Motoman MRC/XRC Controller

Mario Interface User's Manual

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MOTOMAN

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SECTION 1
INTRODUCTION

1.1 Purpose

The purpose of this document is to provide a manual for users of the Motoman Robot to Allen-Bradley Remote I/O Link Module (hereafter referred to as MARIO). This manual is for support and settings of the MARIO Interface card. Please contact Allen-Bradley for PLC questions and configurations.

1.2 Scope

This document is limited to a discussion of the functionality of the MARIO and its connections to the MRC and XRC Controllers and the Allen-Bradley Remote I/O (hereafter referred to as RIO) network. It is assumed that the reader has an understanding of the functionality of the controllers and of the addressing protocol used on the RIO network.

1.3 Hardware Compatibility

The MARIO is electrically compatible with both MRC and XRC controllers that incorporate an MIF01 master module, with a JL-012 bus interface to a JANCD-MBB02 backplane.

Compatibility at the RIO network interface is according to that provided by the Allen-Bradley Company's Node Adapter Chip Set, which provides the following functions:

- RIO adapter-mode functionality
- up to a full logical rack of discrete data (depends on system configuration)
- compatible with all A&B PLC RIO scanners
- compatible with all RIO baud rates: 57.6K, 115.2K, and 230.4Kbaud
- dual-port host interface
- CMOS technology

1.4 Reference to Other Documentation

- Motoman MRC User Functions (P/N 132331-1)
- Concurrent XRC I/O & Parameters Manual (P/N 142102-1)

1.5 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, as applicable, ready before you call:

- Robot Type (SK6, K16, etc.)
- Robot Serial Number (located on the back side of the robot arm)
- Application Type (palletizing, welding, handling, etc.)
- Software version (appears on power-up screen)

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 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
INSTALLATION AND SETUP

3.1 MARIO in an MRC Controller

To install the Mario board in an MRC controller, proceed as follows:

WARNING!

To prevent electrical shock to personnel and to prevent equipment damage, ensure power to the MRC controller is turned OFF before beginning the installation.

CAUTION!

Follow the proper anti-static procedures to ensure that static electricity does not damage the MARIO board.

1. Turn off power to the MRC controller.
2. Open the front door of the MRC cabinet and locate the I/O rack on the MBB02 back board, which is situated to your left in the middle of the cabinet (see Figure 3-1).

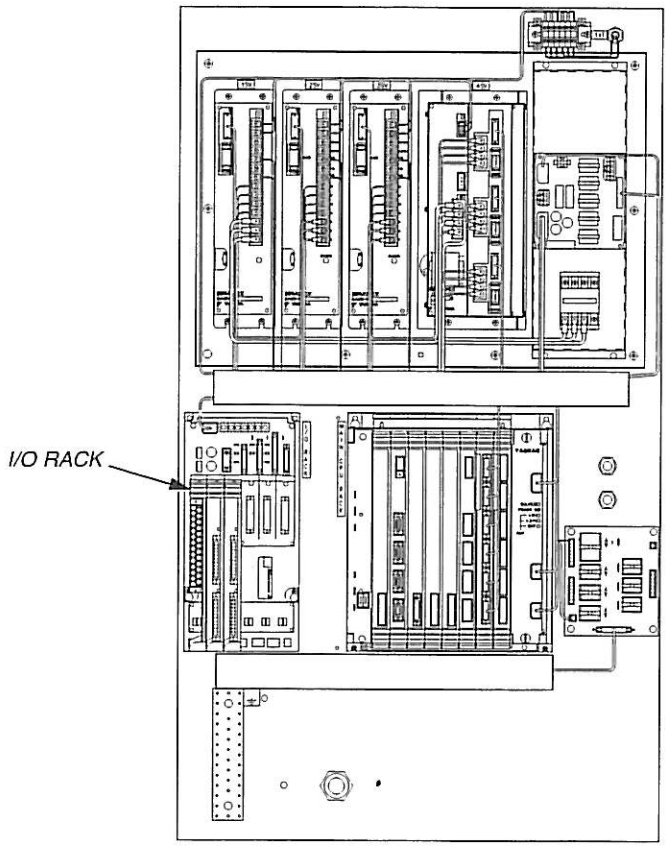

Figure 3-1 Location of I/O Rack Inside MRC Cabinet

3. Set the MARIO board to the desired settings.
4. Install the MARIO board in the **first empty** slot to the left in the I/O rack.
5. To place the MRC controller in maintenance mode, press CUSTOMER on the programming pendant and simultaneously turn on power to the MRC controller.
6. Enter your customer user ID number or 00000000 (eight zeros), and press ENTER. The MAINTENANCE MODE screen is displayed.

NOTE: If the desired selection is not highlighted, use the up arrow key to highlight it.

7. Ensure that SETUP SYSTEM is highlighted, and press ENTER. The SETUP SYSTEM screen is displayed.
8. Ensure that SYSTEM CONFIGURATION is highlighted, and press ENTER. The SYSTEM CONFIGURATION screen is displayed.
9. Ensure that IO MODULES is highlighted, and press ENTER. The display lists the I/O modules installed in the MRC.
10. Press ENTER to display the YES/NO verification..
11. Ensure that YES is highlighted, and press ENTER again. You should hear a beeping sound to confirm your input.

CAUTION!

Never change any of the settings on the MARIO board while controller power is ON!

12. Turn off power to the MRC controller. The MARIO board installation is complete.

3.2 MARIO in an XRC Controller

To install the Mario board in an XRC controller, proceed as follows:

WARNING!

To prevent electrical shock to personnel and to prevent equipment damage, ensure power to the XRC controller is turned OFF before beginning the installation.

CAUTION!

Follow the proper anti-static procedures to ensure that static electricity does not damage the MARIO board.

1. Turn off power to the XRC controller.
2. Open the front door of the XRC cabinet and locate the I/O expansion rack (see Figure 3-2).

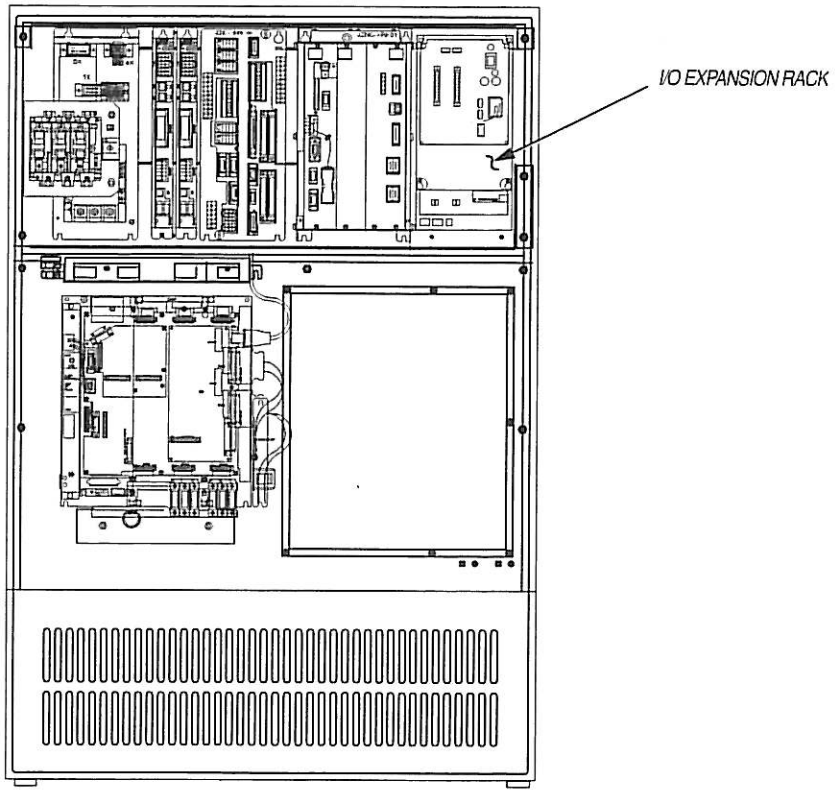

Figure 3-2 Location of I/O Rack Inside XRC Cabinet

3. Set the MARIO board to the desired settings.
4. Install the MARIO board in the **first empty** slot to the left in the I/O expansion rack.
5. To place the XRC controller in maintenance mode, press TOP MENU on the programming pendant and simultaneously turn on power to the XRC controller.
6. Press AREA to get to SECURITY.
7. Arrow down to DROP MENU.
8. Arrow down to MANAGEMENT MODE, and press SELECT.
9. Enter your customer user ID number or 00000000 (eight zeros), and press ENTER.

NOTE: If the desired selection is not highlighted, use the up arrow key to highlight it.

10. Ensure that SYSTEM is highlighted, and press SELECT.
11. Ensure that SETUP is highlighted, and press SELECT.
12. Ensure that IO MODULES is highlighted, and press SELECT. The display lists the I/O modules installed in the XRC.
13. Verify that the MARIO's I/O can be seen, then press ENTER to display the YES/NO verification.
14. Ensure that YES is highlighted, and press ENTER again. You should hear a beeping sound to confirm your input.

CAUTION!

Never change any of the settings on the MARIO board while controller power is ON!

15. Turn off power to the XRC controller. The MARIO board installation is complete.

SECTION 4
I/O MAP

Motoman controllers have the capability of supporting 144 Input and 144 Output signals. Depending on the application of the system, the number of user-definable I/O points will vary. In examples that follow, a single robot with an arc welding application will be used to demonstrate the installation of the Mario board.

Controller I/O's follows a basic Octal numbering system, i.e., each input or output group will occur in a grouping of eight. For example, in arc welding, the first **user** input group will contain addresses from 2030 through 2037, and the second **user** group will contain addresses from 2040 through 2047.

The tables that follow illustrate the standard memory configuration **without** the MARIO board (Table 4-1 [MRC] and Table 4-2 [XRC]) and **with** the MARIO board (Table 4-3 [MRC] and Table 4-4 [XRC]). This will be helpful in understanding which addresses are user definable as well as clarify which addresses are MARIO definable.

NOTE: The following examples are for Arc Welding applications only. Please consult User Function Manual for all other applications.

Tables 4-1 (MRC) and 4-2 (XRC) illustrate I/O addresses, which are factory set, for the following inclusive boards: MIO04 board uses addresses 2010 thru 2023 (CN2) and 2024 thru 2037 (CN1); MEW02 (Welding Interface Board) addresses 2170 thru 2177; MRY01B board is preset and not user definable. Notice that I/O addresses 2040 thru 2167 are user definable for future expansion.

Table 4-1 Standard MRC Memory Map (without MARIO Board)

#	INPUTS	#	OUTPUTS
2010	External Start	3010	Operating
2011	--	3011	Servo On
2012	Master Job Call	3012	Top Master Job
2013	Alarm/Error Reset	3013	Alarm Error Occurrence
2014	Remote Mode Select	3014	Battery Alarm
2015	Play Mode Select	3015	Remote Mode Selected
2016	Teach Mode Select	3016	Play Mode Selected
2017	--	3017	Teach Mode Selected
2020	Interference Cube 1	3020	In Cube 1
2021	Interference Cube 2	3021	In Cube 2
2022	Work Prohibit	3022	Cube 8
2023	Work Response	3023	Sequence Executing
2024	--	3024	Gas Shortage
2025	--	3025	Wire Shortage
2026	Weaving Prohibit	3026	Wire Sticking
2027	Sensing Prohibit	3027	Arc Shortage
2030	IN 1	3030	OUT 1

Table 4-1 Standard MRC Memory Map (without MARIO Board) - continued

#	INPUTS	#	OUTPUTS
2031	IN 2	3031	OUT 2
2032	IN 3	3032	OUT 3
2033	IN 4	3033	OUT 4
2034	IN 5	3034	OUT 5
2035	IN 6	3035	OUT 6
2036	IN 7	3036	OUT 7
2037	IN 8	3037	OUT 8
2040-2167	**User definable for future expansion**	**3040-3167**	**User definable for future expansion**
2170	Gas Shortage	3170	--
2171	Wire Stick	3171	Arc On
2172	Arc Shortage	3172	Inch Fwd
2173	Arc On	3173	Inch Rev
2174	Wire Stick	3174	--
2175	--	3175	--
2176	--	3176	--
2177	--	3177	--

Table 4-2 Standard XRC Memory Map (without MARIO Board)

#	Connector	INPUTS	#	Connector	OUTPUTS
2010	CN12-B1	External Start	3010	CN12-B8	Operating
2011	CN12-A1	--	3011	CN12-A8	Servo On
2012	CN12-B2	Master Job Call	3012	CN12-B9	Top Master Job
2013	CN12-A2	Alarm/Error Reset	3013	CN12-A9	Alarm/Error Occurrence
2014	CN12-B3	Remote Mode Select	3014	CN12-B10	Battery Alarm
2015	CN12-A3	Play Mode Select	3015	CN12-A10	Remote Mode Selected
2016	CN12-B4	Teach Mode Select	3016	CN12-B11	Play Mode Selected
2017	CN12-A4	Fan Stop Alarm (IN192)	3017	CN12-A11	Teach Mode Selected
2020	CN12-B5	Interference 1 entry prohibit	3020	CN12-B12	In Cube 1
2021	CN12-A5	Interference 2 entry prohibit	3021	CN12-A12	In Cube 2
2022	CN12-B6	Work Prohibit	3022	CN12-B13	Work Home Position
2023	CN12-A6	Work Response	3023	CN12-A13	Sequence Executing

Table 4-2 Standard XRC Memory Map (without MARIO Board) - continued

#	Connector	INPUTS	#	Connector	OUTPUTS
2024	CN13-B1	--	3024	CN13-B8	Gas Shortage (monitor)
2025	CN13-A1	--	3025	CN13-A8	Wire Shortage(monitor)
2026	CN13-B2	Weaving Prohibit	3026	CN13-B9	Wire Sticking(monitor)
2027	CN13-A2	Sensing Prohibit	3027	CN13-A9	Arc Shortage(monitor)
2030	CN13-B3	--	3030	CN13-B10	Search Instruction
2031	CN13-A3	--	3031	CN13-A10	--
2032	CN13-B4	--	3032	CN13-B11	--
2033	CN13-A4	--	3033	CN13-A11	--
2034	CN13-B5	--	3034	CN13-B12	--
2035	CN13-A5	--	3035	CN13-A12	--
2036	CN13-B6	--	3036	CN13-B13	--
2037	CN13-A6	--	3037	CN13-A13	--
2040	CN10-B1	IN00	3040	CN10-A8	OUT00+
				CN10-B8	OUT00-
2041	CN10-A1	IN01	3041	CN10-A9	OUT01+
				CN10-B9	OUT01-
2042	CN10-B2	IN02	3042	CN10-A10	OUT02+
				CN10-B10	OUT02-
2043	CN10-A2	IN03	3043	CN10-A11	OUT03+
				CN10-B11	OUT03-
2044	CN10-B3	IN04	3044	CN10-A12	OUT04+
				CN10-B12	OUT04-
2045	CN10-A3	IN05	3045	CN10-A13	OUT05+
				CN10-B13	OUT05-
2046	CN10-B4	IN06	3046	CN10-A14	OUT06+
				CN10-B14	OUT06-
2047	CN10-A4	IN07	3047	CN10-A15	OUT07+
				CN10-B15	OUT07-
2050	CN11-B1	IN08	3050	CN11-A8	OUT08+
				CN11-B8	OUT08-
2051	CN11-A1	IN09	3051	CN11-A9	OUT09+
				CN11-B9	OUT09-
2052	CN11-B2	IN10	3052	CN11-A10	OUT10+
				CN11-B10	OUT10-

Table 4-2 Standard XRC Memory Map (without MARIO Board)

#	Connector	INPUTS	#	Connector	OUTPUTS
2053	CN11-A2	IN11	3053	CN11-A11	OUT11+
				CN11-B11	OUT11-
2054	CN11-B3	IN12	3054	CN11-A12	OUT12+
				CN11-B12	OUT12-
2055	CN11-A3	IN13	3055	CN11-A13	OUT13+
				CN11-B13	OUT13-
2056	CN11-B4	IN14	3056	CN11-A14	OUT14+
				CN11-B14	OUT14-
2057	CN11-A4	IN15	3057	CN11-A15	OUT15+
				CN11-B15	OUT15-

Tables 4-3 (MRC) and 4-4 (XRC) illustrate I/O addresses with the MARIO Board included. Notice that all standard addresses remain the same as in Table 4-1, except for addresses 2040 thru 2047, which are now defined by the MARIO Board as Status Bits. For purposes of this example, 2050 thru 2080 are defined as MARIO I/O points, which is based upon the I/O Group Thumbwheel (see Figure 6-2) being set to a position of 4, for a total of 32 points. It is important to note that addresses 2080 thru 2167 remain for future expansion.

For your specific interfacing requirements with the PLC, refer to Section 6.5 for rack configuration, and Table 6-2 for starting quarters and baud rates.

Table 4-3 Standard MRC Memory Map with MARIO Board

#	INPUTS	#	OUTPUTS
2010	External Start	3010	Operating
2011	--	3011	Servo On
2012	Master Job Call	3012	Top Master Job
2013	Alarm/Error Reset	3013	Alarm Error Occurrence
2014	Remote Mode Select	3014	Battery Alarm
2015	Play Mode Select	3015	Remote Mode Selected
2016	Teach Mode Select	3016	Play Mode Selected
2017	--	3017	Teach Mode Selected
2020	Interference Cube 1	3020	In Cube 1
2021	Interference Cube 2	3021	In Cube 2
2022	Work Prohibit	3022	Cube 8
2023	Work Response	3023	Sequence Executing
2024	--	3024	Gas Shortage
2025	--	3025	Wire Shortage
2026	Weaving Prohibit	3026	Wire Sticking
2027	Sensing Prohibit	3027	Arc Shortage
2030	IN 1	3030	OUT 1

Table 4-3 Standard MRC Memory Map with MARIO Board - continued

#	INPUTS	#	OUTPUTS
2031	IN 2	3031	OUT 2
2032	IN 3	3032	OUT 3
2033	IN 4	3033	OUT 4
2034	IN 5	3034	OUT 5
2035	IN 6	3035	OUT 6
2036	IN 7	3036	OUT 7
2037	IN 8	3037	OUT 8
2040-2047	**Status Bits**	**3040-3047**	**Not available for use**
2050-2087	**MARIO I/O Points**	**3050-3087**	**MARIO I/O Points**
2090-2167	**User definable for future expansion**	**3090-3167**	**User definable for future expansion**
2170	Gas Shortage	3170	--
2171	Wire Stick	3171	Arc On
2172	Arc Shortage	3172	Inch Fwd
2173	Arc On	3173	Inch Rev
2174	Wire Stick	3174	--
2175	--	3175	--
2176	--	3176	--
2177	--	3177	--

Table 4-4 Standard XRC Memory Map with MARIO Board

#	Connector	INPUTS	#	Connector	OUTPUTS
2010	CN12-B1	External Start	3010	CN12-B8	Operating
2011	CN12-A1	--	3011	CN12-A8	Servo On
2012	CN12-B2	Master Job Call	3012	CN12-B9	Top Master Job
2013	CN12-A2	Alarm/Error Reset	3013	CN12-A9	Alarm/Error Occurrence
2014	CN12-B3	Remote Mode Select	3014	CN12-B10	Battery Alarm
2015	CN12-A3	Play Mode Select	3015	CN12-A10	Remote Mode Selected
2016	CN12-B4	Teach Mode Select	3016	CN12-B11	Play Mode Selected
2017	CN12-A4	Fan Stop Alarm (IN192)	3017	CN12-A11	Teach Mode Selected
2020	CN12-B5	Interference 1 entry prohibit	3020	CN12-B12	In Cube 1
2021	CN12-A5	Interference 2 entry prohibit	3021	CN12-A12	In Cube 2

Table 4-4 Standard XRC Memory Map with MARIO Board - continued

#	Connector	INPUTS	#	Connector	OUTPUTS
2022	CN12-B6	Work Prohibit	3022	CN12-B13	Work Home Position
2023	CN12-A6	Work Response	3023	CN12-A13	Sequence Executing
2024	CN13-B1	--	3024	CN13-B8	Gas Shortage (monitor)
2025	CN13-A1	--	3025	CN13-A8	Wire Shortage(monitor)
2026	CN13-B2	Weaving Prohibit	3026	CN13-B9	Wire Sticking(monitor)
2027	CN13-A2	Sensing Prohibit	3027	CN13-A9	Arc Shortage(monitor)
2030	CN13-B3	--	3030	CN13-B10	Search Instruction
2031	CN13-A3	--	3031	CN13-A10	--
2032	CN13-B4	--	3032	CN13-B11	--
2033	CN13-A4	--	3033	CN13-A11	--
2034	CN13-B5	--	3034	CN13-B12	--
2035	CN13-A5	--	3035	CN13-A12	--
2036	CN13-B6	--	3036	CN13-B13	--
2037	CN13-A6	--	3037	CN13-A13	--
2040	CN10-B1	IN00	3040	CN10-A8	OUT00+
				CN10-B8	OUT00-
2041	CN10-A1	IN01	3041	CN10-A9	OUT01+
				CN10-B9	OUT01-
2042	CN10-B2	IN02	3042	CN10-A10	OUT02+
				CN10-B10	OUT02-
2043	CN10-A2	IN03	3043	CN10-A11	OUT03+
				CN10-B11	OUT03-
2044	CN10-B3	IN04	3044	CN10-A12	OUT04+
				CN10-B12	OUT04-
2045	CN10-A3	IN05	3045	CN10-A13	OUT05+
				CN10-B13	OUT05-
2046	CN10-B4	IN06	3046	CN10-A14	OUT06+
				CN10-B14	OUT06-
2047	CN10-A4	IN07	3047	CN10-A15	OUT07+
				CN10-B15	OUT07-
2050	CN11-B1	IN08	3050	CN11-A8	OUT08+
				CN11-B8	OUT08-

Table 4-4 Standard XRC Memory Map with MARIO Board - continued

#	Connector	INPUTS	#	Connector	OUTPUTS
2051	CN11-A1	IN09	3051	CN11-A9	OUT09+
				CN11-B9	OUT09-
2052	CN11-B2	IN10	3052	CN11-A10	OUT10+
				CN11-B10	OUT10-
2053	CN11-A2	IN11	3053	CN11-A11	OUT11+
				CN11-B11	OUT11-
2054	CN11-B3	IN12	3054	CN11-A12	OUT12+
				CN11-B12	OUT12-
2055	CN11-A3	IN13	3055	CN11-A13	OUT13+
				CN11-B13	OUT13-
2056	CN11-B4	IN14	3056	CN11-A14	OUT14+
				CN11-B14	OUT14-
2057	CN11-A4	IN15	3057	CN11-A15	OUT15+
				CN11-B15	OUT15-
2060-2067		**MARIO Status Bits**	**3060-3067**		**Not Available for use**
2070-2240		**MARIO I/O and User Definable**	**3070-3240**		**MARIO I/O and User Definable**
2300		Gas Shortage	3300		--
2301		Wire Shortage	3301		Arc On
2302		Arc Shortage	3302		Inch Fwd
2303		Arc On	3303		Inch Rev
2304		Wire Stick	3304		--
2305		--	3305		Search Instruction
2306		--	3306		--
2307		--	3307		--

NOTE: The MARIO can only transfer 112 I/O points.

NOTES

SECTION 5
POWER MONITOR & SOFTWARE WATCHDOG

5.1 Module Power Supply Monitor

To monitor the power supply reaching the MARIO from the controller rack (the module's only source of power), circuitry is present that, under certain conditions, can reset the on-board processor. If the supply voltage is not within an acceptable tolerance, the MARIO circuitry may behave unpredictably, and the supply monitor is intended to prevent erroneous data from being sent to the PLC via the RIO network, in the event of power failure at the controller rack. It is set to accept a rising 5-volt supply only when it exceeds 4.75V, and to reject a falling 5-volt supply as soon as it reaches 4.5V.

5.2 Module Software Watchdog

Circuitry is present on the MARIO that resets the module unless the software executing on the on-board processor does not periodically prevent it from doing so. This helps to prevent a hardware or software fault from causing execution of incorrect code, with unpredictable, undesirable, and uncontrolled results. The processor must perform a write access to a certain location in its I/O space at least once every 150ms, changing the state of a particular bit, to prevent being reset. This operation is performed automatically by software on the MARIO. It takes only a few cycles from the processor's execution, and does not have a significant impact on its performance as far as handling its other tasks.

NOTES

SECTION 6
MODULE EXTERNAL CONNECTIONS, SWITCHES, AND INDICATORS

6.1 Remote I/O Network Cable Connection

The RIO connector is a three-circuit, two-piece, screw-type connector, compatible with that used by Allen-Bradley Company for their Remote I/O hardware. The RIO network cable ("Blue Hose") attaches to this connector as detailed in Figure 6-1. Atach the blue wire to terminal **1** on the Remote I/O Connector, and the clear wire to terminal **2**.

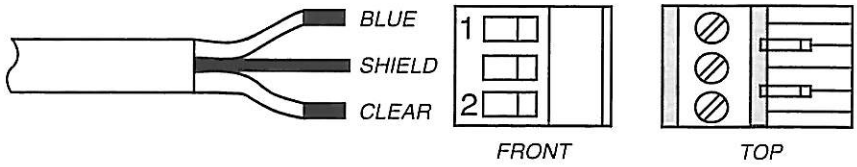

Figure 6-1 Remote I/O Connector

6.2 External Computer Serial Connection

For upgrading the on-board software for the MARIO, there is an asynchronous serial connection for communicating with the on-board processor. This connection will not generally be used, but an interface module may be attached to the 5-pin header provided, for communication with an external computer.

6.3 Switches and External Connections

The MARIO contains three switch groups (see Figure 6-2). One is used to set the number of I/O groups supported by the rack; one to set the starting rack quarter and network data rate; and the third to set the rack number.

All switches are read by MARIO software once when the MARIO is reset (at power-on). Changing the switches with the power on has no effect until power is cycled.

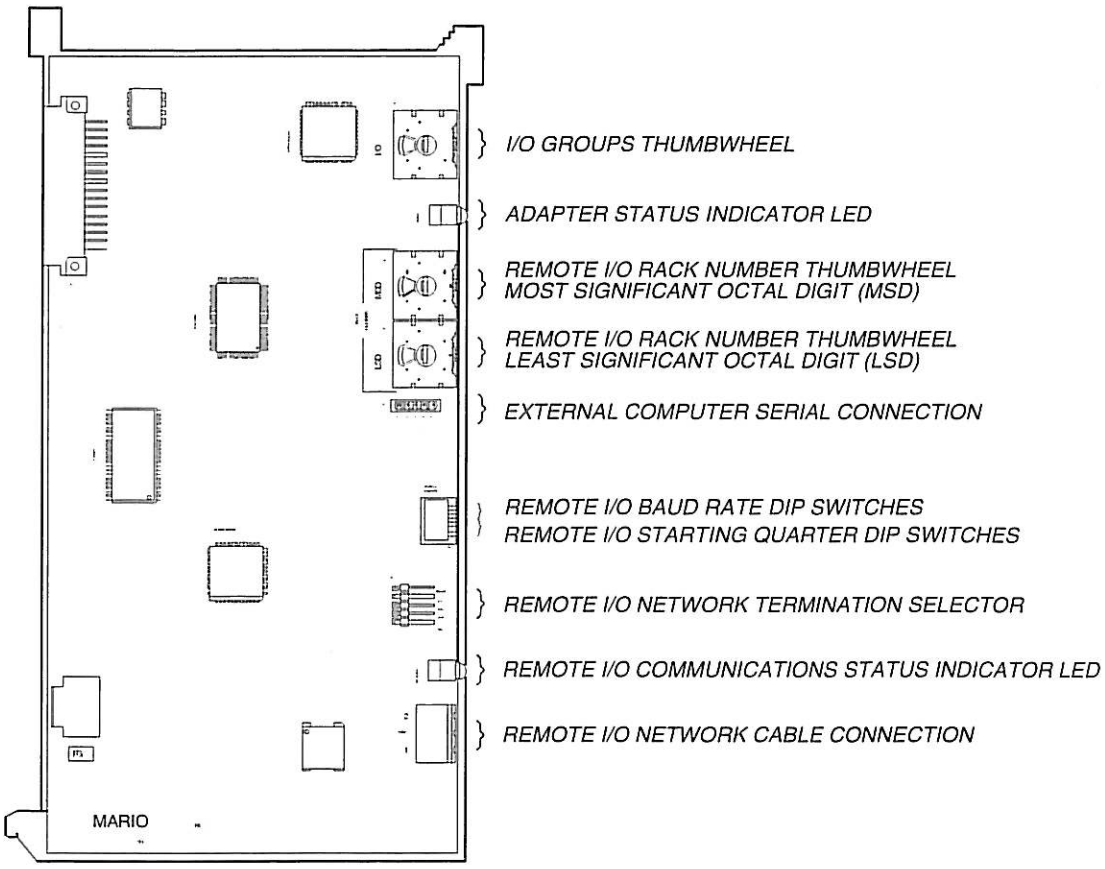

Figure 6-2 Adapter Switch and Indicator Identification

6.4 I/O Groups Thumbwheel

To set the number of I/O groups which the drop supports on the RIO link, a small 16-position thumbwheel switch (S1), with position indicators '0'-'9', and 'A'-'F', is present on the front of the MARIO. This switch should be set to indicate the number of groups that the MARIO is to transfer between the controller and the RIO scanner, according to Table 6-1. The number of I/O groups selected is also used to determine the minimum drop size required on the RIO.

Table 6-1 Number of I/O Groups Switch Settings

SWITCH POSITION (I/O Groups)	USER I/O POINTS	RIO DROP SIZE
0	0	1/4 rack
1	8	1/4 rack
2	16	1/4 rack
3	24	1/4 rack
4	32	1/4 rack
5	40	1/2 rack
6	48	1/2 rack
7	56	1/2 rack
8	64	1/2 rack
9	72	3/4 rack
A	80	3/4 rack
B	88	3/4 rack
C	96	3/4 rack
D	104	1 rack
E	112	1 rack
F	<unused>	

NOTE: The number on this switch represents the number of groups transferred to the RIO. Since the MARIO Status Group is not transferred to the RIO, the MARIO appears in the controller configuration to provide one group (eight points) more than the switch setting.

6.5 Remote I/O Rack Number Thumbwheels

The MARIO contains a switch group for selecting the logical rack address on the RIO network. This takes the form of two small thumbwheel switches, mounted to the module's printed circuit board. In keeping with the Allen-Bradley standard use of the octal numbering system, these switches permit setting of the logical rack address to one of the 64 octal numbers in the range 008 through 778. Since each switch can be set in the 0-9 range, an address that includes a non-octal digit (8 or 9) is not valid, and results in a flashing red LED on the module, and the module does not appear on the RIO network. Such a switch setting error is also indicated to the controller, in the MARIO Status Group. A switch setting error is also caused by selection of rack address 778, when any but the first quarter rack are included in the rack setting. That is, only the first quarter may be selected as the starting quarter for rack address 778, and the number of selected I/O groups must fit into a quarter rack.

6.6 Remote I/O Starting Quarter and Baud Rate Switches

A set of four switches is present on the front of the MARIO for selecting the starting quarter of the rack that the MARIO is to represent, and the network data rate. This takes the form of a piano-key-style 4-circuit DIP switch, (S5). Two of these switches set the starting quarter and two set the data rate, according to Table 6-2.

NOTE: The selected baud rate must match the data rate of the PLC.

Table 6-2 Remote I/O Starting Quarter and Baud Rate Switch Settings

POLE 1	POLE 2	STARTING RACK QUARTER
off	off	1st
on	off	2nd
off	on	3rd
on	on	4th

POLE 3	RIO POLE 4 RATE	BAUD
off	off	230.4k
on	off	115.2k
off	on	57.6k
on	on	57.6k

If the switch is set to a starting quarter that is incompatible with the selected number of I/O groups to transfer to the RIO (that is, if the starting quarter selected leaves insufficient room in the rack for the selected number of groups), a switch setting error exists, and is indicated by a flashing red LED, and to the controller via the MARIO Status Group.

6.7 Remote I/O Network Termination Selector

The Remote I/O link is a local area network, connected in a daisy-chain configuration. Each end of the cable must be terminated with an appropriately-valued resistor to prevent signal reflections and distortion arising from cable impedance discontinuities. More information regarding cabling and cable termination may be found in Allen-Bradley wiring guidelines Technical Support Bulletin 92-D1770-BC0.

It is necessary to terminate each end of the Remote I/O bus cable, and an on-board network termination resistor is provided, for use when the MARIO is the last adapter on the cable. The selection of termination is made at the Remote I/O network termination selector by placing a shorting plug over the pair of pins corresponding to the selected network baud rate. The shorting plug locations for the four termination possibilities are shown in Figure 6-3.

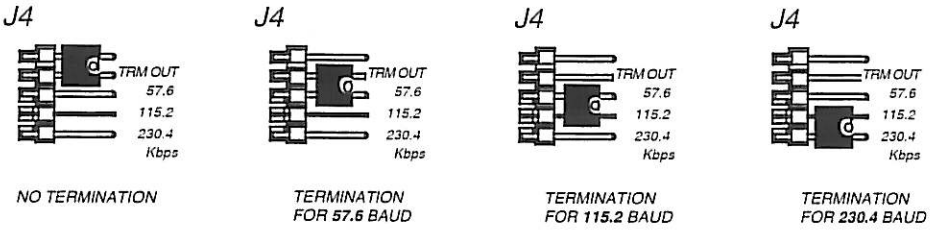

Figure 6-3 Network Terminator Section

SECTION 7

LED INDICATORS AND ADAPTER STATUS GROUP

The MARIO contains LED indicators for network activity and module health. The module health is also reflected in the contents of the MARIO Status Group, returned to the controller as the first of the assigned input groups.

7.1 Remote I/O Communications Status Indicator

A green LED on the bottom front of the MARIO is used to indicate network activity on the RIO link. This indicator is extinguished until a RESET OUTPUTS command is received from the PLC, at which time it begins to flash at a 2Hz rate. When the outputs are updated by the PLC, the indicator remains on steadily. If RIO traffic addressed to the MARIO ceases, the indicator is again extinguished.

7.2 Adapter Status Indicator

A red/green/amber tricolor LED on the top front of the MARIO is used to indicate general module health. This indicator is initially amber while the software tests the MARIO memory and communications devices, becoming green if all tests pass, or flashing red/off at 5Hz if a test fails. When a switch setting error is detected as the switches are read, this indicator flashes red/off at a 2Hz rate. When an external computer is connected to the MARIO for loading a module software upgrade, this indicator flashes red/green at a 2Hz rate. During normal operation, this indicator is a steady green, flashing amber for 1/2-second when an RIO network data error occurs.

7.3 Mario Adapter Status Group Data

The controller, during normal operation, communicates regularly with each of the installed and configured Concurrent I/O devices (such as MARIO), passing it fresh output data and receiving fresh input data. The first input data group from the MARIO contains status information, as detailed in Table 7-1.

Table 7-1 Adapter Status Group Bits

BIT	MEANING WHEN CLEAR (0)	MEANING WHEN SET (1)
7	not used, always 0	n/a
6	not used, always 0	n/a
5	CPU ready	CPU not ready (hardware fault)
4	PLC communications OK or not established	PLC communications were OK, now failed
3	PLC communications OK	PLC communications not OK
2	adapter switches OK	adapter switch setting error
1	not used, always 0	n/a
0	not used, always 0	n/a

Bit 5 is set if the adapter fails in its self-test, but passes sufficiently to communicate with the controller, or if some error causes the adapter to be reset by the hardware watchdog. If the self-test fails to the extent that communication is not possible, it is the responsibility of the controller to detect it and to indicate that the adapter has failed. If the adapter self-test fails, then after communicating the failure in the Adapter Status group, if possible, the MARIO does not continue with normal operation. If the hardware watchdog causes the adapter to be reset, then this bit is set for no less than 50ms, and then cleared. In this case, the MARIO continues normal operation.

Bit 4 is initially clear, and is set only if communication with the PLC fails, after having been once established. After a communication failure occurs, attempts are made to restart communications. This bit is cleared whenever valid communication is made with the scanner.

Bit 3 is initially set, and is cleared whenever valid communication is made with the scanner. It is set again when any communications fault is detected, as with bit 4.

Under various conditions, bits 3 and 4 are as indicated in Table 7-2.

Table 7-2 Adapter Status Communications State Indication

COMMUNICATIONS STATE	BIT 4	BIT 3
Communicating OK	0	0
Communications never established	0	1
PLC always in Program mode	0	1
Comm OK, then cable disconnected	1	1
Comm OK, then PLC entered Program mode	1	1
Comm OK, then error	1	1
Comm OK, then NA chip fail	1	1

Bit 2 is set or cleared after reading the adapter switches used for defining PLC communications parameters (i.e., rack number, starting quarter, number of I/O groups). It is set if these parameters are illegal, as defined below, and cleared otherwise:

- Any non-octal number (digits 8 or 9) in rack number
- Rack 77_8 starting at other than the first quarter
- Rack 77_8 with more than 4 I/O groups
- Any rack starting at second quarter, with more than 12 I/O groups
- Any rack starting at third quarter, with more than 8 I/O groups
- Any rack starting at fourth quarter, with more than 4 I/O groups

No Adapter Status group bit changes state faster than 50ms since its last state change, to ensure its readability by the controller.

SECTION 8
SOFTWARE FUNCTIONALITY

8.1 Remote I/O Rack Size and Addressing

CAUTION!

If the configuration of the board is changed, the controller's configuration must be reconfigured to reflect he change. Depending on the configuration of the PLC, a modification might also be required to that system.

The MARIO appears to the scanner PLC and communicates on the network as if it were a rack (or partial rack) of I/O. Addressing within the RIO link is based on logical rack addresses. A logical rack is 128 input bits and 128 output bits (8 input words and 8 output words), distributed among the rack's 16 logical slots. Partial rack addressing may be made, depending on the number of I/O points contained at the node, on quarter-rack boundaries and in quarter-rack denominations. In the MARIO, the size has an upper limit of one full rack (128 I/O points), and is set by the switch that selects the number of I/O points, according to Table 7-2, on the preceeding page.

NOTE: The number of available I/O points is dependent upon controller application. In most cases 112 I/O points will be available.

The address of the MARIO on the RIO link is set with the thumbwheel switches, to set the rack number, and with the Starting Rack Quarter switch set according to the table above. This allows setting of the MARIO address on partial rack boundaries, if less than a full rack of I/O is required. Switch setting errors result in a flashing red LED, and are communicated to the controller via the MARIO Status Group. Table 8-1 summarizes the number of I/O points available to the possible partial racks. A (-) in the table indicates impossible starting quarter and size combinations.

Table 8-1 Remote I/O Points in Partial Racks

STARTING QUARTER	PARTIAL RACK SIZE IN POINTS			
	1/4	1/2	3/4	FULL
1ST	32	64	96	128
2ND	32	64	96	--
3RD	32	64	--	--
4TH	32	-	--	--

8.2 Robot I/O Point to Remote I/O Point Mapping

Software resident on the MARIO maps data between the assigned External Input and External Output locations in the controller and the points in the rack (or partial rack) that is being presented to the scanner.

Scanner output points are copied to the controller External Inputs in a one-to-one fashion. This effectively connects the first of the PLC's discrete outputs for the MARIO rack with the first controller input assigned to the MARIO, immediately following the MARIO Status Group, which is always the first. An output that is set by the scanner (an energized coil) appears as a set input to the controller, and an output that is cleared by the scanner (a de-energized coil) appears as a clear input to the controller.

Robot output points are copied to scanner input points in a one-to-one fashion. This effectively connects the first controller output assigned to the MARIO with the first of the PLC's discrete inputs for the MARIO rack. An output that is set by the robot appears as a set input point to the scanner, and an output that is cleared by the robot appears as a clear input point to the scanner.

Since partial racks are assigned in quarter-rack (32 I/O points) denominations, while robot I/O points are assigned in single group (8 I/O points) denominations, the scanner may have accessible points that do not map to any robot point. Making use of these does not affect the MARIO or robot since such points are ignored by MARIO software.

8.3 Block Transfers

Since all controllers use only discrete I/O points, with no analog I/O, RIO block transfers are unnecessary and are not supported by the MARIO software.

SECTION 9
ENVIRONMENTAL SPECIFICATIONS

The MARIO has the following power and environmental requirements:

Table 9-1 Power and Environmental Requirements

Humidity	15%-95% non-condensing
Temperature	
Operating ambient	0 to 55° C (32 to 131° F)
Storage ambient	-20 to 70° C (-4 to 158° F)
Flame retardant	uses UL94V-0 components

SECTION 10

PLC-2, PLC-3, PLC-5, AND SLC-500 CONNECTIONS

When connecting to a PLC-2, the MARIO occupies the remainder of the rack in which it is set to start. This means that if, for example, a quarter rack other than the MARIO exists beginning at rack address 03_8, and the MARIO is set to start at the second quarter of rack address 03_8, then it will occupy the second, third, and fourth quarters of that rack, regardless of the number of I/O points that are being transferred. Furthermore, a PLC-2 network will address only racks 01_8 through 07_8, and rack addresses are offset by one, requiring that the MARIO rack address switches be set to 00_8 through 06_8 to select PLC-2 racks 01_8 through 07_8, respectively.

When connecting to a PLC-3, the above restrictions do not apply; however, rack addresses between 00_8 and 37_8 are termed standard I/O, and those above 37_8 are termed supplementary I/O, and impose other limitations:

- Program instructions that reference supplementary I/O use one word of memory more than instructions referencing standard I/O;
- Program instructions addressing bits reflecting standard I/O are executed up to 10 times faster than instructions addressing bits reflecting supplementary I/O;
- The scan time is extended when supplementary I/O addresses are used;
- Rack 77_8 is not available on a PLC-3.

None of the above restrictions applies when connecting to a PLC-5. When connecting to a SLC-500, rack 00_8 is unavailable, as it is used for addressing local I/O.

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