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 under the CAUTION caption 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 caption 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, section 6.13.4 and 6.13.5, 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 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 measures are available:

- Safety fences and barriers
- Light curtains
- Door interlocks
- Safety mats
- Floor markings
- Warning lights

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 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 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. All personnel involved with the operation of the equipment must understand potential dangers of operation. Programming tips are as follows:

Any modifications to PART 1 of the XRC controller PLC can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1. 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.

Back up all programs and jobs onto a floppy disk whenever 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.

The concurrent I/O (Input and Output) function allows the customer to modify the internal ladder inputs and outputs for maximum robot performance. Great care must be taken when making these modifications. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations that may damage the robot or other parts of the system.
• 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 operate the system.

• 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 the E-STOP button on the teach pendant for proper operation before programming.

• Carry the teach pendant with you when you enter the workcell.

• Be sure that only the person holding the teach pendant enters the workcell.

• Test any new or modified program at low speed for at least one full cycle.

2.7 Operation 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. All personnel involved with the operation of the equipment must understand potential dangers of operation. Operation tips are as follows:

• Be sure that only trained personnel familiar with the operation of this robot, the operator’s manuals, the system equipment, and options and accessories are permitted to operate this robot system.

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

• Inspect the robot and work envelope to ensure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.

• Ensure that all safeguards are in place.

• 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 operate the system.

• Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the cell.

• The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.

• This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller, external servo box, and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
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. This includes
controller parameters, ladder parts 1 and 2, and I/O (Input and Output)
modifications. Check and test all changes at slow speed.

2.8 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. All personnel involved with the operation of the equipment must understand
potential dangers of operation. Maintenance tips are as follows:

- Do not perform any maintenance procedures before reading and understanding the
  proper procedures in the appropriate manual.
- Check all safety equipment for proper operation. Repair or replace any
  non-functioning safety equipment immediately.
- 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 operate the system.
- Back up all your programs and jobs onto a floppy disk whenever program changes
  are made. A backup must always be made before any servicing or changes are made
to options, accessories, or equipment to avoid loss of information, programs, or jobs.
- Do not enter the robot cell while it is in automatic operation. Programmers must have
  the teach pendant when they enter the cell.
- The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in
  use.
- Be sure all safeguards are in place.
- Use proper replacement parts.
- This equipment has multiple sources of electrical supply. Electrical interconnections
  are made between the controller, external servo box, and other equipment.
  Disconnect and lockout/tagout all electrical circuits before making any modifications
  or connections.
- 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. This includes
controller parameters, ladder parts 1 and 2, and I/O (Input and Output)
modifications. Check and test all changes at slow speed.
- 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
Equipment Description

3.1 Linear Rail Module

The linear rail module is designed to provide linear transport of a ceiling (inverted), or wall mounted Motoman robot. Robot base to floor height is approximately 2650 mm (104.3 in.) for the UP20 and UP50, and 3500 mm (137.8 in.) for the UP130T. The additional linear axis gives the robot an extended reach with a linear traverse speed of 2.5 meters per second and repeatability of 0.1 mm (0.004 in.). Standard rail lengths are 4, 6, and 8 meters with a travel lengths of approximately 3, 5, and 7 meters respectively. Custom rail lengths greater than 8 meters are available. See Table 4 for additional specifications.

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Unit</th>
<th>Standard Rail Lengths</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4 m</td>
<td>6 m</td>
</tr>
<tr>
<td>Rated Carriage Travel</td>
<td>mm</td>
<td>2950</td>
<td>4950</td>
</tr>
<tr>
<td>Dim A (see Figure 3)</td>
<td>mm</td>
<td>4000</td>
<td>6000</td>
</tr>
<tr>
<td>Dim B (see Figure 3)</td>
<td>mm</td>
<td>6250</td>
<td>8250</td>
</tr>
<tr>
<td>Dim C (see Figure 3)</td>
<td>mm</td>
<td>5020</td>
<td>7020</td>
</tr>
<tr>
<td>Max. Carriage Velocity</td>
<td>mm/sec</td>
<td></td>
<td>2500</td>
</tr>
<tr>
<td>Rated Acceleration Time</td>
<td>sec</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Repeatability; Carriage Only</td>
<td>+/- mm</td>
<td></td>
<td>0.05</td>
</tr>
<tr>
<td>Repeatability w/Robot (Stable Temp)</td>
<td>+/- mm</td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>E-Stop Response</td>
<td>sec</td>
<td></td>
<td>0.37</td>
</tr>
<tr>
<td>E-Stop Response</td>
<td>mm</td>
<td></td>
<td>455</td>
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**Table 5** Linear Rail Specifications - UP50

<table>
<thead>
<tr>
<th>Specifications</th>
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<th>6 m</th>
<th>8 m</th>
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<tr>
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<td>4950</td>
<td>6950</td>
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<tr>
<td>Dim A (see Figure 3)</td>
<td>mm</td>
<td>4000</td>
<td>6000</td>
<td>8000</td>
</tr>
<tr>
<td>Dim B (see Figure 3)</td>
<td>mm</td>
<td>7000</td>
<td>9000</td>
<td>11000</td>
</tr>
<tr>
<td>Dim C (see Figure 3)</td>
<td>mm</td>
<td>5020</td>
<td>7020</td>
<td>9020</td>
</tr>
<tr>
<td>Max. Carriage Velocity</td>
<td>mm/sec</td>
<td></td>
<td></td>
<td>2500</td>
</tr>
<tr>
<td>Rated Acceleration Time</td>
<td>sec</td>
<td></td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Repeatability; Carriage Only</td>
<td>+/- mm</td>
<td></td>
<td></td>
<td>0.05</td>
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<tr>
<td>Repeatability w/Robot (Stable Temp)</td>
<td>+/- mm</td>
<td></td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>E-Stop Response</td>
<td>sec</td>
<td></td>
<td></td>
<td>0.37</td>
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<tr>
<td>E-Stop Response</td>
<td>mm</td>
<td></td>
<td></td>
<td>455</td>
</tr>
</tbody>
</table>

**Figure 3** System Dimensions UP20, UP50
Table 6  Linear Rail Specifications - UP130T

<table>
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<tr>
<th>Specifications</th>
<th>Unit</th>
<th>4 m</th>
<th>6 m</th>
<th>8 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Carriage Travel</td>
<td>mm</td>
<td>2950</td>
<td>4950</td>
<td>6950</td>
</tr>
<tr>
<td>Dim A (see Figure 4)</td>
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<td>4000</td>
<td>6000</td>
<td>8000</td>
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<tr>
<td>Dim B (see Figure 4)</td>
<td>mm</td>
<td>7700</td>
<td>9700</td>
<td>11700</td>
</tr>
<tr>
<td>Dim C (see Figure 4)</td>
<td>mm</td>
<td>5020</td>
<td>7020</td>
<td>9020</td>
</tr>
<tr>
<td>Max. Carriage Velocity</td>
<td>mm/sec</td>
<td>2665</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated Acceleration Time</td>
<td>sec</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeatability w/Robot (Stable Temp)</td>
<td>+/- mm</td>
<td>0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-Stop Response</td>
<td>sec</td>
<td>0.7</td>
<td></td>
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<tr>
<td>E-Stop Response</td>
<td>mm</td>
<td>800</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 4** System Dimensions UP130T
The linear rail module includes the following components:

- Main beam with linear carriage
- Leg support (2 minimum)
- Lateral brace

### 3.1.1 Main Beam with Linear Carriage

The linear, single-axis module is built using standard components for easy maintenance. Its modular design, with hardened/ground guideways, provides high positioning accuracy and quiet operation.

**Energy Chain**
The energy chain provides a consistent means to roll/unroll cables for the robot as it travels along the beam.

### 3.1.2 Leg Supports

The leg supports provide primary support for the rail system. There are multiple mounting hole patterns for each column on the track assembly. This allows each column to be placed in different locations to accommodate machine placement. Use system prints as a guide to locate each column.

### 3.1.3 Lateral Brace

The lateral brace stabilizes the forces on the rail system caused by acceleration/deceleration of the linear carriage and robot. The lateral brace can be positioned against any column of the rail system to accommodate the application layout. Use system prints as a guide to locate the lateral brace (mounting pads for lateral brace must be welded at installation).
3.2 UP-series Robot Description

The Motoman UP20, UP50 and UP130T robots and XRC 2001 robotic controller represent state-of-the-art technology in robotics today. The Motoman UP-series robots provide high speed, accurate path control, large work envelope, and reliability for your automation needs.

For additional information, please refer to the manipulator manual for your robot model (see Section 1.3 Reference to Other Documentation).

Table 7 Robot Specifications

<table>
<thead>
<tr>
<th>Robot Model</th>
<th>Payload</th>
<th>Reach</th>
<th>Relative Positioning Accuracy</th>
<th>Repeatability</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP20</td>
<td>20 kg (44.1-lbs)</td>
<td>1,658 mm (65.27-inch)</td>
<td>± 0.01 mm (0.004-inch)</td>
<td>0.06 mm (0.002 in.)</td>
</tr>
<tr>
<td>UP50</td>
<td>50 kg (110.3 lbs)</td>
<td>2,046 mm (80.6 in.)</td>
<td>± 0.6 mm (0.0027 in.)</td>
<td>0.007 mm (0.003 in.)</td>
</tr>
<tr>
<td>UP130T</td>
<td>130 kg (286.6 lbs)</td>
<td>2,416 mm (95.1 in.)</td>
<td>± 0.2 mm (0.0027 in.)</td>
<td></td>
</tr>
</tbody>
</table>

3.3 XRC 2001 Controller

The XRC 2001 robotic controller, shown in Figures 2 and 3, coordinates the operation of the MotoRail system. It controls manipulator and track movement and processes input and output signals. It maintains variable data and performs numeric processing to convert to and from different coordinate systems. In addition, the controller provides the following: main logic functions, servo control, program and constant data memory, and power distribution. For more information, refer to the manipulator manual that came with your system.

![XRC 2001 Controller - UP20 Robot](image)
3.3.1 **External Axis Cabinet**

The external axis cabinet on the controller contains the amplifier and converter for the servo motor on the rail. There is also room in the cabinet for two additional amplifiers and hardware for custom applications. See Figure 3-3 for external axis cabinet components.

![Figure 6 XRC 2001 Controller - UP50, UP130T Robot](image)

### Figure 6  XRC 2001 Controller - UP50, UP130T Robot

![Figure 7 External Axis Cabinet](image)

### Figure 7  External Axis Cabinet
### 3.3.2 Playback Panel

The playback panel (see Figure 8) contains the primary system controls and consists of the features described below. For more information, refer to the manipulator manual that came with your system.

![Playback Panel Diagram](image)

**Figure 8** XRC Controller Playback Panel

**Servo On Ready**

The SERVO ON READY pushbutton turns servo power ON. The switch lights when servo power is on. In TEACH mode, the SERVO ON READY pushbutton operates only when the TEACH LOCK button on the programming pendant is ON and the ENABLE switch on the programming pendant is held in.

**Mode**

The Mode push buttons (PLAY, TEACH and REMOTE) set the robot’s mode of operation.

*Note: Changing modes from PLAY to TEACH, during playback, will cause the program to cease execution (similar to HOLD); to resume operation, press PLAY and then START.*

**Alarm/Error**

The ALARM/ERROR indicator light turns ON whenever an alarm or error condition occurs.

**Emergency Stop (E-STOP)**

The E-STOP button on the playback panel is connected in series with the system Emergency Stop circuit. Pressing E-STOP ceases all system operation.

**Start**

Pressing the START button while in PLAY mode with servo power on, causes playback execution of the current job to begin.

**Hold**

The HOLD button is a normally closed, momentarily actuated switch. Pressing HOLD halts operation of the manipulator until another Start signal is sent.
3.3.3 **Programming Pendant**

The programming pendant (see Figure 3-3) is the primary user interface for the system. The pendant has a 4x5-inch 12-line, 40-character LCD display and keypad. The system uses the INFORM II robot language and a menu-driven interface to simplify operator interaction with the robot. By using the pendant, the operator can teach robot motion, and perform programming, editing, maintenance, and diagnostic functions. The programming pendant consists of the items described below. For more information, refer to the manipulator manual that came with your system.

*Note: The programming pendant LCD display goes dark after a few minutes of inactivity. Press any key to restore screen.*

![Programming Pendant Diagram]

**Figure 9** Programming Pendant

**General Purpose Display Area**
The General Purpose Display Area displays the currently selected menu choice.

**Menu Area**
The Menu Area contains menu selections for the currently selected screen.

**Emergency Stop (E-STOP)**
The E-STOP button on the programming pendant is connected in series with the system Emergency Stop circuit. Pressing the E-STOP button interrupts this circuit and stops all system operation.

**Keypad**
The user keypad on the programming pendant serves as an input device. The keys are grouped into different functional sections to simplify operator use.
Status Area
The Status Area shows system status via the following symbols:

- Active Robot, External Axis, or Base Axis
  R1, R2, R3; S1, S2, etc.; or B1, B2, etc.
- Coordinate System
  Joint, World, Cylindrical, Tool, or User Frame
- Manual Speed Setting
  Inching, Low, Medium, or High
- Cycle Mode
  Step, 1-Cycle, or Auto
- System Status
  E-Stop, Stop, Running/Start, Hold, or Alarm
- Additional Pages (when applicable)

TOP MENU Key
The TOP MENU key returns the pendant display to the initial start-up menu. The cursor key can then be used to choose from the following menu icons:

- JOB
  This icon accesses job selections including: Master Job, Select Job, Job Capacity, and Create New Job while in TEACH mode.
- ARC WELDING, GENERAL, HANDLING, and SPOT WELDING
  This icon allows you to select the applications available to the controller.
- VARIABLE
  This icon accesses the display and editing menu for the arithmetic variables and display of position variables.
- IN/OUT
  This icon accesses DETAIL and SIMPLE displays of all XRC I/O signals. In EDITING or MAINT. mode, Universal Outputs can be forced ON or OFF.
- ROBOT
  This icon accesses robot information including: CURR.POS, POWER ON/OFF, POS, COMMAND POS, SECOND HOME POS, OPE ORIGIN POS, and TOOL and USER COORDINATE.
- SYSTEM INFO
  This icon provides Version information for both hardware and software, Alarm History, and Monitoring Time.
Area Key
The Area key moves the cursor to the different areas of the display screen.

Cursor Key
The Cursor key is an 8-way, directional key that moves the up, down, left or right to highlight a desired item that can then be chosen using the SELECT key.

SELECT Key
The SELECT key is used to choose the item currently highlighted by the cursor.

TEACH LOCK Key
The TEACH LOCK key locks operation of the robot with the programming pendant. Operation is not possible from the playback panel or operator station. Servo power can not be applied in TEACH mode unless TEACH LOCK is ON.

RS-232C Serial Port
This 9-pin serial port is used for data communication between the XRC controller and a floppy disk controller (FC1 or FC2), FDE (Floppy Disk Emulator) software, or other form of communication (see Figure 3-4).

Figure 10 RS-232C Serial Port

ENABLE Switch
The ENABLE switch (see Figure 3-5) is a three-position switch located on the left rear of the programming pendant. It is a safety feature that controls servo power while in TEACH mode. When pressed in, this switch enables servo power to be turned on. However, should the operator release the switch, or grasp it too tightly, servo power is immediately disabled, preventing further robot movement.
3.3.4 Brake Release

**WARNING!**
Releasing brakes could cause personal injury or machine damage. Always support the axis to be released BEFORE you release it.

The Brake Release Control is a safety feature that allows you to release the automatic brakes on the robot in case of an emergency or robot failure. The Brake Release Control is mounted on the front of the XRC controller cabinet (see Figure 3-1).

3.4 Safety Features

The ANSI/RIA R15.06 Robot Safety Standard stipulates the user is required to validate the safeguarding. Users are responsible for determining whether the provided safeguards are adequate for plant conditions. Users must also ensure that safeguards are maintained in working order.

*Note: Users are responsible for determining whether the provided safeguards are adequate for plant conditions. Users must also ensure that safeguards are maintained in working order.*

3.4.1 Emergency Stops (E-STOPs)

The MotoRail system has two E-STOP push buttons. One E-STOP is located on the playback box on the controller and the other is on the programming pendant. These push buttons are operator actuated devices that, when activated, immediately stop all system operation. Brakes are applied to the robot and all servo power is removed from the system. The system E-STOP lights come on and all positioner motion is stopped.
3.4.2 **ENABLE Switch**

The ENABLE switch is a safety feature which controls servo power while in TEACH mode. When pressed in, this switch allows the operator to turn servo power ON and initializes the system. However, should the operator release the switch or grasp it too tightly, servo power is immediately disabled, preventing further robot movement. For detailed information about the operation of the ENABLE switch, refer to the XRC controller section in the manipulator manual that came with your system.

3.4.3 **Brake Release**

**WARNING!**

Releasing brakes could cause personal injury or machine damage. Always support the axis to be released BEFORE you release it.

The Brake Release Control is a safety feature that releases the automatic brakes on the robot in case of an emergency or robot failure. The Brake Release Control is mounted on the front of the XRC controller cabinet (see Figure 3-1). Refer to Operation Section for the proper operation of the brake release.
Chapter 4
Installation

The MotoRail system can be installed easily in just a short time by three workers. The more people involved (within reason), the more quickly installation can be completed. Follow established safety procedures at all times throughout the installation process. Failure to use safe work practices can result in damage to the equipment and injury to the workers.

⚠️ CAUTION!
Installation of the MotoRail system is not a task for the novice. The MotoRail system is not fragile, but it is a highly sophisticated robotic system. Handle components with care. rough handling can damage system electronic components.

4.1 Materials Required

All system hardware necessary for installing the MotoRail system is included with the system. This section identifies customer-supplied items and tools required to complete installation.

4.1.1 Customer-Supplied Items

- Suitable floor anchors rated at 4000-kgf working load
- Compressed air filter/regulator/lubricator
- Incoming air supply: 0.04ccm at 620.5 kPa (1.5scfm at 90 psi)
- Forklift and/or overhead crane

4.1.2 List of Tools

- Safety glasses
- Face shields
- Gloves
- Level
- Hammer drill with appropriate concrete bits
- Phillips and flat screwdrivers
- Socket set
- Forklift and/or overhead crane
- Large torque wrench
- Welder
- Large hex sockets-M14, M17, M19, M24
- Wrench sets (standard and metric)
4.2 Site Preparation

All components of the MotoRail system must be firmly mounted on a foundation rigid enough to support its static and dynamic forces. Review drawing package for specifications. To prepare your site, proceed as follows:

1. Clear the floor space needed for your MotoRail system. Refer to your system layout drawings for needed dimensions. If the drawing package does not have a system layout, refer to Section 3.5.
2. Gather all customer-supplied items and required tools listed in Section 4.1.

4.3 Unpacking MotoRail

MotoRail system components are shipped individually on a flat-bed trailer. To unpack MotoRail, proceed as follows:

1. Carefully remove protective plastic wrapping from system components.
2. Inspect system for shipping damage.

Note: If damage is found, notify shipper immediately.

WARNING!
The heaviest component (8m main beam) of the MotoRail system weighs 4336 kg (10000 lbs). Be sure that the lifting device used to lift all components is capable of handling this much weight or damage to the equipment or injury to personnel can result.

3. Lift each component from the trailer and place on floor.

4.4 Cell Components

4.4.1 List of Components

Once the cell components have been removed from the shipping skid, account for each of the following items:

- XRC Controller
- Robot (UP20, UP50, or UP130T)
- Main beam
- Linear carriage
- Leg columns
- Lateral brace
- Lateral brace mounting pads
- Cables
- 1/2 inch air hose
- Leveling pads
4.5 Installing Track and Columns

Motoman recommends assembling MotoRail at its permanent location. DO NOT PRE-DRILL LAGGING HOLES! Use the system prints to identify location of cell components.

**WARNING!**

The heaviest component (8m main beam) of the MotoRail system weighs 4336 kg (10000 lbs). Be sure that the lifting device used to lift all components is capable of handling this much weight or damage to the equipment or injury to personnel can result.
1. Set both leg columns and leveling pads at anchor position. The leg columns can be mounted in several locations along the main beam (see Figure 4-2 through Figure 4-4). Locate leg columns so mounting holes line up with the desired mounting holes on the main beam. Make sure columns are positioned within the proper boundaries.

![Diagram showing leg position boundaries and mounting holes.]

**Figure 13** Locate Leg Columns - 4m

![Diagram showing improper leg position and mounting holes.]

**Figure 14** Locate Leg Columns - 6m
2. Lift the main beam up to both leg column overhangs and attach with M24 bolts. Torque to 860 N·m (634 ft-lb).

3. Check the location of the system. If repositioning is needed, use a process that is consistent with your company’s safety standards.
4.6 Securing MotoRail

After everything is in position, level the equipment and secure it to the floor. The customer must provide suitable anchoring hardware. Each leg column requires six anchors rated at 4000-kgf working load. A 22-mm hole is provided through the leveling bolt for anchoring purposes. Install anchors per manufacturers’ recommendations.

4.7 Installing Lateral Brace

Locate the lateral brace in desired position (see Figure 4-6).

![Diagram of MAIN BEAM and LATERAL BRACE](image)

**Figure 17** Lateral Brace Location

1. Refer to the system prints to determine desired location for lateral brace.
2. Bolt the mounting pads to the lateral brace.
3. Place the brace in the desired position, including the leveling bolts/pads, and clamp the mounting pad(s) to the column.
4. Weld the mounting pad(s) to the leg column. Use certified welder.
5. Insert bolts and torque to 255 N•m (188 ft-lb).
6. When the weld has cooled, clean and paint welded area as required.
7. Adjust all leveling bolts hand tight against the leveling pad.
8. Tighten all leveling bolts an additional 1/4 to 1/2 turn.
9. Install four anchors per manufacturers’ recommendations.
4.8 Installing the Robot

**WARNING!**

The UP20 robot weighs 280 kg (618 lbs), the UP50 robot weighs 550 kg (1212 lbs), and the UP130T robot weighs 1300 kg (2866 lbs). Be sure the lifting device used to lift the robot is capable of handling this much weight or damage to equipment, or injury to personnel can result.

1. Lift the robot and invert it. Orient the robot on the track mounting plate per the system drawings. Contact Motoman if assistance is required to invert the robot.

2. Attach the robot to the mounting plate per the chart below:

<table>
<thead>
<tr>
<th>Robot</th>
<th>Bolt Size</th>
<th>Torque Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP20</td>
<td>M16</td>
<td>255 N•m (188 ft-lb)</td>
</tr>
<tr>
<td>UP50</td>
<td>M20</td>
<td>370 N•m (237 ft-lb)</td>
</tr>
<tr>
<td>UP130T</td>
<td>M20</td>
<td>370 N•m (237 ft-lb)</td>
</tr>
</tbody>
</table>

Figure 18 Lateral Brace Installation
4.9 **Connecting the Cables**

The MotoRail system may have been set up and tested prior to shipment to your site. If this is the case, unwrap the cables from around the equipment and lay them out according to the cable diagram.

If MotoRail has not been set up and tested prior to shipment to your site, the system cables will arrive packed in a box. Unpack the cables, uncoil them and allow them to lay on the floor for 24 hours to eliminate cast.

4.9.1 **Connecting the Robot Cables**

**UP20 Robot**
Three cables –1BC, 2BC, and 3BC – connect the robot to the controller. The 1BC cable supplies power to the robot servo motors. The 2BC cable provides communication between the controller and the robot. The 3BC cable provides access to discrete I/O.

**UP50, UP130T Robot**
Four cables –1BC, 2BC, 3BC, and 4BC – connect the robot to the controller. The 1BC and 2BC cables supply power to the robot servo motors. The 3BC cable provides communication between the controller and the robot. The 4BC cable provides access to discrete I/O.

To connect the robot cables, proceed as follows:

*Note: The right side of the controller is on your right as you are facing the front of it.*

1. Unpack programming pendant and plug connector into receptacle on right side of the controller.
2. Route the cables and air hose from the controller up through the column leg.

![Figure 19 Cable Layout](image-url)
3. Route cables and air hose through the cable chain. The cable chain stores the cables and air hose and protects them from damage as the robot moves on the track.

4. Carefully engaging connectors, connect the robot cables on back of robot (see Figure 4-9).

Note: Right-hand configuration shown. For left-hand configuration, mirror the controller, energy chain, cable tray, and cable brace connections.

5. Secure the cables and hose to the cable brace using wire ties and ensure the cables do not drag on the cable tray.

![From Controller]

Figure 20 Connecting Robot to Controller

4.10 Connecting the Power

After all of the system components have been properly installed, connect the power to MotoRail. To connect incoming power to MotoRail, proceed as follows:

DANGER!

Power should be connected only by a qualified electrician. Electrical and grounding connections must comply with applicable portions of the national electrical code and/or local electrical codes.
1. Install 3-phase power wiring to the circuit breaker located inside the left wall of the controller cabinet (see Figure 4-10). Table 4-2 shows the size and type of wire needed.
2. Tighten screws to the torque indicated in Table 4-2.

![Figure 21 Incoming Power Connections](image)

3. Install an M5 lug on the incoming ground wire.
4. Terminate the ground wire to the frame ground M5 threaded stud with M5 hardware provided.

*Note: The MotoRail is configured for 3-phase 460/480V AC, unless other voltage was requested. If other voltage is required for your plant, you must make the necessary modifications to the transformer. For more information, refer to the manipulator manual that came with your system.*

**Table 9 Incoming Power Specifications (Decal)**

<table>
<thead>
<tr>
<th>Lug Data</th>
<th>60/75° C wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalog No.</td>
<td>TCAL14</td>
</tr>
<tr>
<td>Wire Size</td>
<td>Refer to system drawings</td>
</tr>
<tr>
<td>Torque</td>
<td>#14-7, 4.0 N•m (35 in.-lb)</td>
</tr>
</tbody>
</table>
4.11 Conducting a Safety/Operation Check

Before operating the MotoRail system, take a few minutes to perform a safety/operation check. To perform a safety/operation check, proceed as follows:

1. Check that all cable connections are tight.
2. Check that all component hardware is tight.
Chapter 5

Operation

5.1 Programming

The operation of this system is programming dependent. The following operating instructions are based on one possible configuration of this system. Your system configuration and job structure may differ slightly from that presented here, however basic operation will be the same.

Any changes made to your system configuration and/or job structure will alter the operation of this cell. Motoman recommends you do not modify the original jobs and system configuration that came with your system. If modifications need to be made, they should be made to copies of these jobs and not to the originals. Modifications should only be performed by personnel who have received operator training from Motoman, and who are familiar with the operation of this Motoman system. If you have questions concerning the configuration of your system please contact the 24 hour Service Hotline, at (937) 847-3200 (see Section 1.4).

5.1.1 I/O Assignment

The MotoRail system uses the following user and dedicated inputs and outputs.

<table>
<thead>
<tr>
<th>XRC 2001 Dedicated Inputs</th>
<th>XRC Dedicated Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo On</td>
<td>Servo Power ON</td>
</tr>
<tr>
<td>External Job Start</td>
<td>TEACH mode</td>
</tr>
<tr>
<td>Alarm Reset</td>
<td>Cube 24</td>
</tr>
<tr>
<td>REMOTE mode ON</td>
<td>Alarm Occurrence</td>
</tr>
<tr>
<td>Hold</td>
<td>Safety Device Interference</td>
</tr>
<tr>
<td>External Emergency Stop</td>
<td></td>
</tr>
</tbody>
</table>

For more information on user and dedicated I/O, refer to the XRC 2001 controller User Functions & I/O Structure Manual (P/N 147626-1).
5.2 Daily Operation

The procedures below represent the typical operating sequence from power up to shutdown. Yours basic operating procedures may vary depending on your situation.

- Perform Start-up Procedures (see Section 5.2.1).
- Perform Shutdown Procedures (see Section 5.2.2).

5.2.1 Start-Up

To start up the MotoRail system from a Power-Off condition, proceed as follows:

1. Set MAIN POWER switch on XRC to ON.
2. Make sure robot is in Home position (Cube 24) or other dedicated starting position.
3. Select Master job.
4. Put controller in PLAY mode.
5. Select AUTO/CYCLE mode of operation
6. Turn ON servo power.
7. Press the start button to start playback of job.

5.2.2 Shutdown

Use the following procedure to shut down the cell after operation is complete:

1. Make sure robots are in home position (Cube 23 and Cube 24).
2. Make sure the robot is in the Safe position (Cube 24) or other dedicated starting position.
3. Turn OFF system servo power.
4. Press TEACH mode button on playback panel.
5. Set Main Power switch on auxiliary equipment to OFF position.
6. Set controller Main Power switch to OFF position.

The MotoRail system is now shut down.
5.3  **System Recovery**

Under certain conditions you will be required to clear an alarm or error. Clearing an alarm or error requires different operator actions depending on the type. The paragraphs below describe the different types of alarms and errors you may encounter and how to remedy them when you do.

5.3.1 **Alarms and Errors**

Alarms and errors will cause the program to stop. There are three levels of alarms and errors: Error Messages, Minor Alarms, and Major Alarms. For more detailed information about alarm recovery, refer to manipulator manual that came with your system.

**Error Messages**
These are simple errors such as pressing the START button when the robot is not in PLAY mode, or enabling the programming pendant without the servo power being live. Errors like these are cleared by pressing the CANCEL button on the programming pendant.

**Minor Alarms**
Minor alarms are usually programming errors. Minor alarms might occur if a circle has been programmed with fewer than three circular points, etc. These alarms are cleared by pressing the RESET (F5) soft key on the programming pendant.

**Major Alarms**
Major alarms are hardware failures. Major alarms might occur because of a servo tracking error or an abnormal speed and are usually associated with crashes. To clear these alarms, you must turn off the controller and then turn it on again.

5.3.2 **E-STOP Recovery**

An E-STOP can occur under any of the following conditions:

- Pressing the E-STOP button on the operator station, programming pendant, or playback panel (see Section 5.3.4).
- Entering the cell area when the robot is not in Teach mode.

**Restart**
To restart the MotoRail system after an E-STOP condition occurs, follow the procedure below.

1. Release the E-STOP button on the programming pendant, or XRC playback panel.
2. Clear personnel from cell area
3. Make sure controller is in PLAY mode.
4. Press SERVO ON button.
5. Press START.

The MotoRail system is now ready to continue operation.
5.3.3 **Using the Brake Release**

The brake release control panel is located on front of the XRC. Each axis brake is controlled by an individual axis buttons. Simultaneously pressing the ENABLE button and one of these axis buttons releases the indicated axis. To release the brakes, proceed as follows:

1. Press E-STOP button on programming pendant, playback panel, or operator station, to be sure servo power is OFF.
2. Provide adequate support for axis to be released. Support should withstand payload of robot and approximate weight of robot. Listed below is the weight of each robot available:
   - UP20 – 280kg (617 lb)
   - UP50 – 550kg (1212 lb)
   - UP130T – 1450kg (3197 lb)

**WARNING!**

**Releasing brakes could cause personal injury or machine damage. Always support the axis to be released BEFORE you release it.**

3. Release specific axis brake by pressing and holding corresponding axis button and ENABLE button at same time.

   *Note: You must hold both the axis and ENABLE buttons down for the axis to remain released. Releasing either button will automatically lock the brakes again.*
Chapter 6

Maintenance

Maintenance of MotoRail components should be performed only by authorized personnel who are familiar with the design and construction of this product. The following procedures should be performed only as needed. Read through the instructions completely before performing any maintenance procedure. Be sure that you understand the procedure, have the proper tools, and observe all applicable safety precautions.

6.1 Parts Ordering

To order replacement parts, contact the Motoman service staff at:

Motoman Customer Service
805 Liberty Lane
West Carrollton, Ohio 45449
Telephone: 937.847.3200
Fax: 937.847.3211

Please provide the following information:

- System Type (MotoRail)
- Application Type (material handling, arc welding, etc.)
- Part Name
- Motoman Part Number
- Quantity of Parts

6.2 Maintenance/Troubleshooting

For maintenance and troubleshooting procedures, please refer to the manipulator manual for your robot model and the Gudel vendor manual provided with this system.
6.3 Resetting the Linear Track to Home Position

Resetting of the Home position is typically done before a gripper is installed, or after the motor has been serviced.

To reset home position, proceed as follows:

1. Locate the homing hole in the hard stop.
2. Install the homing pin into the homing pin hole (see Figure 6-1) located in the hard stop. The pin may need to be tapped in with a hammer.

3. Place the robot in TEACH MODE and jog the linear rail slowly until it is just touching the homing pin. If you go too far, the pin will bend, causing an inaccuracy. Slowly jog the linear rail in reverse until the pin is straight but is still touching the linear rail.

4. Place the programming pendant in MAINTENANCE MODE.
5. Press TOP MENU key on programming pendant.
6. Cursor to ROBOT and press SELECT.
7. Cursor to HOME POSITION and press SELECT.
8. Press the PAGE OVER key to the desired station (indicated in the top right corner).
9. Make sure the linear rail is in the position that you want to teach as home and press SELECT.
10. Cursor to YES and press SELECT. The linear rail is now reset to zero.
11. Remove the alignment pin from linear track.
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