

Motoman XRC 2001 Controller QR4C Conversion Instructions

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SECTION 1

INTRODUCTION

The Quadruple-Robot, 4-Controller (QR4C) system setup is part of the Motoman family of robotic solutions and is fully supported by Motoman, Inc. The QR4C features four Motoman robots and four XRC 2001 controllers connected by a series of cables. This configuration allows the four robots to operate as a fully functional quadruple robot system, taking full advantage of all the unique functions available only in a quadruple robot system configuration. Also, the QR4C can be divided into four completely separate, stand alone units (contact Motoman service for assistance at (937) 847-3200). **Reinitialization of the XRC 2001 controllers after setup must be performed by a trained Motoman technician. Reinitialization of the XRC 2001 controller by a non-Motoman employee may void your warranty.**

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 QR4C 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 QR4C system.

SECTION 3 - SETUP INSTRUCTIONS

This section provides detailed instructions for set up of the QR4C.

APPENDIX

Appendix A contains references to system drawings.

1.2 System Overview

The QR4C is designed around four XRC 2001 controllers - one master and three slaves. The master controller holds the programming pendant. Three communication cables connect the four controllers, giving the master control over each slave. Figure 1-1 illustrates the system layout of the QR4C.

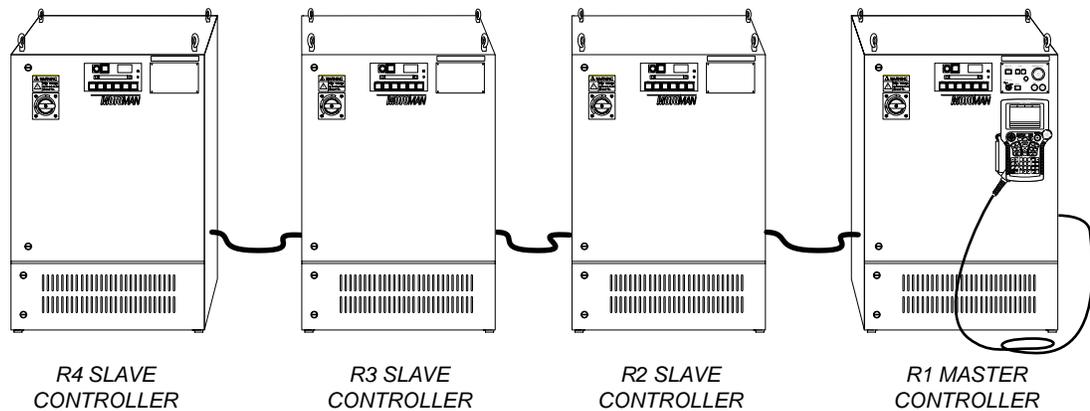


Figure 1-1 QR4C System Layout

The QR4C system includes the following major components:

- Four Motoman manipulators
- Four XRC 2001 controllers
- QR4C Controller Kit (P/N 148098)

1.3 Reference to Other Documentation

For additional information refer to the following:

- Motoman UP6 Manipulator Manual (P/N 145960-1)
- Motoman UP20 Manipulator Manual (P/N 145965-1)

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
- Application Type (welding)
- System Type (QR4C)
- Software Version (access using TOP MENU/SYSTEM INFO/VERSION/SYSTEM on the programming pendant)
- Robot Serial Number (located on the back side of the robot arms)
- Robot Sales Order Number (located on front of XRC 2001 master controller)

SECTION 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:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: 313/994-6088
FAX: 313/994-3338

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 2001 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).

SECTION 3

SETUP INSTRUCTIONS

Four XRC 2001 controllers can be easily combined to create the QR4C in just a short time. Follow established safety procedures at all times throughout the setup process. Failure to use safe work practices can result in damage to the equipment and injury to the workers.

Reinitialization of the XRC 2001 controllers after setup must be performed by a trained Motoman technician. Reinitialization of the XRC 2001 controller by a non-Motoman employee may void your warranty.

3.1 *Materials Required*

All system hardware necessary for set up of the QR4C is included with the system. Make certain you have the following kit before beginning setup procedures.

- QR4C Controller Kit, XRC 2001 P/N 148098

3.1.1 *Customer-Supplied Items*

- Incoming power supply
- Safety glasses
- Phillips and flat screwdrivers
- Wire ties
- Wire cutters

3.2 *Software Version*



CAUTION!

It is the customer's responsibility to ensure that all controllers use the same software version prior for initialization of a QR4C system. If the software versions are different, call the Motoman Service Staff at 937.847.3200.

All controllers must use the same software version. Access the software version using TOP MENU/SYSTEM INFO/VERSION/SYSTEM on the programming pendant.

3.3 Slave XRC 2001 Setup



DANGER!

All power must be removed from each controller before setup begins. Failure to remove power before setup will cause serious personal injury, loss of life, or equipment damage.



CAUTION!

Be sure to follow proper anti-static procedures to avoid damage to system components.

To set up each slave controller for QR4C operation, perform the modifications indicated in paragraphs Section 3.3.1 through Section 3.3.5:

3.3.1 Remove Cables from the Slave Controllers

1. Open each slave XRC 2001 controller door and locate the XSU02 and WRCA01 boards (see Figure 3-1).

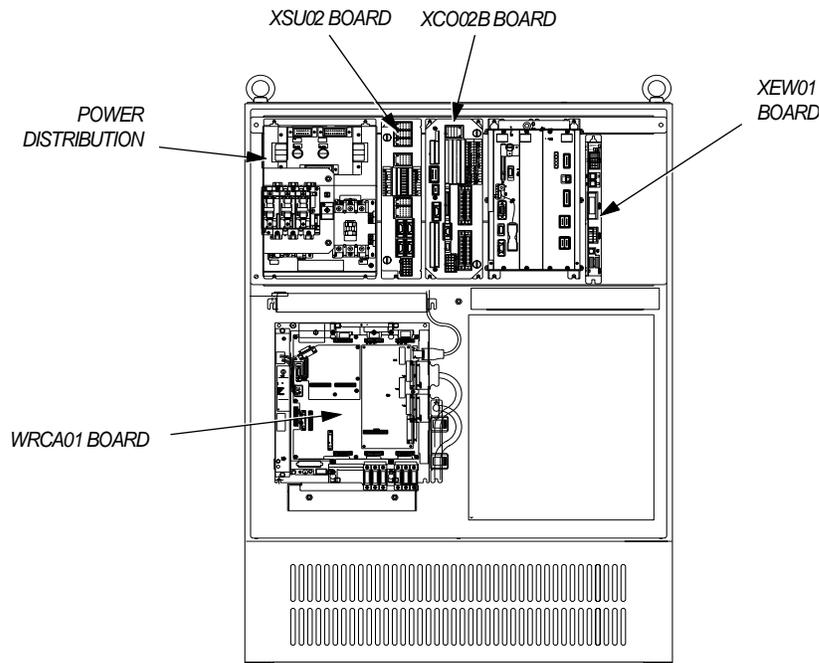


Figure 3-1 Slave Controller Components

2. Remove each CN10 cable from the WRCA01 board and store in wire duct below the board.
3. Remove cables that connect to the following XSU02 board connectors and store in wire duct below board.
 - CN23 and CN24 in the R2 controller
 - CN23 and CN24 in the R3 controller
 - CN23 in the R4 controller

3.3.2 **Removing the Playback Panel**

Complete the following instructions on all three slave controllers – R2/R3/R4.

1. Locate the playback panel on back of the controller door and disconnect all cables on the playback panel. Store cables in wire duct below playback panel.
2. Wire-tie loose connectors safely out of way.
3. Unbolt playback panel by removing its four mounting bolts and place it into an anti-static bag.

NOTE: The playback panel should be stored in a safe and dry location for future use should the QR4C need to be separated in the future.

4. Install playback panel gland plate (P/N 143386-1) over opening left in door using four bolts removed in Step 3.
5. Disconnect programming pendant and pack safely away.
6. Cover programming pendant connector with plug provided.

3.3.3 **Wiring the R2 Slave Controller**

The QR4C communication cable provides communication between controllers.

Connecting the QR4C Communication Cable

To connect the QR4C communication cable to the R2 controller, proceed as follows:

1. Remove the XSU02 board (see Figure 3-2) from the controller. Locate the XCT01 board, which is on back of the XSU02 board. Locate the SW1 and SW2 jumpers on the XCT01 board and set as follows: SW1 = 1-2, SW2 = 1-2. Reinstall XSU02 board in controller.
2. Remove one gland plate from side of the R2 controller, adjacent to R1 controller.
3. Insert a QR4C communication cable (P/N 146579) through opening where gland plate was removed, and attach cable plate to controller with screws provided. The other end of the cable will be connected to the R1 controller.
4. Remove the terminating resistor from the CN01 output connector on the XEW01 board. Save the terminating resistor for future QR4C separation.
5. Remove the terminating resistor from the CN10 output connector on WRCA0 servo control board. Save the terminating resistor for future QR4C separation.
6. Attach the CN10 connector from communication cable to the CN10 input connection on the WRCA01 board.
7. Attach the CN23 connector from communication cable to CN23 input connection on XSU02 board.
8. Attach the CN01 connector from communication cable to CN01 input connection on XEW01 board.
9. Locate the rotary switch on WRCA01 board and set to 1.
10. Locate the S1 rotary switch on XEW01 board and set to 2.

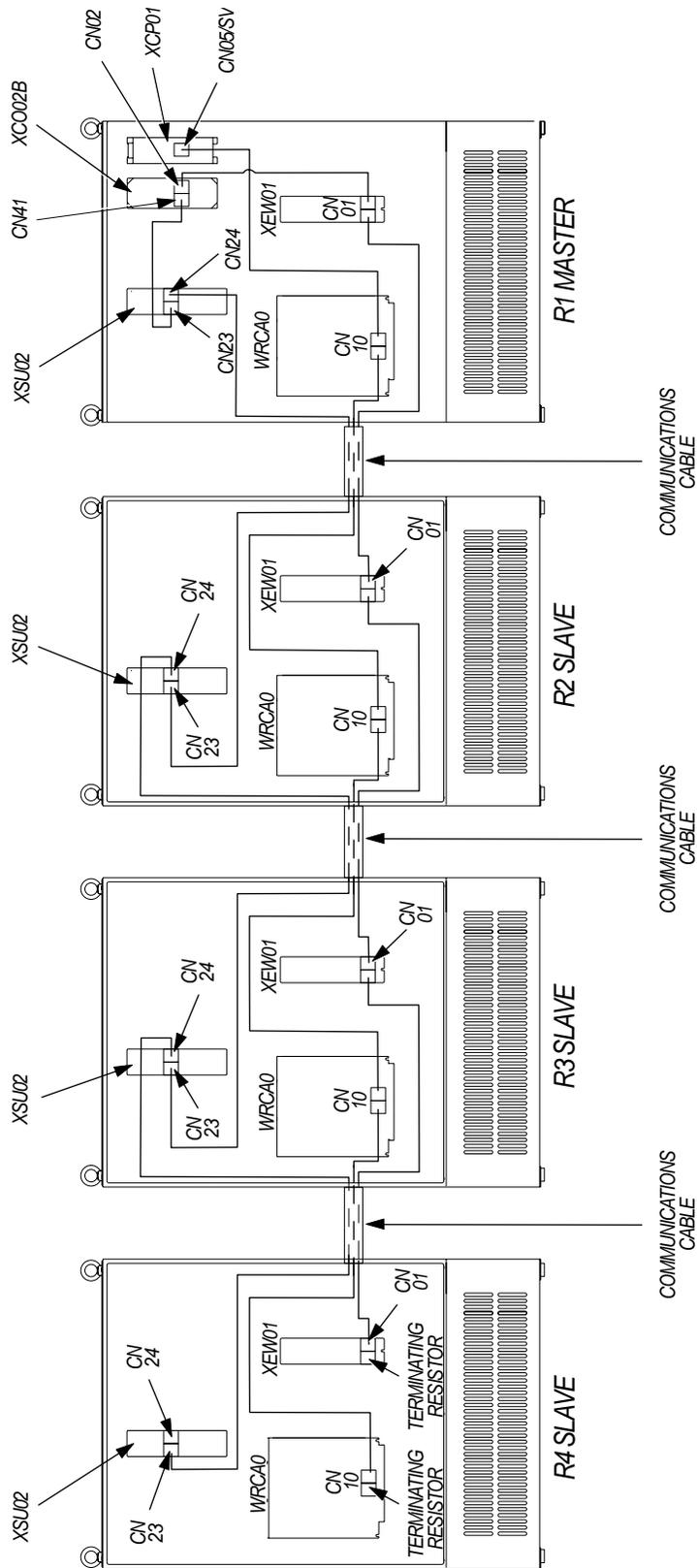


Figure 3-2 QR4C Connection Diagram

- Place QR4C controller configuration labels, P/N 146483-3, on each break-out card (see Figure 3-3) in the controller, XCP01 board, and XCO02B board.

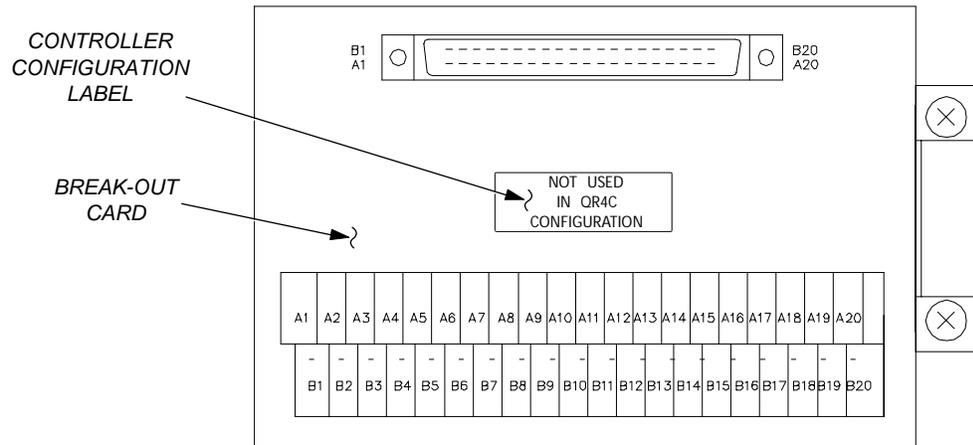


Figure 3-3 Label Location

Steps 12 - 16 provide instructions for connecting the QR4C communications cable between R2 slave and R3 slave controllers.

- Remove one gland plate from the side of R2 slave controller, adjacent to R3 controller.
- Insert a QR4C communication cable (P/N 146579) through opening where gland plate was removed, and attach cable plate to controller with screws provided. The other end of the cable will be connected to the R3 controller.
- Attach the CN10 connector from communication cable to the CN10 output connection on the WRCA01 board.
- Attach the CN24 connector from communication cable to CN24 output connection on XSU02 board.
- Attach the CN01 connector from communication cable to CN01 output connection on XEW01 board.

3.3.4 Wiring the R3 Slave Controller

Connecting the QR4C Communication Cable

To connect the QR4C communication cable to the R3 controller, proceed as follows:

- Remove the XSU02 board from the R3 controller. Locate the XCT01 board, which is on back of the XSU02 board. Locate SW1 and SW2 jumpers on the XCT01 board and set as follows: SW1 = 1-2, SW2 = 1-2. Reinstall XSU02 board in controller.
- Remove one gland plate from the side of R3 slave controller, adjacent to R2 controller.
- Insert the communication cable from the R2 controller through opening where the gland plate was removed, and attach cable plate to controller with screws provided.
- Remove the terminating resistor from the CN01 output connector on the XEW01 board. Save the terminating resistor for future QR4C separation.

5. Remove the terminating resistor from the CN10 output connector on WRCA0 servo control board. Save the terminating resistor for future QR4C separation.
6. Attach the CN10 connector from communication cable to the CN10 input connection on the WRCA01 board.
7. Attach the CN23 connector from communication cable to CN23 input connection on XSU02 board.
8. Attach the CN01 connector from communication cable to CN01 input connection on XEW01 board.
9. Locate rotary switch on WRCA01 board and set to 2.
10. Locate the S1 rotary switch on XEW01 board and set to 3.
11. Place QR4C controller configuration labels, P/N 146483-3, on each break-out card (see Figure 3-3) in the controller, XCP01 board, and XCO02B board.

Steps 12 - 16 provide instructions for connecting the QR4C communications cable between R3 slave and R4 slave controllers.

12. Remove one gland plate from the side of R3 slave controller, adjacent to R4 controller.
13. Insert a QR4C communication cable (P/N 146579) through opening where gland plate was removed, and attach cable plate to controller with screws provided.
14. Attach the CN10 connector from communication cable to the CN10 output connection on the WRCA01 board.
15. Attach the CN24 connector from communication cable to CN24 output connection on XSU02 board.
16. Attach the CN01 connector from communication cable to CN01 output connection on XEW01 board.

3.3.5 Wiring the R4 Slave Controller

Connecting the QR4C Communication Cable

To connect the QR4C communication cable to the R4 controller, proceed as follows:

1. Remove the XSU02 board from the R4 controller. Locate the XCT01 board, which is on back of the XSU02 board. Locate SW1 and SW2 jumpers on the XCT01 board and set as follows: SW1 = 2-3, SW2 = 1-2. Reinstall XSU02 board in controller.
2. Remove one gland plate from the side of R4 slave controller, adjacent to R3 controller.
3. Insert the communication cable from the R3 controller through opening where the gland plate was removed, and attach cable plate to controller with screws provided.
4. Attach the CN10 connector from communication cable to the CN10 input connection on the WRCA01 board.
5. Attach the CN23 connector from communication cable to CN23 input connection on XSU02 board.
6. Attach the CN01 connector from communication cable to CN01 input connection on XEW01 board.
7. Locate rotary switch on WRCA01 board and set to 3.

8. Locate the S1 rotary switch on XEW01 board and set to 4.
9. Place QR4C controller configuration labels, P/N 146483-3, on each break-out card (see Figure 3-3) in the controller, XCP01 board, and XCO02B board.

3.4 **Master XRC 2001 Setup**



CAUTION!

Be sure to follow proper anti-static procedures to avoid damage to system components.

3.4.1 **Connecting the QR4C Communication Cable**

The QR4C communication cable enables communication between the master and slave controllers. To connect the QR4C communication cable to the master controller, proceed as follows:

1. Remove the XSU02 board from the R1 controller. Locate the SW1 and SW2 on the XCT01 board and set as follows: SW1 = 1-2, SW2 = 1-2. Reinstall XSU02 board in controller.
2. Remove one gland plate from the side of R1 controller, adjacent to R2 controller.
3. Insert the communication cable from the R2 controller through opening where the gland plate was removed and attach cable plate to controller with provided screws.
4. Remove the terminating resistor from the CN01 output connector on the XEW01 board. Save the terminating resistor for future QR4C separation.
5. Remove the terminating resistor from the CN10 output connector on WRCA0 servo control board. Save the terminating resistor for future QR4C separation.
6. Attach the CN10 connector from communication cable to the CN10 output connection on the WRCA01 board.
7. Attach the CN24 connector from communication cable to CN24 output connection on XSU02 board.
8. Attach the CN01 connector from communication cable to CN01 output connection on XEW01 board.
9. Locate rotary switch on WRCA01 board and set to 0.
10. Locate S1 rotary switch on XEW01 board and set to 1.

3.5 **Connecting the Power**

After all of the system components have been properly installed, three-phase AC power must be connected to all controllers. To connect incoming power to the QR4C, complete the following steps:



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 three-phase power wiring to circuit breaker located inside the master controller (see Figure 3-4). The engineering drawings show the size and type of wire needed.
2. Tighten screws to specified torque indicated on engineering drawings.

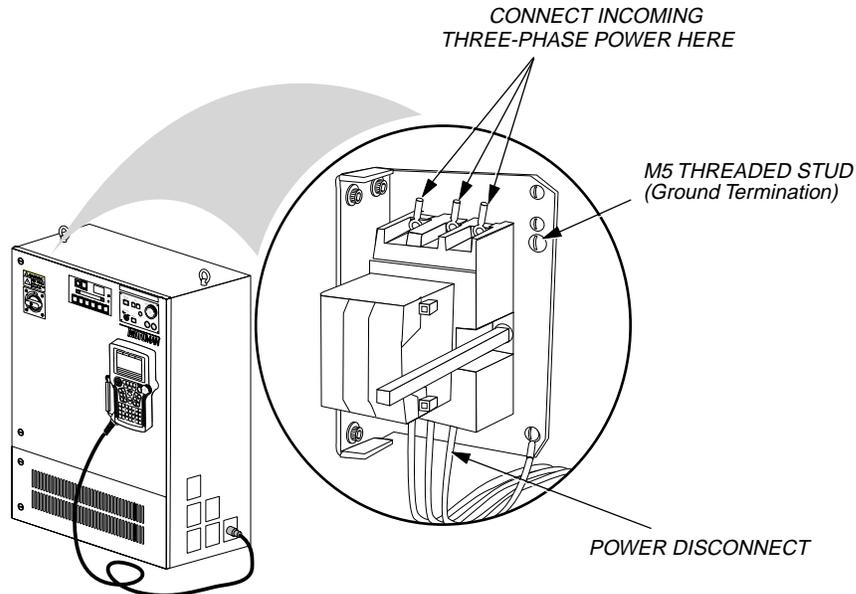


Figure 3-4 Incoming Power Connections

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

NOTE:

The QR4C is configured for three-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.

3.6 Power-Up Instructions

Use the following instructions to turn power on to the QR4C system:



CAUTION!

The master/slave controller setup must first be configured as a four-controller system before any external axes can be added. Failure to set up the QR4C as required will cause incorrect operation or operational problems.

1. Turn on power to slave controllers.
2. Turn power on to master controller.

3.7 Reinitialization of the Controller

Reinitialization of the XRC 2001 controllers after setup must be performed by a trained Motoman technician. Reinitialization of the XRC 2001 controller by a non-Motoman employee may void your warranty. For more information, please contact the Motoman service staff at 937.847.3200.

NOTES

APPENDIX A

SYSTEM DRAWINGS

This section contains references to system drawings for the QR4C system. For information on specific part numbers, call the Motoman service staff at 937.847.3200.

<u>Drawing Number</u>	<u>Title</u>	<u>Sheet Number</u>
148098	Controller Kit, QR4C, XRC 2001	1
148098	Controller Kit, QR4C, XRC 2001	2
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