

Yasnac ERC Controller
ArcWorld 1000
Operator's Manual

Part Number 130890-2

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1.0 INTRODUCTION

The ArcWorld 1000 is part of the ArcWorld family of standardized arc welding solutions. It is fully integrated and supported from wire to weld by Motoman, Inc.

The ArcWorld 1000 features a Motoman arc welding robot and ERC controller with menu-driven arc welding application software, complete welding package, 180° rotary positioner, operator interface, and total safety environment.

1.1 REFERENCE TO OTHER DOCUMENTATION

For additional information, refer to the following:

- ¥ Motoman K10 Robot Manipulator Manual (Part Number 479951-4)
- ¥ Motoman K6SB Robot Manipulator Manual (Part Number 479951-2)
- ¥ Motoman ERC Programming Manual (Part Number 479950-3)
- ¥ Motoman ERC OP2 Key Function Manual (Part Number 479950-4)
- ¥ Motoman Robotic Welding Manual (Part Number 479950-6)
- ¥ Motoman ArcWorld 1000 Installation Manual (Part Number 130890-1)
- ¥ Motoman ArcWorld 1000 Installation Video (Part Number 130511-1)
- ¥ Vendor manuals for system components not manufactured by Motoman

NOTES

2.0 SAFETY

It is the purchaser's responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems. This information can be obtained from the Robotic Industries Association by requesting ANSI/RIA R15.06. The address is as follows:

Robotic Industries Association

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

Ultimately, the best safeguard is trained personnel. The user is responsible for providing personnel who are adequately trained to operate, program, and maintain the robot cell. **The robot must not be operated by personnel who have not been trained!**

We recommend that all personnel who intend to operate, program, repair, or use the robot system be trained in an approved Motoman training course and become familiar with the proper operation of the system.

This safety section addresses the following:

- Standard Conventions (see Section 2.1)
- General Safeguarding Tips (see Section 2.2)
- Mechanical Safety Devices (see Section 2.3)
- Installation Safety (see Section 2.4)
- Programming Safety (see Section 2.5)
- Operation Safety (see Section 2.6)
- Maintenance Safety (see Section 2.7)

2.1 **STANDARD CONVENTIONS**

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

- DANGER
- WARNING
- CAUTION
- NOTE

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



DANGER!

Information appearing under the DANGER caption concerns the protection of personnel from the immediate and imminent hazards that, if not avoided, will result in immediate, serious personal injury or loss of life in addition to equipment damage.



WARNING!

Information appearing under the WARNING caption concerns the protection of personnel and equipment from potential hazards that can result in personal injury or loss of life in addition to equipment damage.



CAUTION!

Information appearing under the CAUTION caption concerns the protection of equipment, software, and data from hazards that can result in minor personal injury or equipment damage.

NOTE: *Information appearing in a NOTE caption provides additional information which is helpful in understanding the item being explained.*

2.2 GENERAL SAFEGUARDING TIPS

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows:

- Improper operation can damage the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
- Do not enter the robot cell while it is in operation. Place the robot in Emergency Stop (E.STOP) mode and ensure that all motion has stopped before entering the cell.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
- The robot must be placed in Emergency Stop (E.STOP) mode whenever it is not in use.

2.3 MECHANICAL SAFETY DEVICES

The safe operation of the robot, positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, RIA safety recommendations, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety measures are available:

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

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

2.4 **INSTALLATION SAFETY**

Safe installation is essential for protection of people and equipment. The user must be aware of the various national codes, RIA safety recommendations, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations.

- Ensure that only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories are permitted to operate this robot system.
- Identify the work envelope of each robot with floor markings, signs, and barriers.
- Position all controllers outside the robot work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.5 **PROGRAMMING SAFETY**

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. Programming safety tips are as follows:

- Any modifications to NODE 2 (for ERC controllers) or PART 1 (for MRC controllers) of the controller PLC can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to NODE 2 or PART 1. Making any changes without the written permission of Motoman will **VOID YOUR WARRANTY!**
- Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. **YOUR WARRANTY WILL BE VOID** if you use these special passwords.
- Back up all programs and jobs onto a floppy disk whenever program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.
- The concurrent I/O (Input and Output) function allows the customer to modify the internal ladder inputs and outputs for maximum robot performance. Great care must be taken when making these modifications. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations that may damage the robot or other parts of the system.

- Improper operation can damage the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to operate the system.
- Inspect the robot and work envelope to ensure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Ensure that all safeguards are in place.
- Check the E.STOP button on the teach pendant for proper operation before programming.
- Keep the teach pendant with you when you enter the workcell.
- Ensure that only the person holding the teach pendant enters the workcell.
- Test any new or modified program at low speed for at least one full cycle.

2.6 OPERATION SAFETY

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. Operation safety tips are as follows:

- Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Inspect the robot and work envelope to ensure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Ensure that all safeguards are in place.
- Improper operation can damage the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to operate the system.
- Do not enter the robot cell while it is in operation. Place the robot in Emergency Stop (E.STOP) mode and ensure that all motion has stopped before entering the cell.
- The robot must be placed in Emergency Stop (E.STOP) mode whenever it is not in use.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller, external servo box, and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot. On ERC controllers this includes controller parameters; ladder nodes 1, 2, or 3; and I/O (Input and Output) modifications. On MRC controllers this includes controller parameters, ladder parts 1 and 2, and I/O (Input and Output) modifications. Check and test all changes at slow speed.

2.7 MAINTENANCE SAFETY

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. Maintenance safety tips are as follows:

- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Improper operation can damage the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to operate the system.
- Back up all your programs and jobs onto a floppy disk whenever program changes are made. A backup must always be made before any servicing or changes are made to options, accessories, or equipment to avoid loss of information, programs, or jobs.
- Do not enter the robot cell while it is in operation. Place the robot in Emergency Stop (E.STOP) mode and ensure that all motion has stopped before entering the cell.
- The robot must be placed in Emergency Stop (E.STOP) mode whenever it is not in use.
- Ensure all safeguards are in place.
- Use proper replacement parts.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller, external servo box, and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot. On ERC controllers this includes controller parameters; ladder nodes 1, 2, or 3; and I/O (Input and Output) modifications. On MRC controllers this includes controller parameters, ladder parts 1 and 2, and I/O (Input and Output) modifications. Check and test all changes at slow speed.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).

3.0 DETAILED DESCRIPTION OF EQUIPMENT

3.1 ROBOT DESCRIPTION

The standard ArcWorld 1000 is supplied with a Motoman K6SB robot manipulator. The ArcWorld 1010 is provided with a K10S manipulator. The ArcWorld 1000 and 1010 are identical from an operational standpoint.

The Motoman K6SB Robot and YASNAC ERC Controller represent state-of-the-art technology in robotics today. The six-axis K6SB Robot has a payload of 6 kg. or 13.2 lbs. The K6SB Robot features a 1,322 mm (52.01") reach and has a relative positioning accuracy of + 0.1 mm and + .004 inches.

The Motoman K10S Robot and YASNAC ERC Controller represent state-of-the-art technology in robotics today. The six-axis K10S Robot has a payload of 10 kg. or 22 lbs. The K10S Robot features a 1,555 mm (61.2") reach and has a relative positioning accuracy of + 0.1 mm and + .004 inches.

Each robot can reach below its own base as well as behind itself. These Robots can also be mounted in floor, wall, or ceiling configurations with few hardware modifications. Motoman K-Series robots have been constructed for ease of maintenance utilizing brushless AC servo motors with absolute position encoders. All motors are readily accessible. A combination of capacitance and lithium batteries in both the robot encoder assemblies and in the Motoman YASNAC ERC controller protects program position data for up to one year. The replacement life expectancy for the lithium battery is approximately three years.

A teach pendant is used to program all robot motions. Standard software features include point-to-point, linear, and circular interpolation. A 9-inch CRT display and menu programming are supplied as a standard feature. This feature facilitates initial programming, editing, and maintenance functions, as large blocks of program or maintenance information can be readily displayed. The teach pendant has its own eight-character LED display. In addition to controlling robot motion, the teach pendant allows for program scrolling and verification.

3.2 MR-500 POSITIONER

3.2.1 Part / Fixture Rating

This is the combined weight of part and fixture - 500 pounds on each side of the Motoman MR-500 180° Indexing Positioner.

3.2.2 Part Center of Gravity

The Motoman MR-500 180° Indexing Positioner is rated for a maximum load with a center of gravity of 500 pounds located 10 inches above the table tooling plate surface at a radius of 20 inches.

3.2.3 Temperature Operating Range

40-110 ° Fahrenheit.

3.2.4 Humidity

Non-condensing 10-90% relative humidity.

NOTE: In high humidity areas, the table tooling plate may rust or corrode. Surface protection should be used.

3.2.5 Shock

Less than 0.5 G.

3.2.6 Sweep Speed

Typically 5 seconds with a full load of 500 pounds on each side.

3.2.7 Electrical Requirements

All electrical power required to operate the Motoman MR-500 180° Indexing is supplied from the ERC controller and consists of a 115 VAC / 60 Hz / Single-Phase circuit to provide power for the drive system and interface.

3.2.8 *Welding Current Rating*

The Motoman MR-500 180° Indexing Positioner has a welding current capacity of 600 amperes at 100% duty cycle. The welding ground system consists of a spring loaded copper brush that contacts a large ring mounted below the surface of the table. The ground cable to the welding power source is connected to the insulated ground stud located on the lower right side of the positioner base when facing the front of the ArcWorld 1000 cell.

3.2.9 *Hard Stops and Shock Absorbers*

The Motoman MR-500 positioner is equipped with two hard stops and two shock absorbers. The hard stops and shock absorbers are located on the right side of the positioner base beneath the table top. The hard stops and the shock absorbers are adjustable for positioner Side A and Side B.

3.2.10 *Arc Shield*

The Motoman MR-500 positioner is provided with a sheet metal screen for arc radiation protection between the operator loading zone and the welding zone. Do not operate this equipment unless the arc shield is in place.

3.3 *OP-STATION*

3.3.1 *Emergency Stop*

The operator station **E-STOP**, the robot **E-STOP**, the sliding door interlocks, and the ArcWorld 1000 safety mats are connected in series in the Emergency Stop circuit. If the E-STOP circuit is interrupted, the robot and the Motoman MR-500 positioner will go into the E-STOP condition. The operator station E-STOP light will come on when the E-STOP button is pressed. In the E-STOP condition, power to the Motoman MR-500 positioner interface is removed. This stops the table sweep.

3.3.2 *Hold*

The operator station **HOLD** button is a normally closed pushbutton and is connected to the ERC to cause the robot to go into hold when the button is pressed.

3.3.3 *Cycle Start*

The palm buttons in the operator station use an anti tie-down technique for robot input. The anti tie-down timer is set for 10 seconds. If the palm buttons are held down for more than 10 seconds, the timer will time out and prevent the input from reaching the robot. The **CYCLE START** buttons are connected to robot Input #1.

3.3.4 Station Ready

The **STATION READY** lamp is interlocked with the robot CUBE #1 output. The robot Output #11 turns on the **STATION READY** lamp.

3.3.5 Alarm

The **ALARM** lamp is connected to the robot Alarm Occurrence output. The **ALARM** lamp turns on when the robot encounters a major or minor alarm condition.

3.3.6 Servo On

The **SERVO ON** pushbutton is connected to the robot Servo On input. The robot servo motors will turn on when the **SERVO ON** pushbutton is pressed and an E-STOP condition does not exist.

3.3.7 Positioner Auto / Manual

The **POSITIONER Auto / Manual** selector switch is used to select Automatic or Manual Mode for the Motoman MR-500 positioner. The selector switch is connected to robot Input #2. When the selector switch is in the Automatic position, the robot will process the part after the positioner sweeps. In Manual Mode, the robot will not process the part after the positioner sweeps. **This function is dependent on the structure of the master job.**

3.3.8 Master Job Start

The **MASTER JOB START** pushbutton is connected to the robot external start input. The robot will start the current active job when pressed if the robot is in Play Mode and the servo motors are on.

3.3.9 Reset

The **RESET** pushbutton is connected to the robot alarm reset input. Any alarm or error condition will be cleared when this button is pressed. In addition, the **RESET** pushbutton and the **RIGHT CYCLE START** pushbuttons are interlocked and, when pressed simultaneously, enable the MR-500 positioner if the robot servo motors are on. The positioner needs to be enabled at initial power up or emergency stop or shock sensor condition.

NOTE: Resetting the positioner may cause some table motion. Do not reset the positioner with the robot close to tooling. If E-Stop occurs during programming, be sure to reset table before resuming programming.

3.4 SAFETY EQUIPMENT

The ArcWorld 1000 system has a host of safety equipment integrated into it. The safety equipment is provided to ensure safe operation of this robotic cell providing all standard safety precautions are taken. The ANSI/RIA RIS.06 Robot Safety Standard stipulates the user is responsible for safeguarding. **Users are responsible for determining if the provided safeguards are adequate for plant conditions. Users must also ensure that safeguards are maintained in working order.**

3.4.1 Safety Mats

The safety mat provided with the ArcWorld 1000 is used to prevent serious injury to anyone entering the turntable positioner area during the sweeping process. If someone would step on this mat when the positioner is in motion, an E-STOP would occur causing the entire system to shutdown. To restart the system you must:

1. Turn on servo power at the operator station.
2. Hit **reset** and the **right cycle start** button simultaneously.
3. Push the **master job** start button to start the program where it left off.

3.4.2 Interlocks

The dual safety interlocks on the cell entrance door are used to stop entrance into the cell during PLAY mode. If this should happen, an E-STOP would occur causing the entire system to stop.

3.4.3 Emergency Stops

The ArcWorld 1000 has several strategically placed emergency stops (E-STOPS) in the system. The following is a list of their location:

1. The ERC control panel has one **E-STOP** button.
2. The ERC teach pendant has one **E-STOP** button.
3. Opening the entrance door during PLAY mode will cause an E-STOP.
4. Stepping on the safety mat during positioner sweeping will cause an E-STOP.
5. The turntable positioner operator station has one **E-STOP** button.

3.4.4 Arc Screen

There are two separate arc screens used on the ArcWorld 1000. The first is a metal arc screen used on the turntable positioner. This screen prevents any arc rays or sparks from getting too close to the operator during the time parts are being loaded. The second is an arc screen material used to cover the safety fencing of the entire robotic cell. This screen material prevents ultra-violet arc rays and sparks from exiting the robotic cell.



WARNING!

Although this screen is used to block dangerous arc radiation, it is not recommended that you look directly at the arc during operation without protective eyewear!

3.4.5 Fencing

The safety fencing provided with the ArcWorld 1000 is used to enclose the entire robotic cell. This prevents inadvertent entry into the robot envelope.

3.5 OPTIONAL EQUIPMENT

The following is a list of standard options that can be added to the ArcWorld 1000.

1. Torch Cleaning and Prep Station
2. Automatic Wire Cutter
3. Com-Arc II Seam Tracking with Touch Sense Seam Finder
4. Motoman Bulk DeReeler
5. Water Cooled Weld Package

For a complete list of options available for the ArcWorld 1000, please contact your local Motoman sales representative.

4.0 THEORY OF OPERATIONS

4.1 GENERAL DESCRIPTION

NOTE: Refer to Motoman Outline Drawing 130150, Sheet 1 for cell layout.

The main components of the ArcWorld 1000 cell are as follows:

- ¥ Robot Manipulator
- ¥ ERC Robot Controller
- ¥ Welding power source
- ¥ Motoman MR-500 180° Indexing Positioner
- ¥ Safety Fencing with dual interlocked entrance door
- ¥ Arc Screen Curtains Kit
- ¥ Safety Mat Kit

The ArcWorld 1000 is a fully integrated robotic MIG welding cell. The robot welds on one side of the 180° turntable positioner while the operator loads the opposite side with parts. Once the robot is finished with its process, it returns to the home position. The operator sweeps the turntable enabling the robot to start welding on the next part. The safety entrance door interlocks prevent anyone from entering the cell while the robot is in PLAY mode. If the safety mat in front of the turntable positioner is stepped on during the sweeping of the turntable positioner, the system will E-STOP.

4.2 SEQUENCE OF OPERATIONS

The following is the sequence of operations for the ArcWorld 1000 Cell after start-up:

1. Load the fixture on operator side of the positioner with the parts to be welded.
2. Wait for the **STATION READY** light to turn ON.
3. Press the right and left **CYCLE START** palm buttons on the operator station. The positioner will sweep to the other side and place the unwelded parts in the robot work area. The robot will begin welding the unwelded parts.
4. Unload the welded parts from the fixture.
5. Repeat Steps 1 through 4.

4.2.1 Start-up

To start up the ArcWorld 1000 Cell from a POWER OFF condition, the following procedure should be used:

1. Turn ON the ERC.
2. Turn ON the welding power source.
3. Turn ON the welding gas.
4. Place the robot in TEACH MODE.
5. Turn ON the robot servo motors.
6. Make sure the robot is in the starting position (CUBE 1 position).
7. Call up the master job.
8. Make sure the sliding door is closed and the safety plug is connected.
9. Place the robot in PLAY MODE/AUTO CYCLE.
10. Initialize the positioner by pressing the **RESET** button and the **RIGHT CYCLE START** button simultaneously on the operator station.
11. Press the **MASTER JOB START** button on the operator station.
12. Wait for the **STATION READY** light to turn ON.

The ArcWorld 1000 Cell is now ready for operation.

4.2.2 E-STOP Occurrence

There are three different ways an E-STOP condition can occur:

1. Pressing the **E-STOP** button on the operator station, the teach pendant, or the ERC terminal.
2. Attempting to open the sliding door or removing the safety plug when the robot is not in TEACH MODE.
3. Stepping on the safety mat when the MR-500 positioner is sweeping.

4.2.3 **E-STOP Recovery**

To restart the ArcWorld 1000 Cell from an E-STOP condition occurring during operation, the following procedure should be used:

1. Clear the cause of the E-STOP condition.
 - a. Release the **E-STOP** button on the operator station, the teach pendant, or the ERC terminal.
 - b. Close the sliding door and connect the safety plug.
 - c. Step off the safety mat.
2. Turn ON the robot servo motors.



CAUTION!

If the E-STOP condition occurred while the positioner was sweeping, the positioner will continue the sweep when initialized.

3. Initialize the positioner by pressing the **RESET** button and the right **CYCLE START** button simultaneously on the operator station.
4. Press the **MASTER JOB START** button on the operator station.

The ArcWorld 1000 Cell will continue its operation.

4.2.4 **Shutdown**

To shut down the ArcWorld 1000 Cell after operation is complete, the following procedure should be used:

1. Make sure the robot is in the starting position (CUBE 1 position).
2. Turn OFF the robot servo motors by pressing the **E-STOP** button on either the operator station, teach pendant, or monitor.
3. Place the robot in TEACH MODE.
4. Turn OFF the ERC.
5. Turn OFF the welding power source.
6. Turn OFF the welding gas.

The ArcWorld 1000 Cell is now shutdown.

4.3 PROGRAMMING

4.3.1 Sweeping Table to Side A

To sweep the Motoman MR-500 positioner to Side A:

- ¥ The robot Servo Power must be ON.
- ¥ The positioner must be enabled.
- ¥ The robot must be in CUBE #1.
- ¥ The robot Output #9 must be ON.

When the table sweeps into position at Side A, the positioner provides an input to IN #3 "AT SIDE A." When this input is turned ON, robot Output #9 should be turned OFF.

4.3.2 Sweeping Table to Side B

To sweep the Motoman MR-500 positioner to Side B:

- ¥ The robot Servo Power must be ON.
- ¥ The positioner must be enabled.
- ¥ The robot must be in CUBE #1.
- ¥ The robot Output #10 must be ON.

When the table sweeps into position at Side B, the positioner provides an input to IN #4 "AT SIDE B". When this input is turned ON, robot Output #10 should be turned OFF.

NOTE: The Cube function is a software feature that turns on an output when the robot tool center point is within established boundaries. If the robot moves outside of the cube, the output is lost and the positioner will not sweep. The cube position is factory set to be clear of the table. To redefine the cube position, see information in the appendix.

4.4 **SAMPLE JOBS**

The following jobs are shown as **examples only**. Your system may have other features and / or options requiring program changes. Double-check your system before running these jobs. The text with apostrophes are comments and do not affect robot operation.

4.4.1 **I/O Assignment**

The ArcWorld 1000 Positioner and ArcWorld Operator Station use the following Motoman ERC user and dedicated inputs and outputs:

ERC User Inputs

- IN#1 Cycle Start Interlocked with CUBE #1
- IN#2 Auto/Manual Selector Switch
- IN#3 At Side A
- IN#4 At Side B

ERC User Outputs

- OUT #9 Sweep to A Interlocked with CUBE #1
- OUT#10 Sweep to B Interlocked with CUBE #1
- OUT#11 Station Ready Interlocked with CUBE #1

The Motoman K-series robot must be in CUBE #1 in order to sweep the ArcWorld 1000 positioner.

ERC Dedicated Inputs

- ¥ Servo ON
- ¥ Master Job Start
- ¥ Alarm Reset
- ¥ Hold
- ¥ External Emergency Stop

ERC Dedicated Outputs

- ¥ Servo Power ON
- ¥ Emergency Stop OK
- ¥ Teach Mode
- ¥ CUBE #1
- ¥ Alarm Occurrence

For more information on the Motoman ERC User and Dedicated I/O, please refer to the ERC Controller I/O Structure Manual. (Motoman Part Number 479236-4) and ERC Dedicated I/O Guidelines Manual (Motoman Part Number 479236-14).

4.4.2 Master Job

<u>Line</u>	<u>Step</u>	<u>Function</u>
000	000	NOP
001		'Turn off Output 9 and 10 (sweeping outputs)
002		DOUT OT#9 0
003		DOUT OT#10 0
004		'Move to home position in CUBE #1
005	001	MOVJ VJ=50.00
006		'Turn on Output 11 Station Ready Lamp
007		DOUT OT#11 1
008		'Wait for cycle start input (palm buttons)
009		WAIT IN#1=1
010		'Turn Station Ready Lamp Off
011		DOUT OT#11 0
012		'Jump to Sweep to Side B if already at Side A
013		JUMP *1 IF IN#03=1
014		'Sweep positioner to Side A
015		DOUT OT#9=1
016		WAIT IN#3=1
017		DOUT OT#9=0
018		'Turn on Station Ready Lamp, Sweep Complete
019		DOUT OT#11 1
020		'Call the WELD-A job if in Auto Mode
021		CALL JOB: WELD-A IF IN #2 = 1
022		'Jump to end of job
023		JUMP *2
024		*1
025		DOUT OT #10=1
026		WAIT IN#4=1
027		DOUT OT#10=0
028		'Turn on Station Ready Lamp, Sweep Complete
029		DOUT OT#11 1
030		'Call the WELD-B job if at Side B in Auto Mode
031		CALL JOB: WELD-B IF IN #2 = 1
032		*2
033		'Optional nozzle clean
034		CALL JOB: CLEAN IF B00≥4
035		END

The master job should be played in AUTO Cycle. The above program will move to a home position. Turn on the **station ready** lamp and wait for the operator palm buttons to be activated. When the operator hits the palm buttons, the robot checks which side is towards the robot and jumps to the conditions to sweep to the other side. During sweep cycle, the **station ready** lamp remains OFF indicating that it is unsafe to enter the part loading zone. At the end of the sweep, the **station ready** lamp turns ON indicating to the operator that it is safe to step on the safety mats. The ArcWorld 1000 cell can weld a different part by changing the job name in the "CALL JOB:" instruction.

4.4.3 **WeldA Job**

<u>Line</u>	<u>Step</u>	<u>Function</u>
000	000	NOP
001		'Return to Master Job if not at Side A
002		RET if in #3=0
003		'Move to first point at 25% velocity
004	001	MOVJ VJ=25.00
005		'Move to second point at 50% velocity
006	002	MOVJ VJ=50.00
007		'Move to third point at 50% velocity
008	003	MOVJ VJ=50.00
009		'Call the welding start job
010		CALL JOB: ARCON1
011		'Move to next point at linear speed of 80 CM/M
012	004	MOVL V=80
013		'Call the arc off job to end the welding
014		CALL JOB: ARCOFF1
015		'Move away from the weld end at speed 25%
016	005	MOVJ VJ=25.00
017		'Move to next point at velocity of 50%
018	006	MOVJ VJ=50.00
019		'Counter for nozzle cleaner
020		INC B00
021		RET
022		END

4.4.4 **WeldB Job**

<u>Line</u>	<u>Step</u>	<u>Function</u>
000	000	NOP
001		'Return to Master Job it not at Side B
002		RET if in #4=0
003		'Move to first point at 25% velocity
004	001	MOVJ VJ=25.00
005		'Move to second point at 50% velocity
006	002	MOVJ VJ=50.00
007		'Move to third point at 50% velocity
008	003	MOVJ VJ=50.00
009		'Call the welding start job
010		CALL JOB: ARCON1
011		'Move to next point at linear speed of 75CM/M
012	004	MOVL V=75
013		'Call the arc off job to end the welding
014		CALL JOB: ARCOFF1
015		'Move away from the weld end at speed 25%
016	005	MOVJ VJ=25.00
017		'Move to next point at velocity of 50%
018	006	MOVJ VJ=50.00
019		'Counter for nozzle cleaner
020		INC B00
021		RET
022		END

4.4.5 Clean Job

000	000	NOP
001		RET if in #2=0
002		SET B00=0
003	001	MOVJ VJ = 100.00 etc.

NOTE: Add 'INC B00' instruction in each of the welding jobs.

4.4.6 Arcon1 Job

<u>Line</u>	<u>Step</u>	<u>Function</u>
000	000	NOP
001		'Set current at 180 Amps
002		ABSCUR = 180A
003		'Set power source voltage to 21 VOLTS
004		ABSVOL - 21V
005		'Turn on welding contactor
006		ARCON
007		'Hold at the above setting 1/2 second for arc establishment
008		TIMER T=0.50
009		RET
010		END

4.4.7 **Arcoff1 Job**

<u>Line</u>	<u>Step</u>	<u>Function</u>
000	000	NOP
001		'Lower amperage to 120 for crater fill
002		ABSCUR = 120
003		'Lower voltage to 15 for crater fill
004		ABSVOL = 15
005		'Hold crater fill conditions for 1 second
006		TIMER T=1.00
007		'Stop wire feed
008		ABSCUR = 0
009		'Lower voltage to 4 volts to get clean burn back on wire
010		ABSVOL = 4
011		'Set burnback time
012		TIMER T = 0.10
013		ARCOFF
014		RET
015		END

NOTE: Several arcon and arcoff files can be used if different starting and ending conditions are needed. The above example illustrates absolute current and voltage instructions. The analog AWELD and VWELD instructions may be substituted for the ABSCUR and ABSVOL instructions. Refer to Absolute Weld Set-up Manual (479236-23) Appendix D.

5.0 MAINTENANCE

5.1 PERIODIC MAINTENANCE

5.1.1 MR-500 Turntable Positioner Helical Gear Unit

The helical gear unit should be checked regularly for proper oil levels and quality. The oil in the gear unit should be changed every 10,000 operating hours with Shell Omala Oil #220 or equivalent.

The grease packed bearing should be cleaned and regreased every 10,000 operating hours with Shell Alvania Grease #R3.

5.1.2 MR-500 Turntable Positioner Shock Absorber

Proper adjustment of the shock absorber is important to achieve efficient operation. All units are preset at the factory for maximum performance before shipping. If deceleration should become a problem, adjust the shock to achieve the desired deceleration rate:

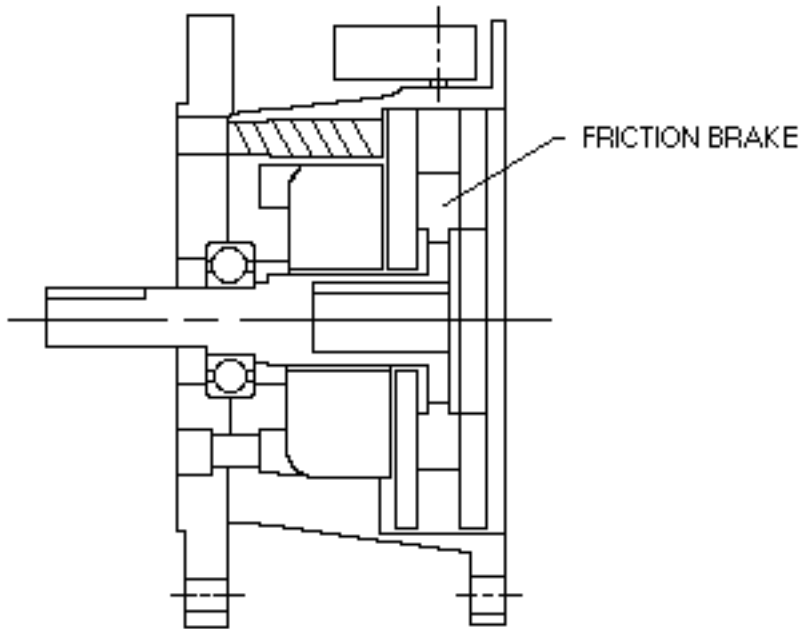
1. Loosen the adjusting ring lock screw.
2. Turn the adjusting ring towards zero to achieve more cushioning and towards nine to achieve less cushioning.
3. Re-tighten the adjusting ring lock screw.

5.1.3 MR-500 Turntable Positioner DC Motor Speed Control Unit

The DC Motor Speed Control Unit is factory set and serviceable by Motoman ONLY! **Opening the DC Motor Speed Controller will VOID YOUR WARRANTY!!**

5.1.4 MR-500 Turntable Positioner Motor Brake

The following information provides the instructions on how to replace the friction disk on the motor brake.



1. Disconnect power source to motor. Remove brake from motor.
2. Make note of the positions of the three torque adjusting screws in the housing, then back off until spring resistance is no longer felt. Do not remove the manual release mechanisms.
3. Place unit open end up and press down continuously on clapper so as to release friction disc. Use arbor press or similar device. Do not apply excessive pressure. Maintain pressure until Step #7.
4. Hold down pressure plate by hand and remove three retaining rings and three washers. Do not turn nuts or apply torque to them.
5. Lift pressure plate and friction disc.
6. Unwind the free tang end of each wrap-spring about 15° to release its grip and unscrew each nut approximately 7-8 turns.
7. Release clamping pressure. Clapper will be retained by the two manual release cams. Remove dust from clapper and pressure plate. Clean with alcohol if needed. Parts must be free of oil.
8. Assemble new friction disc, counterbore side down toward clapper, and reinstall pressure plate.
9. Reapply pressure to clapper as before to hold it down against the magnet.
10. Hold down pressure plate by hand and install washers and retaining rings. Run nuts in so that pressure plate free travel is .012-.017. Free travel should be equal at all three nuts. Use a shim or dial indicator for checking. If nuts need to be turned back out, free up springs as in Step #6.
11. Remove pressure to clapper. Reset torque adjusting screws to original position as noted in Step #2.
12. Brake is now ready for service.

5.1.5 MR-500 Positioner Table Flexible Coupling

The flexible coupling should be checked at regular intervals for tightness of the flange bolts. If operating conditions are severe, checking should be done every three months.

5.1.6 Table Welding Ground

There is an insulated lug provided at the base of the positioner for a welding ground. This lug is connected to carbon brushes located under the table top. These brushes should be checked monthly for proper lubrication and wear. The area of contact should be kept lubricated with copper grease. Excessive heat buildup in the brush indicates uneven wear or the need for grease.

5.2 SPARE PARTS LIST

5.2.1 General ArcWorld Spare Parts

1. AW1000 Safety Mat Kit	130157-2
2. Positioner Table Shock Absorber	130592
3. Positioner Table Interface 2 Pole Relay, 120 VAC	130134-7
4. Positioner Table Interface 2 Pole Relay, 24 VDC	130134-6
5. Positioner Table Interface 4 Pole Relay, 120 VAC	130134-5
6. Positioner Table Interface 2 Amp, 250 Volt Fuse	130294-5
7. Positioner Table Interface Relay Timer	130136-1

5.3 FUSE AND CIRCUIT BREAKER PROTECTION

The following is the location of fuse and circuit breakers that are significant to the operation of the total system. In most cases, ERC spare fuses are placed in the accessory bag with the ERC.



WARNING!

Replace fuses with the same type. Replacement of fuses with higher amperage rating or lower voltage will damage the robot controller and/or auxiliary equipment necessitating costly replacement.

Abbreviations:

CB – designates circuit breaker

F, FU or 101FU – designates fuse

HOBART POWER SOURCE MODEL RC-450RVS

DEVICE	AMP	MFG #	Motoman#	LOCATION
Fuse	15	TSM-15		Front Panel

Purpose: Protects the 115 volt AC and ERC/Power Source 115 volt AC.

ERC CABINET ROBOT PROTECTION

NOTE: The circuit breaker for the K6SB servo packs is on the two servo packs and not individually protected as the K10S is below. All other fuses and protection in the ERC remain the same.

DEVICE	AMP	MFG #	Motoman#	LOCATION
CB(1MCCB)	50	NF50-SS		Upper Left Front - K10S
CB(1MCCB)	30	NF30-SS		Upper Left Front - K6SB

Purpose: This is the main circuit breaker for incoming 200 volt AC, 3-phase for ERC cabinet.

CB(1SV)	K10S	15		Under PC servo board
CB(1SV)	K6SB	20		Lower Servo Pack edge

Purpose: Protects input for servo pack 1SV for S Axis. If this breaker trips, you will get ALARM 0222, SERVO PACK FAILURE with the axis affected highlighted on the CRT. The red LED on the servo pack will display #2. The same ALARM will be displayed for the other axes.

CB(2SV)	K10S	15		Under PC servo board
CB(2SV)	K6SB	20		Lower Servo pack edge

Purpose: Protects input for servo pack 2SV for L Axis.

CB		15		Under PC servo board
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Purpose: Protects input for servo pack 3SV for U Axis.

CB		10		Under PC servo board
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Purpose: Protects input for servo pack 4SV for R Axis.

CB		10		Under PC servo board
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Purpose: Protects input for servo pack 5SV for B Axis.

CB		10		Under PC servo board
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Purpose: Protects input for servo pack 6SV for T Axis.

Fuse(FU2)	1/2	AGC-1/2		I/O-03 PC board
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Purpose: Protects I/O-03 power to the transistors outputs and inputs. If this fuse blows, the ALARM 1170 will be displayed and will indicate "DC 24 V POWER SUPPLY FAILURE." The red LED on the HOLD button will be lit.

ERC CABINET ROBOT PROTECTION (cont'd)

Fuse(1FU) 1 GDL-1 TOP/LEFT/REAR

Purpose: Protects the four fan circuits of the ERC.

Fuse(2FU) 1 GDL-1 TOP/LEFT/REAR

Purpose: Protects the control transformer and fan (above computer rack) in the ERC.

Fuse(3FU) 1 GDL-1 TOP/LEFT/REAR

Purpose: Protects the control transformer and fan (above computer rack) in the ERC.

Fuse(4FU) 1 GDL-1 TOP/LEFT/REAR

Purpose: Protects the 100 volt AC supply to the AC receptacle (under the latching cover below the CRT) for floppy disk controller power.

DEVICE	AMP	MFG #	Motoman#	LOCATION
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Fuse(FU1)	3.2	GP-32		Top of I/O-03
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Purpose: Protects the robot brake circuits. If the fuse blows, ALARM 0212 "Overload S axis" and/or ALARM 0222 "Servo pack failure S-axis" will be displayed on the CRT. This is caused by the servo motor trying to drive against the brake which did not release. The S-axis is usually the first to be overloaded, but other manipulator or external axis may cause the same type alarm.

Fuse (FU3)	3.2	GP-32		Top of I/O-03
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Purpose: Protects the robot brake circuits. Same symptoms as 11.3.13.

MOTOMAN WELDING INTERFACE ON ERC DOOR

DEVICE	AMP	MFG #	Motoman#	LOCATION
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Fuse	2	MDL-2		On Din rail end
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Purpose: Protects 24 volt control transformer and feeder circuit.

Fuse	1/4	AGC-1/4		On Din Rail end
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Purpose: Protects 24 volt DC computer circuit if impact sensor leads short to robot or ground.

Fuse	8	ABC-8		On motor controller
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Purpose: Protects motor controller if output/transistors short.

Fuse	1/2	AGX-1/2		On logic relay board
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Purpose: Protects 24 volt DC regulated power supply on relay logic board when used.

COMARC II FUSE (If Comarc II option is furnished)

DEVICE	AMP	MFG #	Motoman#	LOCATION
Fuse	1	TD-1 250 volt		On front of COMARC box

Purpose: Protects 200 volt circuit in COMARC II.

INDEX POSITIONER FUSE

DEVICE	AMP	MFG #	Motoman#	LOCATION
Fuse	Amptrap	ATM-20		Top of Ratiotrol Under table
Fuse	Littlefuse	MDL216DA-4252-16		In Control box under table

5.4 LIST OF DRAWINGS

The ArcWorld 1000 drawing package is as follows:

SYSTEM OUTLINE (Appx. B)

130150 (Sheet 1 of 11)	Cell Layout
130150 (Sheet 2 of 11)	Main Bill of Material

ELECTRICAL DRAWINGS (Appx. C)

130150 (Sheet 3 of 11)	Cable Layout
130150 (Sheet 4 of 11)	I/O Diagram
130150 (Sheet 5 of 11)	I/O Diagram
130150 (Sheet 6 of 11)	I/O Diagram
130150 (Sheet 7 of 11)	I/O Diagram
130150 (Sheet 8 of 11)	Power Distribution
130150 (Sheet 9 of 11)	Ladder Diagram
130150 (Sheet 10 of 11)	Ladder Diagram
130150 (Sheet 11 of 11)	Ladder Diagram
130100 (Sheet 2 of 3)	Ladder Diagram
130100 (Sheet 3 of 3)	Ladder Diagram
132209 (Sheet 1 of 4)	PLC Controller
132209 (Sheet 2 of 4)	PLC Controller
132209 (Sheet 3 of 4)	PLC Controller
132209 (Sheet 4 of 4)	PLC Controller

MECHANICAL DRAWINGS (Appx. D)

130156 (Sheet 1 of 3)	Positioner, Turntable, 180°
130156 (Sheet 2 of 3)	Positioner, Turntable, 180°
131069 (Sheet 1 of 1)	Positioner, Turntable, 180°
130160 (Sheet 1 of 7)	Safety Fence

5.5 SERVICE TELEPHONE NUMBER

If you are in need of technical assistance, call the Motoman technical service staff at (513)-847-3200.

APPENDIX A - MOTOMAN RISK ASSESSMENT

ArcWorld 1000/1010 Systems

Application: Arc Welding

Robot type: K6SB or K10S

Customer: Varies

Plant Loc.: Varies

See cell layout

This document was prepared to explain the rationale behind the safeguarding of MOTOMAN's ArcWorld 1000/1010 robot cell. **It is the Users responsibility to review this document and verify that the safeguards are adequate for their plant conditions.** This review should include the current revision of ANSI/RIA R15.06 American National Standard for Industrial Robot Systems - Safety Requirements. The User must also ensure that safeguards are used and maintained.

SAFEGUARDING PERSONNEL

Plant Personnel

- Barrier around robot work envelope.
- Interlocked gate for access to cell.
- Curtain around cell blocks Ultra-Violet radiation from arc.
- Serious hazards are identified by warning labels.

Operator

- Interlocked gates stop robot motion if opened in PLAY mode.
- Dual sensors on interlocked gate make safeguards difficult for operator to defeat.
- Emergency Stop button on operator station.
- Two-station positioner keeps operator out of robot work envelope.
- Safety mats are interlocked to stop positioner motion when activated. Requires reset at operator station to restart.
- Robot program will wait for Cycle Start buttons before sweeping positioner.
- Cycle Start has dual palm buttons, anti-tie down, positioned for two-hand operation.
- Round table top minimizes pinch points.

Teacher

- Interlocked gate: Active in PLAY mode; Inactive in TEACH mode.
- Clearance of 24" between robot and fencing.
- Emergency Stop button on Teach Pendant.
- S-axis motion is restricted by hardstops.
- Teach Lock prevents operation from controller while teach pendant is enabled.
- Sweeping of positioner from pendant requires deliberate action.
- Continuous Stepping is at a reduced speed.

Maintenance Personnel

- Robot controls are outside barrier
- Positioner controls are inside cell, but does not require robot drive power to troubleshoot.
- Energy sources equipped with lockout/tagout.
- Robot CRT displays I/O status and other diagnostic functions

SOURCES OF HAZARDS

Unauthorized Access

- Interlocked barrier.
- Dual interlocks, difficult to defeat by operator.

Human Errors In Judgment

- Safety mat interlocked with positioner.
- Dual palm cycle start.
- Emergency Stops on operator station, robot controller, and teach pendant.

Control Errors

- Most Safety features independent of program logic.
- Robot program must have instruction to wait for palm buttons to sweep. Manual has program example and sweep motion is interlocked with mat.

Mechanical / Electrical Failures

- Safety mat supplied with fail-safe circuit.
- Redundant door interlocks.
- Interlocks designed to fail-safe.
- Robot has sophisticated control loop designed to remove drive power in case of positioning error.

Environmental

- Sheet metal partition and UV curtain to prevent eye damage from Ultra-Violet radiation
- UV curtain helps contain welding sparks.

NOTE: Fume ventilation may be required depending on application and plant conditions. (To be determined and provided by USER).

NOTE: Care must be used when handling and securing compressed and combustible gases (USER supplied).

Installation

- Safeguards will place the robot in External **Defects** Emergency Stop unless they are correctly connected.
- Safety fence is self supporting when fully erected (fencing should be lagged).
- Cell is documented with installation manual and video.
- Equipment is shipped on bases to ease installation and provide a secure mounting surface (robot base needs to be leveled and lagged).

Power System Failure / Inadvertent Power Initiation

- Easy recovery from power failure
- Different levels of power up; primary power on, controller power on, servo power on, and robot start. Difficult to inadvertently start.

EQUIPMENT PROTECTION

Human Errors

- Torch breakaway protects robot and torch in the case of a torch crash.
- Cube interlock requires the robot to be in a "safe" position before the table can index.

Power Faults

- Isolation transformer and circuit breaker protect robot control from power surges.
- Robot "remembers" its position and place in program at power down.
- Data has battery backup and can be saved on optional floppy disk drive.

WHAT-IF CONSIDERATIONS

What if personnel reach over safety mat and pinch arm between arc shield and fence?

Mat is 24 inches wide. It would require a deliberate action to position arm between arc screen and fence and avoid activating mat.

What if there is a hazard not covered by a warning label?

Labels are provided on positioner, robot, power source, feeder, transformer, and robot controller. Persons working on equipment should have adequate training to identify hazards.

APPENDIX B - SYSTEM OUTLINE

This section contains the following outline drawings:

Drawing Number	Title	Sheet Number
130150	Cell Layout	1 of 11
130150	Main Bill of Materials	2 of 11

NOTES

APPENDIX C - ELECTRICAL DRAWINGS

This section contains the following electrical drawings:

Drawing Number	Title	Sheet Number
130150	Cable Layout	3 of 11
130150	I/O Diagram	4 of 11
130150	I/O Diagram	5 of 11
130150	I/O Diagram	6 of 11
130150	I/O Diagram	7 of 11
130150	Power Distribution	8 of 11
130150	Ladder Diagram	9 of 11
130150	Ladder Diagram	10 of 11
130150	Ladder Diagram	11 of 11
130100	Ladder Diagram	2 of 3
130100	Ladder Diagram	3 of 3
132209	PLC Controller	1 of 4
132209	PLC Controller	2 of 4
132209	PLC Controller	3 of 4
132209	PLC Controller	4 of 4

NOTES

APPENDIX D - MECHANICAL DRAWINGS

This section contains the following mechanical drawings:

Drawing Number	Title	Sheet Number
130156	Positioner, Turntable, 180°	1 of 3
130156	Positioner, Turntable, 180°	2 of 3
130169	Positioner, Turntable, 180°	1 of 1
130160	Safety Fence	1 of 7

NOTES

APPENDIX E - ERC SETTING OF ABSOLUTE WELDING VALUES

ERC Setting of Absolute Welding Values, P/N 479236-23, is a separate Motoman Manual that has been included as Appendix E for your reference. If you have any questions about this manual/appendix, please refer to it by the part number above.

NOTES