

ArcWorld[®] IV-6000 SYSTEM MANUAL

for ArcWorld IV-6000 and ArcWorld IV-6000HD

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

MOTOMAN INSTRUCTIONS

MOTOMAN XXXXXX INSTRUCTIONS

DX100 INSTRUCTIONS

DX100 OPERATOR'S MANUAL

DX100 MAINTENANCE MANUAL

The DX100 operator's manual above corresponds to specific usage.
Be sure to use the appropriate manual.


Part Number: 156601-1CD

Revision: 1



YASKAWA

MANUAL NO.

156601-1CD 



MANDATORY

- This system manual provides an overview of the Motoman ArcWorld® IV-6000 system. It gives general information about the system, a description of its major components, and the procedures for installation, system operation, and preventive and repair maintenance. Be sure to read and understand this manual thoroughly before installing and operating the ArcWorld® IV-6000 system.
- General items related to safety are listed in Section 2 of the *DX100 Controller Manual*. To ensure correct and safe operation, carefully read the *DX100 Controller Manual* before reading this manual.



CAUTION

- Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure that all covers and shields are replaced before operating this product.
- The drawings and photos in this manual are representative examples, and differences may exist between them and the delivered product.
- YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications.
- If such a modification is made, the manual number will also be revised.
- If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.
- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product's warranty.

Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the Motoman ArcWorld® IV-6000 system.

In this manual, the Notes for Safe Operation are classified as "WARNING," "CAUTION," "MANDATORY," or "PROHIBITED."



WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.



CAUTION

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to personnel and damage to equipment. It may also be used to alert against unsafe practices.



MANDATORY

Always be sure to follow explicitly the items listed under this heading.



PROHIBITED

Must never be performed

Even items described as "CAUTION" may result in a serious accident in some situations. At any rate, be sure to follow these important items.



To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as "CAUTION" and "WARNING."



WARNING

- Before operating the manipulator, check that servo power is turned OFF by pressing the EMERGENCY STOP buttons on the operator station or Programming Pendant (refer to *Figure 1*). When servo power is turned OFF, the SERVO ON LED on the Programming Pendant is turned OFF.

Injury or damage to machinery may result if the Emergency Stop circuit cannot stop the manipulator during an emergency. The manipulator should not be used if the EMERGENCY STOP buttons do not function.

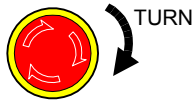
Figure 1: EMERGENCY STOP Button



- Release the EMERGENCY STOP button (refer to *Figure 2*). Once this button is released, clear the cell of all items which could interfere with the operation of the manipulator. Then turn servo power ON.

Injury may result from unintentional or unexpected manipulator motion.

Figure 2 : Release of EMERGENCY STOP Button



- Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator:
 - View the manipulator from the front whenever possible.
 - Always follow the predetermined operating procedure.
 - Ensure that you have a safe place to retreat to in case of emergency.

Improper or unintended manipulator operation may result in injury.

- Confirm that no person is present in the P-point maximum envelope of the manipulator and that you are in a safe location before:
 - Turning on the power for the DX100 controller.
 - Moving the manipulator with the Programming Pendant.
 - Running the system in the check mode.
 - Performing automatic operations.

Injury may result if anyone enters the P-point maximum envelope of the manipulator during operation. Always press an EMERGENCY STOP button immediately if there is a problem. The EMERGENCY STOP buttons are located on the operator station and on the Programming Pendant.



CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately and be sure that all other necessary processing has been performed.
 - Check for problems in manipulator movement.
 - Check for damage to insulation and sheathing of external wires.
- Always return the Programming Pendant to the hook on the cabinet of the DX100 controller after use.

The Programming Pendant can be damaged if it is left in the manipulator's work area, on the floor, or near fixtures.

- Read and understand the Explanation of Warning Labels in the *DX100 Controller Manual* before operating the ArcWorld® IV-6000 system.

Definition of Terms Used Often in This Manual

The MOTOMAN manipulator is the YASKAWA industrial robot product.

The manipulator usually consists of the controller, the Programming Pendant, and supply cables.

In this manual, the equipment is designated as follows:

Equipment	Manual Designation
DX100 controller	DX100
DX100 Programming Pendant	Programming Pendant
Cable between the manipulator and the controller	Manipulator cable

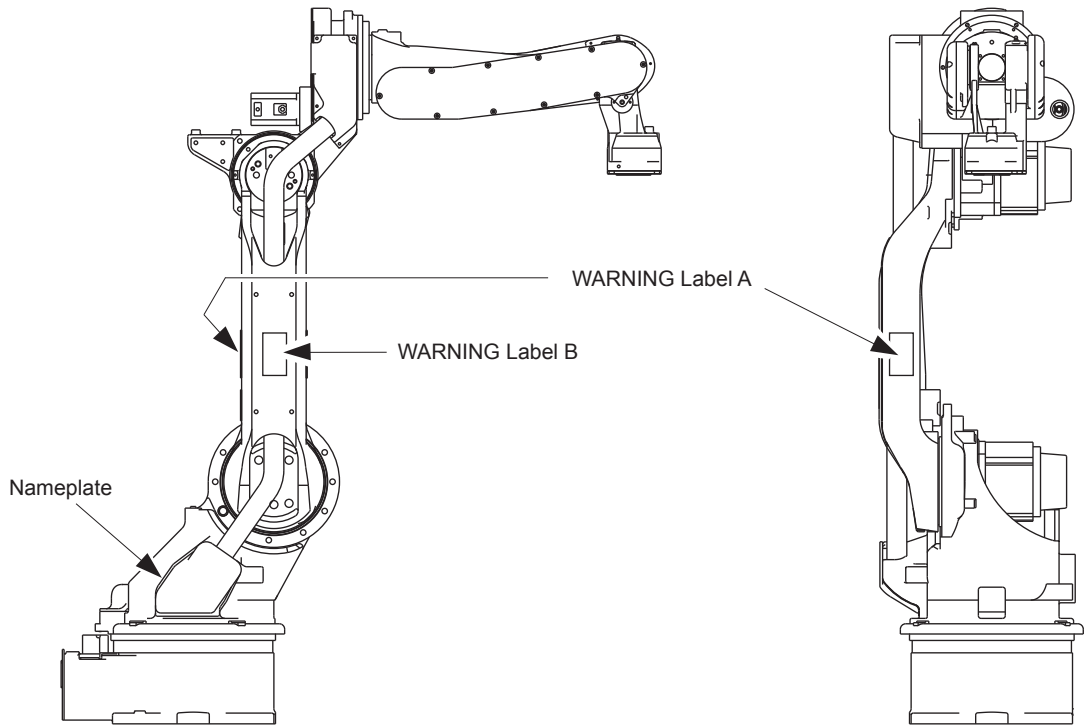
Explanation of Warning Labels

The following warning labels are attached to the manipulator (refer to *Figure 3*).


Always follow the warnings on the labels.

Also, an identification label with important information is placed on the body of the manipulator. Prior to operating the manipulator, confirm the contents.

Figure 3: Warning Labels Location



Nameplate:

MOTOMAN	
TYPE □□□□□	
PAYLOAD □□ kg	MASS □□□ kg
ORDER NO. □□□□□□	DATE □□
SERIAL NO. □□□□□□	
 YASKAWA ELECTRIC CORPORATION JAPAN	

WARNING Label A:



WARNING Label B:



1	Introduction	1-1
1.1	About This Document	1-1
1.2	System Overview	1-2
1.2.1	System Layout	1-3
1.2.2	Major Components	1-3
1.2.3	Optional Equipment	1-4
1.3	Reference Documentation	1-4
1.4	Customer Support Information	1-4
2	Equipment Description	2-1
2.1	Robot Description	2-1
2.2	DX100 Controller	2-1
2.2.1	Programming Pendant	2-2
2.3	Operator Station	2-4
2.3.1	Operator Station — CYCLE START/CYCLE LATCHED	2-4
2.3.2	Operator Station — Emergency Stop (E-STOP)	2-4
2.3.3	Operator Station — ROBOT HOLD	2-4
2.3.4	Operator Station — ALARM	2-5
2.3.5	Operator Station — POSITIONER AUTO/MANUAL	2-5
2.3.6	Operator Station — START	2-5
2.3.7	Operator Station — RESET	2-5
2.3.8	Operator Station — SERVO ON	2-5
2.3.9	Operator Station — JOYSTICK CONTROL (Option)	2-5
2.4	MRM2-M3X Series Positioner	2-5
2.5	Welding Equipment	2-6
2.5.1	Welding Power Sources	2-6
2.5.2	Wire Feeder	2-6
2.5.3	GMAW Torch	2-7
2.6	Safety Features	2-7
2.6.1	Welding Arc Protection	2-7
2.6.2	Safety Fencing	2-8
2.6.3	Safety Light Curtains	2-8
2.6.4	Emergency Stop (E-STOP)	2-8
2.6.5	Programming Pendant's ENABLE Switch	2-8
2.6.6	Emergency Braking System	2-9

2.6.7	Interlocked Work-cell Access Door.....	2-9
3	Installation.....	3-1
3.1	Required Materials.....	3-1
3.1.1	Customer-supplied Items.....	3-1
3.1.2	Recommended List of Hand Tools and Equipment.....	3-2
3.2	Site Preparation.....	3-2
3.3	Removal of System Components from Shipping Skids.....	3-3
3.4	Installation — MRM2-M3X Series Positioner.....	3-5
3.5	Installation — Robot Common Base.....	3-6
3.6	Installation — Safety Fence Assembly.....	3-8
3.6.1	Door Latch Alignment.....	3-9
3.7	Installation — Arc Curtains.....	3-10
3.8	Installation — Safety Light Curtain System.....	3-11
3.9	Installation — Operator Station.....	3-12
3.10	Cable Connections.....	3-12
3.10.1	Connection to Earth Ground.....	3-12
3.10.2	Connecting the Robot Cables.....	3-14
3.10.3	Connection to Local Electrical Service.....	3-15
3.10.3.1	DX100 Controller.....	3-16
3.10.3.2	Welding Power Sources.....	3-16
3.11	Safety/Operation Check.....	3-16
3.12	Installation of Tooling and Fixtures.....	3-17
4	Operation.....	4-1
4.1	Programming.....	4-1
4.2	Sweeping the Positioner.....	4-1
4.3	Daily Operation.....	4-2
4.3.1	Start-up Procedure.....	4-2
4.3.2	Robot HOME Position.....	4-3
4.3.3	Master Job.....	4-3
4.3.4	Operation Cycle.....	4-4
4.3.5	Shutdown Procedure.....	4-4
4.4	System Recovery.....	4-5
4.4.1	Alarms and Errors.....	4-5
4.4.1.1	Error Messages.....	4-5

4.4.1.2	Minor Alarms	4-5
4.4.1.3	Major Alarms	4-5
4.4.2	E-STOP Recovery	4-5
4.4.3	Shock Sensor Recovery	4-6
5	Maintenance.....	5-1
6	Anchoring.....	6-1

1 Introduction

1.1 About This Document

This system manual provides a “first look” and overview of the complete Motoman ArcWorld® IV-6000 system. You should read and understand this system manual before moving on to the more detailed documentation that is included with your ArcWorld® IV-6000 system. Although basic in content, the system manual is intended for personnel who have received operator training from Motoman and who are familiar with the operation of this particular Motoman system. For more detailed information on any specific component or peripheral of the ArcWorld® IV-6000 system, please review the full documentation package that is included with your ArcWorld® IV-6000 system (refer to *Section 1.3*).



This manual documents a standard Motoman system. If your system is custom or modified, please use this manual in conjunction with the drawings, schematics, and parts listing (Bill of Material) for your specific system. The drawings, schematics, and parts listing are included in the documentation package supplied with your Motoman system.

This system manual contains the following sections:

Section 1 – Introduction

This section provides general information about the ArcWorld® IV-6000 system, a list of reference documents, and customer support contact information.

Section 2 – Equipment Description

This section provides a description of the major components of the ArcWorld® IV-6000 system.

Section 3 – Installation

This section provides installation procedures for the ArcWorld® IV-6000 system.

Section 4 – Operation

This section provides an overview of ArcWorld® IV-6000 system operation, including start-up, loading, normal operations, fault recovery, and system shutdown.

Section 5 – Maintenance

This section provides preventive maintenance requirements for certain components of the ArcWorld® IV-6000 system.

Section 6 – Anchoring

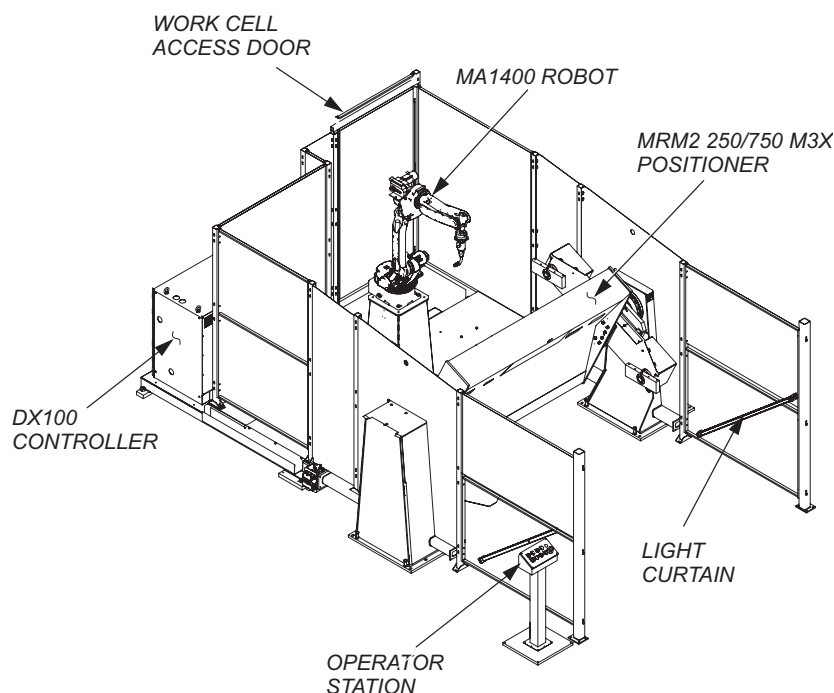
This section gives recommended anchoring hardware specifications and foundation requirements for all the equipment that is part of the ArcWorld® IV-6000 system.

1.2 System Overview

The ArcWorld® IV-6000 system provides a complete arc-welding solution in a standardized configuration (see *Figure 1-1*). The ArcWorld® IV-6000 is designed around a Motoman MA1400 or MA1900 robot, a DX100 controller, welding power source, and an MRM2-series positioner (MRM2-250M3X, or MRM2-750M3X). Refer to *Section 2.2* for a description of features and advantages of the DX100 controller configuration. Refer to *Section 2.4* for a description of the MRM2-Series positioners.

The ArcWorld® IV-6000 system features a total safety environment that meets or exceeds the requirements of the ANSI/RIA R15.06 Robot Safety standard and is designed to safeguard both personnel and equipment. Heavy-gauge, wire-mesh safety fencing prevents unintended entry of personnel into the work cell while it is in operation. Arc curtains cover the wire-mesh fencing to attenuate the amount of arc radiation that escapes the work cell during welding operations. A dual-interlocked access door at the rear of the work cell provides convenient access to equipment while providing a safety interlock to disable all equipment should the access door be opened while the robots are active. A safety light curtain system provides a “sensing field” in front of the positioner to protect the operator. Positioner movement is prevented whenever an operator is in a position that disrupts the sensing field of the light curtain system. In addition, maximum robot travel is physically limited by an S-axis “hard stop” at the base of each robot.

Figure 1-1: System Layout



ArcWorld® IV-6000	1	Introduction
	1.2	System Overview

1.2.1 System Layout

The MA-Series manipulator, MRM2-Series positioner, and heavy-gauge, welded wire safety fencing all share a common steel base for ease of installation and assurance of proper alignment between the robot and positioner. The welded wire safety fencing completely surrounds the ArcWorld® IV-6000 work cell. The DX100 controller shares a common equipment platform with the welding power source.

The common equipment platform is located outside and to the rear of the work cell. This arrangement allows most of the component wiring interconnects to be pre-wired at the factory, thus reducing the amount of point-to-point wiring required of the customer. All operator controls, including those on the Programming Pendant, DX100 controller, welding power supply, and Operator Station, are accessible from outside the ArcWorld® IV-6000 work cell.

1.2.2 Major Components

The ArcWorld® IV-6000 system includes the following major components:

- Motoman MA1400 or MA1900 manipulator
- One DX100 controller assembly
- One MRM2-Series positioner:
 - MRM2-250 M3X
 - MRM2-750 M3X
- One Programming Pendant (located on DX100 controller)
- One Operator Station
- Welding equipment:
 - Welding power supply
 - Welding torch (air-cooled)
 - Wire feeder
 - Applicable welding interface
 - Torch mount
- Safety equipment:
 - Heavy-gauge, wire-mesh safety fencing
 - Arc curtains (cover the safety fencing)
 - Light curtain system
 - Interlocked work-cell access door
 - Steel arc screen on the positioner

1.2.3 Optional Equipment

The following optional equipment is available for use with the ArcWorld® IV-6000 system:

- Torch cleaner
- Wire cutter
- Water-cooled torch (with water circulator)
- TouchSense™ (starting point detection)
- ComArc™ (seam tracking)

1.3 Reference Documentation

For additional information on individual components of the ArcWorld® IV-6000 system, refer to the following documentation that is included with your system:

- Motoman *MA1400 Manipulator Manual* (P/N 155557-1CD)
- Motoman *MA1900 Manipulator Manual* (P/N 156226-1CD)
- Motoman *Brake Release Manual* (P/N 156239-1CD)
- Motoman *DX100 Controller Manual* (P/N 155494-1CD)
- Motoman *Maintenance Manual for DX100* (P/N 155492-1CD)
- Motoman *Operator's Manual for Arc Welding* (P/N 155490-1CD)
- Motoman *DX100 Concurrent I/O Manual* (P/N 155491-1CD)
- Motoman *MRM2-250M3X Positioner Manual* (P/N 152565-1CD)
- Motoman *MRM2-750M3X Positioner Manual* (P/N 152565-2CD)
- Motoman *DX100 Independent/Coordinated Control Function Manual*
- Motoman *INFORM User's Manual* (P/N 155493-1CD)
- Vendor manuals for system components not manufactured by Motoman

1.4 Customer Support Information

If you need assistance with any aspect of your ArcWorld® IV-6000 system, please contact Motoman Customer Support at the following 24-hour telephone number:

(937) 847-3200

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

techsupport@motoman.com

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

ArcWorld® IV-6000	1	Introduction
	1.4	Customer Support Information



Please use e-mail for **routine** inquiries only. If you have an urgent or emergency need for service, replacement parts, or information, you must contact Motoman Customer Support at the telephone number shown above.

Please have the following information ready before you call:

- | | |
|----------------------------|--|
| • System | ArcWorld® IV-6000 |
| • Robots | MA1400 or MA1900 |
| • Positioner | MRM2-250M3X
MRM2-750M3X |
| • Primary Application | Arc Welding |
| • Controller | DX100 |
| • Software Version | Access this information on the Programming Pendant's LCD display screen by selecting {MAIN MENU} - {SYSTEM INFO} - {VERSION} |
| • Robot Serial Number | Located on the robot data plate |
| • Robot Sales Order Number | Located on the DX100 controller data plate |

2 Equipment Description

2.1 Robot Description

The ArcWorld® IV-6000 system uses the Motoman MA-Series six-axis robot(s). The MA-Series robots are specifically designed for arc-welding applications. The MA1400 robot has a payload capability of 3 kg and features a horizontal reach of 1434 mm. The MA1400 robot features a relative positioning accuracy of ± 0.08 mm. The MA1900 robot has a payload capability of 3 kg and features a horizontal reach of 1,904 mm. The MA1900 robot also features a relative positioning accuracy of ± 0.08 mm.

The MA-Series robots feature an internal cabling design that provides high flexibility and streamlines the robot profile, thus allowing access into confined spaces. The robot's B-axis (Pitch/Yaw) features an expanded range of motion that improves circumferential welding on cylindrical work pieces. The T-axis (Twist) can rotate the welding torch ± 200 degrees without cable interference.

The robot's S-axis rotation is physically limited by hard stops located in the base of each robot. For more information, refer to the *MA1400 or MA1900 Manipulator Manual* that came with your ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

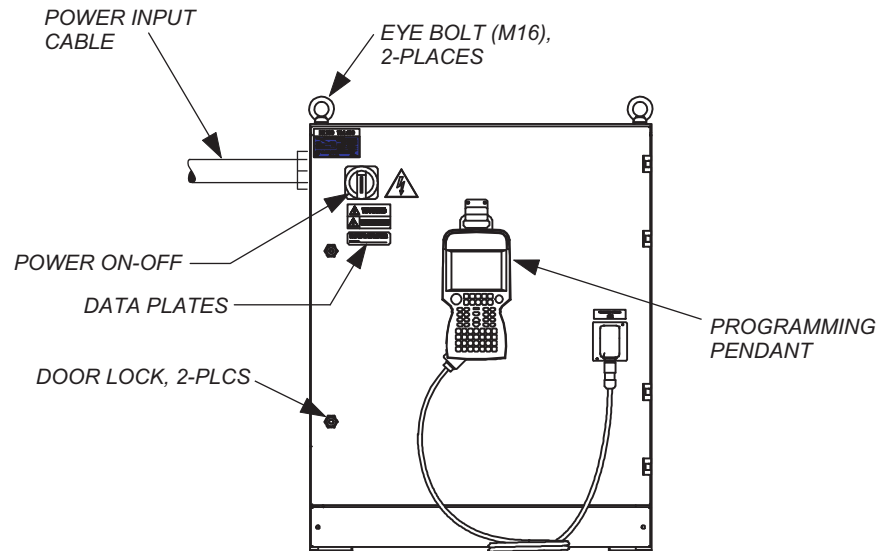
2.2 DX100 Controller

The DX100 robotic controller (see *Figure 2-1*) includes a Windows® CE Programming Pendant with a color touch screen, high-speed processing, built-in Ethernet, and a robust PC architecture. The DX100 easily handles multiple tasks and can control up to eight robots (up to 72 axes, including robots and external axes) and input/output (I/O) devices. Advanced Robot Motion (ARM) control provides high-performance path accuracy and vibration control.

The DX100 coordinates the operation of the ArcWorld® IV-6000 system. It controls manipulator movement and welding power supply, processes input and output signals, and provides the signals to operate the welding system.

For additional information on the Motoman DX100 controller, please refer to the *DX100 Controller Manual* that is included with your ArcWorld® IV-6000 documentation package (see *Section 1.3*).

Figure 2-1: DX100 Controller

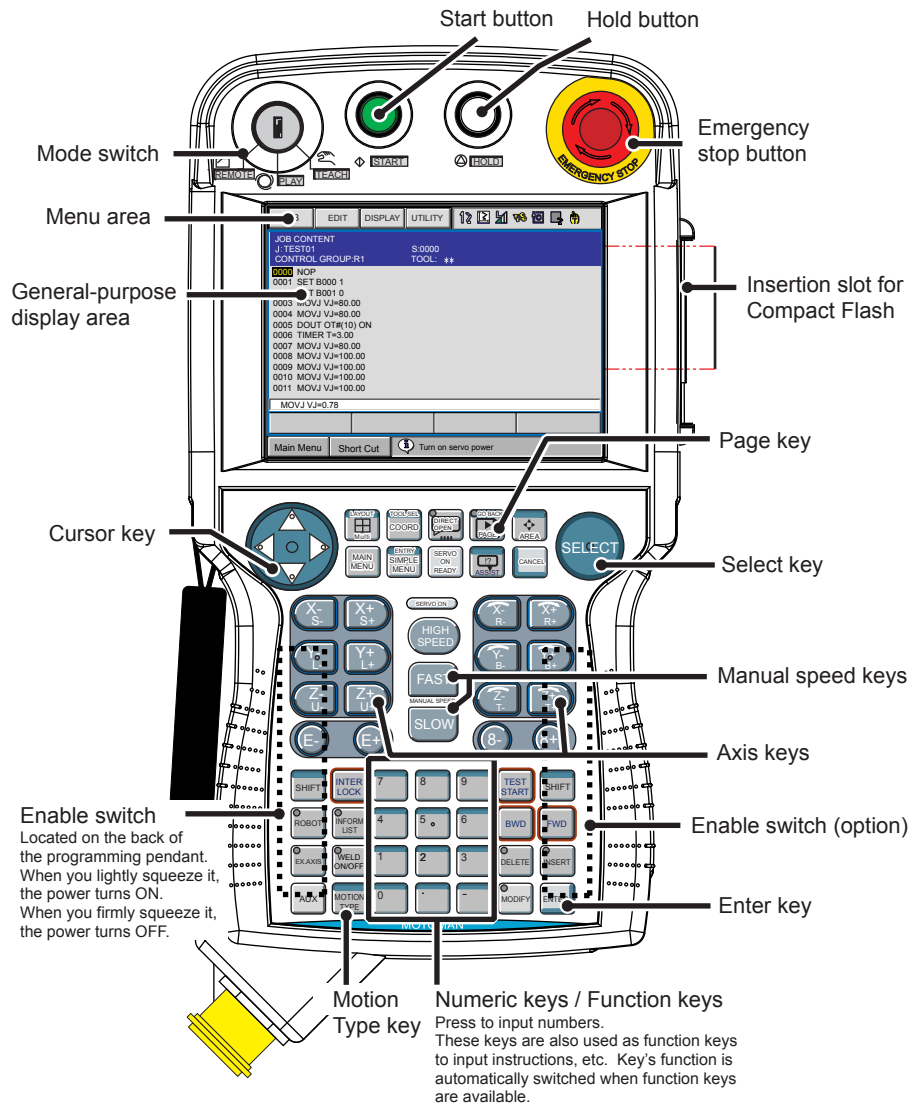


2.2.1 Programming Pendant

The Programming Pendant (see *Figure 2-2*) provides the primary means of programmer/operator interaction with the ArcWorld® IV-6000 system. The pendant features the Windows® CE operating system and displays information on a 6½ -inch, color LCD, touch-screen display (640 X 480 VGA). The pendant also incorporates a CompactFlash® card slot for program backups.

The Programming Pendant provides icon-driven system programming. It also features a menu-driven interface to simplify operator interaction with the robots. Most operator controls are located on the Programming Pendant. This allows remote installation of the DX100 controller. By using the Programming Pendant, the operator can teach the robots motion; perform programming, editing, maintenance, and diagnostic functions; and enable or disable Operator Station control of the ArcWorld® IV-6000 system. For detailed information on the pendant's programming keys, programming functions, and display functions, please refer to the *DX100 Operator's Manual for Arc Welding* that is included with your ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

Figure 2-2: DX100 Programming Pendant

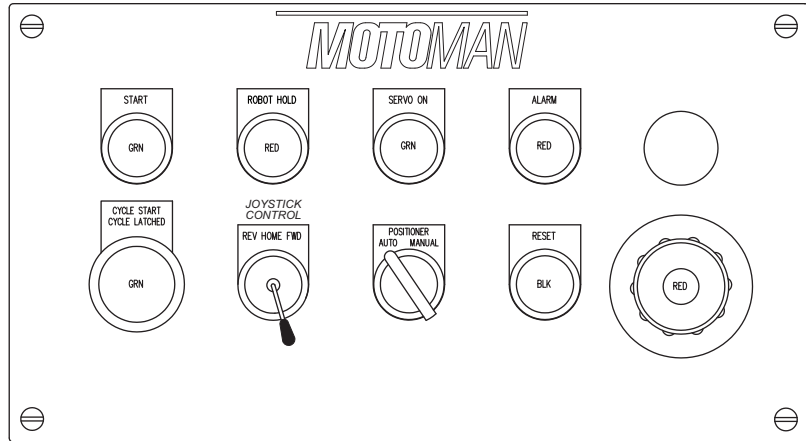


- NOTE**
- The Programming Pendant's LCD display goes dark after a few minutes of inactivity. Press any key to restore the screen.
 - Operator Station Enable or Disable is accomplished with the Programming Pendant's Mode Select Switch. To transfer control of the ArcWorld® IV-6000 system to the Operator Station, set the Mode Select Switch to REMOTE.

2.3 Operator Station

The Operator Station (see *Figure 2-3*) includes a NEMA enclosure on a stand-alone pedestal. The following paragraphs describe the controls on the Operator Station.

Figure 2-3: Operator Station



2.3.1 Operator Station — CYCLE START/CYCLE LATCHED



WARNING

The operation of the CYCLE START/CYCLE LATCHED button is dependent on the structure of the Control Master job. Any alteration of the Control Master Job could result in injury to personnel or damage to equipment.

Pushing the green CYCLE START/CYCLE LATCHED button initiates a positioner sweep cycle if the robots are in HOME (Safe) position. If the CYCLE START/CYCLE LATCHED push button is pressed while the robots are welding, or otherwise not in HOME (Safe) position, the Cycle Start command is “latched” into (stored in) the DX100 controller circuitry. When the robots return to HOME (Safe) position, the “latched” Cycle Start command is executed and the positioner sweeps. Circuitry in the DX100 controller prevents the positioner from continuously cycling should the operator depress and hold the CYCLE START/CYCLE LATCHED push button.

2.3.2 Operator Station — Emergency Stop (E-STOP)

Pressing the Operator Station’s Emergency Stop (E-STOP) push button initiates an Emergency Stop (E-STOP). Refer to *Section 2.6.4* for a discussion of the E-STOP function and the procedures for recovering the ArcWorld® IV-6000 system from the Emergency stop (E-STOP) condition.

2.3.3 Operator Station — ROBOT HOLD

Pressing the red ROBOT HOLD button stops robot operation and interrupts the job until the operator presses the green START button to resume operation. Operation resumes at the point in the program where the ROBOT HOLD state was initiated.

2.3.4 Operator Station — ALARM

A red ALARM lamp illuminates to indicate that the DX100 controller has encountered an alarm condition.

2.3.5 Operator Station — POSITIONER AUTO/MANUAL

The POSITIONER AUTO/MANUAL switch is used to select automatic or manual mode for the positioner. When the switch is set to the AUTO position, the robots weld the parts immediately after the positioner sweeps. When the switch is set to the MANUAL position, the robots do not immediately start to weld after the positioner sweeps. The robots remain in HOME position.



The POSITIONER AUTO/MANUAL signal depends upon the structure of the Control Master job.

2.3.6 Operator Station — START

Pressing the green START button starts the current, active job. The Programming Pendant's Mode Select Switch must be set to REMOTE and servo power must be ON for the START button to function.

2.3.7 Operator Station — RESET

The black RESET button is used to clear a minor alarm or error condition.

2.3.8 Operator Station — SERVO ON

The green SERVO ON push button turns servo power on if the Programming Pendant's Mode Select Switch is set to REMOTE.

2.3.9 Operator Station — JOYSTICK CONTROL (Option)

The MRM2-M3X Series positioners have the ability to position each tooling axis (orbital axis) $\pm 360^\circ$ in 2.5° increments for better part-loading and unloading ergonomics. This rotation of the orbital axis in 2.5° increments (also known as "jogging") is accomplished with the optional JOYSTICK CONTROL located on the Operator Station (see *Figure 2-3*).

2.4 MRM2-M3X Series Positioner

The MRM2-M3X Series positioners are high-speed, three-axis, AC servo-controlled "Ferris-wheel" type positioners. The MRM2-250M3X positioner provides 250-kg capacity per side and three servo axes for high speed positioning. The MRM2-750M3X positioner has a 750-kg capacity per side and also includes three servo axes for high-speed positioning. Fixture lengths are available in 2 or 3 meters.

One external axis is used to rotate the trunnion (swing arm) axis, while the two additional servo motors are used to rotate the two orbital (parts fixture) axes independently of the trunnion (swing arm) axis. The positioner uses a reciprocating motion that sweeps each side of the "Ferris-wheel" type positioner, from the operator's loading zone into the robot work zone and back to the operator again. A metal arc screen divides the positioner into two work areas: Side A and Side B. When Side A is in the robot's welding zone, Side B is facing the operator and ready to be loaded or unloaded.

ArcWorld® IV-6000	2	Equipment Description
	2.5	Welding Equipment



- The customer shall supply all tooling and fixtures for the positioner.
- Motoman recommends application of a corrosion/rust preventive compound to tooling and fixtures located in a high-humidity environment.

The ArcWorld® IV-6000 system is capable of synchronized motion between various components depending on the job configuration. The robot can be synchronized with the positioner to work simultaneously with a rotating work piece. For additional information on this type of independent control and coordinated motion, refer to the DX100 *Independent/Coordinated Control Function Manual* that is included with the ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

For additional positioner information, including specifications, an illustrated parts list, load capabilities, and dimensions, refer to the *Motoman Positioner Manuals* included with the ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

2.5 Welding Equipment

In its standard configuration, the ArcWorld® IV-6000 system includes a welding power source, wire feeder, torch, and torch mount for each of the robots. Optional equipment may also be included with your ArcWorld® IV-6000 system (refer to *Section 1.2.3*).

2.5.1 Welding Power Sources

Motoman offers various brands and types of welding power sources. The welding power sources supplied with the ArcWorld® IV-6000 system depends on the customer's specific application and preference. For specific information on the welding power sources supplied with your ArcWorld® IV-6000 system, refer to the welding power source manual that is included with the system documentation package (see *Section 1.3*).

2.5.2 Wire Feeder

A welding wire feeder is mounted on the upper arm (U-Axis) of each robot. The wire feeder is the "4-roll" type and provides reliable wire feeding at rates up to 750 inches per minute (ipm). An electronically controlled gas valve provides fast welding gas response time. Interchangeable feed rolls are used to accommodate different wire gauges and wire types. For additional information on how the wire feeder is mounted to the robot's upper arm, including allowable load and installation position, refer to the wire feeder documentation that is included with the ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

2.5.3 GMAW Torch

The ArcWorld® IV-6000 system uses either an air-cooled or water-cooled robotic/automatic GMAW torch for each robot. These are heavy-duty torches designed for quick replacement and minimum of robot reprogramming. The GMAW torch is installed in a torch mount at the end of the robot's wrist flange. The torch mount provides multi-dimensional impact (collision) detection to protect the robot, torch, fixture, positioner, and work piece from damage in the event of a collision. Any torch impact (collision) triggers an Emergency Stop condition (refer to *Section 4.4.2* and *Section 4.4.3*).

For applications that use the optional water-cooled torch, the ArcWorld® IV-6000 system includes a water circulator kit for each robot. For additional information on the torches that are supplied with your system, refer to the vendor documentation that is included with the ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

2.6 Safety Features

The ArcWorld® IV-6000 system includes a total safety environment. If you comply with all the safety instructions and precautions given throughout this manual, the safety equipment helps to ensure safe operation of the robot work cell.



Users are responsible for determining that the safeguards provided with the ArcWorld® IV-6000 system are adequate for their plant conditions. Users must also ensure that all safeguards are maintained in working order.

2.6.1 Welding Arc Protection

One by-product of the welding arc is an intense level of ultraviolet light. The ultraviolet light radiates outwardly (equal strength in all directions) from the weld point whenever an arc is established. If not attenuated, the radiated ultraviolet light can present a health risk to personnel near the welding arc.

Two forms of welding arc protection are part of the ArcWorld® IV-6000 system:

- a steel arc screen on the positioner
- arc curtains (attached to the steel-mesh safety fencing)

The steel arc screen on the positioner is always positioned between the welding arc and the operator. This protects the operator from the ultraviolet light radiation and sparks that result from the welding operation (see *Figure 1-1*).



WARNING

Although safety fence arc curtains block the radiation of ultraviolet light, never look directly at the welding arc without protective eye wear.

The arc curtains filter (or "block") most of the ultraviolet light radiation that would otherwise escape the work cell. Just as the arc screen on the

ArcWorld® IV-6000	2	Equipment Description
	2.6	Safety Features

positioner protects the operator from intense ultraviolet light, the arc curtains protect other personnel who are near the work cell.

2.6.2 Safety Fencing

The heavy-gauge, welded wire safety fencing that is provided with the ArcWorld® IV-6000 system encloses the entire work cell. It forms a physical barrier that prevents personnel from entering the work cell during automatic operation.

2.6.3 Safety Light Curtains

Infrared safety light curtains protect the operator from positioner movement. The positioner will not sweep if the light path (between the light curtain's Send unit and Receive unit) is obstructed. Should any person or object enter this zone during a positioner sweep from A to B (or B to A), an E-STOP condition is triggered (refer to *Section 2.6.4*).

For additional information on the safety light curtain system, refer to the vendor documentation that is included with the ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

2.6.4 Emergency Stop (E-STOP)

Emergency Stop (E-STOP) is a primary safety feature of the ArcWorld® IV-6000 system. A work-cell access door interlock, the safety light curtain system, robot welding torch impact (collision) detection circuitry (refer to *Section 2.5.3*), and E-STOP push buttons can all trigger an E-STOP condition. An E-STOP condition immediately de-energizes the control system and activates the robot emergency braking system (refer to *Section 2.6.6*). The E-STOP push buttons are used for an intentional shutdown of the ArcWorld® IV-6000 system and are installed at the following locations:

- Programming Pendant
- Operator Station

To resume operation after an E-STOP system shutdown, the operator must clear and reset the action that caused the E-STOP condition (refer to *Section 4.4.2*).

2.6.5 Programming Pendant's ENABLE Switch

The ENABLE switch is part of the Programming Pendant and provides a safety feature that controls servo power while the system is in TEACH mode (see *Figure 2-2*). When pressed in, this switch allows the operator to enable servo power. Should the operator release the switch or grasp it too tightly, however, servo power is immediately disabled, thus preventing further robot movement. For detailed information about the operation of the ENABLE switch, refer to the *DX100 Operator's Manual for Arc Welding* that is included with the ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

ArcWorld® IV-6000

2	Equipment Description
2.6	Safety Features

2.6.6 Emergency Braking System

The robot incorporates a braking system that protects personnel from injury and prevents equipment damage if servo power is removed. Upon loss of servo power, the brake system activates to hold all robot axes in place. The brake system incorporates a feature that allows the operator to release the brake of a specific robot axis, even if drive power is disabled. Brake release is accomplished with the Programming Pendant. Refer to the *DX100 Manual Brake Release* manual included with the ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

2.6.7 Interlocked Work-cell Access Door

The work-cell access door features a safety interlock (see *Figure 1-1*). Any attempt to open the access door while the robots are in PLAY mode triggers an E-STOP condition (refer to *Section 2.6.4*).

3 Installation



CAUTION

- The ArcWorld® IV-6000 system should be installed by qualified personnel who are familiar with the installation and setup of a robotic system.

Two to three qualified technicians can install the ArcWorld® IV-6000 system in a reasonable amount of time. Always comply all the safety instructions and precautions given throughout this manual during the installation process.

The instructions given in this section are general guidelines for installing the ArcWorld® IV-6000 system. Refer to your system drawings and relevant system component manuals for specific installation information (see *Section 1.3*).

3.1 Required Materials

All system components and most hardware items required for installation of the ArcWorld® IV-6000 system are included with your shipment. There are, however, some required items that the customer must supply, such as typical installation and maintenance tools (refer to *Section 3.1.2*) and special anchor bolts (refer to *Section 6*).

3.1.1 Customer-supplied Items

- Shielding gas for the welding torches
- Local electrical service
- Earth ground wires for the robots, the DX100 controller, and peripheral equipment
- Earth ground rods and/or buried copper sheeting (quantity and placement depth as required to achieve specified resistance-to-ground reading of 100 ohms or less)
- Chemical (optional) to increase the conductivity of soil in the vicinity of the earth ground system
- Welding wire
- Clean, dry air supply (for torch tender or wire cutter options):
 - Flow Rate: 0.425 m³/min. (15 cfm)
 - Pressure: 620 kPa (gage) [90 psi (gage)]
- Forklift(s) and/or overhead crane
- Special anchor bolts and drill bits (refer to *Section 6* for suggested anchoring hardware)

3.1.2 Recommended List of Hand Tools and Equipment

- Safety glasses
- Face shield
- Gloves (heavy-duty leather recommended)
- Levels (short and long)
- Ratchet handle (with 3/4-inch hex socket)
- Adjustable wrench
- Hammer drill with appropriate concrete bits
- Phillips and flat-blade screwdrivers
- Hammers (dead-blow and steel)
- Hammer (non-marring)
- Socket sets (SAE and metric)
- Air-impact gun (with 3/4-inch hex socket)
- Open-end wrench sets (SAE and metric)
- Allen® wrench sets (SAE and metric)

3.2 Site Preparation



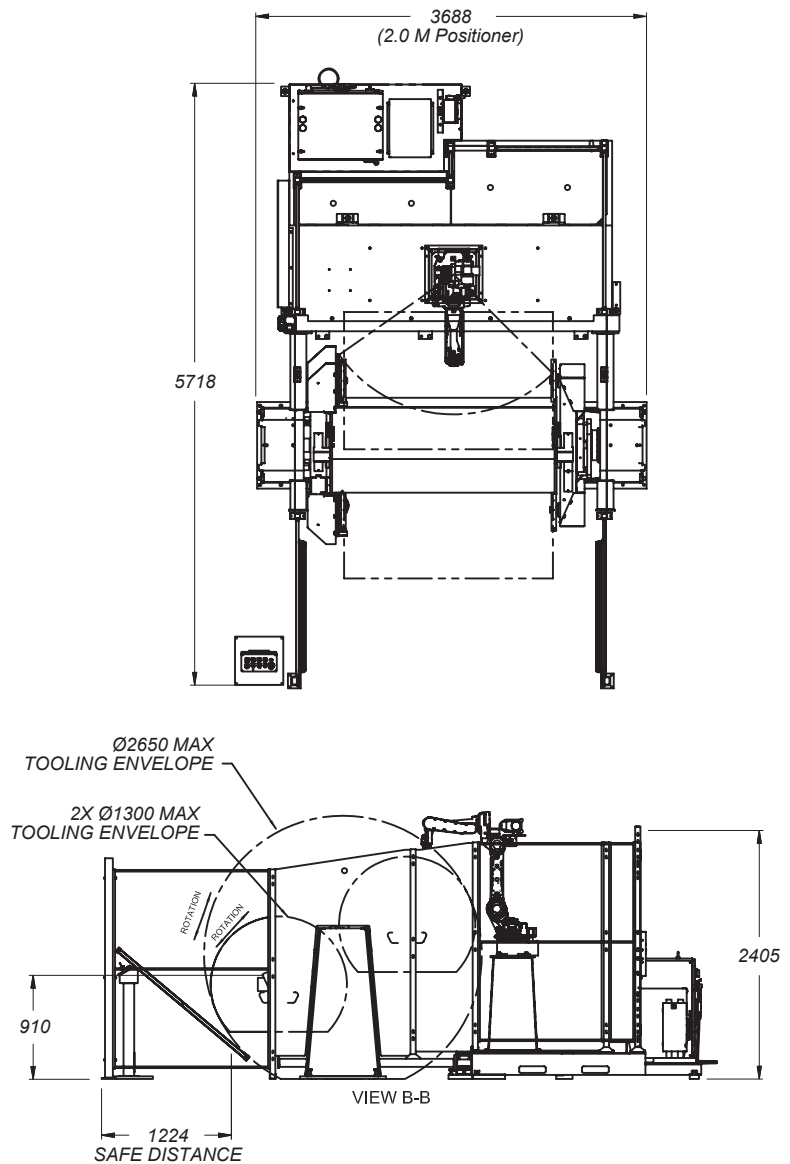
WARNING

Be sure to provide sufficient room for access to the work-cell door, Operator Station, and system components that are exterior to the work cell. Failure to observe this precaution could result in injury to personnel during system operation and maintenance.

To prepare your site, proceed as follows:

1. Clear the floor and overhead space needed for the ArcWorld® IV-6000 system (see *Figure 3-1*). Allow an additional 1.2 m to 1.5 m on all sides of the work cell to provide the clearances needed for installation.
2. Gather all the customer-supplied items and required tools (refer to *Section 3.1*).

Figure 3-1: Plan View - ArcWorld IV-6000



3.3 Removal of System Components from Shipping Skids



WARNING

- The positioner weighs approximately 2550 kg. Be sure that your lifting device is rated to safely handle this load.
- The robot Common Equipment Base (with equipment) weighs approximately 2282 kg. Be sure that your lifting device is rated to safely handle this load.

System components are attached to shipping skids at the factory prior to shipment to the customer. The customer is responsible for removing the components from the skids and inspecting the components for shipping damage.



If you notice any equipment damage, notify your shipping contractor as soon as possible.



CAUTION

Do **not** remove the positioner shipping bracket assembly until the positioner is securely anchored to the foundation. The shipping bracket assembly retains the headstock and tailstock in correct alignment during shipping and installation.

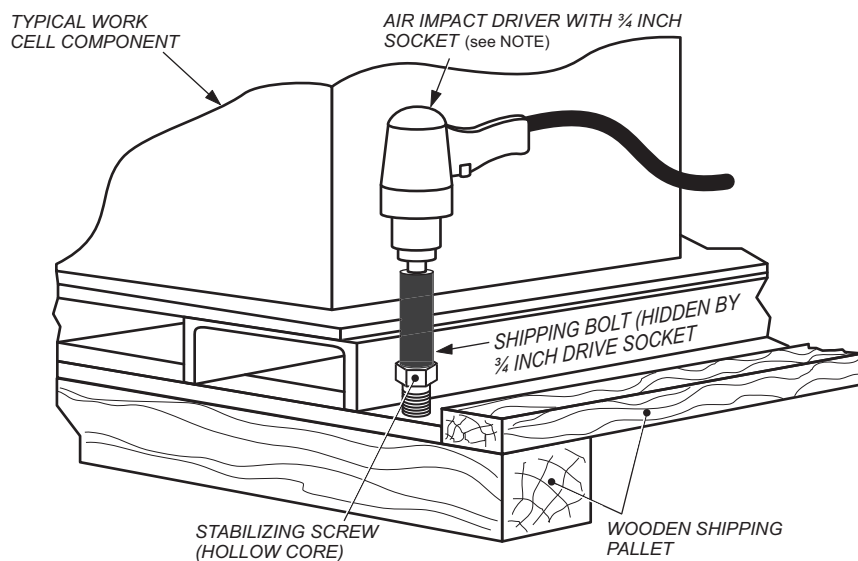
1. Unbolt each component from its shipping skid using a 3/4-inch socket (see *Figure 3-2*).
2. Use a forklift(s) or overhead crane to lift each component away from its shipping skid.



Two forklifts are required to lift or move the positioner. Forklift "pockets" are provided on each end of the positioner for this purpose.

Figure 3-2: Typical Stabilizing Screw and Removal of A Shipping Lag Bolt

NOTE – An air-powered tool is not required for removal of the shipping bolts, as these fasteners can be removed with ordinary hand tools. However, the air-powered tool does make quick work of the task.



3. Remove and discard or recycle all shipping materials, including the shipping skids. Do **not** remove the positioner shipping bracket assembly.

3.4 Installation — MRM2-M3X Series Positioner

Refer to the appropriate positioner manual for detailed instructions on installation of your specific MRM2-M3X positioner.



CAUTION

Do **not** remove the positioner shipping bracket assembly until the positioner is securely anchored to the foundation. The shipping bracket assembly retains the headstock and tailstock in correct alignment during shipping and installation.

Mount the positioner on a foundation rigid and strong enough to support the positioner and withstand dynamic repulsion forces. If the foundation surface is not level and even, grind the swell to flatten the surface. The minimum thickness for a concrete foundation is 150 mm (6 in).

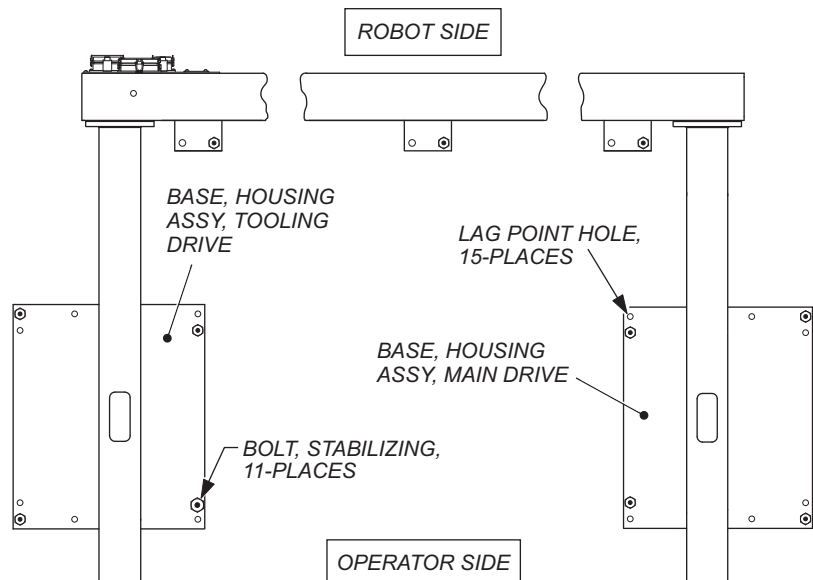


WARNING

The positioner weighs approximately 2550 kg. Be sure that your lifting device is rated to safely handle this load.

1. Using two forklifts, move the positioner to the desired installation location. **Do not** remove any shipping brackets.
2. Insert concrete drill bit for M20 or 3/4" anchor bolt through one of the Primary anchoring holes (see *Figure 3-3*) and drill a hole in the foundation to a minimum depth of 102 mm. Repeat this process for each of the Primary anchoring holes at the positioner headstock and tailstock locations (see *Figure 3-3*).
3. Remove concrete dust from each drilled hole.
4. Install M20 or 3/4" anchor bolts at each Primary anchoring hole (refer to *Section 6* for suggested anchor bolts).

Figure 3-3: Anchor Points and Stabilizing Screw Locations



5. Using an M36 socket, adjust the eight stabilizing screws, as required, to stabilize the MRM2-M3X positioner (see *Figure 3-3*).



The MRM2-M3X positioner does not require leveling. The stabilizing screws are designed to eliminate instability or “rock” caused by imperfections in the mounting surface.

3.5 Installation — Robot Common Base



WARNING

The main robot/controller common equipment base (with equipment) weighs approximately 2282 kg. Be sure that your lifting device is rated to safely handle this load.

1. Loosen and remove lag bolts securing the robot common base and associated panels to the wooden shipping skid.
2. Carefully remove all protective packaging materials and discard or recycle.
3. Carefully inspect the robot(s), robot equipment base, and associated panels for shipping damage.



If you notice any equipment damage, notify your shipping contractor as soon as possible.

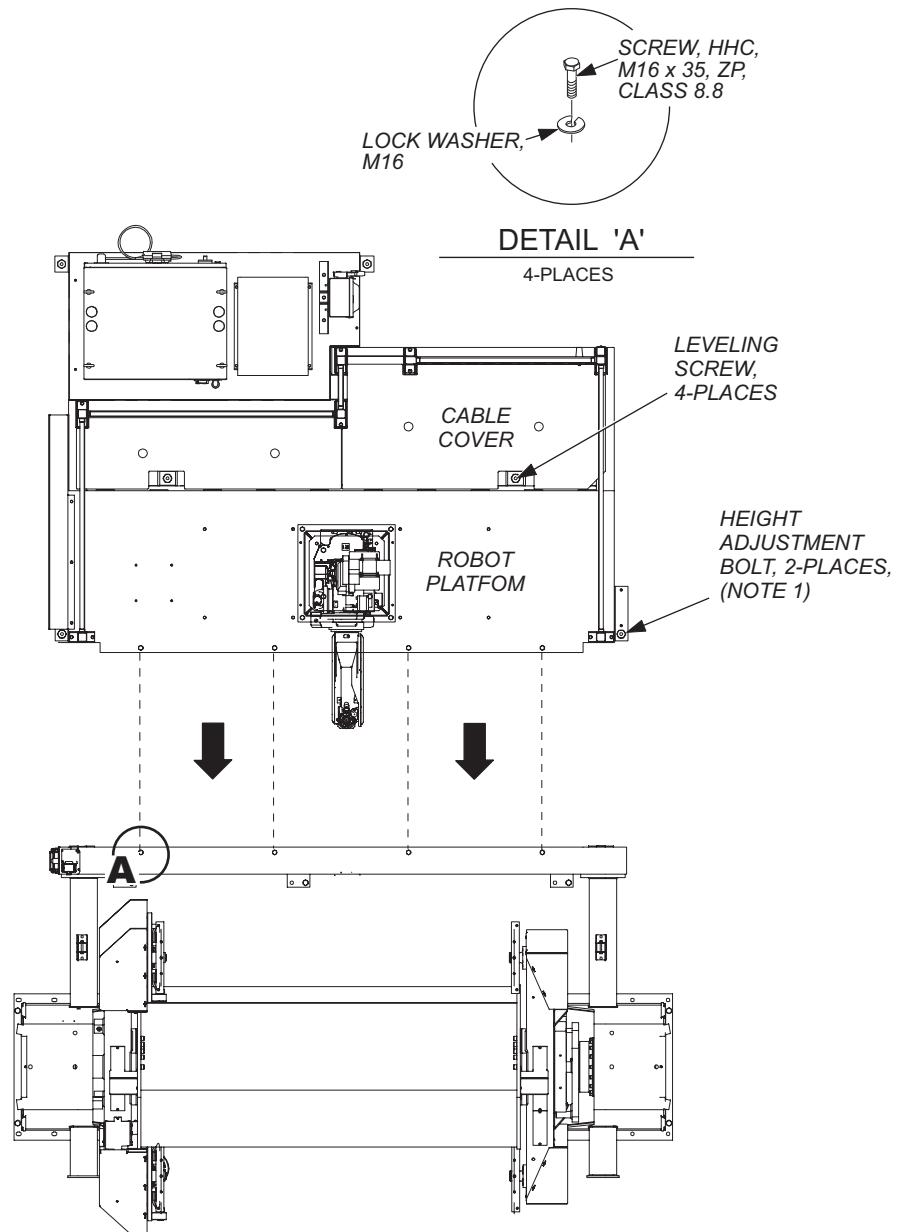
4. Using a forklift, lift the robot common base away from the wooden shipping skid (forklift pockets are located at each end of the base).
5. Carefully place the robot common base in a position that will allow it to be joined to the positioner base with supplied hardware (see *Figure 3-4*).
6. Fasten the robot common base to the positioner base with the supplied hardware (see *Figure 3-4*).



CAUTION

Make certain the joined robot common base/positioner are positioned correctly before levelling and anchoring the unit.

Figure 3-4: Robot Common Base Installation



1. These bolts provide height clearance when attaching Robot Equipment Base to Positioner Base.



WARNING

Wear protective eye wear and sturdy work gloves when you cut steel strapping bands. Make sure that all other personnel are clear of the area before you cut the bands. The steel strapping bands are under tension, and can cause injury to personnel when cut.

7. Cut the steel strapping bands that secure the floor cover plate and remove it from the Robot Common Base. The cover plate will be replaced after control and power cables are routed beneath the Robot Common Base and the Programming Platform.

**WARNING**

Be sure to wear protective eye wear during the anchoring process. Failure to observe this precaution could result in eye injury for the installation technician.

8. Adjust the leveling screws as required to level and stabilize the Robot Common Base/Programming Platform (see *Figure 3-4*).
9. Insert a drill bit through the center of a leveling bolt on the Robot Common Base/Programming Platform and drill a hole into the foundation to accept an anchor bolt (refer to *Section 6* for foundation and anchoring suggestions).
10. Repeat the drilling process for each leveling bolt associated with the joined robot equipment base/positioner base assembly (see *Figure 3-4*).
11. Use compressed air to remove all concrete dust from each drilled hole.
12. At each drilled location, install and secure a suitable anchor bolt (refer to *Section 6* for foundation and anchoring suggestions).

3.6 Installation — Safety Fence Assembly

The fencing that surrounds the positioner and completes the welding cell's protective walls is shipped on its own skid with all the hardware needed for installation.

**CAUTION**

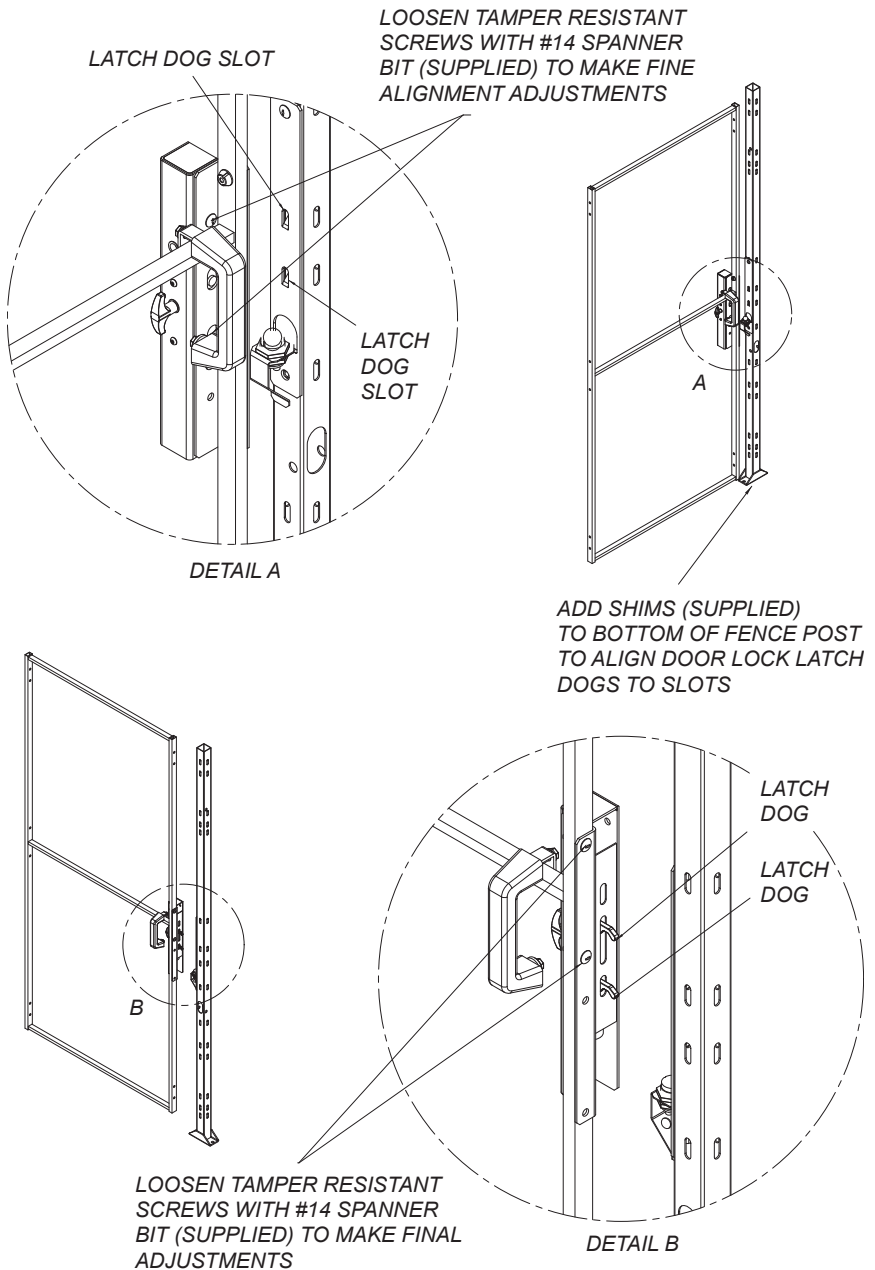
Be careful when cutting the metal bands and wear protective gloves. The metal bands are under tension and may cause injury to anyone near the bands when cut.

See *Figure 1-1* and *Figure 3-1* for the general arrangement and positioning of the safety fence assembly. Refer to the safety fence manufacturer instructions for details of safety fence placement, erection, and anchoring. The safety fence instructions are included in the ArcWorld® IV-6000 system documentation package (refer to *Section 1.3*).

3.6.1 Door Latch Alignment

Adjust the location of the door latch as necessary to provide smooth operation of the door assembly. A #14 spanner bit is provided to loosen and adjust the location of the latch assembly. Metal shims are also provided and can be placed beneath the fence posts to make gross adjustments. See *Figure 3-5*.

Figure 3-5: Door Latch Alignment



3.7 Installation — Arc Curtains

The arc curtains are packaged in an accessories box that is shipped with the ArcWorld® IV-6000 system.



WARNING

Ensure that the work-cell safety fence is anchored in place before installing the arc curtains. Unanchored fence panels can fall and injure personnel or damage equipment.

Install the arc curtains as follows:

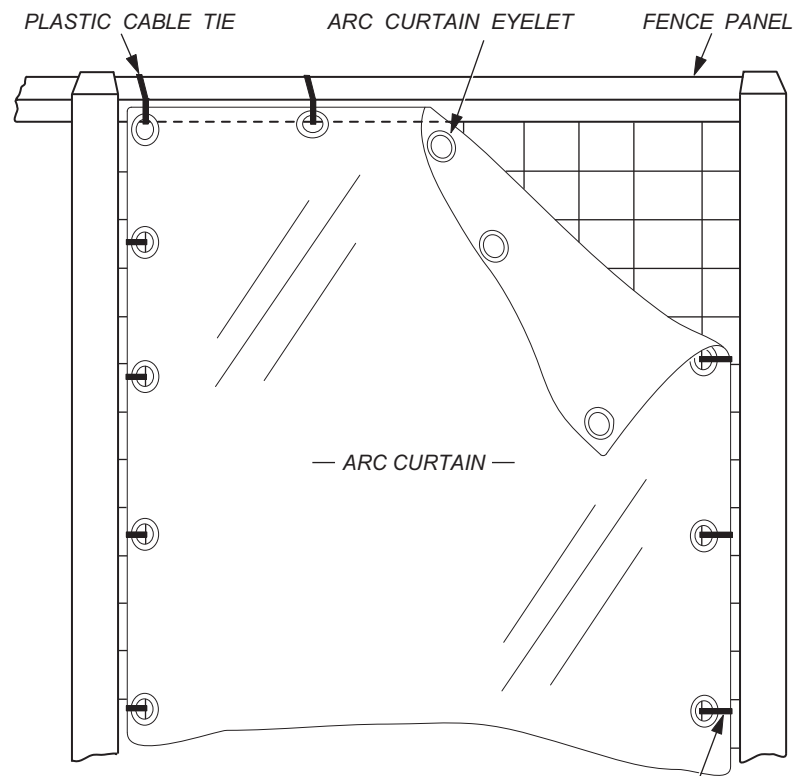
1. Unfold each arc curtain and install one on the **inside** of each work-cell safety fence panel using the supplied plastic cable ties and the eyelets in each arc curtain (see *Figure 3-6*).



The arc curtains are precut to match the work-cell fence panels. Each arc curtain bag contains documentation that includes the arc curtain dimensions. If necessary, these dimensions can be used to match the arc curtain to the correct work-cell fence panel.

2. Make sure that there are no gaps between the arc curtains.
3. Install the work-cell door arc curtain on the **inside** of the door panel using the supplied plastic cable ties and the eyelets in the arc curtain (see *Figure 3-6*).

Figure 3-6: Arc Curtain Installation on Typical Safety Fence Panel



NOTE — Arc curtain is installed on the fence panel side that faces the INTERIOR of the robotic work cell

PLASTIC CABLE TIE

3.8 Installation — Safety Light Curtain System

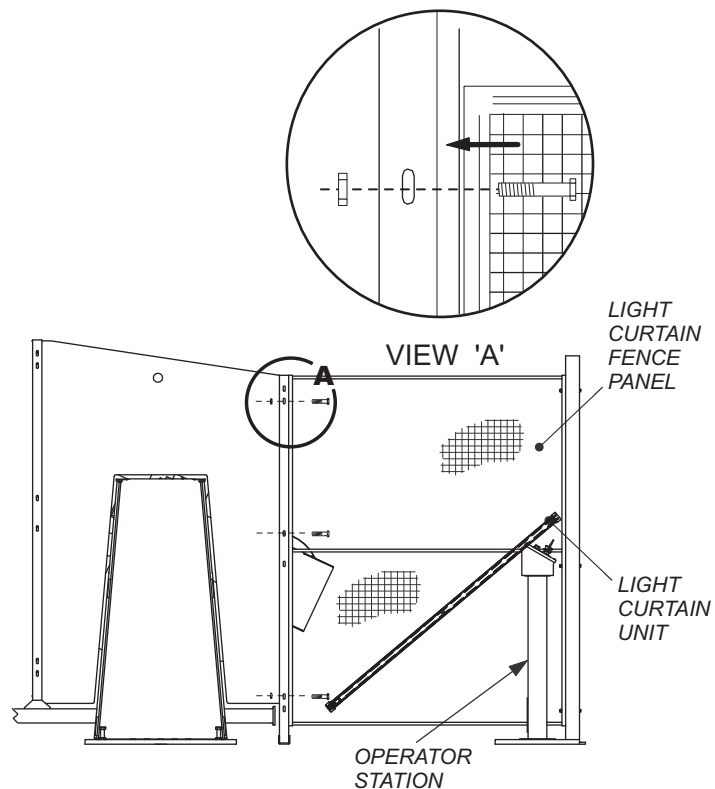


Safety light curtain components (Send unit, Receive unit) are mounted to safety fence panels at the factory and then secured for shipment to the customer.

The procedure for installing the safety light curtain system is as follows:

1. Unpack both safety light curtain fence panels from their shipping position and move them into position. The light curtain units are oriented properly when their status lights are located near the base of the positioner.
2. Use the three bolt holes located on the positioner fence post to mount the light curtain fence panels (see *Figure 3-7*).
3. Unpack the light curtain cables and connect them to the matching connectors on the light curtain Send and Receive units.
4. Align the Send unit with the Receive unit. Refer to the light curtain manufacturer's literature that is included in the ArcWorld® IV-6000 system documentation package (see *Section 1.3*).
5. After the light curtain units are installed and aligned, anchor the light curtain fence panel posts to the foundation (refer to *Section 6* for suggested anchor drills and bolts).
6. Check the alignment of the light curtain Send and Receive units after the fence posts are anchored to the foundation. If indicated, readjust alignment of the light curtain Send unit and Receive unit.

Figure 3-7: Safety Light Curtain Installation



3.9 Installation — Operator Station

The procedure for installing the Operator Station is as follows:

1. Unload the Operator Station.
2. Remove the protective plastic wrapping from the Operator Station.
3. Inspect the Operator Station for shipping damage.



Notify your shipping contractor if you notice any shipping damage.

4. Place the Operator Station outside the fence in front of the positioner (see *Figure 1-1* and *Figure 3-1*).



CAUTION

Be absolutely certain of the correct location for the Operator Station before securing it with anchor (lag) bolts.

5. Anchor the Operator Station to the foundation (refer to *Section 6* for suggested drill bits and anchor bolts).

3.10 Cable Connections

After the ArcWorld® IV-6000 system components and peripherals are anchored in their correct locations, locate the interconnect cables for the system components and route them according to the system drawings and schematics included in the ArcWorld® IV-6000 system documentation package. All cables and connectors are labeled to ensure correct connection to the mating connectors on the applicable system component.



A small gap exists between the bottom of the work-cell safety fence and the floor. This gap provides a passage for cables that run between the components outside the work cell and those inside the work cell.

3.10.1 Connection to Earth Ground



WARNING

Do not use the ArcWorld® IV-6000 system unless specified components are connected to a low-resistance earth ground. Do not connect the earth ground wire with the wires for the electric power source, welder, etc. The low-resistance earth ground must be a “dedicated” ground that is a direct connection between a component and the earth ground point. Operator injury or death, as well as equipment damage, can result from an inadequate or defective earth ground system.

The robot and DX100 controller must be connected to a low-resistance earth ground. If a ground stake is used, it should be driven at least 2.43 m into the soil. The soil surrounding the driven ground stake should be treated with a chemical that increases the soil conductivity in the vicinity of the driven ground stake. This is often referred to as a “low-resistance earth ground” and may require more than a single driven ground rod, depending on soil conditions. Multiple ground rods (bonded together) or even a bonded network of buried copper sheeting (plus conduction-enhancing chemicals) may be required, depending on local soil conditions. In any event, the “low-resistance earth ground” must indicate a resistance of **100 ohms or less** (when measured directly between grounded equipment and the earth ground system). Be advised that specialized measuring equipment is usually required to get an accurate “resistance-to-ground” reading. Consult a specialist in this field, if required.

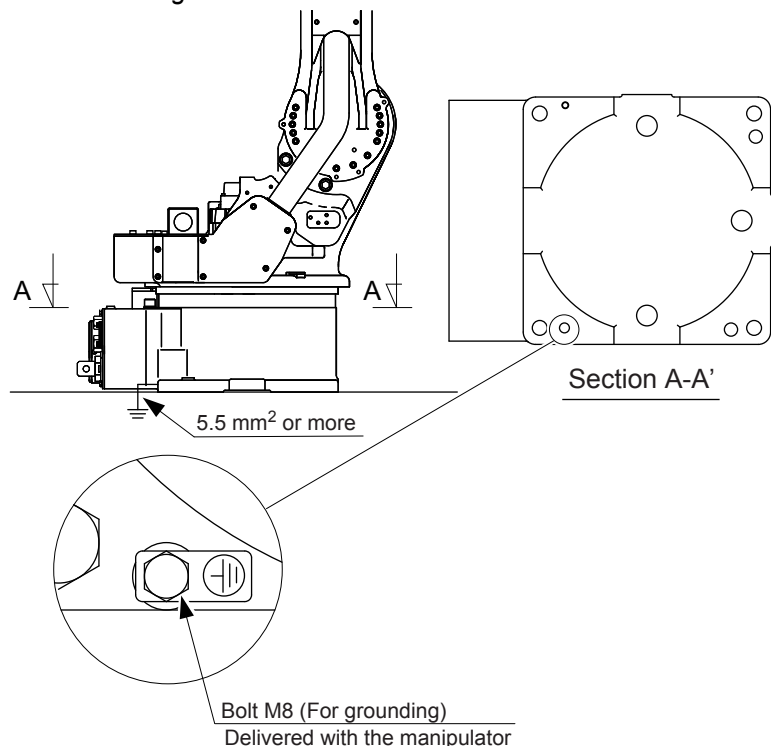


The customer shall supply all wires associated with the earth ground. The customer is responsible for establishing the correct gauge of all wires associated with the earth ground and maintaining an adequate earth ground (measured resistance of 100 ohms or less).

Connect the robots and controller assembly to the earth ground as follows:

1. Connect one end of an earth ground wire to the lug marked EARTH GROUND on the connector panel of robot R1. Connect the other end of the earth ground wire to the low-resistance earth ground. See *Figure 1-1* for the location of robot R1.
2. Connect one end of an earth ground wire to the COMMON GROUND BUS BAR located inside DX100 controller (see *Figure 2-1*). Connect the other end of the earth ground wire to the low-resistance earth ground.

Fig. 3-8: Grounding Method



3.10.2 Connecting the Robot Cables

Two cables, 1BC and 2BC, connect the robot to the controller. The 1BC cable provides position feedback from the robot to the controller. The 2BC cable provides power to the robot's servo motors. To connect the robot cables, proceed as follows:

**CAUTION**

Use care when attaching the cable connectors to the mating connectors on the robot(s) and controller(s). Do not use excessive force. Make sure that the cable connectors are correctly aligned with the mating connectors. The connectors are of the "multi-pin" type and are easily damaged if forced into position.

1. Unpack the Programming Pendant and plug its connector into the receptacle on the front door of the controller.
2. Unpack the two large black manipulator cables and route one to the controller and the other to the back of the robot.
3. Connect one end of each cable (labeled 1BC and 2BC) to the 1BC and 2BC connections on the back of the robot (see *Figure 3-9*). Connect the other ends of the 1BC and 2BC cables to the 1BC and 2BC connections on the side of the controller.

Fig. 3-9: Manipulator Cables

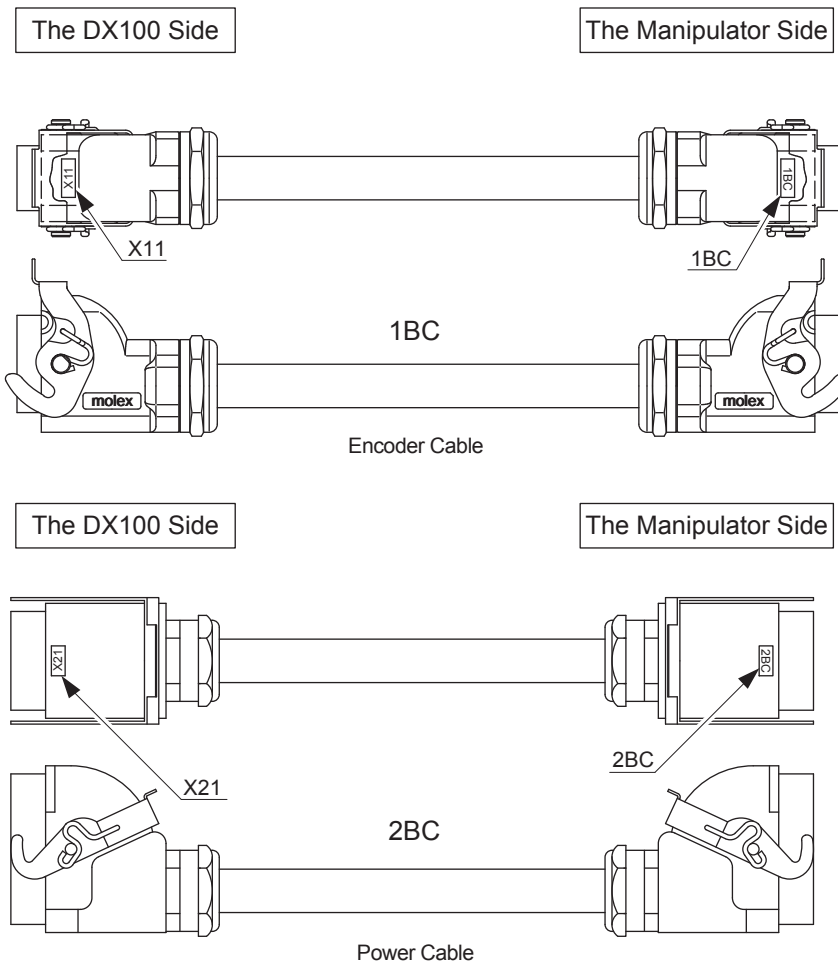


Fig. 3-10(a): Manipulator Cable Connectors (Manipulator Side)

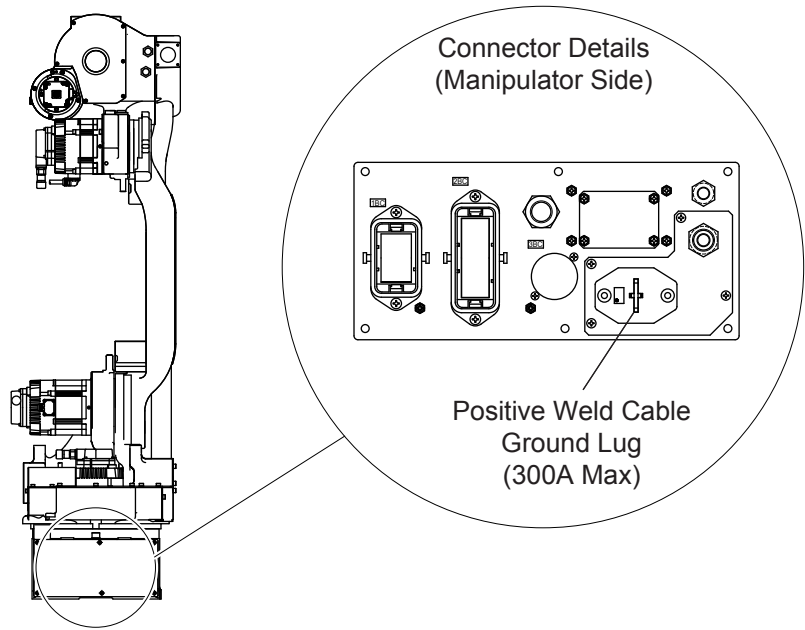
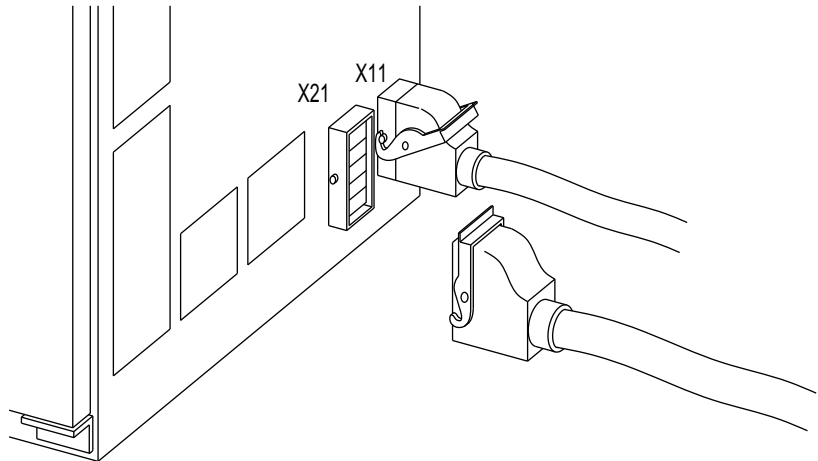


Fig. 3-10(b): Manipulator Cable Connection to the DX100



3.10.3 Connection to Local Electrical Service



WARNING

Local electrical service connection to the ArcWorld® IV-6000 system must be performed by a qualified, licensed electrician. Electrical and grounding connections must comply with the National Electrical Code (NEC), as well as all local electrical codes.



The ArcWorld® IV-6000 system is configured for three-phase 460/480V AC primary power. For additional information, refer to the electrical drawings and schematics that are included with your system documentation package (see Section 1.3).

After all the system components have been properly installed and interconnected, connect local electrical service to the DX100 controller and welding power source (refer to *Section 3.10.3.1* and *Section 3.10.3.2*).

3.10.3.1 DX100 Controller

For detailed electrical service interconnect procedures for the DX100 controller, refer to the *DX100 Controller Manual* and ArcWorld® IV-6000 system drawings and schematics that are included with your system documentation package (see *Section 1.3*).

3.10.3.2 Welding Power Sources

Refer to the welding power source documentation and ArcWorld® IV-6000 system drawings and schematics for electrical service connection procedures and diagrams for the welding power sources.

3.11 Safety/Operation Check

Before installing the tooling and fixtures for your application, take a few minutes to perform the following safety/operation check:

1. Ensure the correct alignment and operation of the safety light curtain system (refer to the safety light curtain documentation that is included with the ArcWorld® IV-6000 system).
2. Check the security and integrity of all cable connections.
3. Ensure that the work-cell sliding access door is closed and the door interlock is engaged.
4. Verify the correct settings for the welding power sources (refer to the welding power source documentation that is included with your ArcWorld® IV-6000 system).
5. Verify that local electrical service complies with the power requirements for your ArcWorld® IV-6000 system.
6. Verify that local electrical service is correctly wired into the DX100 controller assembly and the welding power sources (refer to *Section 3.10.1*).



CAUTION

The ArcWorld® IV-6000 system is now ready for power-up. Qualified, trained personnel who are familiar with this system should perform the power-up sequence.

7. Set the power ON-OFF switch on the DX100 controller to ON (see *Figure 2-1*).



An electrical service disconnect box for the DX100 controller shall be supplied (if desired) by the customer. It is not part of the ArcWorld® IV-6000 system shipment.

8. Set the service disconnect boxes for the welding power sources to ON (see *Figure 2-1*).

9. Set the power ON-OFF switch on the welding power sources to ON.



WARNING

Before operating the robots, verify that each E-STOP push button disables servo power when activated (pushed in). Each E-STOP push button must immediately stop robot and positioner movement when activated (pushed in).

10. Check for correct operation of all E-STOP push buttons (refer to *Section 2.6.4*).
11. Check for correct operation of the system HOLD buttons on the Programming Pendant and Operator Station (ROBOT HOLD). Refer to the *Operator's Manual for Arc Welding* for more information on the pendant's HOLD button (see *Section 1.3*). Refer to *Section 2.3.3* and the manipulator manual for more information on the Operator Station's ROBOT HOLD button (see *Section 1.3*).
12. Check for correct operation of the work-cell access door safety interlock.
13. Remove power from the ArcWorld® IV-6000 system after completion of the safety/operation check.

3.12 Installation of Tooling and Fixtures

Your ArcWorld® IV-6000 system is now ready for installation of tooling and fixtures for your particular application. Personnel who are familiar with the operation of the ArcWorld® IV-6000 system should do the installation. After tooling installation, test the positioner for correct operation. Refer to the positioner manual for information on how to test that the positioner is operating correctly (see *Section 1.3*).



- All tooling and fixtures for the positioner shall be supplied by the customer.
- Motoman recommends application of a corrosion/rust preventive compound to tooling and fixtures located in a high-humidity environment.

4 Operation

This section provides a brief overview of the operating procedures and precautions for your ArcWorld® IV-6000 system. For more detailed operating information, refer to the specific component manuals that are part of the ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

The ArcWorld® IV-6000 system is a fully integrated robotic GMAW welding cell. A Motoman MA-Series robot welds parts on one side of the positioner, while the operator loads the opposite side with parts to be welded. When the robot completes the welding process, it returns to HOME (Safe) position. The operator can then initiate another positioner sweep cycle from the Operator Station. This moves the previously loaded parts into the robot work area, where the robot then moves from HOME (Safe) position to complete another welding cycle.



The customer shall supply all tooling fixtures for the positioner.

4.1 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. For additional programming procedures and information, refer to the DX100 controller documentation that is included with your ArcWorld® IV-6000 system documentation package (see *Section 1.3*).

Any changes made to your system configuration and/or job structure will alter the operation of the system. Motoman recommends that you **do not** modify the original jobs and system configuration of your ArcWorld® IV-6000 system. **If you determine a need to modify the original jobs and system configuration, make any modifications to a copy of the original. Keep the original as a backup. Do not modify the original.** Modifications must be performed by trained and experienced personnel who are familiar with the operation of the ArcWorld® IV-6000 system. If you have questions concerning the configuration of your system, please contact Motoman's 24-hour Customer Support (refer to *Section 1.4*).

4.2 Sweeping the Positioner



The robots must be in HOME position before you can sweep the positioner.

	4	Operation
ArcWorld® IV-6000	4.3	Daily Operation

Selecting MANUAL mode on the Operator Station's POSITIONER AUTO/MANUAL switch allows the operator to sweep the positioner without activating the robot. Parts can be loaded onto the fixture to achieve the most efficient configuration and then swept into the welding zone, before teaching the robot a series of moves. To sweep Side A or Side B of the positioner into the robot's welding zone, proceed as follows:

1. Place the robot in HOME position (refer to *Section 4.3.2*).
2. Make sure that the Operator Station is enabled (Programming Pendant's Mode Select Switch set to REMOTE).
3. Set the Operator Station's POSITIONER AUTO/MANUAL switch to MANUAL and start the Control Master job (refer to *Section 4.3.3*). Normally, the robot will not move out of HOME position when the POSITIONER AUTO/MANUAL switch is set to MANUAL (this depends on job structure).



Cycle Start latching is not operative in MANUAL mode.

4. Press the CYCLE START/CYCLE LATCHED button on the Operator Station (the positioner sweeps each time this button is pressed).

4.3 Daily Operation

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

- Perform the start-up procedure (refer to *Section 4.3.1*).
- Move the robot to HOME position (refer to *Section 4.3.2*).
- Select the Control Master job (refer to *Section 4.3.3*).
- Perform the operation cycle (refer to *Section 4.3.4*).
- Perform the shutdown procedure (refer to *Section 4.3.5*).

4.3.1 Start-up Procedure

To start up the ArcWorld® IV-6000 work cell from a power-off condition, proceed as follows:

1. If installed, switch the DX100 controller electrical service disconnect box to ON.



An electrical service disconnect box for the DX100 controller shall be supplied (if desired) by the customer. It is not part of the ArcWorld® IV-6000 system shipment.

2. Set the power ON-OFF switch on the DX100 controller to ON (see *Figure 2-1*).
3. Switch the welding power source electrical service disconnect box to ON (see *Figure 2-1*).

4. Set the power ON-OFF switch on the welding power source to ON (the ON-OFF indicator lamp on each welding power source illuminates).
5. Open the regulator valve for the welding gas supply.
6. Make sure that the work-cell access door is closed and operating properly and the door safety interlock is engaged.
7. Make sure all E-STOP buttons are released. E-STOP buttons are installed at the following locations:
 - Programming Pendant
 - Operator Station
8. Select TEACH mode on the Programming Pendant.
9. Place the robot in HOME position (refer to *Section 4.3.2*).

4.3.2 Robot HOME Position

To move the robot to HOME position:

1. Select TEACH mode on the Programming Pendant.
2. Select MAIN MENU on the Programming Pendant's touch screen.
3. Select JOB on the Programming Pendant's touch screen.
4. Select SELECT JOB on the Programming Pendant's touch screen (a job list appears on the screen).
5. Use the navigation cursor key to move the cursor to SAFE job and then press SELECT (the job appears on the display screen).
6. Turn servo power ON by pressing SERVO ON and holding in the ENABLE switch.
7. Use the FWD button on the Programming Pendant to jog the robot to HOME position.

4.3.3 Master Job

With the system powered up and in TEACH mode, call up the Master job:

1. Select JOB on the Programming Pendant's touch screen.
2. Select CTRL MASTER on the Programming Pendant's touch screen.
3. Press SELECT twice to activate the Master job.
4. Select PLAY mode on the Programming Pendant (job playback operation is enabled).
5. Press the SERVO ON button on the Programming Pendant.
6. Press the START button on the Programming Pendant (the Control Master job cycles, waiting for a Cycle Start input from the Operator Station).
7. Transfer control to the Operator Station by selecting REMOTE on the Programming Pendant's Mode Select Switch.

The ArcWorld® IV-6000 work cell is now ready for operation.

	4	Operation
ArcWorld® IV-6000	4.3	Daily Operation

4.3.4 Operation Cycle

The following is the typical sequence of operation for the ArcWorld® IV-6000 work cell after start-up:

1. The operator loads the fixture on the operator side of the positioner with parts to be welded.
2. The operator steps out of the safety zone created by the safety light curtain system and moves to the Operator Station.
3. The operator presses the green CYCLE START/CYCLE LATCHED button on the Operator Station.
4. The positioner sweeps, placing parts to be welded into the robot work area. The robot then begins to weld the parts (if the Operator Station's POSITIONER AUTO/MANUAL switch is set to AUTO).
5. While the robot is welding, the operator loads the operator side of the positioner with the next group of parts to be welded.
6. The operator again moves to the Operator Station and presses the green CYCLE START/CYCLE LATCHED button (the Cycle Latched light illuminates). When the robot is finished welding, it returns to HOME position. The positioner then sweeps again to return the completed, welded parts to the operator position, while moving the next group of parts into the robot work area.
7. The operator moves back to the operator side of the positioner and unloads the completed, welded parts.

4.3.5 Shutdown Procedure

Use the following procedure to perform a normal shutdown of the ArcWorld® IV-6000 system:

1. Make sure the robot is in HOME position.
2. Turn off the system servo power by pressing the E-STOP button on the Operator Station or Programming Pendant.
3. Select TEACH mode on the Programming Pendant.
4. Set the DX100 controller power ON-OFF switch to the OFF position.
5. Set both welding power source power ON-OFF switches to the OFF position.
6. Close the regulator valve for the welding gas supply.
7. Switch the DX100 controller disconnect box (if installed) to OFF.



An electrical service disconnect box for the DX100 controller shall be supplied (if desired) by the customer. It is not part of the ArcWorld® IV-6000 system shipment.

8. Switch the welding power source disconnect box to OFF (see *Figure 2-1*).

The ArcWorld® IV-6000 system is now shut down.

4.4 System Recovery

When a system error or alarm occurs, you must clear the error or alarm to return the system to normal operation. The paragraphs below describe the different types of alarms and errors you might encounter and how to remedy them when you do.

4.4.1 Alarms and Errors

There are three levels of alarms and errors that will stop the program:

- Error messages
- Minor alarms
- Major alarms

For more detailed information on alarm and error recovery, refer to the maintenance and DX100 controller documentation that is included with your ArcWorld® IV-6000 system (refer to *Section 1.3*).

4.4.1.1 Error Messages

Error messages are usually the result of simple, easily cleared operation errors. One example of this type of error is pressing the START button when the robots are not in PLAY mode.

Clear errors of this type by pressing the CANCEL button on the Programming Pendant.

4.4.1.2 Minor Alarms

Minor alarms usually involve programming errors. Clear alarms of this type by pressing the CANCEL button on the Programming Pendant.

4.4.1.3 Major Alarms

Major alarms usually involve hardware failures. Examples of this type of error include an overload condition and abnormal speed.

Clear alarms of this type by cycling the DX100 controller in accordance with the following steps:

1. Rotate the DX100 controller's power ON-OFF switch to OFF.
2. Allow the controller's power ON-OFF switch to remain in the OFF position for approximately 10 seconds.
3. Rotate the controller's power ON-OFF switch to ON.

4.4.2 E-STOP Recovery

An E-STOP (emergency stop) will occur under any of the following conditions:

- An E-STOP button is pushed in (activated).
- The work-cell access door is opened while the robots are not in TEACH mode.
- The safety light curtain system is triggered while the positioner is sweeping.
- A welding torch collision triggers a shock sensor output (refer to *Section 4.4.3*).

After an E-STOP condition occurs, restart the ArcWorld® IV-6000 system as follows:

ArcWorld® IV-6000	4	Operation
	4.4	System Recovery

1. To clear the E-STOP condition, perform any of the following actions that apply:
 - Release the activated E-STOP push button
 - Close the work-cell access door
 - Clear the area in front of the positioner that is protected by the safety light curtain system
 - Clear the shock sensor condition (refer to *Section 4.4.3*).



CAUTION

If an E-STOP condition occurs while the positioner is sweeping, the positioner will continue the sweep when the ArcWorld® IV-6000 system is restarted.

2. Press the SERVO ON button on the Programming Pendant.
3. Select REMOTE mode on the Programming Pendant's Mode Select Switch to transfer control of the system to the Operator Station.
4. Press the green START button on the Operator Station.

The ArcWorld® IV-6000 system is now ready to continue operation.

4.4.3 Shock Sensor Recovery

The robot includes a Motoman gun mount. This mount is designed to protect the torch from damage in case of a crash (collision). A slight deflection of the torch activates a SHOCK SENSOR signal that triggers an E-STOP condition. To clear the E-STOP condition, you must override the shock sensor and move the affected robot clear of the impact. To override the shock sensor, proceed as follows:

1. Select MAIN MENU on the Programming Pendant's touch screen.
2. Select ROBOT on the Programming Pendant's touch screen.
3. Select OVERRUN-S.SENSOR on the Programming Pendant's touch screen.
4. Select RELEASE to release the shock sensor.
5. Turn servo power ON (press in on the pendant's ENABLE switch while pressing SERVO ON READY).
6. Move the affected robot clear of the impact position.

The ArcWorld® IV-6000 system is now ready to continue operation.

5 Maintenance

Maintenance must be performed by authorized personnel who are familiar with the ArcWorld® IV-6000 system. Be sure to read and understand the documentation for a particular component before doing repair maintenance or preventive maintenance on that component. Be sure that you understand the maintenance procedures, have the proper tools at hand, and comply with all the safety instructions and precautions given throughout this manual.

The maintenance intervals given in *Table 5-1* are recommendations only. Adjust the frequency and level of repair maintenance and preventive maintenance to suit your specific equipment schedules and shop environment.

For periodic maintenance procedures and schedules for the individual components of your ArcWorld® IV-6000 system, refer to the documentation that is included with your system documentation package (refer to *Section 1.3*).



CAUTION

If your system uses water-cooled torches, use only Motoman-specified antifreeze. Typical automotive antifreeze contains additives that can clog the small cooling ports in the torches and damage sealing gaskets in the water circulator pumps.

Table 5-1: Periodic Maintenance

FREQUENCY	COMPONENT	PROCEDURE
Daily (or on condition)	Water Circulators (water-cooled torch application only)	Add a mixture of Motoman antifreeze (P/N 131224-1) and distilled water, as required. Mix antifreeze and distilled water in proportions shown on the antifreeze container.
	All safeguard items – work-cell door interlocks, E-STOP push buttons, safety light curtains, arc curtains, etc.	Check the physical condition of the safeguard item and ensure that it is working correctly.
One Month (or on condition)	ArcWorld® IV-6000 Work Cell	Remove accumulated dirt, grease, and debris from inside and outside the work cell.
Six Months (or on condition)	Spanner Plates	Check the integrity and torque of the hardware that secures the spanner plates to the robot equipment base and positioner (see <i>Figure 3-4</i>).

6 Anchoring

The purchaser must determine all anchoring and foundation requirements and supply the appropriate anchoring hardware for a particular installation. Always use chemical anchors for equipment with dynamic loads. Use appropriate sized anchors, relative to the clearance holes, to anchor equipment to the floor. *Table 6-1* provides sample anchor and foundation requirements for peripheral equipment. Refer to equipment manuals included with your system documentation package (Section 1.3) for anchoring requirements.



WARNING

Do not mount robots directly to the floor without the indicated floor plate. Failure to follow floor-plate requirements can result in equipment damage or injury to personnel.

Table 6-1: Minimum Recommended Equipment Anchor Requirements

EQUIPMENT	MINIMUM HILTI® ANCHOR ROD DIAMETER/TYPE	MINIMUM FLOOR-PLATE REQUIREMENTS	MINIMUM FOUNDATION REQUIREMENTS
ROBOTS	Refer to the manipulator manual included with your system documentation package (Section 1.3) for anchoring requirements. Always use chemical anchors for equipment with dynamic loads. Use appropriate sized anchors, relative to the clearance holes, to anchor equipment to the floor.		
POSITIONER	Refer to the positioner manual included with your system documentation package (Section 1.3) for anchoring requirements. Always use chemical anchors for equipment with dynamic loads. Use appropriate sized anchors, relative to the clearance holes, to anchor equipment to the floor.		
PERIPHERAL EQUIPMENT	1/2-inch Kwik Bolt II Style Anchor (Note 1)	Not Applicable	3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000 psi Reinforced Concrete
WORK-CELL FENCE POSTS	3/8-inch Kwik Bolt II Style Anchor (Note 1)	Not Applicable	3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000 psi Reinforced Concrete
OPERATOR STATION PEDESTAL	1/4-inch Kwik Bolt II Style Anchor (Note 1)	Not Applicable	3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000 psi Reinforced Concrete
NOTES: (1) Reference source: <i>Hilti® Product Technical Guide</i> (Section 4.3.3) for hardware specifications or equivalent. Refer to http://us.hilti.com or http://ca.hilti.com for further information.			

ArcWorld® IV-6000 SYSTEM MANUAL

HEAD OFFICE

2-1 Kurosaki-Shiroishi, Yahatanishi-ku, Kitakyusyu-shi, 806-0004, Japan
Phone +81-93-645-7745 Fax +81-93-645-7746

MOTOMAN INC. HEADQUARTERS

805 Liberty Lane, West Carrollton, OH 45449, U.S.A.
Phone +1-937-847-6200 Fax +1-937-847-6277

MOTOMAN ROBOTICS EUROPE AB

Franska Vagen 10, Box 4004, SE-390 04 Kalmar, Sweden
Phone +46-480-417800 Fax +46-480-417999

MOTOMAN ROBOTEC GmbH

Kammerfeld strasse 1, 85391 Allershausen, Germany
Phone +49-8166-90-100 Fax +49-8166-90-103

YASKAWA ELECTRIC KOREA CORPORATION

1F, Samyang Bldg. 89-1, Shinchun-dong, Donk-Ku, Daegu, Korea
Phone +82-53-382-7844 Fax +82-53-382-7845

YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.

151 Lorong Chuan, #04-01, New Tech Park, Singapore 556741
Phone +65-6282-3003 Fax +65-6289-3003

YASKAWA ELECTRIC (MALAYSIA) SDN. BHD.

Unit 47-1 and 2, Jalan PJU 5/9, Dataran Sunway, Kota Damansara, 47810, Petaling Jaya Selangor, Malaysia
Phone +60-3614-08919 Fax +60-3614-08929

YASKAWA ELECTRIC (THAILAND) CO., LTD.

252/246, 4th Floor, Muang Thai-Phatra office Tower II Rehadapisek Road, Huaykwang Bangkok 10320, Thailand
Phone +66-2-693-2200 Fax +66-2-693-4200

SHOUGANG MOTOMAN ROBOT CO., LTD.

No.7, Yongchang-North Road, Beijing Economic and Technological and Development Area, Beijing 100076, China
Phone +86-10-6788-0541 Fax +86-10-6788-0542

MOTOMAN MOTHERSON ROBOTICS LTD.

910, DLF Galleria, DLF City Phase IV, Gurgaon - 122002 Haryana, India
Phone +91-124-414-8514 Fax +91-124-414-8016



YASKAWA ELECTRIC CORPORATION

YASKAWA

Specifications are subject to change without notice
for ongoing product modifications and improvements.

MANUAL NO.

156601-1CD