Motoman NX Controller

Spot Welding Instruction Manual

for Medar Integrated Weld Control

Part Number:	151865-1CD
Revision	0

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Chapter 1
Introduction

1.1 About This Document

This manual provides both general and specific information about Motoman's spot welding system using a Medar integrated weld control. This manual is divided into the following sections:

CHAPTER 1 - INTRODUCTION
This section provides general information regarding this manual, descriptions of the integrated weld control and its components, technical specifications, installation instructions, a list of reference documents, and customer service information.

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

CHAPTER 3 - THEORY OF OPERATION
This section provides general spot welding principles. The discussion identifies specific problems and requirements, how the weld control works, and how it addresses specific welding requirements.

CHAPTER 4 - OPERATION
This section provides instructions for the proper use and operation of the spot welding system with the Medar integrated weld control. Instructions provided include step-by-step procedures to prepare the system for use.

CHAPTER 5 - TROUBLESHOOTING
The information provided in this section helps the user identify alarms and errors and remedy problems found during operation and welding. Included are tips and techniques to overcome specific problems related to spot welding.

1.2 System Configuration

A spot welding system is an integrated package of tools and components designed to meet specific welding requirements. A typical system includes the components and optional equipment listed below. Figure 1 shows a typical system configuration.

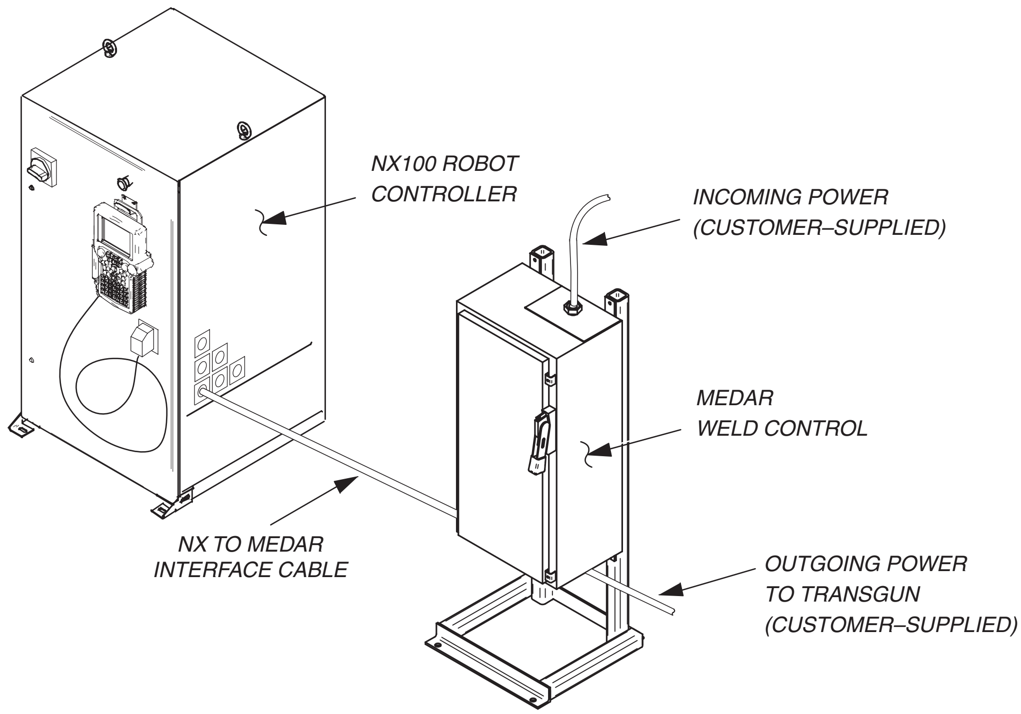


Figure 1 NX100 and Medar Integrated Weld Control

- Motoman robot manipulator and NX100 controller
  - 3-Slot CPU rack
  - Medar integrated welding board
- Welding equipment, including the following:
  - Medar 3006 integrated weld control
  - MedWeld cable
  - Transgun (air or servo-driven)
  - Water circulator/chiller

Options for the welding system include:

- Tip dresser
- Tip changer

The NX100 controls the operation of the spot welding system. It coordinates the operation of the various components of the system through execution of instruction sequences provided in the robot program or “job” file. As the controller steps through the series of instructions, it directs the movement of the robot and operates the weld control.

The robot moves the spot welding gun and supply lines through a series of programmed steps. The NX100 controls the speed, direction, and position of the robot as it moves from point to point. The NX100 also controls the actuation of the spot gun. If the gun is pneumatic, the NX100 turns ON the output to close the gun.

Servo-gun control is more integrated. The robot is programmed to know when the gun reaches the specified clamping forces, and can synchronize the firing of the weld timer with gun pressure.

The Medar weld control provides power to the spot welding gun. The NX100 pendant is used to enter program data; however, the programs are executed by the Medar board installed inside the controller. The Medar board directly controls the firing of SRC and current flow.

The Medar programs are retained in the controller memory.When changes are made through the NX100 pendant, the data must be written to the Medar board to take effect. The Medar programs saved in the controller memory can be downloaded using a flash memory card or PC. If necessary, the Medar pendant can be connected to the Medar board to view the program or change set-up data. See Figure 2.

Note: Changes made with the Medar pendant are not saved in the NX100 memory and will be lost at power down.

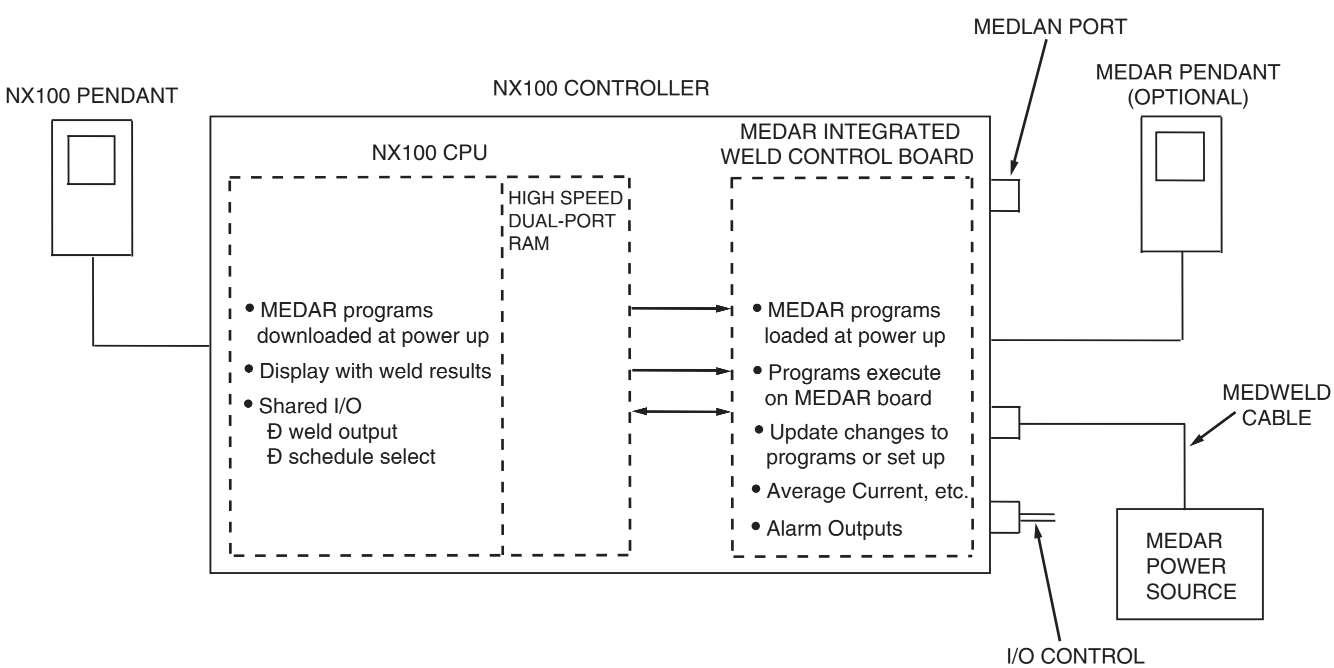


Figure 2 NX100/Medar Board Interface

1.3 System Components

The following paragraphs contain brief descriptions of each of the spot welding system components.

1.3.1 NX100 Controller

The spot welding system includes an NX100 controller and a programming pendant. The NX100 provides the following basic functions:

- Power ON
- Job creation
- Input and edit motion data
- Input and edit process data
- Memory for Medar data
- Playback
- Process sequencing
- Power OFF
- Connection to external devices through the pendant's serial interface port
- Input/output signal processing

The NX100 controls the operation, and monitors the status, of the spot welding system's components: the manipulator, weld control, and spot welding gun. The various safety features of the spot welding system and the associated cell operate through the NX100. Under emergency conditions, the NX100 controls the shutdown of the robot drive power, weld current, positioner, and any other devices connected. Refer to your NX100 Operator's Manual for more information.

1.3.2 Robot

The standard integrated spot welding package includes a vertically articulated, six-axis, ES165 robot with a 165 kg payload. The P-point working envelope is 2650 mm (104 inches). The robot can reach below its own base, and can travel in an arc approximately 360° around the base. However, it is possible to restrict the base axis with hard stops. Weld cables are routed inside the robot arm instead of along the outside, which protects the cables from damage that can be caused by robot motion during welding. These robots can be floor-, wall-, or ceiling-mounted. Motoman robots use brushless AC servo motors with absolute position encoders.

A combination of capacitance and lithium batteries in both robot and controller assemblies protects program positional data for up to a year. The life expectancy for the lithium battery is approximately three years.

Power for the robot manipulator is supplied through the controller. A 4.5 KVA isolation stepdown transformer converts the 230, 460 or 575V delta input to a 208V wye output. Refer to the manipulator manual that came with your system.

Note: HP-Series robots or the ES200 robot are available as options for the standard spot welding package.

1.3.3 Servo Robot Gun

The Motoman servo gun, when provided with the integrated welding package, improves productivity and provides high quality welds. The servo motor variable controls allow operators to program an exact force and ensure that force is accurate and repeatable for every weld. A servo gun also allows the operator to control the contact speed, thus minimizing deformation of the sheet metal and protecting the welding electrodes, which improves weld quality.

Servo-controlled welding guns offer many advantages over pneumatic welding guns. The electric servo motor runs silently, eliminating noisy exhaust sounds, and is more energy efficient than the air compressors used with pneumatic guns. Servo-controlled guns also increase flexibility with multi-position welding.

1.3.4 Medar Integrated Weld Control

The MedWeld 3006 weld control with the Medar integrated weld processing board provides a single point of programming control from the NX100 pendant menu. A single MedWeld cable provides the interface between the weld control and the processing board in the NX100 controller, eliminating the need for multiple discrete I/O cables.

The advantages of the Medar integrated weld control are:

- Quicker response time due to elimination of discrete I/O filtering (150 ms/spot)
- 255 weld schedules
- 10 stepper profiles
- Ability to program weld sequences with the NX100 pendant
- Reduced wiring, smaller enclosure, and lower cost
- Network capabilities with a MedLan cable
- Identical software and processing board for both AC and MF (mid-frequency) DC spot welding
- Easy file backup:
  - Medar weld schedule is stored in NX100 CMOS memory as a spot welding condition file
  - Spot welding condition file can be saved/restored to/from the PCMIA memory card using the NX100 pendant
  - Welding condition files can be transmitted to a remote PC via serial or Ethernet communications

1.3.5 Water Cooling System

The water cooling system circulates water through both the spot weld controller and the weld gun. It is important that the water temperature not exceed 86° F, as inadequate cooling could damage the servo weld gun and transformer.

The Medar board supports thermal overload sensors from the transformer. External flow sensors may be integrated with the NX100 as an interlock for welding.

1.3.6 Tip Dresser (Optional)

The optional tip dresser is used to remove weld flash, oil, grease, or any other deposit from the weld tip that may affect the gun's ability to function properly. The servo gun can vary pressure during tip dress for cut and polish.

1.3.7 Work Cell

In addition to the items above, a complete system typically includes certain work cell components. These components are not specifically part of the spot welding package, but are related items that are supplied separately. Some of these items include light curtains, interlocks, arc screens, fencing, and positioners. The number and type of components required depend on the specific application.

1.4 Equipment and Component Specifications

Specifications for the typical spot welding system and its components are listed in Table 1-1. Additional information is provided in the various vendor manuals supplied with the system.

Table 4 Equipment and Component Specifications

Characteristic	Specification
Power Requirements Electrical service (robot) Electrical service (welding)	 Refer to manipulator manual Refer to drawings included with your specific Medar timer
Operating Environment Temperature range Humidity Vibration Other	 0 - 40 °C 20 - 80% (non-condensing) Less than 0.5 G Free from corrosive gases or liquids, explosive gases, and excessive electrical noise
MedWeld 3006 Weld Control	Refer to the Integrated Spot Welder Programming Manual for MedWeld 3006 (#T99204-01)
Spot Weld Gun	Servo motor is controlled by the NX100. Refer to your spot gun drawings for transformer power limitations.
Water Circulator	Varies. See vendor manuals for specific information.

1.5 Reference to Other Documentation

For additional information, refer to the following:

- Motoman Manipulator Manual provided with your system.
- Motoman Operator's Manual for Spot Welding using Air Gun (P/N 149233-1)
- Motoman Operator's Manual for Spot Welding using Motor Gun (P/N 149232-1)
- Motoman Concurrent I/O Parameter Manual for NX100 (P/N 149230-1)
- Integrated Spot Welding Programming Manual for MedWeld 2006 (#T99204-1)
- Vendor manuals for system components not manufactured by Motoman

1.6 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 (ES165, etc.)
- Application Type (spot welding)
- Robot Serial Number (located on the back side of the robot arm)
- Order No. (located on the front of the controller)

Notes

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 NX100 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

Theory of Operation

In resistance (spot) welding, current is generated by a transformer, and is fired through electrodes, which hold the metal pieces in place. These electrodes also apply force to the metal pieces, usually before, during, and after the firing of the electric current. This method is called resistance welding because it is the resistance between the contact surfaces of the metals being welded that generates the heat to fuse them together.

Resistance is the opposition that a substance offers to the flow of electric current. The less resistance a metal has, the less heat is generated when current passes through it. Conversely, the higher the resistance of a metal, the more heat is generated when that same current passes through it. This behavior can be paraphrased as follows: the heat is where the highest resistance is.

Obtaining the best results in resistance welding requires a thorough understanding of the materials used in the welding process, careful control of the heat and pressure at the weld point, and consideration of numerous other factors.

This section discusses the basics of resistance welding, the variables involved, and why they're so important to the welding process.

3.1 Resistance Welding Variables

The many variables involved in welding can be broadly categorized into two basic sections: process variables and material variables.

- Process variables include:
- Weld current
- Squeeze time
- Electrode force
- Weld time
- Hold time
- Design of the electrode

Material variables include:

- Workpiece material and thicknesses
- Surface condition and cleanliness of materials
- Coating thickness and type
- Part fit-up

3.2 The Weld Cycle

A typical resistance weld is broken down into several distinct periods, as shown in Figure 3.

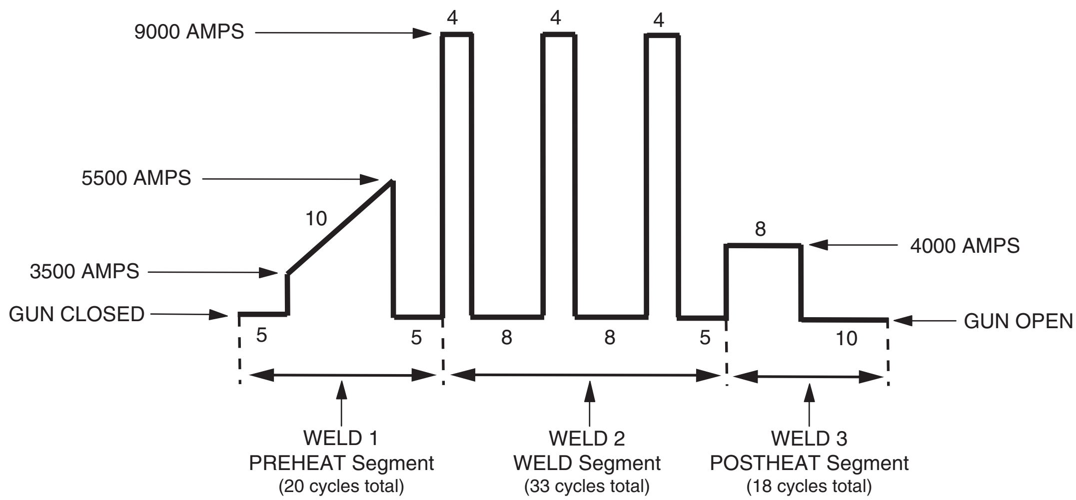


Figure 3 The Weld Cycle

The Squeeze Time occurs when the weld heads (electrodes) come together and build up to a specified amount of force before the current is fired.

The Weld Time is the time it takes the current to actually pass through the workpieces. During the Weld Time, the metals are heated enough to melt and fuse together to form what is called a weld nugget.

During the Hold Time, electrode force is still applied, even after the weld current has ceased. During this period, the weld nugget cools and the metals are forged under the force of the electrodes. The continuing electrode force helps keep the weld intact until it solidifies, cools, and the weld nugget reaches its maximum strength.

3.3 Critical Factors in Resistance Welding

Understanding the resistance weld process requires an understanding of the main factors involved and how they work together. This section will review current, voltage, resistance, and power, as well as the various functions of the electrodes and how they affect surface contact and current density.

3.3.1 Current

Current, usually measured in Kilo-Amperes (one Kilo-Amp is equal to 1,000 Amps), is one of the most important factors in spot welding. A resistance weld cannot be made unless there is sufficient weld current.

The typical amount of current needed to weld low-carbon steel, for example, is about 10,000 Amps (10 KA) at about 5 Volts. To put this in perspective, a normal household or office outlet provides a maximum of 15-20 Amps (0.015-0.020 KA) at 120 Volts, while a power circuit in a factory may only be capable of providing 200 Amps (0.200 KA) at 500 Volts to a welder. The factory's 200 Amps is then converted to the 10,000 Amps needed to weld by means of a welding transformer.

A transformer consists of two coils of wire, called the primary and the secondary, wound around an iron core. SeeFigure 4. Power is transferred from primary to secondary via the magnetic properties of the iron. The factor by which the current and voltage is stepped up or down is equal to the ratio between the number of turns of wire in the coils forming the primary and secondary windings of the transformer. Consider the steel that needs 10,000 Amps (10 KA) of current to be welded in a factory that can only provide 200 Amps (0.200 KA). If the welding transformer had 100 turns on the primary and 2 turns on the secondary, the ‘turns ratio' would be 100 to 2, or more simply, 50 to 1. The 200 Amp current in the primary would then be converted (stepped up) to 10,000 Amps (200 Amps x 50 turns = 10,000 Amps) in the secondary, which would yield enough amperage to make a weld.

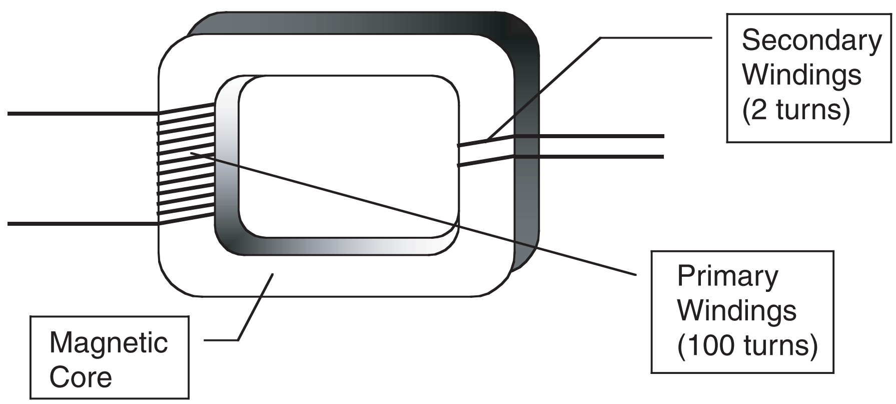


Figure 4 Primary vs. Secondary Voltage

3.3.2 Voltage

If current is the amount of electricity flowing, then Voltage (measured in Volts) is the pressure or force that's causing the flow. A good analogy is water flowing through a pipe. A larger voltage will result in greater water pressure, which will cause more water (current) to flow through the pipe. Using the transformer example above, after the 200 Amps at 500 Volts on the primary passes through the transformer coils, the secondary amperage increases to 10,000 Amps, but the voltage actually drops to 10 Volts. This decrease in voltage occurs because the amount of power coming out of a transformer isn't actually increased, but exchanged.

3.3.3 Ohm's Law

Ohm's Law expresses the relationship between voltage, current, and resistance. The relationship is expressed as voltage equals current times resistance (E = I x R).

- E – Electromagnetic Force (voltage)
- I – Current (pure current)
- R – Resistance (pure resistance)

3.3.4 Secondary Resistance

Secondary resistance is the resistance of the entire welding secondary circuitry. Secondary resistance significantly impacts the amount of I (current) available. In the following example, the turns ratio is 48:1, and the secondary resistance is 500 micro-ohms.

3.3.5 Reactance, Resistance, and Power Factor

Resistance plays a vital role in the amount of current a welding power source can deliver. In addition, reactance ((inductance and capacitance), impedance, and power factor all help determine the capabilities of a welding tool.

An AC current passing through a coil (such as a transformer) is impeded by a property called inductance. As power passes through the transformer findings, the current is "stored" in space around the coil in the form of a magnetic field, while voltage is unimpeded. When the voltage changes direction, this field collapses, inducing current into the coil once again. Thus, in a phase shift due to inductance, voltage leads current. The mathematical symbol for inductance is "L."

Pure resistance applies to both AC and DC currents, but inductance and capacitance cause an extra type of resistance to AC called impedance. Impedance is the result of the phase shift that occurs in inductance and capacitance. The mathematical symbol for impedance is "Z." If you know inductance (L), capacitance (C), and resistance (R), you can figure out impedance (Z). The formula is Z = square root of (L-C)2 + R2. See Figure 5.

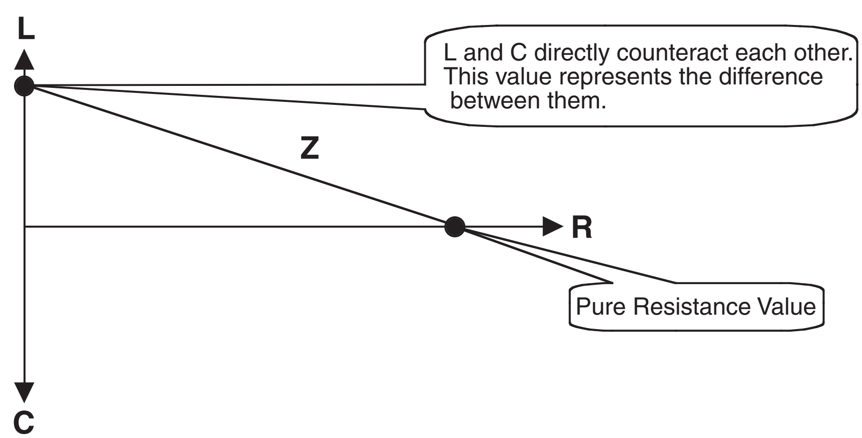


Figure 5 Reactance, Impedance, and Power Factor

Once you know impedance, you can calculate the power factor. Power factor is the amount of useful power used. Its value is always expressed as a decimal less than one (e.g., 0.90 or 90%). Low power factor is inefficient. Welding with 10 kA at 65% power factor actually requires 15.4 kA. The formula is Power Factor = R÷Z.

Monitoring a weld control's power factor over time indicates much about the condition of the welding circuit. Over time, power factor will get higher, because as a tool ages, its resistance increases. Because the weld control calculates power factor and resistance for you, you can calculate impedance without knowing the reactance of the secondary circuit. A large drop in power factor can indicate poor connections that require maintenance.

3.3.6 Primary Current

Primary current indicates the average amount of buss current that is required to make a weld. This value is read directly from a current pickup coil within the weld control cabinet. Together with the turns ratio, the secondary current can be determined with the primary current as follows:

I secondary = I primary X Turns Ratio

3.4 AC Welding

Modern AC welding power sources use silicon-controlled rectifiers (SCRs) as the main current control contactors. These are essentially gate-controlled diodes, and work as shown in Figure 6.

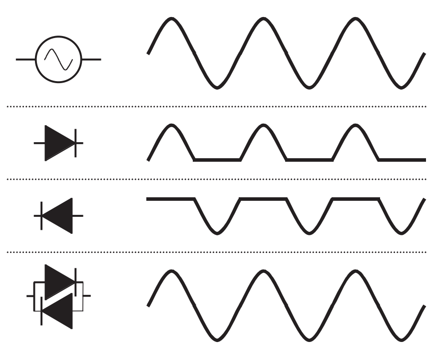


Figure 6 AC Welding

Current is regulated by enabling the SCR of different sine wave angles, as illustrated in Figure 7. More current is delivered as more of the sine wave is allowed to conduct.

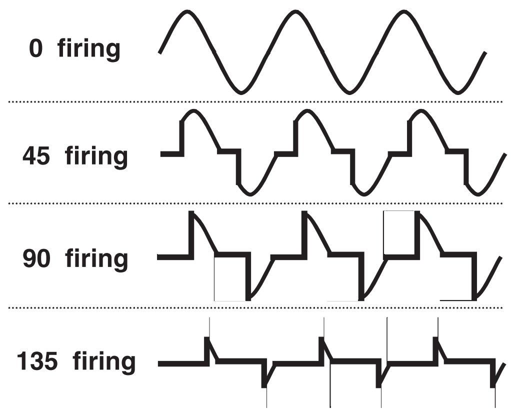


Figure 7 Regulating Current

AC welding uses the concept of cycles to determine duration of time. In North America, the welding buss frequency is 60 Hz, also known as 60 cps (cycles per second). One complete cycle is equal to 1/60 seconds.

3.5 Spot Welding Theory

The welding gun's electrodes are made of copper. Because copper is quite thermally conductive, it draws the heat out of a weld point faster than the surrounding air, and faster than the surrounding metal of the part. The copper is also resistant to fusing to steel parts.

The copper is water-cooled. This cooling allows the weld point to solidify after being melted during weld time (the parts will stay welded together). Too slow or too much cooling may cause the electrodes to stick to the part. Too little cooling may cause welds to come apart (especially if the electrodes are used for clamping). Too rapid cooling can cause the weld spot to crystallize, resulting in an extremely weak weld.

Pressure increases the area of contact and minimizes resistance between each electrode and the part surface (the most resistive part of the circuit must be where the parts join together at the weld point). Too little pressure causes increased resistance at the tip-to-part contact area. This will result in metal loss as expulsion.

Too much pressure can cause severe indentation at the weld point, because the electrodes continue to press together as the metal liquefies.

Resistance to electrical current causes heat. More resistance generates more heat. Heat is bad for a welding system. Therefore, there should be as little resistance as possible on the secondary circuit in order to avoid generating heat. The greatest amount of resistance must be concentrated where the parts to be welded are joined, since this is where the most heat is required. As resistance increases in the circuit, otherwise usable power is converted to waste heat that is diverted away from the weld point.

Figure 8 shows what happens to the heat when resistance is high in places other than the part contact area. In this simple circuit, only 40 percent of the current is used for welding.

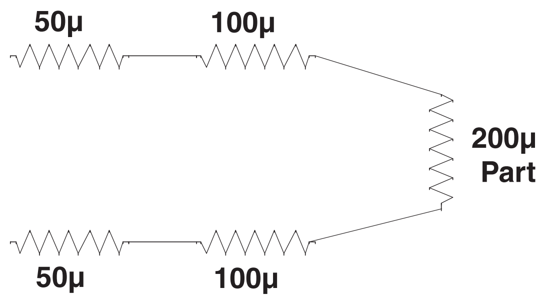


Figure 8 Welding Circuit with Heat Loss

Shunting can occur when spot welds are made too close to each other. Electricity follows parallel paths and the path of least resistance. See Figure 9.

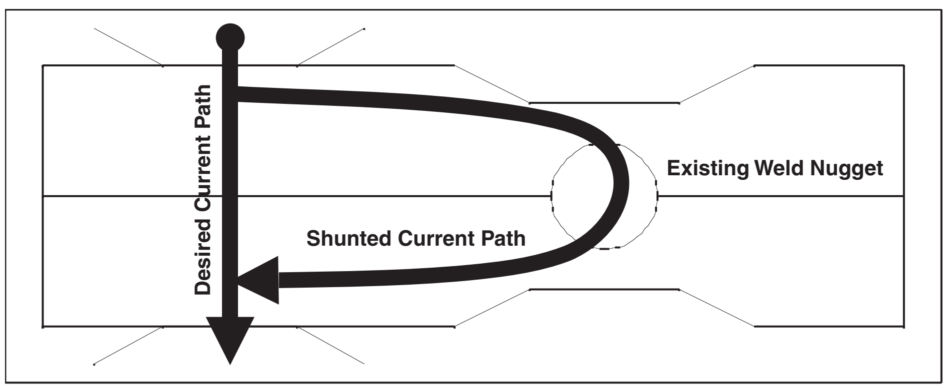


Figure 9 Shunting

Pressure and heat generated during the course of welding causes the electrodes to wear. This wear negatively impacts the welding process and manifests itself in a "mushrooming" fashion. Heat causes the electrode to become softer than normal, and pressure provides the mechanical energy required to force the electrode surface out of shape. This deformity results in an increased area at the tip-to-part contact surface. See Figure 10.

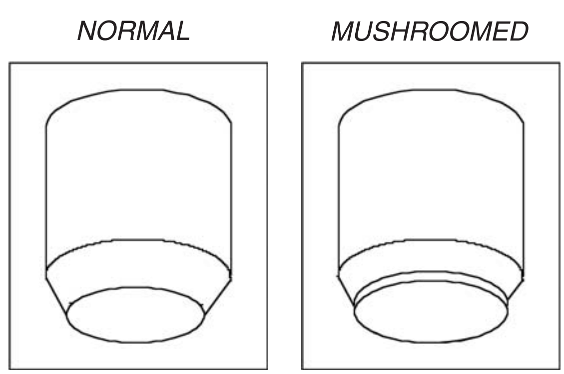


Figure 10 Normal vs. Mushroomed Electrode Surface

The consequences of tip deformity can be severe. Because the worn cap has a larger surface area, it has a lower current density. If both caps were to conduct the same amount of current, the current would be spread out over a larger area on the mushroomed cap. The result is that current (heat) is no longer concentrated precisely where it is needed (at the nugget point); it is distributed and no longer efficient. A possible counter-measure to this inefficiency is to conduct more heat into the mushroomed electrode in order to maintain the same current density.

Also affected by mushrooming is pressure density, which affects the resistance of the tip-to-part contact point. This happens because the force at the contact point is distributed over a larger area. Resistance depends in part on the pressure of an electrode against the part. Mushroomed caps result in less pressure at the weld point.

The use of steppers can compensate for current density losses. By boosting the current as caps "mushroom," current density is maintained. In addition to the use of steppers, tip dressing equipment can be used to machine electrodes. Resurfacing makes them like new again.

Different sized caps cause the heat to be focused at a different point in the welding process. This can be advantageous when welding metal stackups with different part thicknesses. See Figure 11.

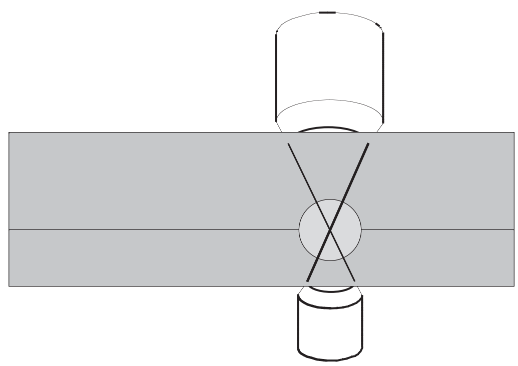


Figure 11 Welding Different Part Thicknesses

3.5.1 Steppers

Steppers are designed to increase current (deliver more heat), time (deliver longer heat), or pressure (deliver lower tip-to-part resistance). Steppers are typically programmed as a series of steps. During each stepper step, current will gradually increase from the first weld to the last weld in that step. Figure 12 illustrates a stepper program with five steps.

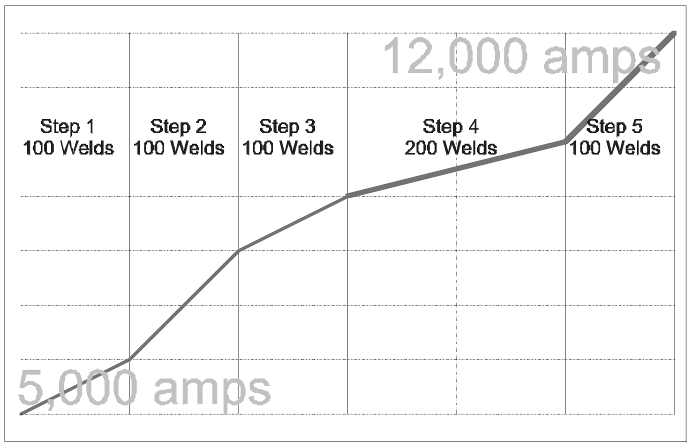


Figure 12 Stepper Program

In Figure 12, we can see that step number one comprises 100 welds, starting at 5000 amps, and ending at 6000 amps. This means that the first weld will produce 5000 amps and the one hundredth weld will produce 6000 amps. Because the total increase for these 100 welds is 1000 amps, each weld will carry a 10-amp boost. The other steps increase amperage in a similar way.

3.6 Current Control Methods

3.6.1 Automatic Power Factor

The automatic power factor is a transparent feature of all modern weld controls. This feature prevents half-cycling by preventing the weld control from gating an SCR (silicon controlled rectifier) during power-factor crossover (i.e, the phase-shift that results from inductance in the circuit, such as from the welding transformer). This affects I-Available, since power factor prevents the weld control from running "wide open." Refer to Figure 13. The SCR shouldn't gate before the vertical line, because the lagging current wave is still positive up to this point.

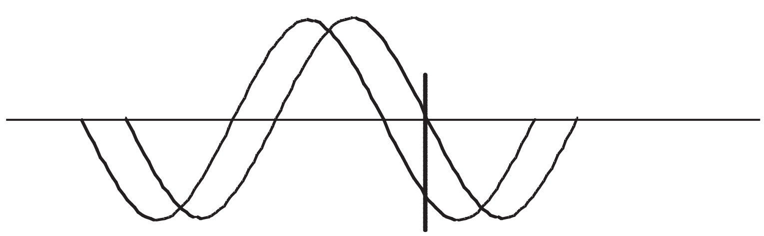


Figure 13 Automatic Power Factor

3.6.2 Automatic Voltage Compensation Mode

If the weld current is programmed as a percentage, you are using Automatic Voltage Compensation (AVC) mode. In AVC mode, current may be monitored by the weld control for reporting purposes (e.g., such as faults), but there is no current feedback mechanism in current delivery. The weld control doesn't use current monitoring as feedback to adjust the amount of current delivered. It monitors buss voltage instead. In this way, AVC can be thought of as a "dumb mode" of operation.

AVC firing mode is programmed as a percentage of available current with a target line voltage in mind. For example, if at 480VAC, I-Available is 20kA, firing at 50 percent should yield 10 kA of current. In this case, 480 VAC is the programmed reference voltage. If the line voltage changes (and it does), then the weld control will alter the firing angle to ensure that the heat output is the same regardless of the fluctuating line voltage. See Figure 14.

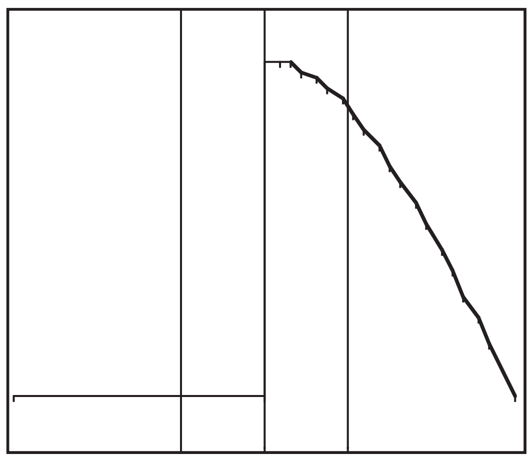


Figure 14 Automatic Voltage Compensation (AVC)

The middle line indicates where the SCR is gated when the instantaneous line voltage is equal to the reference voltage. If the line voltage drops, less current will flow, so the SCR should gate at the left-most line in order to allow more of the waveform to conduct. If line voltage increases, more current will flow, so the SCR should gate at the right-most line in order to allow less of the waveform to conduct. Thus, AVC regulates voltage to maintain a somewhat consistent level of current on the secondary circuit.

3.6.3 Constant Current Mode

If the weld current is programmed in kilo-amps (kA), you are using Constant Current Mode. In Constant Current Mode, current feedback is required.In order to work properly, the turns ratio must be programmed properly. In order for the weld control to dynamically adjust the firing rate to meet the requested current, it must sample the current dynamically and multiply by the turns ratio. Constant current can be considered the “smart mode” of operation.

Constant current control allows the programming of weld current in terms of actual secondary current (for example, 12.5 kA). Just as AVC dynamically adjusts the SCR firing angle to ensure that a constant percentage of available current is delivered, Constant Current regulation monitors the current delivered and dynamically adjusts the SCR firing angle to ensure that the desired amount of current is delivered, regardless of the available current.

✍ *Note: Available current must be greater than the current being delivered.*

AVC strives to deliver a constant “area” of a sine wave (i.e., a constant percentage of available heat). So its waveform will always look relatively constant. Constant Current doesn’t care about the waveform. It will regulate as necessary to deliver a constant amount of current. Figure 15 shows how the waveform differs between the two modes.

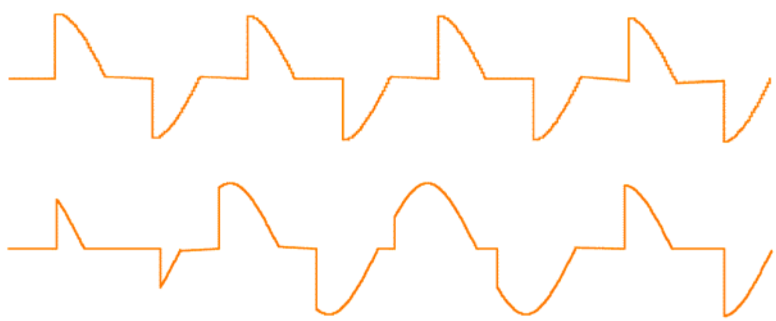


Figure 15 AVC Mode (top) vs. Constant Current Mode

Constant current control will always deliver the requested current as long as the tool capacity allows it. While AVC current drops over time due to increased secondary resistance, Constant current doesn’t have this problem.

Notes

Chapter 4

Setup and Operation

This section provides instructions for setting up the simple and enhanced weld schedules for welding under normal conditions. It also includes instructions for setting up stepper condition files.

For general spot welding operating instructions, refer to the Operator’s Manual for Spot Welding using Air Gun (P/N 149233-1) or the Operator's Manual for Spot Welding using Motor Gun (P/N 149232-1).

4.1 Setup Parameters

Table 4-1 lists the Medar Timer parameters.

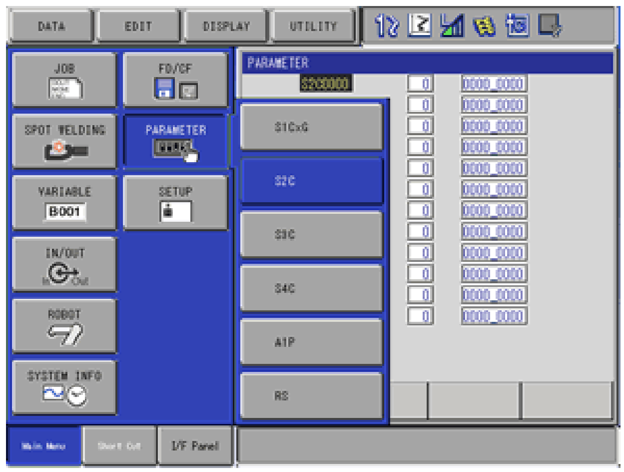
Table 5 Medar Timer Parameter List

Parameter	Default	Function	Setting
S2C440	180	Universal Input for Uploading Dynamic Data	N/A
S2C441	181	Universal Input for Resetting Stepper to Step #2	N/A
S2C442	0	Weld Schedule Edit Security	0: Edit Mode 1: Management Mode
S2C443	0	Weld Schedule Type	0: ACC Simple 2: ACC Enhanced
S2C444	0	Network Address	N/A
S2C445	0	Welder Type	0: AC 1: MFDC Type 1 (most XRC) 2: MFDC Type 2 (most NX)
S2C450	0	Medar Setup File (downloaded at startup)	0: No Setup File Downloaded * 1: Setup File Downloaded

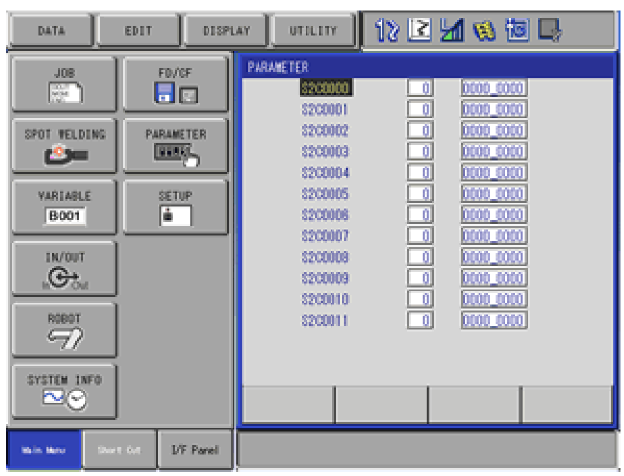
* On a new system, do not change this parameter to “1” until after initial system startup.

To set up parameters S2C442, S2C443, and S2C445, enter Management mode and follow these instructions:

1. From the NX100 Main Menu, select PARAMETER.
2. The following screen appears. Select S2C.



3. A list of parameters appears.



4. Press SELECT, type the number 442, and press ENTER. This takes you to the S2C442 parameter for setting weld schedule edit security. The default is zero for Edit Mode. Change the default to "1" to restrict file changes to Management Mode.
5. Cursor down to parameter 443. This sets the weld schedule type. The default is zero for ACC Simple Weld Schedules. To select the ACC Enhanced Weld Schedules, change S2C443 to "2." All 200 files are displayed as either simple or enhanced.
6. Cursor down to S2C445 to set the weld type. The default is zero for AC welding. Change the default to "1" for DC welding.

Note: After changing the weld schedule type, restart the NX100 to download the new settings to the Medar board.

Do not change the setting for S2C450 from 0 to 1 until you have powered on the NX controller one time and uploaded dynamic data. At power up, the Medar board copies default setup data into its volatile memory. When S2C450 is set to 1, the NX controller downloads the most recent settings to the Medar board and overwrites the Medar defaults.

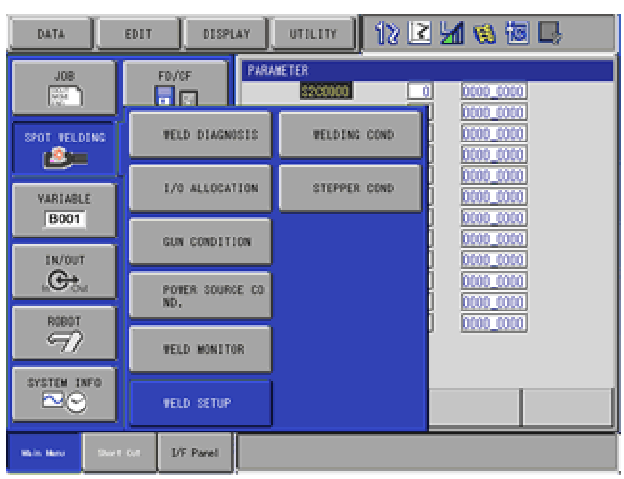
Top set up parameter S2C450 so that the NX controller always writes the most recent settings to the Medar's volatile memory at startup, proceed as follows:

1. Start up the NX controller with S2C450 set to 0.
2. Turn universal output #1001 ON and then OFF. This activates universal input #180, which allows the NX controller to upload dynamic data from the Medar board (see Table 4-1).
3. Set S2C450 to 1. Now, every time the system is powered up, changes made to the setup data will be automatically written to the Medar's volatile memory.
4. To verify the system is set up correctly, change a setup parameter on the Medar pendant. For example: change the "Maximum Primary Current" setting to a smaller value.
5. Download this setting on the Medar pendant.
6. Turn universal output#1001 ON and OFF. (Upload dynamic data)
7. Restart the system and verify that the setting for Maximum Primary Current still has the same value.
8. Repeat steps 4-6 to change the current maximum back to its original value.

4.2 Set Up

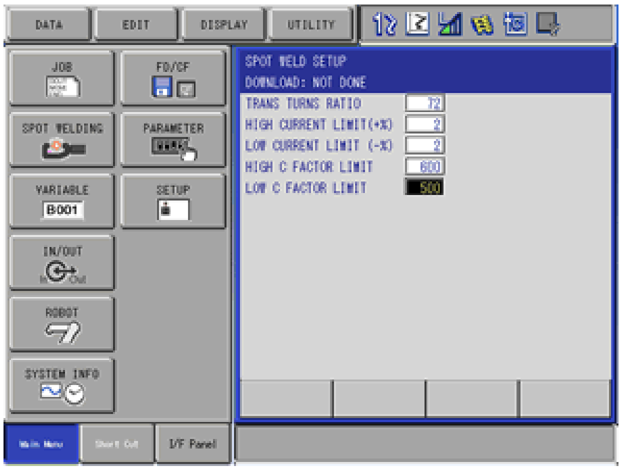
Weld setup is only available in Management mode. Choices shown in the following screens might not be displayed, depending on the set up of the weld schedule edit security parameter (S2C442). To set up weld data, follow these instructions:

1. From the NX100 Main Menu, select SPOT WELDING. The Spot Welding Function Menu appears:

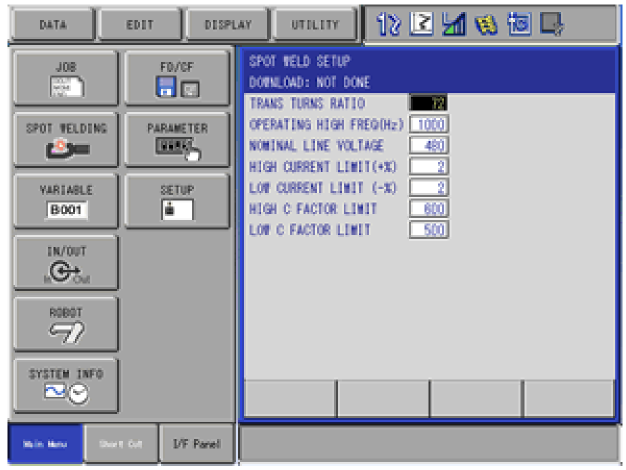


2. Press the down arrow key to view selections at the bottom of the window. Select WELD SETUP. The SPOT WELD SETUP screen appears.

AC SETUP



MFDC SETUP



3. Set the transformer turns ratio. Refer to the rating on the spot gun transformer.
4. Set the high and low current limits. These two parameters define global current range for every weld schedule. The weld control calculates the high current window as a percentage over the current expected, and the low current as a percentage decrease from the expected current. (The expected current is the base current - programmed in the weld function - plus the current boost that the stepper is providing).
5. Set the high and low C- factor limits. These two parameters tell the weld control the range of acceptable values for the C- factor. If the C- factor exceeds or falls below these limits, the weld control generates a C- FACTOR alarm.

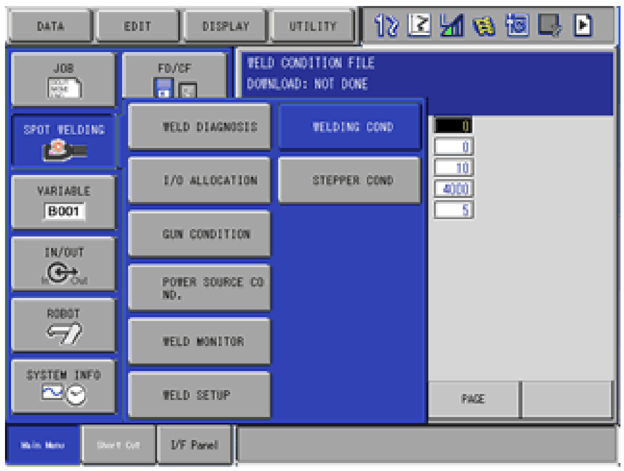
C- Factor equals 1% of the total available current during a weld. The C-Factor will change with changing conditions in the secondary. If the C-Factor decreases, it is an indication that the total capacity of the system is decreasing. This condition occurs when the tool current pathways become more resistive. Two examples of this are cable wear and deterioration of connections.

In the opposite condition (where C-Factor increases), the total capacity of the system is increasing. This change in C-Factor is associated with the event of shorting/shunting conditions in the welding environment. If the full current is not passing through the weld point, a weld below the desired current will occur.

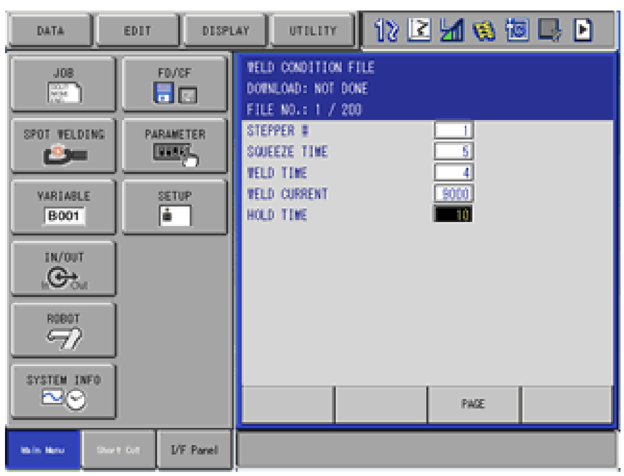
4.3 Simple Weld Condition Files

To set up a simple weld schedule, first follow the instructions in paragraph 4-1, step 5, and set the weld schedule type (S2C443) to SIMPLE (Ø). This changes weld schedules 1-200 to simple. After re-booting the NX100 controller, proceed as follows:

1. From the Main Menu, select WELDING COND.

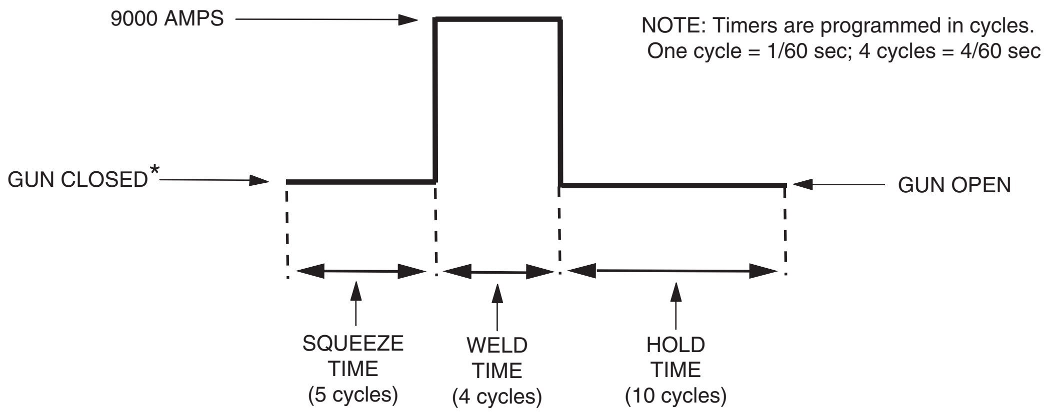


2. The first simple weld condition file will appear. To access additional simple weld schedules, press the ARROW key (in the upper right corner of the pendant). Press SHIFT plus the ARROW key to return to previous schedules. Figure 16 depicts this particular simple weld condition file.



Note: Weld condition files can also be accessed from the job by cursoring over the instruction and pressing the DIRECT OPEN key.

Note: If the Stepper # is set to "0", no stepper will be assigned to this weld schedule. Valid steppers are 1-10.



* The timing of the "gun closed" output is determined by the WST (0-2) setting in the SVSpot instruction (see Motor Fun Function Manual). Factor the timers in the weld file to coincide with timers used in the gun pressure file. If a servo gun is used, then set the SQUEEZE TIME to zero, as pressure is garuanteed before the timer has fired. If a pneumatic gun is used, increase the SQUEEZE TIME to enough cycles to allow the gun to close and settle.

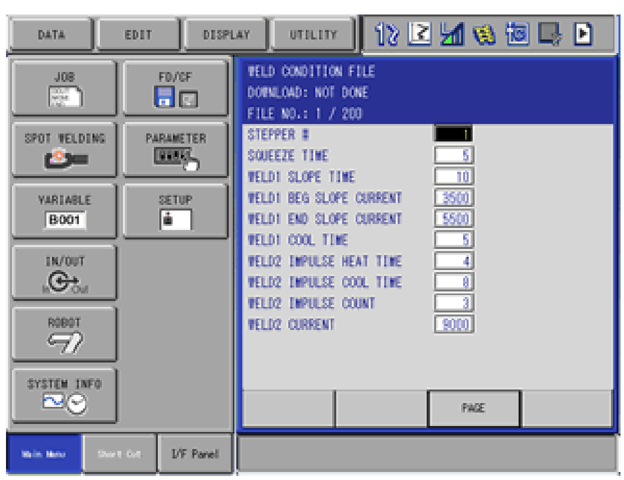
Figure 16 Simple Weld Condition File

4.4 Enhanced Weld Schedules

To set up an enhanced weld schedule, first follow the instructions in paragraph 4-1, step 5, and set the weld schedule type (S2C443)to Enhanced (2). This changes weld schedules 1-200 to Enhanced. After re-booting the NX100 controller, proceed as follows:

1. From the Spot Welding Function Menu, select WELDING COND. The first enhanced weld condition file will appear. Use the CURSOR key to scroll through the file. Figure 17 depicts this particular enhanced weld condition file.

Note: Any of the weld segments shown in Figure 17 can be eliminated by entering Ø in the timers. Likewise, slopes can be eliminated by making the start and end values the same. Cool times can be eliminated by setting them to zero.



MOTOMAN a YASKAWA company

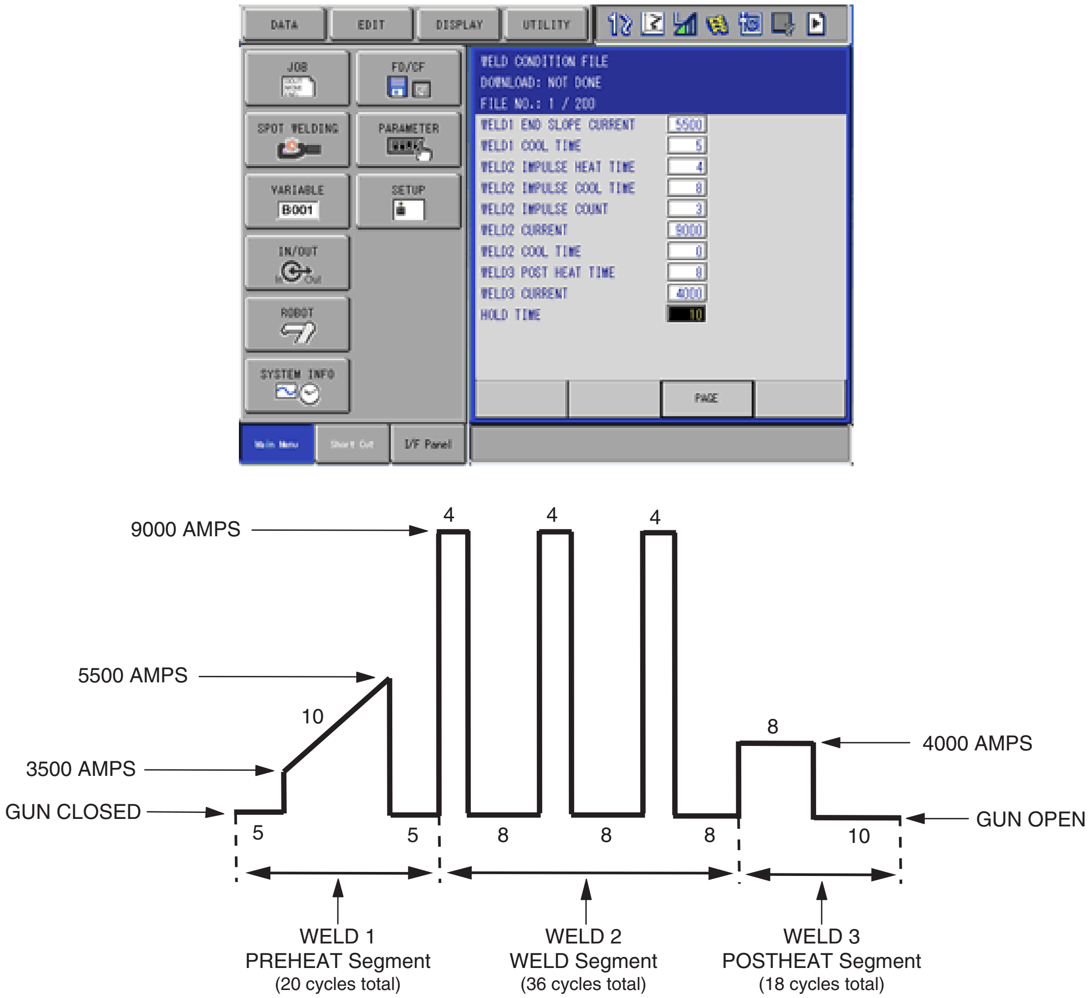


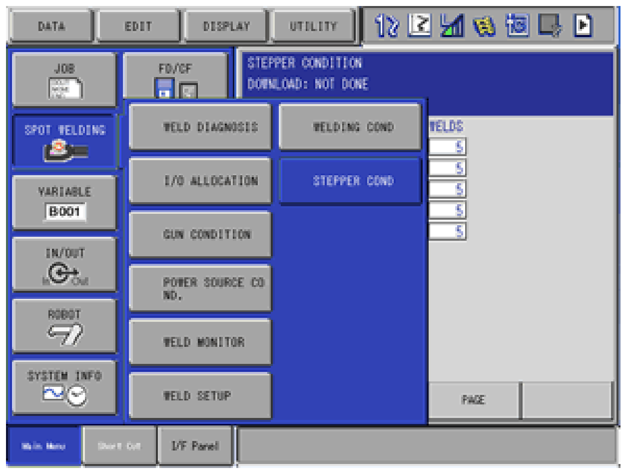
Figure 17 Enhanced Weld Condition File

Note: If the Stepper # is set to "0", no stepper will be assigned to this weld schedule. Valid steppers are 1-10.

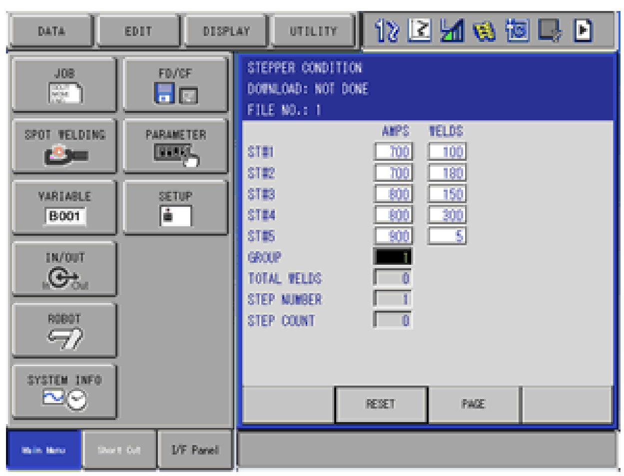
4.5 Stepper Condition Files

There are a total of 10 stepper condition files. Each stepper file can be assigned to one of four different stepper groups. You can assign the group number for each stepper file on each stepper condition file screen. Press the [Page] softkey and enter a number, or press Tab to change the stepper condition file screen. When a stepper in a particular group is fired, all of the stepper files assigned to that group increment.

1. From the Spot Welding Function Menu, select STEPPER COND.



2. The Stepper Condition File appears. Press the down arrow key to see the entire file. This file shows the current boost and number of welds for each step. (Refer to paragraph 3.5.1.) For example, during the first step, current will be incremented 7 amps for each weld.



3. Selecting RESET STEPPER resets to the stepper, weld count zero.

Note: When an automatic tip changer is used, the robot job can reset the stepper to Step 1 by pulsing the Universal Output for the group that stepper is assigned. After an automatic tip dressing, the robot job can reset the stepper to Step 2 by pulsing Universal Output for the group that stepper is assigned (see Table 6).

The "Reset Group X to Step 1" command sends a 3-bit binary output to the Medar controller. Table 6 shows the bit pattern required for each group. The Master Reset bit (79037), must also be turned ON to activate the reset. Pulsing the Universal Outputs does this automatically.

Table 6 Universal Outputs for Resetting Stepper Groups

Universal Output #	Reset Command	Auxiliary Relay 7903x				
		79037	79036, 5, 4, 3	79032	79031	79030
993	Reset Group 1 to Step 1	1	Not Used	0	0	1
994	Reset Group 2 to Step 1	1	Not Used	0	1	0
995	Reset Group 3 to Step 1	1	Not Used	0	1	1
996	Reset Group 4 to Step 1	1	Not Used	1	0	1
997	Reset Group 1 to Step 2					
998	Reset Group 2 to Step 2					
999	Reset Group 3 to Step 2					
1000	Reset Group 4 to Step 2					

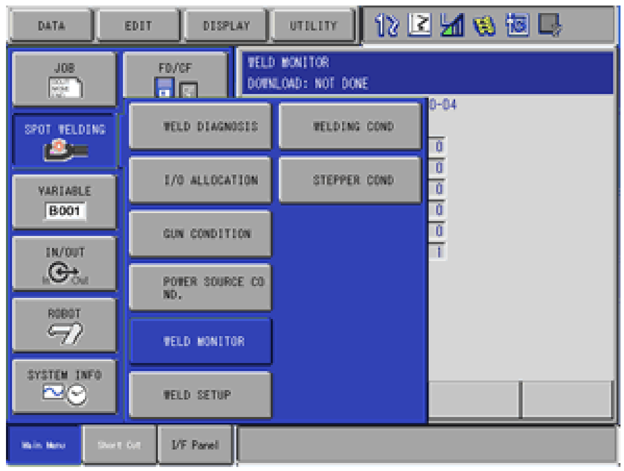
Example: Pulse Universal Output #997 - All stepper files assigned to Group 1 are reset to Step 2.

Example: Pulse Universal Output #994 - In the ladder, Auxiliary relays 79031 and 79037 are turned on, resetting all files assigned to Group 2 to Step 1.

4.6 Monitoring Weld Results

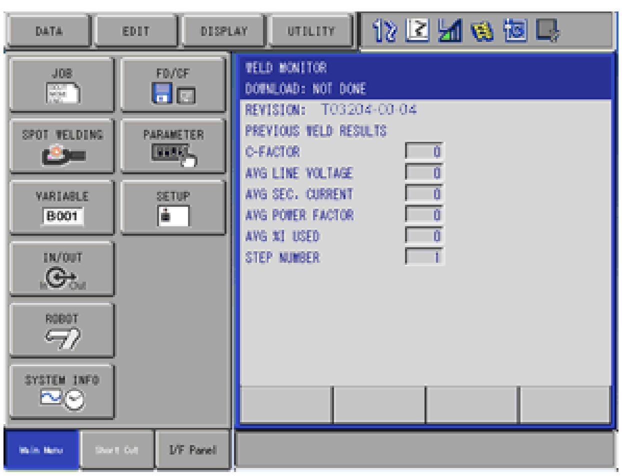
This screen displays weld data. For a complete explanation of C-Factor and Power Factor data, refer to the Manual for the Medar Integrated Weld Control, Appendix B.

1. From the Spot Welding Function Menu, select WELD MONITOR.

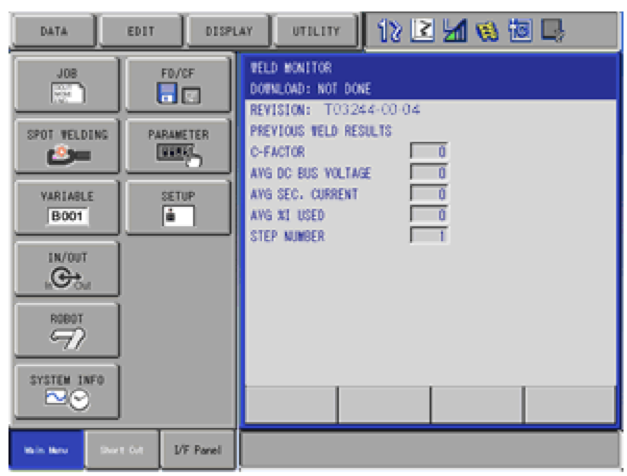


2. The following listing of weld results appears:

AC SETUP



MFDC SETUP



Chapter 5

Troubleshooting

5.1 Medar Alarms and Errors

Table 7 identifies common Medar alarms that may occur on the programming pendant during welding. In most cases, alarms are reset by pressing SELECT when the RESET prompt appears on the display. If for some reason the RESET prompt is no longer visible, simultaneously press and hold INTERLOCK and WELD ALARM RESET to clear alarms.

Table 7 Medar Application Errors

Error Code	Spot Weld Application Message	Source	Source Fault Message
0	No Error		
1	Medar - Input/Output Error	AC/MFDC AC/MFDC AC/MFDC AC/MFDC AC/MFDC AC/MFDC AC/MFDC MFDC	- Verify S2C450 is set to 1. Reboot if changed. - Check Setup, Weld Cond., and Stepper screens for complete information on the Motoman pendant. - Is “DOWNLOAD COMPLETE” shown on any menu? - Check Setup, Weld Cond., and Stepper screens on Medar pendant for correct data. - Weld Initiate Not Present Invalid Sequence Selected - I/O Adapter Failure - Weld Proceed - Charge/Discharge Duty Cycle
2	Medar - Input/Output Alarm	AC/MFDC	- Weld Initiate Not Present
3	Medar - Incomplete Weld	AC/MFDC AC AC/MFDC	- Control Stop - Heat Cycle Limit - Weld Interruption
4	Medar - Stepper Approaching Maximum	AC/MFDC	- Stepper Approaching Maximum
5	Medar - End of Stepper	AC/MFDC	- End of Stepper

Table 7 Medar Application Errors

Error Code	Spot Weld Application Message	Source	Source Fault Message
6	Medar - Sure Weld Trend Limit	AC	- Sure Weld Trend Limit
7	Medar - High/Low Current Limit	AC/MFDC AC/MFDC AC/MFDC	- Adjust current limits on Setup menu - High Current Limit - Low Current Limit
8	Medar - Firing Error	AC AC/MFDC	- SCR Misfire - Control Failed to Fire
9	Medar - Cylinder Fault	AC AC	- Tips Not Touching - Tips Touching
10	Medar - Cylinder Alarm	AC	- Slow Cylinder
11	Medar - Power Factor Error	AC AC	- Initial Power Factor Out of Range - Power Factor Limit
12	Medar - Tip Compensation Error	AC/MFDC AC AC MFDC MFDC MFDC	- Increase slope height in Weld Cond. File - Voltage Compensation Limit - Current Compensation Limit - Low Power Line - Soft Overcurrent - Current Regulation
13	Medar - Insufficient Line Voltage	AC	- Insufficient Line Voltage
14	Medar - Extend Weld	AC/MFDC	- Extend Weld
15	Medar - Isolation Contactor Error	AC/MFDC AC MFDC	- Verify universal input 17 turns OFF when Output 17 turns ON - Isolation Contactor Off When Needed - Inverter ISO CNTR Off
16	Medar - Welding Bus Voltage Error	AC/MFDCA C/MFDC MFDC MFDC	- Check Medar disconnect switch - No Zero Crossing Sync - DC Bus Over Voltage - Inverter Bus

Table 7 Medar Application Errors

Error Code	Spot Weld Application Message	Source	Source Fault Message
17	Medar - Weld Data Not Programmed	AC/MFDC AC/MFDC AC/MFDC AC/MFDC AC AC AC AC MFDC	- Verify S2C450 is set to 1. Reboot if changed. - Check Setup, Weld Cond., and Stepper screens for complete information on the Motoman pendant. - is "DOWNLOAD COMPLETE" shown on any menu? - Check Setup, Weld Cond., and Stepper screens on Medar pendant for correct data - Sequence Not Programmed - Stepper Not Programmed - Setup data Not Programmed - Dynamic Data Not Programmed - Weld Data Not Programmed
18	Medar - Analog Pressure Error	AC/MFDC AC/MFDC	- Pressure Not Achieved - Pressure Current Loop Alarm
19	Medar - C-Factor Limit	AC/MFDC AC/MFDC AC/MFDC	- Adjust C-Factor limits on Setup Menu. - High C-Factor Limit - Low C-Factor Limit
20	Medar - Secondary	AC MFDC	- Secondary Current Coil/Board - Sec. Current Sensor
21	Medar - Welding Transformer	MFDC MFDC MFDC MFDC	- Welding Transformer - Output Ground - Transformer Duty Cycle - Tfmr Sec. Diode Failure
22	Medar - Over Temperature	MFDC	- Inverter over Temperature
23	Medar - Shorted SCR	AC	- Shorted SCR
24	Medar - Internal Timer Error	AC/MFDC MFDC AC/MFDC AC/MFDC AC/MFDC MFDC	- Verify / Install correct Medar software revision and perform Upload Dynamic Data Sequence. - Check/swap blue and white wires on blue cable. - RAM Checksum - ROM Checksum - Hardware/Software Incompatibility - Inverter Serial Comm
25	Medar - Inverter Fault	MFDC MFDC MFDC MFDC	- Capacitor Discharge - Capacitor Charge - Hard OverCurrent - Driver Low Voltage

5.2 NX100 Alarms and Errors

Table 8 identifies common NX100 alarms that may occur on the programming pendant during system start up and welding. In most cases, alarms are reset by pressing SELECT when the RESET prompt appears on the display. If for some reason the RESET prompt is no longer visible, simultaneously press and hold INTERLOCK and WELD ALARM RESET to clear alarms.

Table 8 Alarms and Errors

Alarm Number	Alarm Message	Code	Error
600	Medar Status Error	0	Por_signature
601	Medar Diagnosis Error	1 2 3 4 21 22 23 27	Excessive EPROM checksum error LCA EPROM checksum error Application EPROM checksum error DPR error I/O format type error Command ________ Program number and revision MedLan Netstatus option
602	Medar VErsion Error.	0	Dual port RAM version number error
603	Medar Revision Error	0	Dual port RAM version number error
604	Medar Code Change Error	0	wldr_mode_wldr_ctrl_____
605	Medar Schedule Transmit Error	0 1 2 3 4 5	Sequence Data error Receive Timeout MEDLAN Response Header Character error MEDLAN Response Command Code error MEDLAN Response Checksum error MEDLAN Response NAK
606	Medar Error 1	0	WeldMsg buffer_acknowledge error

Table 8 Alarms and Errors

Alarm Number	Alarm Message	Code	Error
607	Medar Error 2	0 1 2 3 4 5	Sequence Data/Stepper Data Receive Timeout MEDLAN Response Header Character error MEDLAN Response Command Code error MEDLAN Response Checksum error MEDLAN Response NAK
608	Medar Welder Type Mismatch	0	WeldMsg buffer_acknowledge error
609	Medar Parameter Error	26 25 24	S2C (373) error S2C (371) error S2C (372) error
610	Medar Stepper Transmit Error	0 1 2 3 4 5	Stepper data Receive Timeout MEDLAN Response Header Character error MEDLAN Response Command Code error MEDLAN Response Checksum error MEDLAN Response NAK

5.3 Troubleshooting

Table 9 identifies common problems that occur during resistance welding. To troubleshoot your system, identify the type of problem and look for it in the PROBLEM column. Next to this column is a list of PROBABLE CAUSES.

Be aware that sometimes more than one problem can occur at the same time. After identifying and resolving a problem, test the system thoroughly to make sure no other problems exist.

Table 9 Troubleshooting Chart

Problem	Probable Cause
Medar Error 2 during Bootup	Perform Dynamic Upload Procedure
Gun will not fire	Monitor CIO rung of the 79024 coil (Weld Initiate) Verify Universal Inputs 9 and 11 are ON If MFDC, check connections of blue cable Verify weld cable is connected to robot Timers will not fire if programmed current is too low. Try increasing the programmed current.
Excessive indentation	Weld force too high, weld current too high, or weld time too long. Electrode face too small. Fit up is poor. Speed regulator on cylinder is missing. Pressure regulation is poor.
Electrode is mushrooming	Weld force too high, weld current too high, or weld time too long. Electrode face too small. Insufficient electrode cooling.
Weld nugget is undersized	Weld force is too high. Weld current is too low. Weld Time is too short. Fit up is poor. Heat balance is poor. Weld spacing is too close. Weld is too close to edge of part. Shunt path is in secondary. Excess ferrous material in throat.
Weld nugget is offset	Electrodes are not flat and parallel. Electrodes are misaligned. Fit up is poor. Heat balance is poor.
Misshapen weld nugget	Electrodes are not flat and parallel. Electrodes are misaligned. Fit up is poor.

Table 9 Troubleshooting Chart

Problem	Probable Cause
Expulsion at weld surface	Weld force too low, weld current too high, or weld time too long. Electrode face too small. Electrodes are not flat and parallel. Fit up is poor. Material is dirty. Squeeze time is too short. Follow up is poor.
Expulsion at interface	Weld force too low, weld current too high, or weld time too long. Electrode face too small. Fit up is poor. Weld is too close to edge of part. Material is dirty. Squeeze time is too short. Follow up is poor
Cracked or poor weld nugget	Weld force too low. Material is dirty or unsuitable for welding. Follow up is poor. Hold time is too short.
Discolored weld nugget	Weld force too low, weld current too high, or weld time too long. Electrode face too small. Fit up is poor. Material is dirty. Follow up is poor.
No weld	Weld force is too high. Weld current is too low. Weld time is too short. Electrode face is too large. Weld spacing is too close. Material is dirty or unsuitable for welding. Transformer tap set to OFF. “No Weld” switch is set to NO WELD. Pressure switch is OPEN. Temperature limit switch is OPEN. Electrodes are not contacting work. Electrodes/holders are insulated. Shunt path is in secondary. Excess ferrous material in throat. Emergency Stop switch OPEN.

5.4 Tips for Producing Quality Welds

Follow these tips to avoid weld problems and produce consistent, high-quality welds:

- Make sure the electrodes you are using are suitable for the job. Select an electrode tip suitable for the thickness of the stock you are welding. Do not use a small tip for welding heavy gauge materials or a large tip on thin materials.
- Use standard electrodes whenever possible. Avoid using special purpose or offset tips if the job can be handled with a standard straight tip.
- Do not weld using unidentified electrodes or electrode materials.
- Use flow indicators to assure that the proper amount of cooling water flows through the electrodes (typically 1.5 gallons per minute). Always adjust the cooling water to the appropriate pressure before beginning to weld.
- To avoid leaks and loss of water pressure, make sure the water hose firmly fits the water connection nipples. Before welding, check for leaky, broken, or clogged water connections.
- Make sure the holder's internal water cooling tube projects into the tip water hole to within one-fourth inch of the bottom of the tip hole.
- Always use electrode holders with adjustable internal water cooling tubes. When switching to a different tip length, adjust the holder's internal water cooling tube to the appropriate height.
- Do not use holders that have leaky or deformed tapers.
- Use a rubber mallet to align holder and tips, instead of a metallic tool.
- Avoid leaving electrodes unused in tapered holder seats for long periods of time.
- Use a tip dresser on a regular basis to maintain correct electrode contour. Never dress an electrode using a coarse file.
- Clean the tip taper and holder taper on a regular basis, removing foreign materials.
- To simplify tip removal and avoid tip damage, coat the tip with a thin film of cup grease before placing it in the holder. Use ejector-type holders to avoid damaging tip walls. Never use pipe wrenches or similar tools when removing electrodes.

5.5 Troubleshooting Dual Port RAM I/O

If a communication problem occurs in the NX100-to-Medar spot welding interface, use the dual port RAM memory I/O information in Table 10 and Table 11 to troubleshoot the problem. These tables list the concurrent I/O addresses used to check the status of the dual port RAM inputs and outputs. The dual port RAM interface consists of M-registers, which are copied to and from the auxiliary addresses shown in the tables.

Execute the SPOT command and verify the following I/O definitions:

1. Weld sequence numbers 7100 - 7107 should pulse in a non-zero bit pattern.
2. Critical outputs should be defined as follows:
   - 79020 = 0 Control Stop
   - 79021 = 0 Isolation Contactor Status
   - 79023 = 1 Weld/NoWeld
   - 79024 = 1 Weld Initiate (Turns ON to initiate)
   - 79057 = 1 (MFDC only) MFDC Ready to Weld
3. Critical inputs should be defined as follow:
   - 79081 = 1 Ready to Weld
   - 79082 = 0 Weld/No Weld
   - 79107 = 1 (MFDC only) MFDC Timer Detected

Table 10 NX100 Outputs to Medar Board

Byte	M-Register	AUX Address	Description	I/O Definition
Host Count	M000 High Byte	79010 - 79017	Counter to verify communication	Increments 0 to 65535
Sequence #	M000 Low Byte	79000 - 79007	Weld Sequence Number	1 to 255
Group Reset	M001 High Byte	79030 79031 79032 79037	Group Reset, bit 1 Group Reset, bit 2 Group Reset, bit 4 Group Reset, master bit	1= Active 1= Active 1= Active 1= Active

Table 10 NX100 Outputs to Medar Board

Byte	M-Register	AUX Address	Description	I/O Definition
Control 1	M001 Low Byte	79020 79021 79022 79023 79024 79025 - 79027	Control Stop Isolation Contactor Status Fault Reset No Weld Weld Initiate Reserved	0= Active 0= Closed 1= Active 0= No Weld 1= Initiate -
Control 2	M002 High Byte	79050 79051 79052 79053 79054 79055 79056 79057	(not used) (not used) No Stroke/No Weld Input Application Error Ack (not used) (not used) Weld Proceed Input MFDC Ready to Weld	- - 1= NSNW 1= Acknowledge - - 1= Weld Proceed 1= MFDC Ready
Control 3	M002 Low Byte	79040 - 79047	Application Specific	-
Control 4	M003 High Byte	-	Application Specific	-

Table 11 NX100 Inputs from Medar Board

Byte	M-Register	AUX Address	Description	I/O Definition
Welder Count	M004 High Byte	79070 - 79077	Counter to verify communication	Increments 0 to 65535
Group Reset Acknowledge	M004 Low Byte	79060 79061 79062 79063	Group Reset Acknowledge Bit 1 Group Reset Acknowledge Bit 2 Group Reset Acknowledge Bit 3 Group Reset Acknowledge Bit 4	1= Reset
Application Error Code	M005 High Byte	79090 - 79097	Application error code	1 - 25
Status 1	M005 Low Byte	79080 79081 79082 79083 79084 79085 79086 79087	Shunt Trip Ready to Weld In No Weld Alert Fault Initiate Acknowledge Weld in Progress Weld Complete	1= Active 1= Active 1= Active 1= Alert 1= No Fault 1= Initiate Ack 1= Active 1= Active

Table 11 NX100 Inputs from Medar Board

Byte	M-Register	AUX Address	Description	I/O Definition
Status 2	M006 High Byte	79110 79111 79112 79113 79114 79115 79116 79117	(not used) (not used) Application Error Available (not used) (not used) (not used) (not used) MFDC Charge Request	- - 1= Code Available - - - - 1= Charge Request
Status 3	M006 Low Byte	79100 - 79106 79107	Application Specific MFDC Timer	- 1 = MFDC; 0 = AC
Status 4	M007 High Byte		Application Specific	-

Notes

Appendix A

Initialization of Medar Setup Data

The following procedures are performed at the factory. However, there may be an occasion that necessitates the initialization of the Medar setup data.

A.1 Explanation

The S2C450 parameter allows the customer to change the Medar default SETUP parameters. At boot-up, the Medar board copies default setup data from an EPROM into the Medar's volatile memory. For a new system, the NX100 must be initially booted up with parameter S2C450 =0. Toggling the "Upload Dynamic Data" output, uploads the SETUP data into the NX100 memory. Next, parameter S2C450 is set to equal 1, so that at boot-up the default parameters will be overwritten with NX100 saved data. At this point, the data is the same. However, the customer may now change any Medar SETUP parameter on the Medar pendant, and toggle the "Upload Dynamic Data" output to save it into NX100 memory.

A.1.1 Procedure

1. With S2C450=0, re-boot the NX100.
2. Turn the "Upload Dynamic Data Output", universal output 1001, ON. The "Upload Dynamic Data" input (Universal Input 180)is turned ON.
3. Verify that Universal Input 180 is ON. If it is OFF, contact Motoman Service.
4. Turn OFF Universal Output 1001.
5. Set S2C450=1 so that default values can be overwritten at the next boot-up. (Always wait for the 'hour glass' symbol in the upper right corner to disappears before turning OFF the controller).

WARNING!
Never turn off the NX100 when the hourglass symbol is shown. This could damage the internal NX100 memory.

6. Re-boot the NX100

A.1.2 Verification

1. If a Medar pendant is available, change a setup parameter on the Medar pendant. For example, change the "WELD INITIATE NOT PRESENT" action from ALERT to FAULT.
2. Download this setting on the Medar pendant.
3. Toggle the "Upload Dynamic Data Output", universal output 1001.

WARNING!
Never turn off the NX100, when the hourglass symbol is shown. This could damage the NX100 memory.

4. Re-boot the system, and verify on the Medar pendant that the setting for "WELD INITIATE NOT PRESENT" is set to FAULT.

A.1.3 General Notes

- Whenever the schedule format is changed from SIMPLE to ENHANCE or vise versa, the NX must be re-booted.
- After each weld the stepper count is automatically uploaded to the NX100 memory.
- If any SETUP data is changed and saved on the Medar pendant, the 'Upload Dynamic Data' output (1001) must be toggled to save the data to the NX100 memory.
- Weld Cond. Files 1-200 can only be programmed using the Motoman pendant. They can either be the standard SIMPLE or ENHANCED schedule format.
- The schedule format of Weld Cond. Files 201-255 can be customized. However, they must be programmed on the Medar pendant. After saving the weld schedule with the Medar pendant, upload the files to the Motoman pendant by selecting [UTILITY] > [READ SCH] in the Weld Cond. screen on the Motoman pendant.

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