Motoman XRC/NX100 Controller

Robotic Arc Welding Instruction Manual

for Miller® Auto-Axcess

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Revision 0

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Chapter 1
Introduction

1.1 About This Document

This manual provides information about a Motoman's robotic arc welding system using the Miller Auto-Axcess digital power sources. It is intended for welding personnel who have received operator training from Motoman, and are familiar with the operation of their Motoman robot model. For more detailed information, refer to the manuals listed in Section 1.3. This manual contains the following sections:

SECTION 1 - INTRODUCTION
This section provides general information about the Auto-Axcess power source and its components, technical specifications, a list of reference documents, and customer service information.

SECTION 2 - SAFETY
This section describes the conventions used to identify precautionary text throughout this manual. This section also contains a list of general cautions and warnings that apply to many of the procedures described in this manual.

SECTION 3 - INSTALLATION
This section provides instructions for basic setup and integration of a Motoman welding system with an Auto-Axcess power source. This section also provides procedures for start-up and calibration.

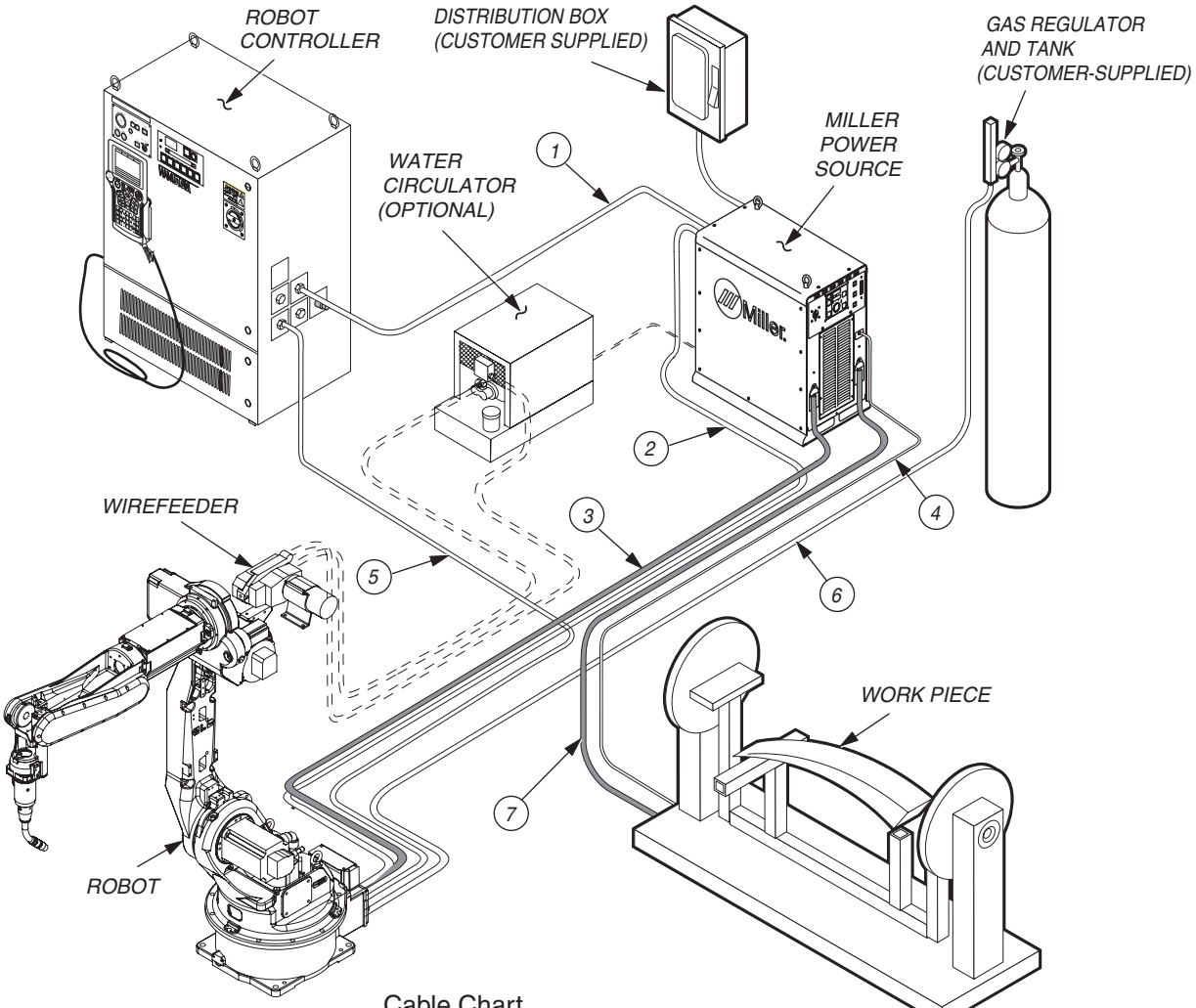
SECTION 4 - THEORY OF OPERATION
This section describes general arc welding principles, how the welding system works, and identifies specific welding problems and requirements.

SECTION 5 - OPERATION
This section provides instructions for basic operation of the Auto-Axcess arc welding system. This section also provides procedures for start-up. Sample robot programs are also included here.

SECTION 6 - TROUBLESHOOTING
This section provides help for the user to identify alarms and errors and remedy problems found during operation and welding. Included are tips and techniques for using the Auto-Axcess power source.

1.2 System Configuration

The Auto-Axcess welding system is an integrated package of tools and components designed for specific welding requirements. A typical system includes the following components and optional equipment.



Cable Chart

1	Power Source Control Cable
2	Feeder Control Cable
3	Weld Positive
4	Voltage Sense Cable
5	Shock Sensor Cable
6	Gas Hose
7	Weld Negative

Figure 1 Typical Auto-Axcess Welding System

1.2.1 Major Components

A typical system includes the following major components:

- Motoman manipulator and controller
- Welding equipment, including the following:
    - Miller Auto-Axcess digital power source
    - Miller AA-40G wire feeder
    - Welding torch
- Optional welding equipment including:
    - Water circulator
    - Program devices - Palm Pilot with an RS232 adaptor.
    - Nozzle cleaner
    - Bulk wire delivery package

1.3 Reference to Other Documentation

For additional information refer to the following:

- Motoman Manipulator Manual
- Motoman Operator's Manual for Arc Welding
    - XRC2001 P/N 142098-1
    - NX100 P/N 149235-1
- Motoman Concurrent I/O Parameter Manual (P/N 142102-1)
    - XRC2001 P/N 147626-1
    - NX100 P/N 149230-1
- Miller Auto-Axcess Manual
- Vendor manuals for system components not manufactured by Motoman

1.4 Customer Service Information

If you are in need of technical assistance, contact the Motoman service staff at (937) 847-3200. Please have the following information ready before you call:

- Robot Type
- Application Type (welding)
- Power Supply Type (Miller Auto-Axcess 300, 450, or 675)
- System Type (ArcWorld III-6200)
- Robot Serial Number (located on back side of robot arm)
- Robot Sales Order Number (located on front door of the controller)

Chapter 2
Safety

2.1 Introduction

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

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

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

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

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

This safety section addresses the following:

- Standard Conventions (Section 2.2)
- General Safeguarding Tips (Section 2.3)
- Mechanical Safety Devices (Section 2.4)
- Installation Safety (Section 2.5)
- Programming Safety (Section 2.6)
- Operation Safety (Section 2.7)
- Maintenance Safety (Section 2.8)

2.2 Standard Conventions

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

DANGER!

WARNING!

CAUTION!

NOTE:

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

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

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

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

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

2.3 General Safeguarding Tips

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

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the robot cell.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
- The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06, section 6.13.4 and 6.13.5, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

2.4 Mechanical Safety Devices

The safe operation of the robot, positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety measures are available:

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

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

2.5 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations.

Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. Installation tips are as follows:

- Be sure that only qualified personnel familiar with national codes, local codes, and ANSI/RIA R15.06 safety standards are permitted to install the equipment.
- Identify the work envelope of each robot with floor markings, signs, and barriers.
- Position all controllers outside the robot work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.6 Programming Safety

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

Any modifications to PART 1 of the XRC controller PLC can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!

Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.

Back up all programs and jobs onto a floppy disk whenever program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.

The concurrent I/O (Input and Output) function allows the customer to modify the internal ladder inputs and outputs for maximum robot performance. Great care must be taken when making these modifications. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations that may damage the robot or other parts of the system.

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to operate the system.
- Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place.
- Check the E-STOP button on the teach pendant for proper operation before programming.
- Carry the teach pendant with you when you enter the workcell.

- Be sure that only the person holding the teach pendant enters the workcell.
- Test any new or modified program at low speed for at least one full cycle.

2.7 Operation Safety

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

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

2.8 Maintenance Safety

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

- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.

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

Chapter 3
Equipment Description

This section contains brief descriptions of Miller Auto-Axcess welding system components.

3.1 Robot and Controller

The robot controller coordinates the operation of the various welding system components. The controller executes instruction sequences provided in a robot job file. As the controller steps through the series of instructions, it directs the movement of the torch, and operates the welding power supply. The robot moves the welding torch and supply lines through a series of programmed steps. The controller controls the speed, direction, and position of the robot as it moves from point to point. The controller communicates weld signals through an interface board mounted in the controller cabinet. The controller sends analog voltages for wire feed speed and voltage/voltage trim, along with a signal to energize the contactor to weld. The robot also selects one of eight schedules by setting three outputs. The Auto-Axcess power source communicates to the controller when the arc is established, when there is a fault condition, or when the wire is stuck to the puddle.

3.2 Miller Auto-Axcess Digital Power Supply

The Auto-Axcess digital power source is a three-phase, high-frequency, multi-process inverter welder. It operates on 190 to 630 volts, 50 or 60-hertz power, AC or DC. Auto-Axcess 300 is rated 8.3 kvA and produces 300 amps at 60 percent duty cycle and 225 amps at 100 percent duty cycle. Auto-Axcess 450 is rated 23.8 kvA and produces 580 amps at 60 percent duty cycle and 450 amps at 100 percent duty cycle.

Auto-Line™ automatically adjusts to line voltage, so no external adjustments are necessary. The power source has multi-process MIG capability consisting of standard MIG (GMAW), standard pulse as well as other pulse modes (GMAW-P), and an optional RMD (GMAW-SC) mode.

Accu-Pulse, Accu-Speed, and Accu-curve reduces burn through problems, increases welding travel speeds, and is superior to pulse mode when welding with short arc lengths. The optional RMD (Regulated Metal Deposition) process is a short circuit transfer process in which the power source alters the welding current output to improve the droplet transfer while minimizing spatter levels. It is limited to use at wire speeds below 250 ipm (depending on electrode diameter) on thin gauge steel applications.

Auto-Axcess uses an analog-type of robot interface and is compatible with the controller. Auto-Cal® allows automatic compensation for inaccurate welder condition files, providing digital accuracy/repeatability in addition to the low-cost analog interface.

Features:

- Broad range of input power (190 volts through 630 volts AC, single or 3-phase), automatically selected by Auto-Line
- Sharp tast™ feature provides consistent arc starts by electrically assuring a ball is not left on the wire when welding stops
- Two forms of serial diagnostic ports: palm and RS232
- Quick disconnect 72-pin Harting connector for robot I/O, with automatic configuration for Motoman robots
- Analog robot interface, with digital precision provided by AutoCal
- Eight remote selectable programs from robot
- Integrated touch sense (80 volts) and seam tracking circuitry
- 115 VAC, 10 Amp auxiliary duplex power receptacle
- Four modes of MIG operation
- World-class product support from Miller Electric
- Quick-change feed rolls

3.3 Software

Multi-MIG software includes common carbon steel, aluminum, and stainless welding programs, including Accu-Pulse, standard or adaptive pulse, conventioal MIG, and optional RMD. The Miller-developed optional Palm Axcess file management system provides an array of functionality. The software allows the user to customize arc starting/arc ending timing, customize pulse shape and adaptive voltage, and customize synergic lines. Palm connectivity also allows the user to beam or email schedule and system data.

Most applications do not require customized factory settings. However, if customization is necessary, the following Palm software programs are available from Miller:

- Service Pak Utility - used to update board level software in rare circumstances. Available at www.millerwelds.com.

- File Manager - allows pulse programs to be uploaded/downloaded to welder, but does not allow modifications to programs. This software allows the user to set edit locks, start/end conditions, etc. The software is supplied on card for the Palm SD expansion slot. The card must be installed to tranfer programs to the welder.
- WaveWriter™ - allows the user to set pulse conditions, including peak time, background voltage, and other variables. Allows user to change parameters for RMD mode. Software is supplied on card for the Palm SD expansion slot. The card must be installed to tranfer programs to the welder.

3.4 Miller AA-40G and AA-40GB Wire Feeders

The AA-40G and AA-40GB Wire Feeders are open frame-type wire feeders equipped with four (4) geared (.045”) feed rolls as standard. The feeders are rated at 650 amps at a 100 percent duty cycle and weighs 7.5 kg. The wire feed speed range is 50 - 1400 ipm, with a default maximum of 999 ipm. If a wire feed speed of greater than 1000 ipm is necessary, the data is the welder condition file must be changed.

NOTES

Chapter 4
Theory of Operation

The Miller Auto-Axcess is a Gas Metal Arc Welding (GMAW) power supply capable of non-pulsed, or MIG, and pulsed (GMAW-P) modes of operation.

4.1 Non-Pulsed (MIG) Mode

With **non-pulsed (MIG) mode**, a consumable electrode (e.g. steel, aluminium, copper, etc.) is fed from a spool or drum through a contact tube (or contact "tip") by a wire feed system. At the contact tip, welding voltage (typically between 12 and 44 volts) is transferred to the electrode. The contact tip is typically placed between 12mm (1/2 in.) and 25mm from the base metal, or workpiece. As the wire is fed, the electrode contacts the workpiece allowing for current to flow. This supplied current is proportional to the wire feed rate (or wire feed speed / WFS) but also based on the resistance between the contact tip and the workpiece. As the WFS is increased, the current increases as well.

Shielding gas, typically argon with additions of oxygen or carbon dioxide, is fed through a gas nozzle, around the contact tip and to the workpiece. When welding begins, current is supplied through the electrode, and melting of the electrode takes place between the contact tip and the workpiece. The electrode quickly melts, ideally at the electrode/workpiece interface, transferring liquid metal to the workpiece and/or to the air (causing spatter), and produces a gap, or arc, between the unmelted electrode and the workpiece. As this occurs, the voltage between the electrode and the grounded (0 volts) workpiece causes the shielding gas to become ionized. When the gas becomes ionized, the ability of the gas to conduct electricity improves, and current flow is maintained.

Another effect of current flow is melting of the workpiece. The liquid metal at the end of the electrode combines with the liquid metal of the workpiece to form the weld pool. At low wire feed speeds the welding current is low enough such that the size of the arc, or arc length, is not maintained. The arc length decreases until a short occurs again. When the electrode again contacts the workpiece, the electrical resistance decreases, allowing the current to increase enough to again break the short. And so the process, defined as **short circuit transfer**, repeats.

Higher wire feed speed levels provide enough current to continuously maintain an arc. At current levels (typically a range of 50-75 Amperes) just above those for short circuit transfer, forces involved around the arc / electrode promote large metal droplets to form before being transferred in free flight across the arc gap to the weld pool. This process is termed **globular transfer**.

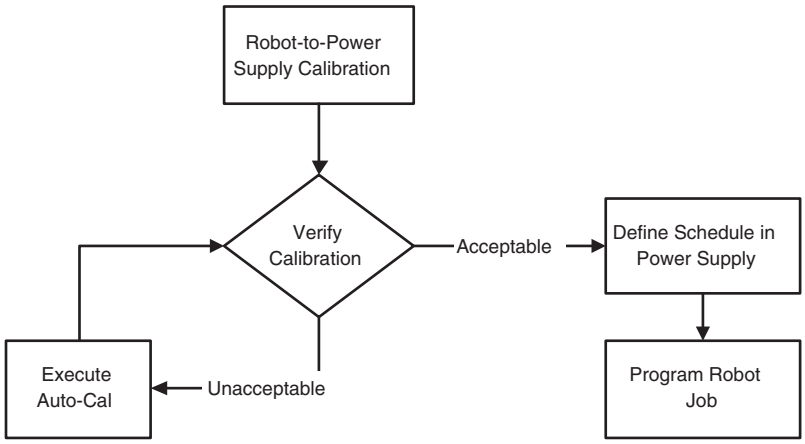
At higher current levels, arc forces promote smaller, but more frequent droplets to form at the electrode tip. These droplets (less than 1.5 times the diameter of the electrode) stream across the arc, providing the low-spatter production spray transfer. **Spray transfer** mode typically extends for hundreds of amperes until the electrode reaches current carrying capacity.

Of these three modes of metal transfer - short circuit transfer, globular transfer and spray transfer - only globular transfer is seldom used due to excessive spatter production and poor arc stability.

4.2 Pulse Mode

Pulse Mode behaves identically to non-pulsed (MIG) mode defined above except that spray current, (low/no-spatter) can be achieved for virtually the entire range of wire feed speeds. Spray transfer is accomplished by elevating the current above that required for globular transfer, holding the current while a droplet(s) is formed and detached from the electrode, and then dropping the current to a low background level. The amount of time at this background level is often based (inversely proportional) on the wire feed speed - higher wire feed speeds require more droplets per second and so shorter background times (higher frequencies) are often used. Pulse mode is recommended for welding conditions (wire feed speeds) wherein globular transfer would be achieved in non-pulsed mode. Pulse mode is typically used for all wire feeds speeds for aluminium GMA welding.

Chapter 5
Operation



5.1 Set-Up Overview

- Define calibration tables (verify welder condition file)
- Execute AutoCal, if necessary
- Confirm calibration
- Define schedule(s)
- Program robot job
    - Set schedule select output
    - Insert ARCON and set weld parameters
    - Insert motion steps
    - Insert ARCOF and set weld parameters

5.1.1 Welder Condition File Verification

1. Verify that POWER SUPPLY is set to A/V, not A/% in the Welder Condition File.

Note: The calibration data does not need to be exact- see section 6-14, Miller Auto-Axcess Manual.

Ref. (V)	Measured (A)
0.14	10
7.00	500
14.00	999

Ref. (V)	Measured (V)
0.14	0.5
7.00	25
14.00	50

This data calibrates analog channel 0 (VWELD) to voltage/pulse trim and calibrates analog channel 1 (AWELD) to wire feed speed.

2. On the programming pendant, select ARC WELDING, WELDER CONDITION.Verify that the welder condition file contains data similar to the following:

Note: Athough the robot teach pendant displays "A", "AC" or "amps" in Arc Start Files, ARCON commands, etc., when using the above calibration data, the values used are in units of INCHES/MIN., NOT AMPERAGE, and correspond to the actual WIRE FEED SPEED of the wire feeder.

Note: In pulse mode, double the voltage value entered to get the trim value. For example, 24.0 volts equals a trim value of 48. Setting the trim value to 50 (25 volts on the NX teach pendant) provides the nominal/recommended welding voltage for the requested wire feed speed.

5.1.2 Calibration Verification

To verify power supply calibration:

1. Insert an ARCSET command into a job.
2. Select the ARCSET command from the instruction side of the job line.
3. Press [SELECT]. The ARCSET command appears on the input buffer line.
4. Press [SELECT]. The Detail Edit screen appears.
5. Cursor to CURRENT and press [SELECT] or [AC=]. Refering to the calibration test examples, enter sample data using the number keypad (examples: AC=100; AC=300). Press [ENTER].
6. Cursor to VOLTAGE and press [SELECT] or [AV=]. Refering to the calibration test examples, enter sample data using the number keypad (examples: AV=15; AV=25). Press [ENTER] twice.

7. Execute the command by holding down the INT LOCK key and pressing FWD. Each time a value is executed, look at the display on the power supply and verify the requested value matches the set value. To change the display on the power supply, press the WFS/A button on the Auto-Axcess until the Wire Feed Speed LED lights.

Calibration Test Examples:

MIG Mode	Required Setting	AC=WFS	Required Setting	AV=Voltage
	100 ipm	100	20 volts	20
	350 ipm	350	25 volts	25
	700 ipm	700	35	35
PULSE/ACCU-PULSE	Required Setting	AC=WFS	Required Setting	AV=Trim
	100 ipm	100	40%	20
	350 ipm	350	50%	25
	700 ipm	700	70%	35

Note: To determine the value for Trim in Pulse/Accupulse mode, the power supply doubles the requested voltage value and converts it to a percentage value.

8. If the requested value does not match the set value, run the robot auto-calibration sequence. Refer to the Miller Auto-Axcess Manual, section 6-14. This step is only necessary if proper calibration cannot be verified.

5.1.3 Defining Schedules

Eight separate schedules can be defined for the Miller Auto-Axcess. Each schedule can be set up for output mode (MIG, Pulse, AccuPulse, RMD), wire type (Steel, Aluminium, etc.), diameter, and shield gas type. Use the robot outputs shown in 5.2.1 to select the schedule number from the welder. See the Miller Auto-Axcess Manual for details.

5.2 Robot Job Programming

5.2.1 Schedule Selection

The robot selects one of the eight schedules by setting three outputs. Typically a binary value (0-7), referenced by a DOUT instruction, is programmed into the robot job. This binary value of 0-7 corresponds to schedules 1-8 in the Auto-Axcess.

In this example, the schedule select bits have been connected to Universal Outputs 9, 10, and 11. These three bits comprise the first three bits of Output Group Half (OGH) #3.

Sample Robot Job:

```
0000   NOP
0001   MOVJ VJ=33.0 (Welding start position)
0002   DOUT OGH#(3)5(Selection of Schedule #6)
0003   ARCON AC=285 AV=22.0 (ArcOn request)
0004   MOVL
0005   ARCOF
0006   MOVJ VJ=33.0
```

The above job selects schedule #6 with the DOUT instruction. It also sets wire feed speed to 285 in/min and sets either voltage to 22.0V (MIG mode) or trim to 44% (Pulse or AccuPulse) depending on the mode selected in Schedule #6.

5.3 Weld Parameter Verification

When the welder is powered on, “MOTO” will appear on the welder display. During day-to-day operation, the welder display shows the following:

- Power Supply Idle (not welding): Displays the set Wire Feed Speed and Voltage or Arc Length values.
- Power Supply Welding: Displays the actual average Amperage (or the wire feed speed) and actual average Voltage.
- Immediately after Welding: Displays the actual average Amperage and actual average Voltage.

5.4 Troubleshooting

The robot generates an Arc Shortage alarm if the power supply detects a fault during welding. If the welder is not turned on, this alarm will occur. To prevent the alarm, operate the robot with the welder turned on or disconnect the large plug from the rear of the welder. For other service related problems, call Motoman Customer Service (937) 847-3200.

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