ArcWorld® 200/500
SYSTEM MANUAL

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

YASKAWA INSTRUCTIONS

MA1440 MANIPULATOR MANUALS
DX200 INSTRUCTIONS
DX200 OPERATOR’S MANUAL
DX200 MAINTENANCE MANUAL
DX200 FUNCTIONAL SAFETY BOARD OPERATION MANUAL

The DX200 operator’s manual above corresponds to a specific usage. Make sure to use the appropriate manual.

Part Number: 172089-1CD
Revision: 3
DANGER

• This instruction manual is intended to explain mainly on the mechanical part of the MOTOMAN-AW200/500 for the application to the actual operation and for proper maintenance and inspection. It describes on safety and handling, details on specifications, necessary items on maintenance and inspection, to explain operating instructions and maintenance procedures. Be sure to read and understand this instruction manual thoroughly before installing and operating the manipulator.

• General items related to safety are listed in the Chapter 1: Safety of the DX200 instructions. To ensure correct and safe operation, carefully read the DX200 instructions before reading this manual.

CAUTION

• Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure 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 modification is made, the manual number will also be revised.

• If this 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 the product’s warranty.
ANSI/RIA National Safety Standard

We suggest obtaining and reviewing a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems (ANSI/RIA R15.06-2012). This document can be obtained from the Robotic Industries Association (RIA) at the following address:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338
www.roboticsonline.com

Ultimately, well-trained personnel are the best safeguard against accidents and damage that can result from improper operation of the equipment. The customer is responsible for providing adequately trained personnel to operate, program, and maintain the equipment. NEVER ALLOW UNTRAINED PERSONNEL TO OPERATE, PROGRAM, OR REPAIR THE EQUIPMENT!

We recommend approved YASKAWA training courses for all personnel involved with the operation, programming, or repair of the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the Motoman AW200/500 system.

In this manual, the Notes for Safe Operation are classified as “DANGER”, “WARNING”, “CAUTION”, or “NOTICE”.

**DANGER**
Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.

**WARNING**
Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

**CAUTION**
Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.

**NOTICE**
NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

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

WARNING

• Before operating the manipulator, check that servo power is turned OFF by pressing the EMERGENCY STOP button 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. Do not use the manipulator if an EMERGENCY STOP button does not function.

Figure 1 : EMERGENCY STOP Button

• Release the EMERGENCY STOP button (refer to Figure 2). Once the EMERGENCY STOP 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:
  – Be sure to use a lockout device to the safeguarding when going inside.
  – View the manipulator from the front whenever possible.
  – Always follow the predetermined operating procedure.
  – Ensure there is 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 are in a safe location before:
  – Turning on the power for the 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 working envelope of the manipulator during operation. Always press an EMERGENCY STOP button immediately if there are problems.

The EMERGENCY STOP button is located on the right side of the front door of the controller and programing pendant.
This Robot Cell has Collaborative Motion functionality:

Collaboration is a special type of operation between a person and robot sharing a common workspace. The following are the guidelines for collaborative operation.

1. Used for pre-determined tasks.
2. Possible when all protective measures are active.
3. For robots with features specifically designed for collaborative operation.
   • The integrator shall include in the information for use the safeguards and mode selection required for collaborative operation.

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- 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 DX200 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 DX200 Controller Manual before operating the AW200/500 system.
Definition of Terms Used In this Manual

The Motoman manipulator is a YASKAWA industrial robot product.

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

In this manual, the equipment is designated as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DX200 controller</td>
<td>DX200</td>
</tr>
<tr>
<td>DX200 Programming Pendant</td>
<td>Programming Pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator cable</td>
</tr>
</tbody>
</table>

Descriptions of the programming pendant keys, buttons, and displays are shown as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Pendant</td>
<td>Character Keys: The keys which have characters printed on them are denoted with [ ]. ex. [ENTER]</td>
</tr>
<tr>
<td></td>
<td>Symbol Keys: The keys which have a symbol printed on them are not denoted with [ ] but depicted with a small picture. ex. PAGE key 📖 The Cursor is an exception, and a picture is not shown.</td>
</tr>
<tr>
<td></td>
<td>Axis Keys, Numeric Keys: “Axis Keys” and “Numeric Keys” are generic names for the keys for axis operation and number input.</td>
</tr>
<tr>
<td></td>
<td>Keys pressed simultaneously: When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them. ex. SHIFT key 📖 + COORD key 📖</td>
</tr>
<tr>
<td></td>
<td>Mode Key: Three kinds of modes that can be selected by the mode key are denoted as follows: REMOTE, PLAY, or TEACH</td>
</tr>
<tr>
<td></td>
<td>Button: Three buttons on the upper side of the programming pendant are denoted as follows: HOLD button, START button, EMERGENCY STOP button</td>
</tr>
<tr>
<td></td>
<td>Displays: The menu displayed in the programming pendant is denoted with { }. ex. {JOB}</td>
</tr>
<tr>
<td></td>
<td>PC Keyboard: The name of the key is denoted ex. Ctrl key on the keyboard</td>
</tr>
</tbody>
</table>
Description of the Operation Procedure

In the explanation of the operation procedure, the expression “Select • • •” means that the cursor is moved to the object item and the SELECT key is pressed, or that the item is directly selected by touching the screen.

Registered Trademark

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or brand names for each company or corporation. The indications of (R) and TM are omitted.
Explanation of Warning Labels

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

Always follow the warnings 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 Label Locations

WARNING
Do not enter robot work area.

WARNING
Moving parts may cause injury

WARNING
Do not enter robot work area.

Nameplate:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DATE</th>
<th>PAYLOAD</th>
<th>SERIAL NO.</th>
<th>MASS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

YASKAWA ELECTRIC CORPORATION
2-1 Kurosakishiritsu, Yahatanishi-ku,
Kitakyushu 806-0004 Japan
MADE IN JAPAN
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1 Introduction

The AW200/500 system is part of the Motoman family of standardized arc welding solutions. It is a fully integrated welding system, and is supported from wire to weld by Motoman.

1.1 About This Document

This system manual provides a “first look” and overview of the complete Motoman AW200/500 system. Read and understand this system manual before moving on to the more detailed documentation that is included with the AW200/500 system. Although basic in content, the system manual is intended for personnel who have received operator training from YASKAWA and are familiar with the operation of this particular Motoman system. For more detailed information on any specific component or peripheral of the AW200/500 system, please review the full documentation package that is included with the AW200/500 system (refer to section 1.4).

**NOTICE**

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

This system manual contains the following sections:

* chapter 1 “Introduction”
  This section provides general information about the AW200/500 system, a list of reference documents, and customer support contact information.

* chapter 2 “Equipment Description”
  This section provides a description of the major components of the AW200/500 system.

* chapter 3 “Installation”
  This section provides installation procedures for the AW200/500 system.

* chapter 4 “Operation”
  This section provides an overview of AW200/500 system operation, including start-up, loading, normal operations, fault recovery, and system shutdown.

* chapter 5 “Maintenance”
  This section provides preventive maintenance requirements for certain components of the AW200/500 system.

* chapter 6 “Anchoring”
  This section gives recommended anchoring hardware specifications and foundation requirements for all the equipment that is part of the AW200/500 system.

**Appendix A**

The Appendix includes a checklist for start-ups and after maintenance.
1.2 System Overview

The AW200/500 system provides a complete arc-welding solution in a standardized configuration (see Figure 1-1). The system is designed around an MA1440 robot, a DX200 controller, welding power source, and two work stations, Station 1 and Station 2. The AW200 work stations each provide a work area of 600mm x 1,300mm with a door opening of 1,200mm. The AW500 work stations include MHT-185 positioners to provide coordinated part positioning. Each AW500 station accommodates a work envelope of 800mm diameter x 1,000mm long, with a door opening of 1,200mm. Stationary tables are also available as an option on both systems.

The AW200/500 system features a total safety environment that meets or exceeds the requirements of the ANSI/RIA R15.06-2012 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-channel interlocked access door at the back 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 robot is active.

Each station also includes a heavy duty, motor driven safety barrier located in front of each positioner module to protect the operator from weld flash or other debris and prevents entry into the robot work area during robot operation. Robot travel is limited by the Functional Safety Unit.

Safeguards for the system complement the system operation while protecting various people that will program, operate, and/or provide maintenance to the system. Possible pinch points and other hazards from the risk assessment process determined needed safeguards and interlocks. While the system design safeguards the support staff, it does not protect against misuse of the system. Misuse of the system includes, but is not limited to climbing over/under barriers, climbing over/under interlocked doors, or disabling/bypassing of system interlocks.

During the install and commissioning process the end user must ensure tooling, ancillary equipment, etc. have not introduced additional hazards into the design. This evaluation ensures that the system will provide a safe and reliable operation. The Risk Assessment document should be reviewed for installation of the system and prior to operation. Any changes and additions to the system require full review of the Risk Assessment document.
1.2.1 System Layout

All components of the AW200/500 system are mounted directly to a common base.

The robotic cell is fully enclosed by safety fencing and an interlocking door. The interlocking barrier doors allow the operator to load parts at one station while the robot is welding at the other station. FSU based logic provides a safety zone to prevent the robot from entering an open/occupied station. All system controls, including those on the programming pendant, DX200 controller assembly, welding power supply, and operator station, are safely accessible from outside the AW200/500 work cell (see Figure 1-1 for the location of these components).
1.2.2 Major Components

The AW200/500 system includes the following major components:

- Motoman MA1440 manipulator
- One DX200 controller assembly
- Two work stations
- MHT-185 headstock/tailstock drive assemblies (AW500 only)
- One Programming Pendant (located on DX200 controller)
- Operator Station mounted at each barrier door
- Barrier Assemblies

Welding equipment:
- Welding power supply
- Welding torch (air-cooled)
- Wire feeder
- Applicable welding interface
- Torch mount

Safety equipment:
- Heavy-gauge, wire-mesh safety fencing (Solid Panel is an option)
- Arc curtains (cover the safety fencing)
- Light curtain system (several options available)
- Interlocked work-cell access door
- Barrier door for each station

1.2.3 Optional Equipment

The following optional equipment is available for use with the AW200/500 system:

- Torch cleaner
- Wire cutter
- Water-cooled torch (with water circulator)
- TouchSense™ (starting point detection)
- ComArc™ (seam tracking)
- Stationary tables
- Common mounting base for robot, positioners, and fencing
- Common mounting base for controller and welding power source
1.3 System Overview and Variations

The DX200 “ArcWorld 200/500” series of cells are designed to accommodate a single MA1440 robot and include two part loading stations which are guarded by up/down barrier doors. If the cell configuration is AW200 then each station will be empty or an optional flat table can be added. (The customer should supply their own fixtures in either case.) If the cell configuration is AW500 then each station will include MHT-185 positioners with MotoMount. A few options can be added to the standard design prior to shipment. The standard barrier door can optionally be configured with light curtains integrated into the “front” which offers protection to operators as the door moves. The Configurator is used to guide the construction of a cell using many standard pieces and several options described in this section.

The cell is designed for arc welding applications where the robot controller and welding power source are located on the side of the cell. The cables will be long enough to configure the cell so that the controller could also be moved near the operator door at the rear of the cell. The cell has a sliding door with safety interlock to allow teaching access, and for adjustments when the cell the cell is not in operation. Each of the stations includes a physical barrier with a dual channel interlock to determine when the door is fully closed.

Each station includes a small operator station with a “Cycle Start” push button, “Auto/Manual” selector switch, and an “E-Stop” button. The operator stations will be installed on the right side of each station.

Access to the positioner at either station is guarded by a physical barrier door. When the barrier door is down the robot is restricted from entering the corresponding station through logic in the FSU. Additionally, if a headstock is included at that station, then “stand still monitoring” using the Axis Speed Monitor function will be invoked which will E-Stop the cell if headstock motion occurs.

*Fig. 1-2: ArcWorld 500 (with MA1440 and optional interior curtains.)*
1.3.1 System Teaching

All systems can be programmed by entering the fence enclosure door at the rear of the cell. Alternatively, the teacher can view inside the cell from the exterior, through an open barrier door. To program the robot, the controller needs to be in TEACH mode from the selector switch on the front of the pendant. This Teach selection will limit all robot and external axes speeds to 250mm/sec while in this mode. While in TEACH Mode the robot's safety gate can be open or closed. In order for the robot's servo motors to be turned on, the “Enable” switch on the programming pendant needs to be maintained. Once servo power is on, the operator is able to program the part from inside or outside the cell using the programming pendant. The teacher should take care to avoid trip hazards (cable or other structures within the cell) as programming occurs. During teaching the headstock positioners are free to rotate as commanded from the programming pendant without concern over Door Status or optional Light Curtain violations.

The Risk Assessment should be reviewed prior to any interaction with this cell.

1.3.2 System Operation

Once path and logic programming has been completed, the system can be placed into an automatic operation mode once the following conditions have been met:

1. Programming pendant must be in PLAY mode
2. Close sliding door to activate the gate interlock safety switch.
3. {MASTER} job should be selected on the Programming Pendant
4. Servo power has to be applied. Use the [SERVO ON] button on the programming pendant.
5. Select cycling mode. Select Continuous Cycle only after all programs, safety functions and cell interactions are verified.
6. Press the [START] button on the programming pendant. (This begins execution of the {INFORM} job.) Once servo power has been applied and job execution begins normal cell production can begin.

Normal cell production begins with the assumption that the robot is in the home position. FSU Zones and Axis Range Limits ensure that the robot(s) operate in areas that are clear of potential human presence.

If the cell is an ArcWorld 500: When a station is open (not fully closed) the dual channel in-position safety switch in the barrier door reports this condition to the FSU and enacts “Stop Position Monitoring” mode (this is also known as “Standstill Monitoring” mode) via the FSU. This prevents the headstock at the corresponding station from moving. If motion of the headstock is detected the entire system will go into E-Stop and can be recovered after the source of this fault is addressed (possibly bad robotic programming or door position). If the robot enters a station that is open while in PLAY mode, the entire cell goes into an Emergency Stop condition. Recovery from this E-Stop condition can be done by closing the barrier door (via I/O or cycle start button) or changing to TEACH mode and jogging the robot(s) out of this station.
When the operator has completed work in a station, they will exit the station, observe that all other operators and equipment is clear of the station, headstock, and customer supplied tooling/fixture and then press the [Cycle Start] button. This will send the barrier door to closed position in about 2 seconds. If anything obstructs the movement of the door a barrier door control fault will occur and trigger a DX200 alarm. Significant blockage of the door's travel will also halt the motion as the motor control is torque limited. When the [Cycle Start] button was pressed, successful door closure will latch this station in for queing of work. The robot will approach this station immediately if no work is currently being performed. If work is occurring in the other station, then the Cycle Start Latched light will be illuminated Green and will turn off when the cycle has begun. Assuming there are no faults or issues during the production of the part, the robot(s) should return to a safe position once completed.

The robot's MASTER job waits for Cycle Start inputs. It will call jobs based on whichever cycle start button is pressed. This job also controls the frequency of torch cleaning if that type of device is included in the cell.

The CLEAN job can only be called when STATION 1 remains closed. This is a deviation from the behavior of this cell under DX100 control.
1.3.3 Key Safety Devices

1.3.3.1 DX200 controller with one FSU:

- Dual channel programming pendant E-STOP
- Dual channel programming pendant “Enable” switch
- “TEACH/PLAY” mode input to FSU
  - Logic mapped from Machine Safety to FSU.
- Functional Safety Unit (FSU) - one per robot
  - Limits robots access as follows:
    - Complete perimeter access granted in TEACH mode.
    - Three axis limits are defined per robot depending on barrier door status in IN PLAY mode.
      - Station 1 valid/allowed (barrier door 2 not closed/down)
      - Station 2 valid/allowed (barrier door 1 not closed/down)
      - Allowed in only “rear” of cell (barrier door 1 and 2 not closed/down).
    - If AW500 - the FSU manages when the external axes in the system are in “Standstill Monitoring” based on the barrier door “up” status inputs
      - Station 1’s MHT-185 positioner must be stationary if Station 1’s barrier door is not up/fully closed
      - Station 2’s MHT-185 positioner must be stationary if Station 2’s barrier door is not up/fully closed

1.3.3.2 Safety Gate Interlock - tongue type: mechanical (qty 1):
- Dual channel dry contact outputs

1.3.3.3 One Op Station per Workstation:
- Green “CYCLE START/CYCLE LATCHED” button/light - single channel with illumination
- Black “AUTO/MANUAL” selector switch - single channel
- Red “EMERGENCY STOP” button - dual channel with illumination
1.3.4 Safety Logic Implementation (all cells):

1.3.4.1 TEACH/PLAY Mode (all AW200/AW500):

Disabling the FSU features function (files) can be difficult, especially when the robot violates a defined robot range or some other corrective action needs to be taken. Disabling the FSU functions requires the “Safety Mode” password to disable individual functions and then all of those functions have to be re-enabled before PLAY Mode production can begin. To eliminate these issues and expedite the steps to a remedy, PLAY mode status is a condition for many of the FSU files, thus changing to TEACH Mode will let a user quickly escape from the violating condition. **Putting the system into TEACH is often a first step to bypass or recover from many of the FSU’s monitoring functions.** The next thing to do is to move the robot or barrier door into a condition that allows the cell to resume operation safely.

In TEACH mode, the robot(s) are limited to motions with the cell. This perimeter definition is in a Range Limiting file to match the cell fencing.

**Fig. 1-3: Setting TEACH Mode in the Safety Logic Circuit Screen**

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1.3.4.2 Functional Safety Unit: Safety Logic Implementation:

- **TEACH Mode**
  In TEACH mode a “R1 Teach Zone” has been established for the purpose of ensuring that the robot remains within the confines of the work cell. Since TEACH speeds are already limiting speed to 250mm/sec, no additional safeguards will be taken. In TEACH mode, “Standstill Monitoring” on either headstock will be disabled so that the programmer can jog and teach with the positioners.

**Fig. 1-4: Teach Zone: (R1 allow perimeter of fence interior)**
1.3.4.3 PLAY Mode

In “PLAY” mode, a combination of FSU-based “Robot Range Limiting” and “Stop Position Monitoring” (“Standstill Monitoring”) mode will ensure safe operation of the cell.

The FSU-based “Stop Position Monitoring” (“Standstill monitor”) function will be used to ensure that the appropriate headstock remains stationary in “PLAY” mode anytime the barrier door at the corresponding station is down (not fully up). The robot is also restricted from entering the station until the barrier door at the station is closed. This robot restriction is enforced by the “Robot Range Limit” function.

Also, in “PLAY” mode, the DX200 monitors that the Safety Gate is closed ensuring that someone is not accessing the work cell. This is wired directly into the Machine Safety Unit, not the FSU, this is mentioned here in the interest of safety discussion.

- **Robot 1 - Robot Range Limit Files**

  - **Robot Range Limits**: Seven zones are defined that define the robot’s access. Using FSU logic these zones prevent or grant access to the robot based on teach/play conditions and barrier door status.

    ![Robot Range Limit Table](image)

**NOTICE**

Some numeric values in the screen shots that follow may not represent actual values for your system. The general shape and theory of operation remain constant. Consult YASKAWA for back-ups of your specific system configuration.
- **Robot Range Settings:**

  - **Zone 1** - definition of Station 1 Access Allowed when Station 2 barrier door is opened. (Station 1 closed).

  - **Zone 2** - definition of Station 2 Access Allowed when Station 2 barrier door is opened. (Station 2 closed).
• **Zone 3** - definition of Access Allowed when both Station 1 and 2 barrier doors are opened.

• **Zone 4** - definition of Access Allowed when both Station 1 and 2 barrier doors are closed. (This perimeter is the same as Zone 7 - Teach Zone. It is defined twice intentionally.)
• Zone 5 - definition of Access Allowed NOT allowed by the robot in Station 1, while in PLAY mode. This is to keep the robot out of the area of potential operator reach over.

• Zone 6 - definition of Access Allowed NOT allowed by the robot in Station 2, while in PLAY mode. This is to keep the robot out of the area of potential operator reach over..
• Zone 7 - definition of full cell perimeter, for teaching purposes.

• Axis Speed Monitor (Stop Monitor) Files: (ArcWorld 500 only)
  - Axis Speed Monitor Files Used (aka Standstill Monitoring):
    Always enabled. Results are evaluated in the safety logic circuit
– **Station#1 Stopped:** Headstock in Station 1 has motion monitored to 0.2 degrees of motion (allows some variance when installing parts / fixture.)

– **Station#2 Stopped:** Headstock in Station 2 has motion monitored to 0.2 degrees of motion (allows some variance when installing parts / fixture.)
1 Introduction

1.3 System Overview and Variations

• Safety Logic Circuit:
  – NO Light Curtain Options, AW500 shown

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• With Interior Light Curtain Option, AW500 shown

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1.3 System Overview and Variations

- Safety Logic Circuit Ext Signal Allocation
  (AW500 Shown)

- Safety Logic Circuit Signal Display Setup
1.4 Reference Documentation

For additional information on individual components of the AW200/500 system, refer to the following documentation that is included with the system:

- **MA1440 Manipulator Manual** (P/N 165830-1CD)
- **MA1440 Manipulator Maintenance Manual** (P/N 165831-1CD)
- **Brake Release Manual** (P/N 165310-1CD)
- **DX200 Controller Manual** (P/N 165292-1CD)
- **DX200 Maintenance Manual** (P/N 165293-1CD)
- **Operator's Manual for Arc Welding** (P/N 166346-1CD)
- **Concurrent I/O Manual** (P/N 165294-1CD)
- **MH(T)-Series SIGMA-5 Positioner Manual** (P/N 168961-1CD)
- **DX200 Independent/Coordinated Control Function Manual** (P/N 165836-1CD)
- **INFORM User's Manual** (P/N 165301-1CD)
- **Functional Safety Board Operation Manual** (P/N 165988-1CD)
- Vendor manuals for system components not manufactured by YASKAWA
# 1.5 Reference Table

The table below provides location(s) for various operations.

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<th>Use of System</th>
<th>Maintenance</th>
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1.6 Customer Support Information

If assistance is needed with any aspect of the AW200/500 system, please contact YASKAWA Customer Support at the following 24-hour telephone number:

(937) 847-3200

For routine technical inquiries, YASKAWA Customer Support can be contacted at the following e-mail address:

techsupport@motoman.com

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

Please have the following information ready before calling:

- System: AW200/500
- Robots: MA1440
- Positioner: MHT-185 Positioner
- Primary Application: Arc Welding
- Controller: DX200
- 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 DX200 controller data plate

NOTICE

Please use e-mail for routine inquiries only. If there is an urgent or emergency need for service, replacement parts, or information, contact YASKAWA Customer Support at the telephone number shown above.
2 Equipment Description

2.1 Robot Description

The AW200/500 system includes the Motoman MA1440 six-axis robot. This robot is specifically designed for arc-welding applications. The MA1440 robot has a payload capacity of 6kg and features a horizontal reach of 1,434mm. The robot features a relative positioning accuracy of ±0.08mm.

The MA1440 robot features 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 ± 210 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 MA1440 Manipulator Manual that came with the AW200/500 system documentation package (see section 1.4).

2.2 DX200 Controller

The DX200 robotic controller, shown in Figure 2-1, features a Windows® CE Programming Pendant with a color touch screen, high-speed processing, built-in Ethernet, and robust PC architecture. The DX200 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 DX200 coordinates the operation of the AW200/500 system. It controls the manipulator movement and welding power supply, processes input and output signals, and provides the signals to operate the welding system.

For more information on the DX200 controller, please refer to the DX200 Controller Manual that is included with the AW200/500 system documentation package (see section 1.4).

Figure 2-1: DX200 Controller
2.2.1 Programming Pendant

The Programming Pendant (see Figure 2-2) provides the primary means for programmer/operator interaction with the AW200/500 system. The pendant features a 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 and USB port 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 DX200 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 AW200/500 system. For detailed information on the pendant’s programming keys, programming functions, and display functions, refer to the DX200 Operator’s Manual for Arc Welding that is included with the AW200/500 system documentation package (see section 1.4).

Figure 2-2: DX200 Programming Pendant

NOTICE

• The Programming Pendant’s LCD display goes dark after a few minutes of inactivity. Press any key to restore the screen.

• Placing the Programming Pendant’s Mode Select Switch to REMOTE to transfers control of the AW200/500 system to the Operator Station.
2.3 Operator Station

The Operator Station (see Figure 2-3) is mounted on a panel between the two safety barrier doors. See Figure 1-1 for the location of the Operator Stations in relation to the other components of the AW200/500 system. The following paragraphs describe the controls on the Operator Stations.

**NOTICE**

Placing the Programming Pendant’s Mode Select Switch to REMOTE to transfers control of the AW200/500 system to 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 cycle at the corresponding station if the robot is in the HOME (Safe) position. If the CYCLE START/CYCLE LATCHED push button is pressed while the robot is still welding, or otherwise not in the HOME (Safe) position, the CYCLE START/CYCLE LATCHED command is “latched” in (stored in) the DX200 controller’s circuitry. When the robot returns to the HOME (Safe) position, the “latched” CYCLE START/CYCLE LATCHED command is automatically executed in the queued station. Circuitry in the DX200 controller prevents the positioner from continuously cycling should the operator depress and hold the CYCLE START/CYCLE LATCHED button.
2.3.2 Operator Station — EMERGENCY STOP (E-STOP)
Pressing the Operator Station's EMERGENCY STOP (E-STOP) button initiates an Emergency Stop (E-Stop) condition. Refer to section 2.6.6 for information on the E-Stop condition and the procedures for recovering the AW200/500 system from an Emergency Stop (E-Stop) condition.

2.3.3 Operator Station — POSITIONER AUTO/MANUAL
The POSITIONER AUTO/MANUAL selector switch is used to select automatic or manual mode for the positioner. When the selector switch is in the AUTO position, the robot welds parts immediately after the barrier door closes. In MANUAL mode, the positioner rotates, but the robot does not weld parts - this mode is useful to verify the door operation is occurring properly.

NOTICE
The POSITIONER AUTO/MANUAL command depends upon the structure of the Control Master job.
2.4 Weld Station - MHT-185 (AW500 Only)

The AW500 includes two workstations; Station 1 and Station 2 and feature the MHT-185 positioner. The maximum tooling diameter for this positioner is 750mm.

The MHT-185 positioner is equipped with YASKAWA's patented MotoMount™ flexible fixture system, which eliminates the need for precision headstock/tailstock alignment. The pin-to-pin dimension of the MotoMount is 1072mm ±13mm. The MHT-185 has a load capacity of 550kg at 50mm from the center of rotation and overhang load capacity of 550kg at 250mm from the faceplate. The MHT-185 indexes 180 degrees in 2.72 seconds.

For additional positioner information, including specifications, an illustrated parts list, load capabilities, and dimensions, refer to the Motoman Positioner Manuals included with the AW200/500 system documentation package (see section 1.4).

**NOTICE**

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

In its standard configuration, the AW200/500 system includes a welding power source, wire feeder, torch, and torch mount for the robot. Optional equipment may also be included with the AW200/500 system (refer to section 1.2.3).

2.5.1 Welding Power Sources

YASKAWA offers various brands and types of welding power sources. The welding power source supplied with the AW200/500 system depends on the customer’s specific application and preference. For specific information on the welding power source supplied with the AW200/500 system, refer to the welding power source manual that is included with the system documentation package (see section 1.4).

2.5.2 Wire Feeder

A welding wire feeder is mounted on the upper arm (U-Axis) of the 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 AW200/500 system documentation package (see section 1.4).

2.5.3 GMAW Torch

The AW200/500 system uses either an air-cooled or water-cooled robotic/automatic GMAW torch. These are heavy-duty torches designed for quick replacement and a 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 4.3.2).

For applications that use the optional water-cooled torch, the AW200/500 system includes a water circulator kit. For additional information on the torches that are supplied with the system, refer to the vendor documentation that is included with the AW200/500 system documentation package (see section 1.4).
2.6 Safety Features

The AW200/500 system includes a total safety environment. 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.

**NOTICE**

Users are responsible for determining that the safeguards provided with the AW200/500 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.

**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 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 (Standard)

The heavy-gauge, welded wire safety fencing that is provided with the AW200/500 system encloses the entire work cell. It forms a physical barrier that prevents personnel from entering the work cell during automatic operation.

2.6.2.1 Safety Fencing (Option)

The cell can also be configured with solid panel fencing as an upgrade. This will block more of the ultraviolet light radiation that could escape from the work environment and also forms a physical barrier that prevents personnel from entering the work cell during automatic operation.
2.6.3 Motoman Door Guard

The YASKAWA Door Guard (YDG) is an AC motor driven door. The AC motor is controlled by a programmable YASKAWA J1000 inverter drive. The inverter drive provides full control of the YDG requiring only “up”, “down” and “brake release” input signals from the DX200 to operate. The barrier is designed with rounded edges and guards to minimize pinch points. The motor circuit is designed to slow or stall when impeded by an obstacle.

Each guard door includes a dual channel proximity sensor to safely indicate when the door is closed (up). This sensor’s feedback is provided to the Functional Safety Unit to help prevent serious injury to anyone entering a station safety zone while the robot is working in that area. In PLAY mode, if guard door is NOT closed, the robot is prohibited from entering the particular station. In the case that the door is opened and either the robot enters this zone, or the positioner moves, servo power is removed from the system and all positioner and robot motion stops. Servo power can be re-applied and operation resumed once the condition is corrected in TEACH mode.

As an option, light curtains can be built into the frame assembly to prevent contact with any component or operators while in motion, adding an additional measure of safety. The YDG moves from a fully closed position to a fully opened position within 2.0 seconds. In the fully opened position, the moveable section retracts within the door frame assembly preventing any damage from the operator leaning on the door. The YDG is designed for a 4-second duty cycle.

2.6.4 Safety Light Curtains (Optional at Barrier Doors)

The safety light curtains work in conjunction with the Functional Safety Unit to help prevent serious injury. If these light curtains are violated while the barrier door is moving the door control will immediately stop. This is to protect operators, equipment, and parts.

For additional information on the safety light curtain system, refer to the vendor documentation that is included with the AW200/500 system documentation package (see section 1.4).

2.6.5 Safety Light Curtains (Optional Between Each Station and the Robot)

The safety light curtains work in conjunction with the Functional Safety Unit to help prevent serious injury. These light curtains are optionally added protection in the case of an operator reaching past the area of operation in the open station. If these light curtains are violated with the corresponding barrier door open, the system will immediately stop. This is to protect operators, equipment, and parts.
2.6.6 Emergency Stop (E-Stop)

Emergency Stop (E-Stop) is a primary safety feature of the AW200/500 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 EMERGENCY STOP buttons can 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 2.6.8). The EMERGENCY STOP buttons are used for an intentional shutdown of the AW200/500 system and are installed at the following locations:

- Programming Pendant
- Operator Stations

To resume operation after an E-Stop condition shutdown, the operator must clear and reset the action that caused the E-Stop condition (refer to section 4.3.2).

2.6.7 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 Fig. 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 DX200 Operator’s Manual for Arc Welding that is included with the AW200/500 system documentation package (see section 1.4).

2.6.8 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 DX200 Manual Brake Release manual included with the AW200/500 system documentation package (see section 1.4).

2.6.9 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 2.6.6).
3 Installation

3.1 Required Materials

Two to three qualified technicians can install the AW200/500 system in a reasonable amount of time. Always comply with all the safety instructions and precautions given throughout this manual.

The instructions given in this section are general guidelines for installing the AW200/500 system. Refer to the system drawings for more specific installation information.

3.1 Required Materials

All system components and most of the materials and fasteners needed for installation of the AW200/500 system are included with shipment from the factory; however, the customer must supply some required items and installation tools (refer to section 3.1.1 and section 3.1.2).

3.1.1 Customer-supplied Items

- Shielding gas for the welding torches
- Local electrical service
- Earth ground wires for the robots and the DX200 controller assembly
- 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 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: 0.425m³/min (15cfm)
  - Pressure: 620kPa, gauge (90psi, gauge)
- Forklift
- Special anchor bolts and drill bits (refer to chapter 6 for suggested anchoring hardware)

CAUTION

- The AW200/500 system should be installed by qualified personnel who are familiar with the installation and setup of a robotic system.
- Handle all system components with care. The AW200/500 system is not extremely fragile, but it is a sophisticated robotic system that can be damaged by rough handling.

NOTICE

The customer must supply all anchoring hardware for the AW200/500 system. Refer to chapter 6 for suggested anchoring hardware and foundation specifications.
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 wrenches (large and small)
- Hammer drill with appropriate concrete bits
- Phillips and flat-blade screwdrivers
- Hammers (dead-blow, steel, and non-marring)
- Socket sets (SAE and Metric)
- Air-impact gun (with 3/4-inch hex socket)
- Open-end wrench sets (SAE and metric)
- Hex key wrench sets (SAE and metric)
3.2 Site Preparation

**WARNING**

During installation planning, allow sufficient room for access to the work-cell door and system components that are exterior to the work cell. Failure to observe this warning could result in injury to personnel during system operation and maintenance.

To prepare the site, proceed as follows:

1. Clear the floor space and overhead area needed for the AW200/500 system (see Figure 3-1(a)). Allow an additional 1.2m to 1.5m on all sides of the work cell to provide the clearances needed for installation.

2. Gather all customer-supplied items and required tools (refer to section 3.1).

**NOTICE**

Though the AW200 is shown in the following figures the dimensions for the AW500 are the same.
Fig. 3-1(b): Plan View Front View (AW200 Shown)

Fig. 3-1(c): Plan View Side Views (AW200 Shown)
3.3 Removal of System Components from Shipping Skids

The AW200/500 components are attached to wooden shipping skids at the factory, prior to shipment to the customer. The customer is responsible for removing the shipping skids and inspecting the components for shipping damage.

**NOTICE**

If there is any equipment damage, notify the shipping contractor as soon as possible.

1. Unbolt the AW200/500 components from the shipping skids using a 3/4-inch hex socket (see Figure 3-2).

   **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.

2. Discard and recycle the shipping skids and other shipping material.
3.4 Installing the System Components

**WARNING**

The components shipped on common bases are very heavy. Be sure the crane or forklift is capable of handling large capacities or damage to the equipment or injury to personnel can result.

1. Unbolt cell base and controller base from shipping skids using a 3/4 inch socket wrench.
2. Inspect cell, fence, robot, torch, and associated components for shipping damage.

**NOTICE**

If there is any equipment damage, notify shipper immediately.

3. Place the cell assembly base and robot controller base according to the system prints.
4. Attach cables between the controller base and the cell assembly base.
5. Once components are correctly installed, anchor each component securely in place (refer to chapter 6 "Anchoring" for requirements).
3.4.1 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. Shims can also be placed beneath the fence posts to make gross adjustments. See Figure 3-4(a) through Figure 3-4(c) for various latch adjustments.

**NOTICE**

Lockout/tagout procedures can be used with the door interlock by attaching a lock to the door handle key.

*Fig. 3-4(a): Door Latch Alignment*
**3 Installation**

**3.4 Installing the System Components**

*Fig. 3-4(b): Right Hand Sliding Configuration*

*Fig. 3-4(c): Left Hand Sliding Configuration*

DOOR INTERLOCK CAN BE LOCKOUT/TAGOUT WITH LOCKOUT KEY OR BY ATTACHING LOCK TO DOOR HANDLE KEY.
3.4.2 Installing the Arc Curtains

**WARNING**

Do not install the arc curtains until the cell walls have been secured. Unsecured cell walls can fall and injure personnel and damage equipment.

The arc curtains may be shipped in an accessories box. Unfold arc curtains and install one curtain on inside of each cell wall section.

3.4.3 Installing the Auxiliary Equipment

The controller, welder, and main service disconnect are typically installed just outside the cell fencing. To install the auxiliary equipment, proceed as follows:

1. Unbolt the auxiliary equipment from the shipping skid.
2. Carefully remove plastic wrapping and cardboard from controller and welder.
3. Inspect for any shipping damage.

**WARNING**

The controller weighs approximately 150kg (330lbs). Make sure the lifting device is capable of handling this much weight or damage to the equipment or injury to personnel can result.

4. Using a forklift, lift the controller and remove from shipping skid.
5. Using the system drawings, place the controller and welder next to the cell.
6. Once components are correctly installed, anchor each component securely in place (refer to chapter 6 “Anchoring” for anchor requirements).
3 Installation

3.5 Cable Connections

After components are level and securely in place, the cables should be unwrapped from around the equipment and laid out according to the cable diagram included in the system drawing package. Each cable connection is clearly identified for ease of installation.

3.5.1 Connection to Earth Ground

WARNING

Do not use the AW200/500 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 DX200 controller must be connected to a low-resistance earth ground. If a ground stake is used, it should be driven at least 2.43m 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.

NOTICE

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 DX200 controller. Connect the other end of the earth ground wire to the low-resistance earth ground.
3.5.2 Connection to Local Electrical Service

**WARNING**

Local electrical service connection to the AW200/500 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.

**NOTICE**

The AW200/500 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 the system documentation package (see section 1.4).

After all the system components have been properly installed and interconnected, connect local electrical service to the DX200 controller and welding power source (refer to chapter 3.5.2.1 and chapter 3.5.2.2).

3.5.2.1 DX200 Controller

For detailed electrical service interconnect procedures for the DX200 controller, refer to the *DX200 Controller Manual* and AW200/500 system drawings and schematics that are included with the system documentation package (see section 1.4).
3.5.2.2 Welding Power Source

Refer to the welding power source documentation and AW200/500 system drawings and schematics for electrical service connection procedures and diagrams for the welding power sources.
3.6 Safety/Operation Check

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

1. Ensure that all shipping brackets and material are removed from the system.
2. Check the security and integrity of all cable connections.
3. Ensure that the work-cell sliding access door closes and the door interlock engages properly.
4. Verify the correct settings for the welding power source (refer to the welding power source documentation that is included with the AW200/500 system).
5. Verify that local electrical service complies with the power requirements for the AW200/500 system.
6. Verify that local electrical service is correctly wired into the DX200 controller assembly and the welding power source (refer to section 3.5.1).

⚠️ CAUTION ⚠️

A qualified, trained personnel who is familiar with the AW200/500 system should perform the power-up sequence.

Not using a qualified, trained personnel to power-up the AW200/500 system could result in damage to the equipment.

7. Rotate the power ON-OFF switch on the DX200 controller to ON (see Figure 2-1).

⚠️ WARNING ⚠️

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

If the EMERGENCY STOP buttons do not work correctly serious injury or death can occur.

8. Check for correct operation of all EMERGENCY STOP buttons (refer to section 2.6.6).
9. Check for correct operation of the system HOLD button on the Programming Pendant. Refer to the Operator’s Manual for Arc Welding for more information on the pendant’s HOLD button (see section 1.4).
10. Check for correct action of the work-cell access door safety interlock.
11. Remove power from the AW200/500 system after completion of the safety/operation check.
3.7 **Installation of Tooling and Fixtures**

The AW200/500 system is now ready for attachment of tooling fixtures to the positioner kits. YASKAWA recommends assigning this task to personnel who are familiar with AW200/500 system operation and setup. After installation of the tooling and fixtures, test the positioner kit for correct operation. Refer to the positioner manual for instructions on how to test the positioner kit for correct operation (see section 1.4).

**NOTICE**

- The customer will supply all tooling and fixtures for the positioner kit.
- YASKAWA recommends using a corrosion/rust preventive compound on tooling and fixtures located in a high-humidity environment.
4 Operation

4.1 Programming

This section provides a brief overview of the operating procedures and precautions for the AW200/500 system. For more detailed operating information, refer to specific component manuals that are part of the AW200/500 system documentation package (refer to section 1.4).

The AW200/500 system is a fully integrated robotic GMAW welding cell. The MA1440 robot welds parts in Station 1 of the two-station system while the operator loads Station 2 with parts to be welded. When the robot completes the welding program at Station 1, it returns to the HOME (Safe) position. The operator can then initiate a CYCLE START/CYCLE LATCHED from the Operator Station for the new set of parts at Station 2. This moves the robot to Station 2, and the welding processes continues. The operator moves into Station 1 and replaces the completed welded parts with parts for another welding cycle.

4.1 Programming

The operation of this system is programming dependent. The following operating instructions are based on one possible configuration of this system. The system configuration and job structure may differ slightly from that presented here; however, basic operation will remain the same. For additional programming procedures and information, refer to the DX200 controller documentation included with the AW200/500 system documentation package (see section 1.4).

Any changes made to the system configuration and/or job structure will alter the operation of the system. YASKAWA recommends not modifying the original jobs and system configuration of the AW200/500 system. If it is determined, 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 AW200/500 system. If there are any questions concerning the configuration of the system, please contact YASKAWA's 24-hour Customer Support (refer to section 1.6).

---

CAUTION

The customer is responsible for providing trained operators to run the equipment. The customer is also responsible for making sure that the equipment is operated in accordance with the ANSI/RIA R15.06-2012 Robot Safety standard, as well as any other local or state standards. Not providing training for operators and making sure the equipment operates in accordance to standards can result in injury or death.

NOTICE

Customer will supply all tooling fixtures for the positioner.
4.2 Daily Operation

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

- Perform the start-up procedure (see section 4.2.1).
- Move the robot to HOME position (see section 4.2.2).
- Select the Control Master job (see section 4.2.3).
- Perform the operation cycle (see section 4.2.4).
- Perform the shutdown procedure (see section 4.2.5).

4.2.1 Start-up Procedure

To start up the AW200/500 work cell from a power-off condition, proceed as follows:

1. Rotate the DX200 controller’s power ON-OFF switch to ON (see Figure 2-1).
2. Set the power ON-OFF switch on the welding power source to ON (the ON-OFF indicator lamp on the welding power source will illuminate).
3. Open the regulator valve for the welding gas supply.
4. Make sure that the work-cell access door is closed and operating properly and the door safety interlock is engaged.
5. Make sure that all EMERGENCY STOP buttons are released. EMERGENCY STOP buttons are installed at the following locations:
   - Programming Pendant
   - Operator Station
7. Place the robot in HOME position (refer to section 4.2.2).

4.2.2 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.
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 move the robot to HOME position.
4.2.3 Control Master Job

With the system powered up and in TEACH mode, call up the Control 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 Control Master job.
4. Select PLAY mode on the Programming Pendant and press the PLAY MODE ENABLE button on the DX200 controller’s door (job playback operation is enabled). See Figure 2-1 for the location of the PLAY MODE ENABLE button on the controller.
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/CYCLE LATCHED input from the Operator Station).
7. Transfer control to the Operator Station by selecting REMOTE on the Programming Pendant’s Mode Select Switch.

The AW200/500 work cell is now ready for operation.

4.2.4 Operation Cycle

The following is the typical sequence of operation for the AW200/500 work cell after start-up:

1. The operator loads the fixture in Station 1 with the parts to be welded.
2. At the Operator Station, the operator presses the green CYCLE START/CYCLE LATCHED button for Station 1. The safety barrier door closes, and the robot moves to Station 1 to perform the welding program.
3. While the robot is welding, the operator moves to Station 2 and starts loading the next group of parts to be welded.
4. When the welding program in Station 1 is complete, the robot returns to the HOME (Safe) position, and the safety barrier door opens automatically.
5. When Station 2 is ready, the operator moves to the Operator Station, and presses the CYCLE START/CYCLE LATCHED button. The safety barrier door closes, and the robot moves to Station 2 to perform the welding program.

Notice
If the robot is still welding at the opposite welding station when the CYCLE START/CYCLE LATCHED button is pressed, the robot will finish and then proceed to the other station automatically (see section 2.3.1).

6. The operator moves into Station 1, removes the welded parts, replaces them with non-welded parts, and the process continues.

4.2.5 Shutdown

Use the following procedure to perform a normal shutdown of the AW200/500 system:

1. Make sure that the robot is in HOME position.
2. Turn off the system servo power by pressing the EMERGENCY STOP button on the Operator Station or Programming Pendant.
3. Select TEACH mode on the Programming Pendant.
4. Rotate the DX200 controller’s power ON-OFF switch to OFF (see Figure 2-1).
5. Set the welding power source’s power ON-OFF switch to OFF.
6. Close the regulator valve for the welding gas supply.

The AW200/500 system is now shut down.
4.3 **System Recovery**

When a system error or alarm occurs, it is required to clear the error or alarm to return the system to normal operation. The paragraphs below describe the different types of alarms and errors that might be encountered and how to clear them.

4.3.1 **Alarms and Errors**

Alarms and errors will stop the program. The three levels of alarms and errors are as follows:

- Error Messages
- Minor Alarms
- Major Alarms

For more detailed information on alarm and error recovery, refer to the DX200 controller and SSA2000 robot documentation that is included with the AW200/500 documentation package (see section 1.4).

4.3.1.1 **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 robot is not in PLAY mode. Clear errors of this type by pressing the CANCEL button on the Programming Pendant.

4.3.1.2 **Minor Alarms**

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

4.3.1.3 **Major Alarms**

Clear alarms of this type by cycling the DX200 controller in accordance with the following steps:

1. Rotate the DX200 power ON-OFF switch to OFF (see Figure 2-1).
2. Allow the DX200 power ON-OFF switch to remain in the OFF position for approximately 10 seconds.
3. Rotate the DX200 power ON-OFF switch back to ON.

4.3.2 **E-Stop Recovery**

An E-Stop (Emergency Stop) condition is triggered by any of the following conditions:

- An EMERGENCY STOP button is activated.
- A work-cell access door is opened while the robot is **not** in TEACH mode.
- A welding torch collision triggers a shock sensor output (refer to section 4.3.3).
- System Options:
  - Light curtain system is tripped while corresponding station door is moving.
  - Rear light curtain(s) are tripped by operator presence in an open station.
4 Operation

4.3 System Recovery

If an E-Stop condition is triggered, restart the AW200/500 system as follows:

1. Press the SERVO ON button on the Programming Pendant.
2. Select the REMOTE mode on the Programming Pendant’s Mode Select Switch to transfer control of the system to the Operator Station.
3. Press the green CYCLE START/CYCLE LATCHED button on the Operator Station.

The AW200/500 system is now ready to continue operation.

4.3.3 Shock Sensor Recovery

The AW200/500 welding package includes a Motoman gun mount for the MA1440 robot. This mount protects the torch from damage in case of an impact (collision). A slight deflection of the torch activates a SHOCK SENSOR signal that triggers a system Emergency Stop condition. To clear the Emergency Stop condition, override the shock sensor and move the robot clear of the impact is required. Refer to the following procedure to override the shock sensor:

1. Press MAIN MENU on the Programming Pendant.
2. Use the Programming Pendant cursor key to select the ROBOT icon, then press SELECT.
3. Use the Programming Pendant cursor key to select OVERRUN-S.SENSOR, then press the SELECT key.
4. Select RELEASE to release the shock sensor.
5. Turn servo power ON by pressing and holding the Programming Pendant’s ENABLE switch in the middle position while pressing the SERVO ON/READY push button.
6. Move the robot clear of the impact position.

The AW200/500 system is now ready to continue operation.

CAUTION

If an EMERGENCY STOP condition occurs while the positioner is rotating, the positioner will complete the rotation when the AW200/500 system is restarted.

CAUTION

Always reactivate the Shock Sensor before continuing system operation.

The robot can be damaged if the Shock Sensor Override Switch remains in the “Override” position.
Maintenance must be performed by authorized personnel who are familiar with the AW200/500 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 to 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 the specific equipment schedules and shop environment.

For periodic maintenance procedures and schedules for the individual components of the AW200/500 system, refer to the documentation that is included with the system documentation package (refer to section 1.4).

---

**CAUTION**

Use only YASKAWA-specified antifreeze if the system uses a water-cooled torch.

A typical automotive antifreeze contains additives that can clog the small cooling ports in the torch and damage sealing gaskets in the water circulator pump.
### Table 5-1: Periodic Maintenance

<table>
<thead>
<tr>
<th>FREQUENCY</th>
<th>COMPONENT</th>
<th>PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>Water Circulator (optional)</td>
<td>Check level of coolant/antifreeze. If necessary, add a mixture of YASKAWA coolant/antifreeze (P/N 131224-1) and distilled water. Mix antifreeze and distilled water in proportions shown on the antifreeze container.</td>
</tr>
<tr>
<td></td>
<td>All safeguard items – work-cell door interlocks, EMERGENCY STOP buttons, safety light curtains, arc curtains, etc.</td>
<td>Check physical condition of each safeguard item and ensure that the safeguard item is working correctly.</td>
</tr>
<tr>
<td></td>
<td>Gas and Water Hoses</td>
<td>Inspect hoses for damage and replace as required.</td>
</tr>
<tr>
<td>Monthly (or on condition)</td>
<td>AW200/500</td>
<td>Remove accumulated dirt, grease, and debris from inside and outside the work cell.</td>
</tr>
<tr>
<td>Every Six Months</td>
<td>System Components, Common Equipment Base (optional)</td>
<td>Check the integrity and security of anchor hardware in accordance with Hilti® documentation. Check the torque of hold-down nuts in accordance with Hilti® documentation (refer to chapter 6).</td>
</tr>
</tbody>
</table>
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 the system documentation package 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>
<thead>
<tr>
<th>Equipment</th>
<th>Minimum HILTI® Anchor Rod Diameter/ Type</th>
<th>Minimum Floor-plate Requirements</th>
<th>Minimum Foundation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Cell Base</td>
<td>Qty 2: 3/8-inch Chemical Anchor</td>
<td>Not Applicable</td>
<td>3.5-inch minimum thickness 4000psi Reinforced Concrete</td>
</tr>
<tr>
<td></td>
<td>Qty 4: 5/8-inch Chemical Anchor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robot Controller Base</td>
<td>1/2-inch Kwick Bolt II Style Anchor (Note 1)</td>
<td></td>
<td>3-inch minimum thickness or 1.3 embedment depth (whichever is larger) 4000psi Reinforced Concrete</td>
</tr>
<tr>
<td>Peripheral Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work-Cell Fence Posts</td>
<td>3/8-inch Kwick Bolt II Style Anchor (Note 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operator Station Pedestal</td>
<td>1/4-inch Kwick Bolt II Style Anchor (Note 1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

(1) Reference source: *Hilti® Product Technical Guide (Section 4.3.3)* for hardware specifications or equivalent.

Refer to [http://us.hilti.com](http://us.hilti.com) or [http://ca.hilti.com](http://ca.hilti.com) for further information.
7 Alarms and Messages

This section contains information on alarms and ladders that are generated by the DX200 ladder. Cause and resolution of each alarm are presented to help with troubleshooting. For additional help contact Yaskawa Technical Support.

7.1 Alarms Based on Barrier Door Operation

Many of the alarm text below are for Station 1 (ST1). These alarms may also occur for Station 2, in that case the alarm text will show “ST2” instead of “ST1”.

Table 7-1: Barrier Door Alarms

<table>
<thead>
<tr>
<th>Alarm Text</th>
<th>Alarm Cause</th>
<th>Suggested Resolutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1 Barrier Fault Occurred</td>
<td>Some sort of alarm in the VFD controller for this door</td>
<td>- Press corresponding general output to reset the VFD.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Station 1 = OUT #20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Station 2 = OUT #24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some alarms can only be cleared by cycling power to the control drive. These are not typical.</td>
</tr>
<tr>
<td>ST1 Door Overtime Flt</td>
<td>Door was moving longer than 4.0 seconds. The total door cycle time is expected to be under 3.0 seconds.</td>
<td>Check for mechanical failure of the door, brake sticking, or failures in Raised or Lower switches.</td>
</tr>
<tr>
<td>ST1 Door Raised Not On</td>
<td>Door was moving up longer than 5 seconds and the “Door Raised” switch never engaged.</td>
<td>Investigate Door Raised proximity switch. Check for proper operation in Manual mode. Verify cabling.</td>
</tr>
<tr>
<td>ST1 Door Raised Not Off</td>
<td>Door was moving down longer than 5 seconds and the “Door Raised” switch stayed on.</td>
<td>Investigate Door Raise switch. Check for proper operation in Manual mode. Verify cabling.</td>
</tr>
<tr>
<td>ST1 Door Lowered Not On</td>
<td>Door was moving down longer than 5 seconds and the “Door Lowered” switch never engaged.</td>
<td>Investigate Door Lowered proximity switch. Check for proper operation in Manual mode. Verify cabling.</td>
</tr>
<tr>
<td>ST1 Door Lowered Not Off</td>
<td>Door was moving up longer than 5 seconds and the “Door Lowered” switch stayed on.</td>
<td>Investigate “Door Lowered” switch. Check for proper operation in Manual mode. Verify cabling.</td>
</tr>
</tbody>
</table>
## 7.2 Alarms Based on Functional Safety Unit Conditions

### Table 7-2: Functional Safety Unit Alarms

<table>
<thead>
<tr>
<th>Alarm Text</th>
<th>Alarm Cause</th>
<th>Suggested Resolutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYS CRITICAL FSU FUNCT DISABLED</td>
<td>The Functional Safety Unit has several files which need to be enabled to ensure safe operation of the cell. The Functional Safety Unit uses one the “Robot Range Limit” setting to control or limit the range of robot motion based on several conditions. If the cell is a an AW500, then the “Axis Speed Monitor” function also monitors headstock monitor when the barrier doors are open.</td>
<td>In Teach Mode - Robot Range Limit File #7 will be active, if someone changed the logic or other setting, this alarm could occur. Under normal operation this file is activated by signal condition, which is a “Teach/Play” mode input.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In Play Mode - with Station 1 barrier door closed (up) and Station 2 barrier door open (down), Robot Range Limit File #1 will be active, if someone changed the logic or other setting, this alarm could occur. Under normal operation this file is activated by the safety prox signals from each barrier door. If the safety prox is not activating properly this alarm may also occur falsely.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In Play Mode - with both barriers open (down), Robot Range Limit File #3 will be active, if someone changed the logic or other setting, this alarm could occur. Under normal operation this file is activated by the safety proximity signals from each barrier door. If the safety proximity is not activating properly this alarm may also occur falsely.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In Play Mode - with both barriers closed (up), Robot Range Limit File #4 will be active, if someone changed the logic or other setting, this alarm could occur. Under normal operation this file is activated by the safety prox signals from each barrier door. If the safety prox is not activating properly this alarm may also occur falsely.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In Play Mode - Robot Range Limit File #5 and #6 must always be active, if someone changed the logic or other setting, this alarm could occur.</td>
</tr>
</tbody>
</table>

1 Reference cell drawings (176436-1 and 176437-1) and barrier drawings (175116-1) for specific locations of each sensor.
### 7.3 Cell Messages

#### Table 7-3: Cell Messages

<table>
<thead>
<tr>
<th>Message Text</th>
<th>Message Cause</th>
<th>Suggested Resolutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROBOT RANGE FILE 1-6 DISABLED</td>
<td>After &quot;SYS CRITICAL FSU&quot; type alarm occurs, this message will follow, which helps point towards the specific feature to examine.</td>
<td>Check the menu: SAFETY FUNC. &gt; ROBOT RANGE LIMIT and verify that all Files 1 through 6 are setup per section 1.3.4</td>
</tr>
<tr>
<td>ROBOT RANGE FILE #7 DISABLED</td>
<td>After &quot;SYS CRITICAL FSU&quot; type alarm occurs, this message will follow, which helps point towards the specific feature to examine.</td>
<td>Check the menu: SAFETY FUNC. &gt; ROBOT RANGE LIMIT and verify that File 7 is setup per section 1.3.4</td>
</tr>
<tr>
<td>AW500 Only: ANY SPEED MONITOR FILE DISABLED</td>
<td>After &quot;SYS CRITICAL FSU&quot; type alarm occurs, this message will follow, which helps point towards the specific feature to examine.</td>
<td>Check the menu: SAFETY FUNC. &gt; AXIS SPEED MONITOR and verify that Files 1 and 2 are setup per section 1.3.4</td>
</tr>
</tbody>
</table>
7 Alarms and Messages
7.3 Cell Messages
8  Spare Parts

Maintenance of the AW200/AW500 cell and its associated components should be performed only by authorized personnel who are familiar with the design, construction, and operation of the system. When exchanging failed parts be sure to understand the procedure, risks, have the proper tools, and observe all applicable safety precautions.

8.1 Robot Spare Parts

Reference the supplied MA1440 Manipulator Manual (P/N 165830-1CD) for spare part recommendations.

8.2 Positioner Spare Parts

For a AW500 cell, reference the MH(T)-Series SIGMA-5 Positioner Manual (P/N 168961-1CD) for spare part recommendations relative to the MHT-185 positioner.

8.3 ArcWorld Door Interface Spare Parts

Each AW200 or AW500 is supplied with a interface panel that is mounted to the DX200's controller door. Recommended spare parts include:

<table>
<thead>
<tr>
<th>Component</th>
<th>YASKAWA Part Number</th>
<th>Recommended Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Amp Fuse 24VDC</td>
<td>149593-1</td>
<td>2</td>
</tr>
<tr>
<td>2 Amp Fuse 24VDC</td>
<td>703039-1</td>
<td>2</td>
</tr>
<tr>
<td>1.6 Amp Fuse 24VDC</td>
<td>703039-8</td>
<td>2</td>
</tr>
<tr>
<td>1 Amp Fuse 24VDC</td>
<td>703093-3</td>
<td>2</td>
</tr>
<tr>
<td>Relay (Pilz Safety)</td>
<td>155916-2</td>
<td>1</td>
</tr>
</tbody>
</table>

WARNING

Ensure that servo power is OFF and observe standard lockout/tagout practices before performing the following procedures.
Injury may result if servo power is not removed.

When a part malfunctions, it is helpful to have replacement parts in stock for quick replacement. YASKAWA recommends the parts in the following sections be kept on hand.
# Appendix A

## A.1 Checklist

Since our customer is very important to us we include a checklist to use before start-ups and after maintenance for convenience and safety.

<table>
<thead>
<tr>
<th>BEFORE APPLYING POWER</th>
<th>Time/Date</th>
<th>Checked By</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(Refer to System Drawings)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Mounting</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Installation Section in all Manuals)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Power</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Connections, Controller Manual)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Grounding in all Manuals)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Operation and Vendor Manuals)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Manipulator and Vendor Manuals)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer Operation and Vendor Manuals)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Interlocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Work Cells in all Manuals)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Limiting Devices/Software</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Limits in all Manuals)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Installation in Controller Manual)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Version</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Confirmation of Software Version)</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other Items to Check Before Applying Power**

*(Vendor or Integrator Supplied)*
## AFTER APPLYING POWER

<table>
<thead>
<tr>
<th>Task</th>
<th>Time/Date</th>
<th>Checked By</th>
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</thead>
<tbody>
<tr>
<td>Check Control Switches</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Operator Station, Controller Manual)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check Axis Move and are Restricted</td>
<td></td>
<td></td>
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<tr>
<td><em>(Refer to Basic Specifications, Manipulator Manual)</em></td>
<td></td>
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<tr>
<td>Check Emergency Stop(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*(Refer to E-Stop in all Manual(s))</td>
<td></td>
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<tr>
<td>Check External Power Disconnect</td>
<td></td>
<td></td>
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<tr>
<td><em>(Refer to Turning OFF The Power Supply, Controller Manual)</em></td>
<td></td>
<td></td>
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<tr>
<td>Check Teach Mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Teach Mode, Controller Manual)</em></td>
<td></td>
<td></td>
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<tr>
<td>Check Playback Mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Play Mode, Controller Manual)</em></td>
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<td></td>
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<tr>
<td>Check Environment</td>
<td></td>
<td></td>
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<tr>
<td><em>(Refer to Location in Manipulator Manual)</em></td>
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<tr>
<td>Check Safeguards</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(Refer to Safeguards in all Manuals)</em></td>
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<tr>
<td>Check Manual Mode</td>
<td></td>
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<tr>
<td><em>(Refer to Manual Mode in Operations Manual)</em></td>
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<td></td>
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<tr>
<td>Check Automatic Mode</td>
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<tr>
<td><em>(Refer to Automatic Mode in Operations Manual)</em></td>
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</tbody>
</table>

### Other Items to Check After Applying Power

*Vendor or Integrator Supplied*
### DOCUMENTATION INCLUDED

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</table>

- **System Drawings**

- **Modifications Made to Original Protective Equipment**

- **End Effector Load Analysis**

- **Instructions on Synchronized Motion**  
  *(More than one piece of moving synchronized equipment)*

- **Programmed Limits**

- **Collaborative Operation Declaration**  
  *(Robot is suitable for integration that includes requirements met and types of operation)*

- **Compliance Documents**  
  *(ANSI, ISO, RIA, etc.)*

- **Risk Assessment**

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- **Other Documents to Include**  
  *(Vendor or Integrator Supplied)*  
  *(Vendor Manuals, Supplier Certifications, Compliance Documents, etc.)*

<table>
<thead>
<tr>
<th>Time/Date</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MARKINGS INCLUDED ON EQUIPMENT</td>
<td>Time/Date</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Business Name, Address, Info</td>
<td></td>
</tr>
<tr>
<td>Machinery Designation and Type</td>
<td></td>
</tr>
<tr>
<td>Year Built</td>
<td></td>
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<tr>
<td>Explosive Proof</td>
<td></td>
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<tr>
<td>Order Number (Serial Number)</td>
<td></td>
</tr>
<tr>
<td>Other Markings on Equipment</td>
<td></td>
</tr>
<tr>
<td>(Vendor Machine Designation, Type, Serial No, Version, etc.)</td>
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</tbody>
</table>

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<thead>
<tr>
<th>OTHER ITEMS</th>
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