USER'S MANUAL **990-370**

Revision F **November 2014**

AMADA MIYACHI AMERICA, INC.

HF27
25kHz HIGH FREQUENCY
DC RESISTANCE WELDING SYSTEM

MODEL NUMBER	STOCK NUMBER
HF27/240	1-320-01
HF27/400	1-320-01-01
HF27/480	1-320-01-02

Revision Record

Revision	EO	Date	Basis of Revision
A	20294	03/05	None. Original edition.
B	21590	09/07	Weld Status Codes added to *Appendix E, Communications.*
C	34461	12/09	Updated technical information & specifications.
D	42009	7/12	Updated communication codes.
E	42840	10/13	Updated to Miyachi America name and logo.
F	43480	11/14	Updated to Amada Miyachi America name and logo.

Important Note

The **HF27** contains advanced technology and improved features, yet from an operational standpoint, it performs the same as older Miyachi Unitek Controls. See *Appendix H, Compatibility and Comparison* for an overview of the differences between the new and old models.

This manual describes **HF27** Models 1-320-01, 1-320-01-01, 1-320-01-02 manufactured ***after*** June 2005 which contain significant differences than older models.

HF27 models 1-287-01, 1-287-01-01, and 1-287-01-02 manufactured ***before*** June 2005 require a different manual. To get **User's Manual 990-335** for older HF27 models, order a copy using the phone number or e-mail address listed under **Contact Us** on page **ix** of this section.

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CONTACT US

Thank you for purchasing a Miyachi Unitek™ Resistance Welding System Control.

Upon receipt of your equipment, please thoroughly inspect it for shipping damage prior to its installation. Should there be any damage, please immediately contact the shipping company to file a claim, and notify us at:

Amada Miyachi America
1820 South Myrtle Avenue
P.O. Box 5033
Monrovia, CA 91017-7133

Telephone: **(626) 303-5676**

FAX: **(626) 358-8048**

e-mail: **info@amadamiyachi.com**

The purpose of this manual is to supply operating and maintenance personnel with the information needed to properly and safely operate and maintain the Miyachi Unitek™ HF25 Resistance Welding System Control.

We have made every effort to ensure that the information in this manual is accurate and adequate.

Should questions arise, or if you have suggestions for improvement of this manual, please contact us at the above location/numbers.

Amada Miyachi America is not responsible for any loss due to improper use of this product.

SAFETY NOTES

DANGER

- ***Lethal voltages exist within this unit***. Do ***not*** perform any maintenance inside this unit.
- ***Never*** perform any welding operation without wearing protective safety glasses.

This instruction manual describes how to operate, maintain and service the HF25 resistance welding system control, and provides instructions relating to its ***safe*** use. A separate manual provides similar information for the weld head used in conjunction with the power supply. Procedures described in these manuals ***must*** be performed, as detailed, by ***qualified*** and ***trained*** personnel.

For ***safety***, and to effectively take advantage of the full capabilities of the weld head and power supply, please read these instruction manuals before attempting to use them.

Procedures other than those described in these manuals or not performed as prescribed in them, may expose personnel to electrical, burn, or crushing hazards.

After reading these manuals, retain them for future reference when any questions arise regarding the proper and ***safe*** operation of the power supply.

Please note the following conventions used in this manual:

WARNING: Comments marked this way warn the reader of actions which, if not followed, might result in immediate death or serious injury.

CAUTION: Comments marked this way warn the reader of actions which, if not followed, might result in either damage to the equipment, or injury to the individual if subject to long-term exposure to the indicated hazard.

DNB Engineering
5969 Robinson Ave.
Riverside, CA 92503
(951) 637-2630

EN61010-1: 2001

DECLARATION OF CONFORMITY

Application of Council Directive: 72/23/EEC

Standards to which conformity is declared:	EN 61010-1:2001
Manufacturer's Name:	Miyachi Unitek
Manufacturer's Address:	1820 S. Myrtle Ave. Monrovia, CA 91016
Equipment Description:	Welding Station
Equipment Class:	I
Model Number:	HF25, HF27

I the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

DNB

Place: Monrovia, CA
Signature: Kevin Gunning
Full Name: Kevin Gunning
Position: Director, R+D

CHAPTER 1
Description

Section I: Features

The **HF27 High Frequency Resistance Welding System Control** precisely controls and monitors both electrical and mechanical weld parameters.

Control Features

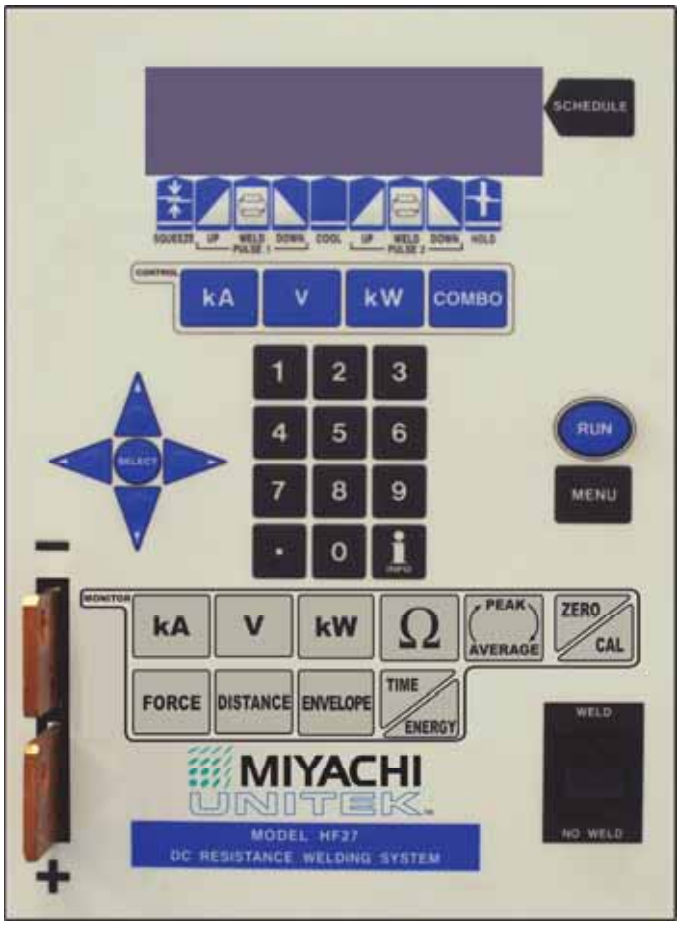
- Constant Current, Voltage & Power modes
- Monitor Energy and Resistance
- Force Control
- Monitor Displacement and Force

Weld Quality Process Tools

- Envelope Function
- Active Part Conditioning
- Pre-weld Check
- Combo Mode
- Weld to Limits

Descriptions of the various control modes and process tools are located in *Chapter 3, System Configuration,* and *Chapter 4, Introduction to Feedback Modes and Weld Monitoring*.

Detailed instructions on using these features are located in *Chapter 5, Operating Instructions.*



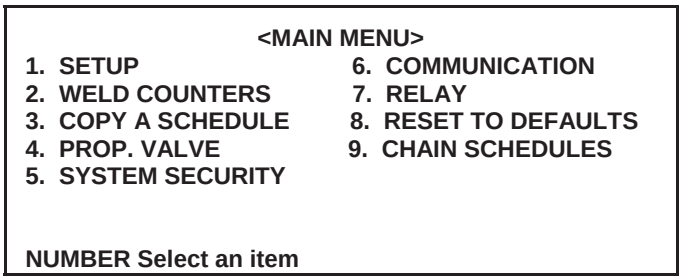
NOTE: For the rest of this manual, the Miyachi Unitek **HF27 High Frequency Resistance Welding System Control** will simply be referred to as ***the Control***.

Section II: Introduction

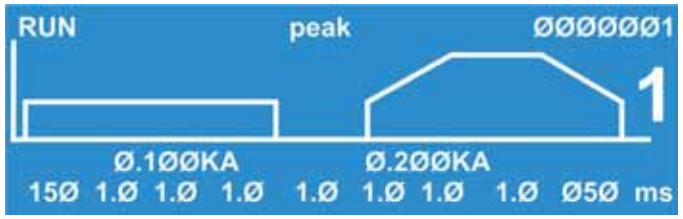
This Control contains advanced technology and improved features, yet from an operational standpoint, it performs the same as older Miyachi Unitek Controls (see *Appendix H, Compatibility and Comparison* for an overview of the differences between the new and old models).

The Control is a 25 kHz, three-phase, state-of-the-art inverter power supply for joining precision small parts at high speed with controllable rise times. The delivered welding energy is in the form of DC welding energy. High speed (40 microseconds) digital feedback automatically controls weld current, voltage, or power, providing more welding consistency compared to traditional direct energy (AC) or capacitive discharge (CD) technologies. This microprocessor technology automatically compensates for changes in work piece resistance, load inductance, weld transformer saturation, and changes in line voltage. In addition, special power device technology precisely controls the weld energy at both high and low energy levels.

- You can program the Control from the front panel, using simplified key clusters and on-screen data fields. A **MAIN MENU** screen allows you select all of the system setup options for working with inputs from external equipment.



- The **RUN** screen allows you to easily modify any time period, current, voltage, or power value.



Run Screen

- The **MONITOR** screen provides instant visual feedback on the actual current, voltage, or power used to make each weld. It permits you to program adjustable limits for both weld pulses.

Monitor Screen

- Rear-mounted RS-232 and RS-485 connectors allow for remote programming, weld schedule selection, and data logging for SPC purposes. The Control has communication and data options that allow you to connect a single Control, or multiple Controls, to a printer or a computer in order to:
  - Compile, store, view, and print weld history data for detailed analysis.
  - Remotely program weld schedules on the Control(s).
  - Remotely program menu items on the Control(s).

  Appendix E, Communications in this manual lists all of the commands that the Control will respond to, and instructions on how to format commands sent to the Control so it will respond properly. These commands have been implemented in Amada Miyachi America's *Weld Stat* program that provides PC based communication and control of the HF27.
- The Control has a **Linear Variable Differential Transformer** (**LVDT**) function that allows the user to:
  - Measure Initial Part Thickness
  - Measure Final Part Thickness
  - Measure displacement during welding
  - Stop the weld energy after a programmable displacement is reached.

  Programmable relay outputs are also provided with this option.
- The Control has a 0-5 volt input for a weld force transducer. This input allows the user to put limits around the firing force and the final force used during the weld.
- The Control has a 0-5 volt output to drive a proportional valve. This allows the user to adjust the weld force from the Control and change it in each schedule.
- The design of the Control is directed toward compactness, lightweight, operational simplicity, and ease of repair. Metric hardware is used throughout the chassis to facilitate international servicing and repair.
- The 25 kHz operating frequency ensures that the integral welding transformer is light and compact. The input/ output connectors on the rear panel provide for quick-connect signal I/O cabling, facilitating interface with automation systems.

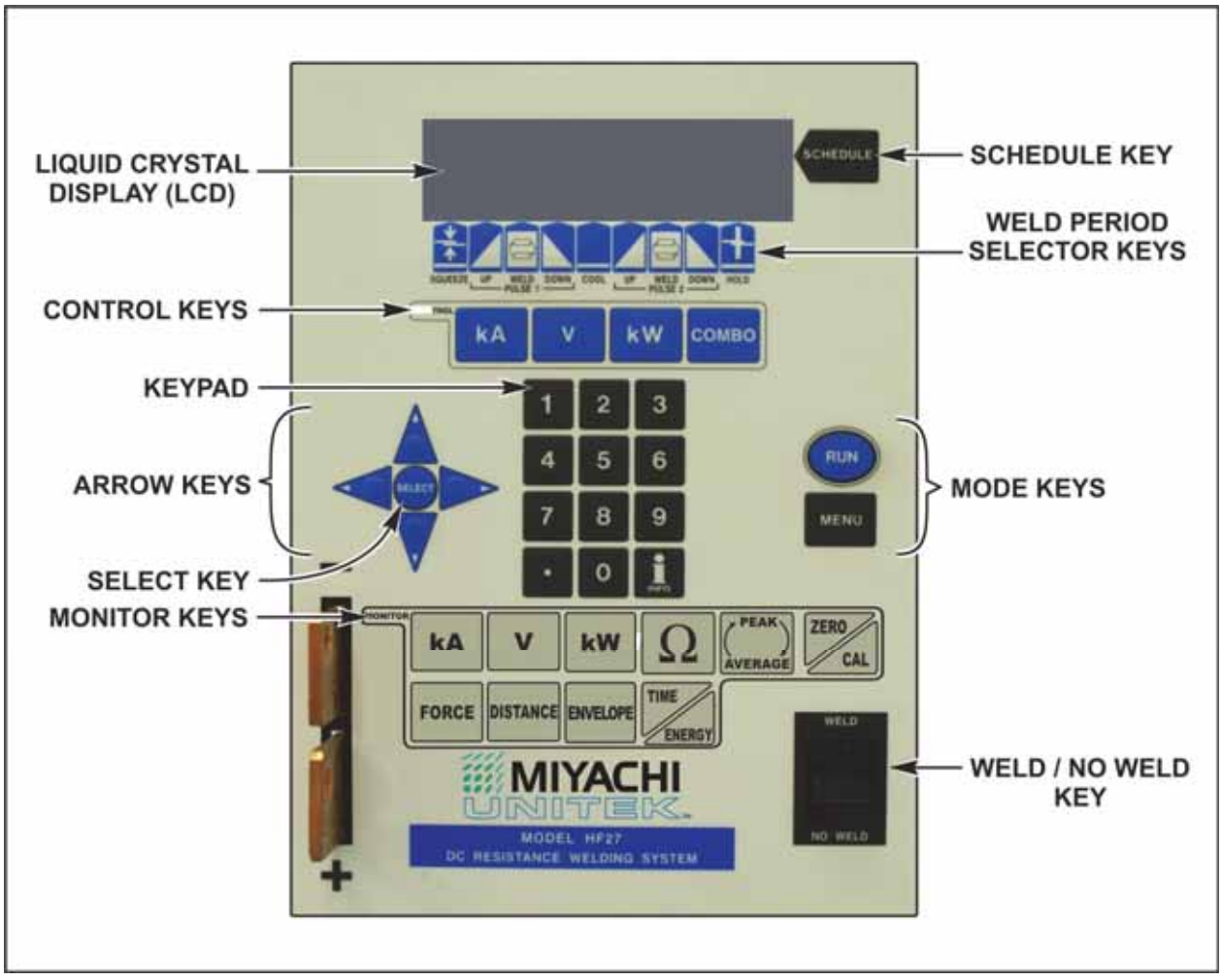
Section III: Major Components

Major Components

The major components are the front panel, which contains the operator's controls and indicators, and the rear panel, which contains fuses, circuit breakers and power and signal connectors. The rear panel connections are discussed in *Chapter 2, Installation and Setup*.

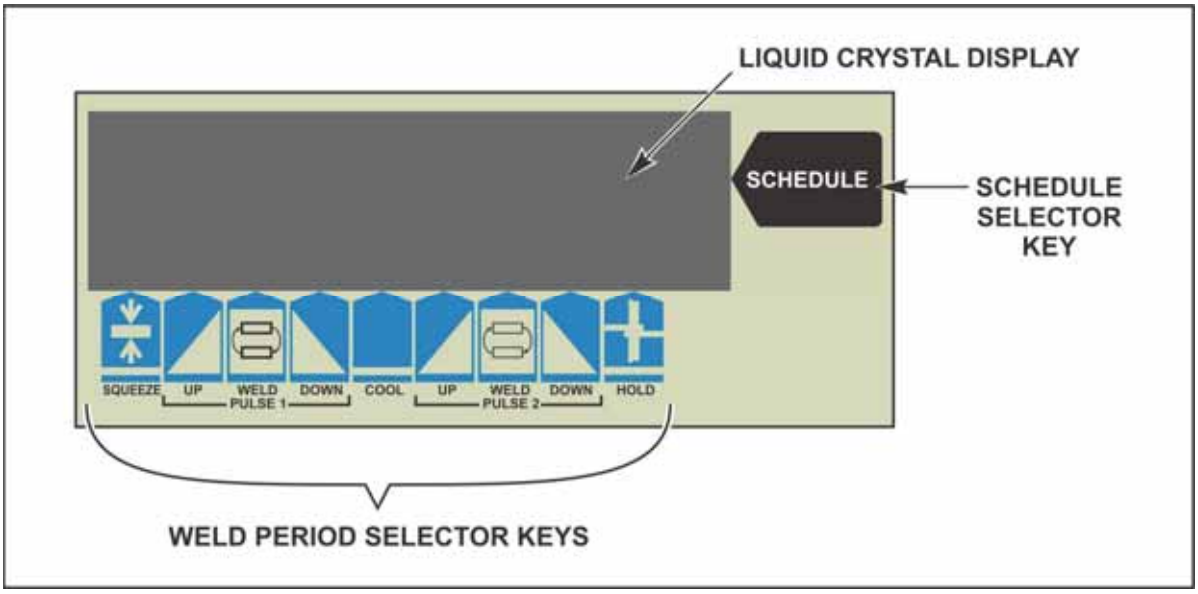
Front Panel Display and Display Controls

The front panel of the Control below shows controls and indicators. The function of each item is described on the following pages.



Front Panel Controls

Display



Liquid Crystal Display (LCD)

The Liquid Crystal Display (LCD) on the front panel allows you to locally program the Control with the front panel controls, and read the results of a weld process following its initiation.
The LCD has three distinct functions, depending on the active mode of the Control. In the run mode, the display permits you to:

- View the entire weld schedule profile, individual weld periods, and weld energy parameters.
- View individual weld parameter program changes as you enter them via the weld period selector keys.
- View completed weld feedback data and use the data to modify the weld schedule.

In the menu mode, the display presents system setup options for you to select. In the monitor mode, the display is your means of programming the energy limits monitor and viewing actual out of limit conditions.

Display Controls

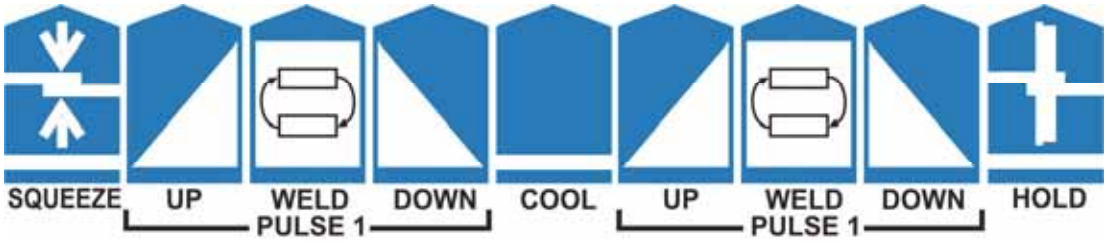
There are three display control functions:

- **SCHEDULE** Selector Key
- Weld Period Selector Keys
- Time/Energy Selector Keys

SCHEDULE Key

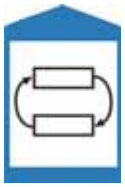
Puts the Control into the weld schedule selection mode. Use the keypad to directly enter a desired weld schedule (refer to *Front Panel Data Entry and Mode Controls* in this section), then press the **RUN** key.

Weld Period Selector Keys



Select individual weld periods and weld energy fields in the weld schedule profile for programming. See *Front Panel Data Entry and Mode Controls*.

Time/Energy Selector Keys

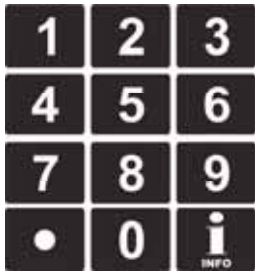


These two switches, one for each of the **PULSE 1** and **PULSE 2** weld periods, select either the bottom line of data or the second-to-bottom line of data on the screen to be programmed. The bottom line of data is weld period time in milliseconds. The second-to-bottom line is **Weld Energy**, in the units selected by the energy units selection keys. See *Front Panel Data Entry and Mode Controls*.

Front Panel Data Entry and Mode Keys

Key Pad

The keypad consists of the numeric keys and the up/down/left/right keys.



Numeric Keys: The numeric keys allow you to:

- Enter or modify weld period time and energy values
- Enter or modify monitor and limit values
- Directly recall a specific weld schedule.

To use the numeric keypad, you must first select a time/energy weld period key or the schedule key.

The arrow keys move the highlighted cursor up, down, to the left and right in all screens. Pressing **SELECT** allows editing of the highlighted field. The ▲▼ keys allow you to increment (up) or decrement (down) numeric values on the display, to change states, such as **OFF** to **ON** (up) or **ON** to **OFF** (down); and to scroll the schedule number up and down while in the run mode. To end the edit mode for that field, press any key ***except*** **SELECT**, ▲ , ▼ , or the numeric keypad.

Mode Keys. The mode keys consist of the **RUN** key and the **MENU** key.

RUN Key: Sets the Control to the operating mode. Used to terminate program mode if already in the **RUN** screen.

MENU Key: You access the menu screen with this key. Menu items control system parameters such as setup and weld counter operation. Refer to *Menus* in *Chapter 3, Section II* for details of the functions accessible through that screen.

Control Keys

Control Mode Selection Keys. These keys allow you to select the control mode when programming with the **WELD** (time/energy) selector keys.

Pressing the **kA** key selects current as the control mode for this schedule. The control will output the current waveform shown on the LCD.

Pressing the **V** key selects voltage as the control mode for this schedule. The control will output the voltage waveform shown on the LCD.

NOTE: Selecting the voltage feedback mode requires you to make a test weld when the voltage or weld pulse time is changed. The test weld optimizes the Control feedback performance. The weld status message **TEST** disappears after the internal control parameters are optimized.

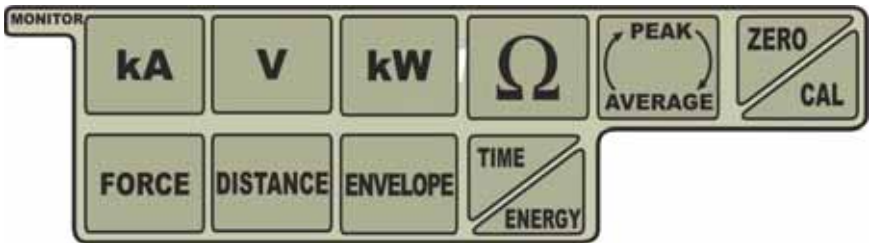
Pressing the **kW** key selects power as the control mode for this schedule. The control will output the power waveform shown on the LCD.

This allows the user to start a weld in voltage or power mode and then switch to a constant current when the user-selected current level is reached.

NOTES:

- **COMBO** mode can be selected independently for pulse 1 and pulse 2.
- **Limits** and **Monitor** functions will still apply for this mode.

Monitor Keys



These keys allow you to view the results of the last weld and to set the limits of the welding parameters beyond which the energy limits monitor terminate the weld and/or initiate alarms.

Pressing the **kA** key displays the current monitor. This screen shows the results of the most recent weld. This screen also allows the operator to set limits that automatically interrupt the weld when they are reached. You can also program the current monitor to output an alarm when the limits are exceeded.

Pressing the **V** key displays the voltage monitor. This screen shows the results of the most recent weld. This screen also allows the operator to set limits that automatically interrupt the weld when they are reached. You can also program the voltage monitor to output an alarm when the limits are exceeded.

Pressing the **kW** key displays the power monitor. This screen shows the results of the most recent weld. This screen also allows the operator to set limits that automatically interrupt the weld when they are reached. You can also program the power monitor to output an alarm when the limits are exceeded.

Pressing the **Ω** key displays the resistance monitor. This screen shows the results of the most recent weld.

The Control is always monitoring both the **PEAK** and **AVERAGE** of current, voltage, power, and resistance. When you press this key, the top line in the LCD screen toggles back and forth between displaying **PEAK** and **AVERAGE**.

This key will bring up a menu with two options:

- LVDT
- Force.

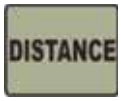
This key brings up the **CALIBRATION** menu with five options:

- Unit calibration
- LVDT gauge thickness
- LVDT calibration
- LVDT quick calibration
- Force input calibration and force output (proportional valve) calibration.

This key brings up the force screen. On this screen you can:

- Set the output force for the proportional valve
- Set force limits around the measured value. You can set different limits in each schedule. Force will be in lb, N or kgf units. You can set upper and lower limits for the force at the start and end of the weld.

NOTE: Setting a force value to zero turns that measurement OFF. The function is turned totally OFF if these values are set to zero.



This allows programming high and low limits for initial thickness, final thickness, displacement and allows the user to set a thickness at which the unit will stop providing energy to the weld.

This key brings up the **ENVELOPE** function for the graphical monitor trace presently on the screen, or last used monitor screen if the unit is in the **RUN** mode. This allows setting independent upper and lower offsets around the waveform displayed on the screen. Independent envelope modes (current , voltage or power) can be selected for Pulse 1 and Pulse 2.

The function of the time screen is to allow the user to program limits around the Cut Off time. The Cut Off time is defined as the time when the control system commands current to turn off. Current can be turned off either by reaching a "weld to" type of limit or by reaching the end of the pulse.

The user will be able to program upper and lower energy limits for the first and second pulse. The display will show the calculated watt second value for the first and second pulse. The limits will apply for the entire upslope, weld and downslope time.

WELD/NO WELD Switch

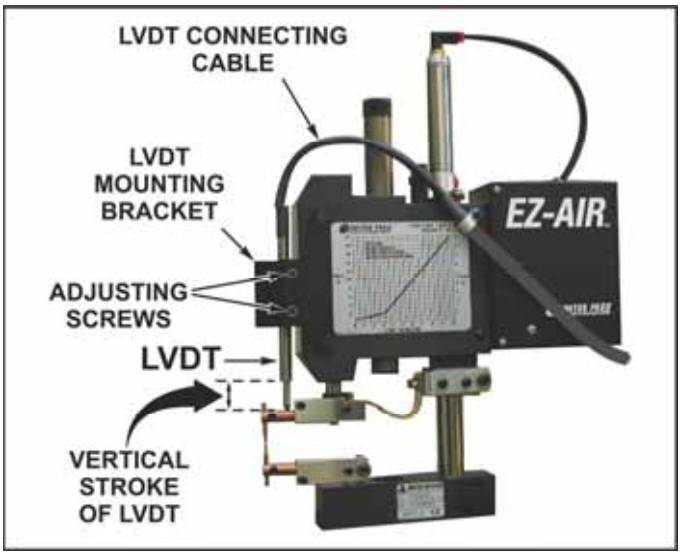
When the switch is in the **WELD** position, the programmed weld sequence can initiate weld energy.

When you set this switch to the **NO WELD** position, ***no*** weld current can flow. However, the Control ***can*** execute a complete weld sequence. This function is required to adjust the weld head prior to operation.

Emergency Stop Switch Operation

If your work station is equipped with an emergency stop switch (connected to the emergency stop connection of the Control), operate the switch to immediately stop the welding process. All power to the air valves and power circuits will be disconnected. To restart the Control, you must press the RUN key on the front panel.

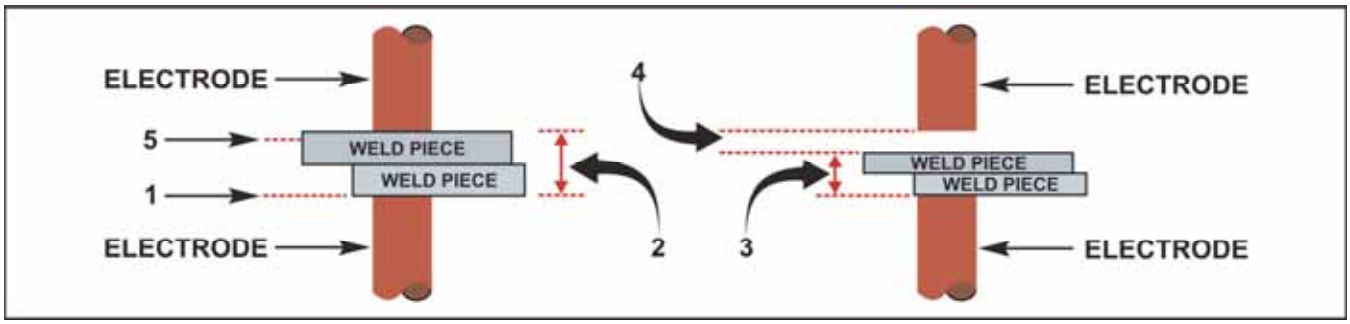
Section III. LVDT Capability



The Control is fully capable of using a **Linear Variable Differential Transformer**. This is a combination of an electro-mechanical device attached to the weld head, which is electronically linked to software installed in the Control. For the rest of this manual, this combination will be referred to simply as ***the LVDT***.

The LVDT allows the user to:

- Measure initial part thickness as the electrodes close on the part.
  (If too thin, parts may be missing. If too thick, something extra may be in the way of the parts.)
- Measure displacement during the weld.
  (To measure the collapse of the parts during welding.)
- Measure final part thickness after the weld.
  (Too thick maybe an indication of a cold weld. Too thin maybe an over-welded or blown weld.)
- Weld to a preset displacement.
  (The weld energy will stop when the parts reach a user-programmed displacement value.)
- Actuate a relay when specific LVDT conditions are reached.
  (**Example**: If a weld has too much displacement, a relay could trigger an alarm for the operator or automation.)



1 = Zero The point where the two electrodes touch (*zero* distance between them).

2 = Initial Thickness The thickness of the weld pieces *before* welding takes place (measured at the end of squeeze time).

3 = Final Thickness The thickness of the weld *after* welding takes place (measured at the end of hold time).

4 = Displacement The amount of *collapse* when the weld pieces were forced together during the weld (the difference between **Initial Thickness** and **Final Thickness**).

5 = Stop Energy At Also referred to as **WELD STOP.** The thickness of the weld pieces (programmed by the user) at which weld energy stops. Note that further displacement will occur even after the weld energy is cut off.

CHAPTER 2
Installation and Setup

Section I: Installation

Unpacking

The Control is shipped to you completely assembled, together with the accessories you ordered and a shipping kit. The contents of the shipping kit, available accessories, and contents of the Datacom Kit are listed in *Appendix A, Technical Specifications*. Be sure that the accessories that you ordered have been packed and the contents of the shipping kit and Datacom kit are as listed.

Verify that the Control shows no signs of damage. If it does, please contact the carrier. Also, contact Amada Miyachi America Customer Service immediately at the postal or e-mail address or telephone or FAX number shown in the Foreword of this manual.

Space Requirements

- Allow ample workspace around the Control so that it will not be jostled or struck while welding.
- Allow sufficient clearance around both sides and back of the Control for power and signal cabling runs.
- Install the Control in a well-ventilated area that is free from excessive dust, acids, corrosive gases, salt and moisture.
- Other installation considerations are:
  - The work surface must be level, stable, free from vibration, and capable of supporting the combined weight of the total welding system. The weight of the Control is 62 lbs. (28 kg).
  - The Control must be far enough from the weld head to avoid contact with weld splash.
  - There are ***no*** sources of high-frequency energy close by.

Utilities

Power

Because of the different electrical requirements for the countries in which the Control is used, the Control is shipped without a power cable connector. The required connections for your power cable connector are described in *Appendix B, Electrical and Data Connections.* Input power requirements for the Control are as listed below.

Power Input Specifications

HF27 Model	Input Voltage, 50-60 Hz, 3 phase (Vrms)	Ckt Brkr Current (A rms)	Copper Wire Gauge, 7 strands (AWG)	Wire Dia (mm)	Fuses F1, F2	
					Amps/ Volts	Amada Miyachi America P/N
HF27/240	240	25	10	2.5	6.3	330-096
HF27/400	400	20	10	2.5	3.15	330-095
HF27/480	480	13	10	2.5	3.15	330-097

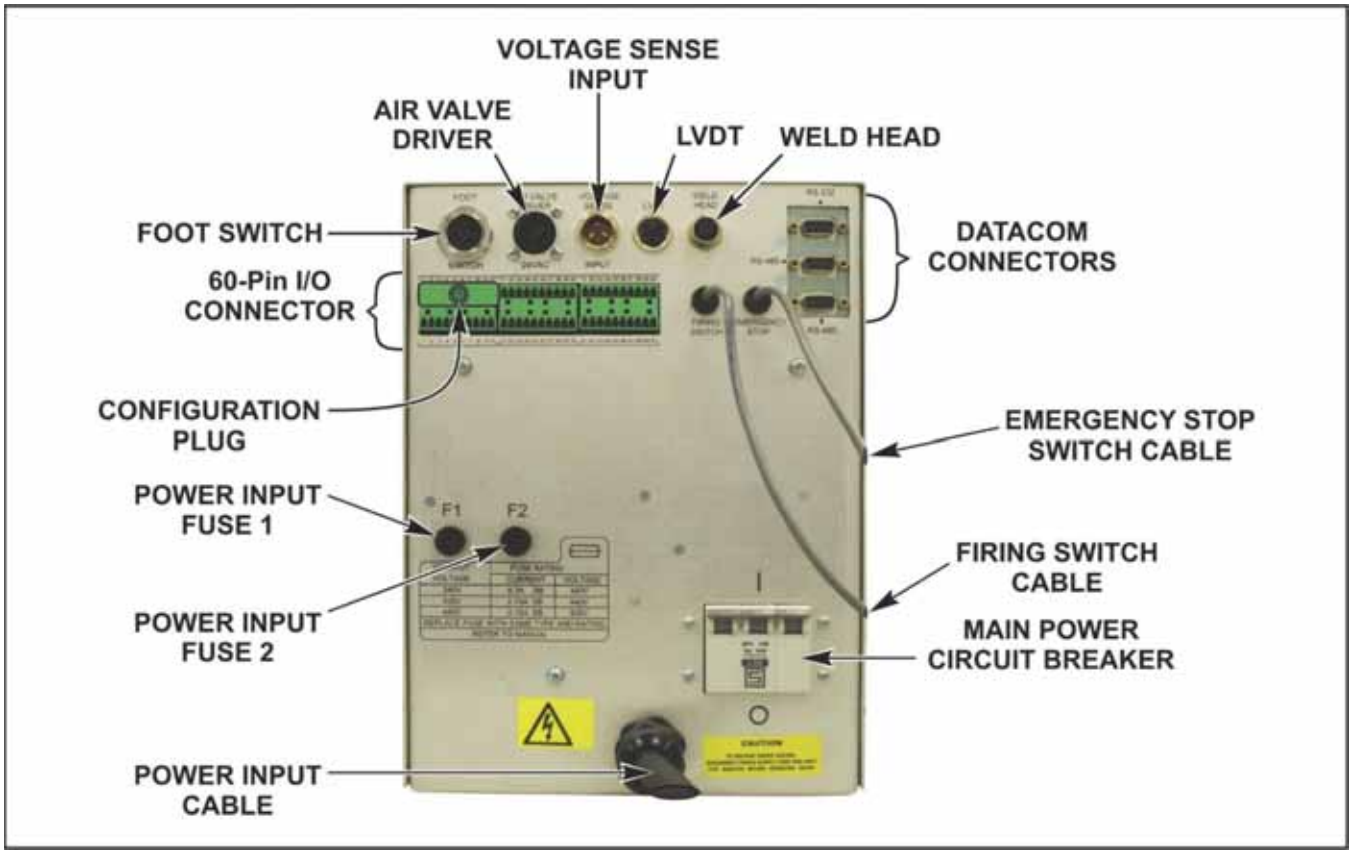
Compressed Air and Cooling Water

If you require compressed air and cooling water service for the weld head, please refer to the weld head manufacturer's user's manual for service specifications.

Section II: Setup

Connections to External Equipment

All connections, other than the weld cable connections, between the Control and external equipment are made through the rear panel.

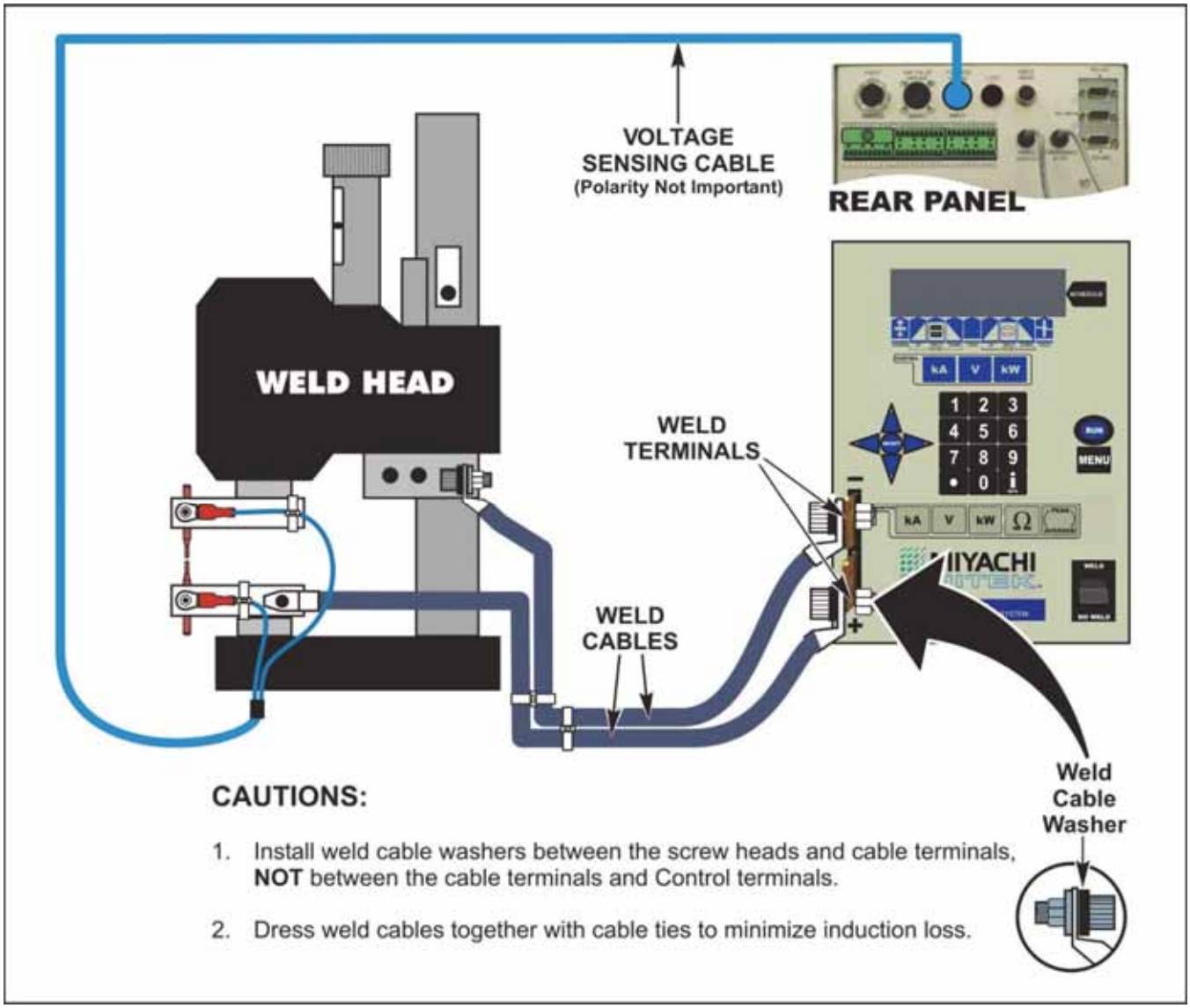


Rear Panel Components and Connectors

NOTES:

- The weld cable connections from the weld head are made at the weld cable terminals on the front panel.
- The pre-wired **Configuration Plug** allows the use of Miyachi Unitek standard foot switches and weld heads without further configuration. The Control requires configuration of the I/Os to accept ***any*** inputs. For normal use, this plug must be connected to pins **11** through **20** on the 60-pin connector. For other configurations, see *Appendix B, Electrical and Data Connections*.

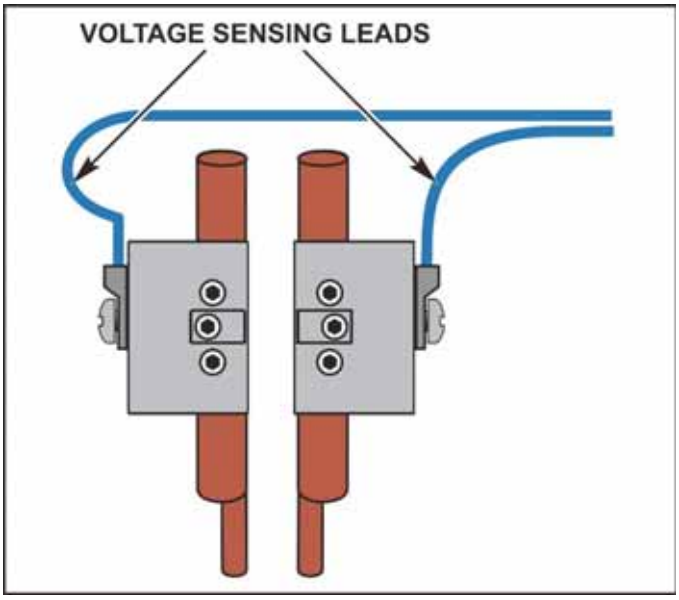
Weld Head Connections



1. Connect one end of a weld cable to the negative (-) welding transformer terminal on the Control.
2. Connect one end of the second weld cable to the positive (+) welding transformer terminal on the Control.
3. Connect the other end of the weld cables to the weld head.
4. Attach the voltage sensing cable connector to the **VOLTAGE SENSE INPUT** connector.
5. Install electrodes in the weld head electrode holders.

   NOTE: If you need additional information about the weld heads, please refer to their user's manuals.

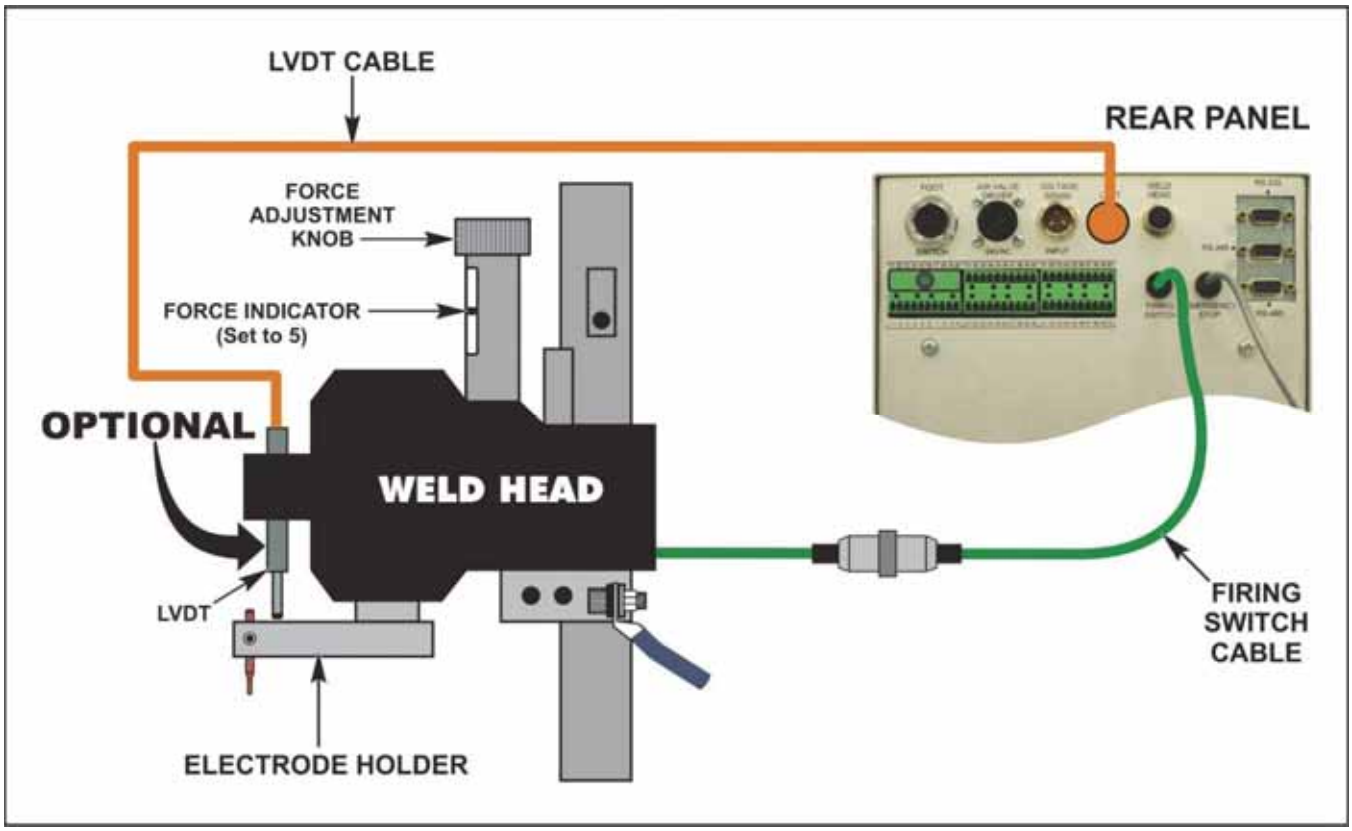
6. Connect the voltage sensing cable terminals to the electrode holders.
7. Attach a leads directly to each electrode holder as shown on the right.
8. Put a strain relief on each voltage sensing lead to its corresponding electrode holder so that the leads will not break away under heavy operating conditions.



NOTES:

- Do ***not*** attach the firing switch, foot switch or **EMERGENCY STOP** cables at this time.
- The polarity of the voltage feedback connections is not important.
- If the tapped holes and screws for the voltage sensing connections are not present on the electrode holders, the holders must be modified to include the tapped holes and screws prior to installation of the equipment.

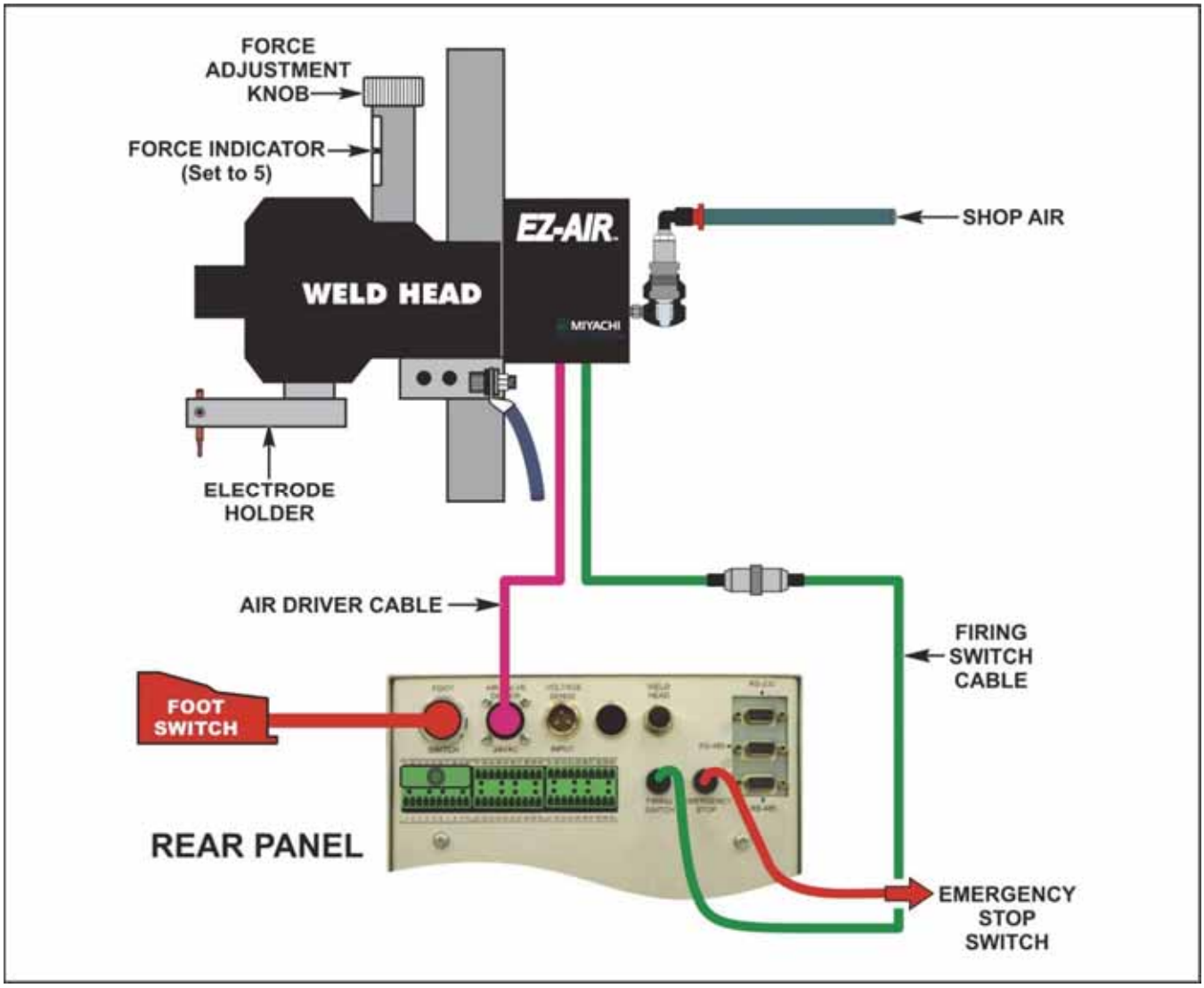
Foot Pedal-Actuated Weld Head Connection



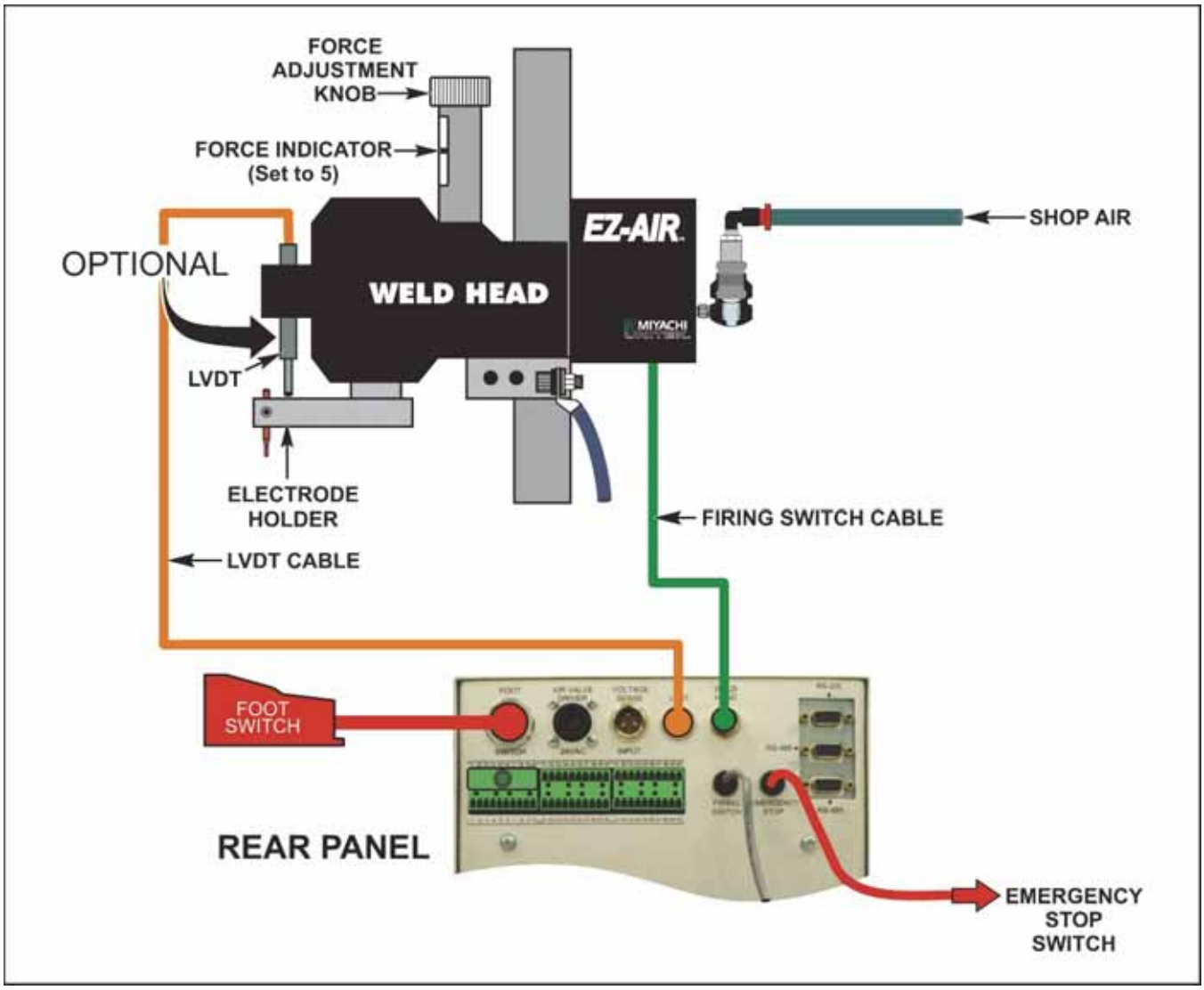
1. Adjust the weld head force adjustment knob to produce 5 units of force, as displayed on the force indicator index.
2. Connect the weld head firing switch cable connector to the Control firing switch cable connector.
3. Connect the LVDT cable to the LVDT input connector.
4. Connect a normally closed, approved, emergency stop switch across the two leads of the operator emergency stop switch cable. This switch, when operated (open), will immediately stop the weld cycle. See *Appendix B. Electrical and Data Connections* for circuit details.
5. Set the **WELD/NO WELD** switch on the Control front panel to the **NO WELD** position. In this position, the Control cannot deliver weld energy, but the firing switch connection can be verified.
6. Set the circuit breaker on the rear panel of the Control to the ON position. The default **RUN** screen will be displayed. You will use this screen to enter welding parameters. See *Chapter 3, Using Weld Functions* and *Chapter 4, Operating Instructions.*

EZ-AIR Weld Head Connections

AC EZ-AIR Weld Head Connection



DC EZ-AIR Weld Head Connection



1. Adjust the weld head force adjustment knob to produce 5 units of force, as displayed on the force indicator index.
2. Connect the weld head firing switch cable connector to the Control firing switch cable connector.
3. Connect a normally closed, approved, emergency stop switch across the two leads of the operator emergency stop switch cable. This switch, when operated (open), will immediately stop the weld cycle and retract the weld head. See *Appendix B. Electrical and Data Connections* for circuit details.
4. Connect a Model FS2L or FS1L Foot Switch to the Control **FOOT SWITCH** connector.

5. Refer to the weld head manufacturer user's manual. Connect the weld head air valve solenoid cable connector to the Control **AIR VALVE DRIVER** connector.

   NOTE: This connector supplies 24 VAC power only, and will ***not*** drive 115 VAC air valves.

6. Connect a properly filtered air line to the air inlet fitting on the weld head. Use 0.25 inch O.D. by 0.17 inch I.D. plastic hose with a rated burst pressure of 250 psi. Limit the length of the air line to less than 40 in. (1 m) or electrode motion will be very slow.

   NOTE: Use a lubricator ***only*** with automated installations.

7. Turn on the air system and check for leaks.

8. Set the **WELD/NO WELD** switch on the Control front panel to the **NO WELD** position. In this position, the Control cannot deliver weld energy, but it can control the weld head.

9. Set the circuit breaker on the rear panel of the Control to the ON position. The default **RUN** screen will display.

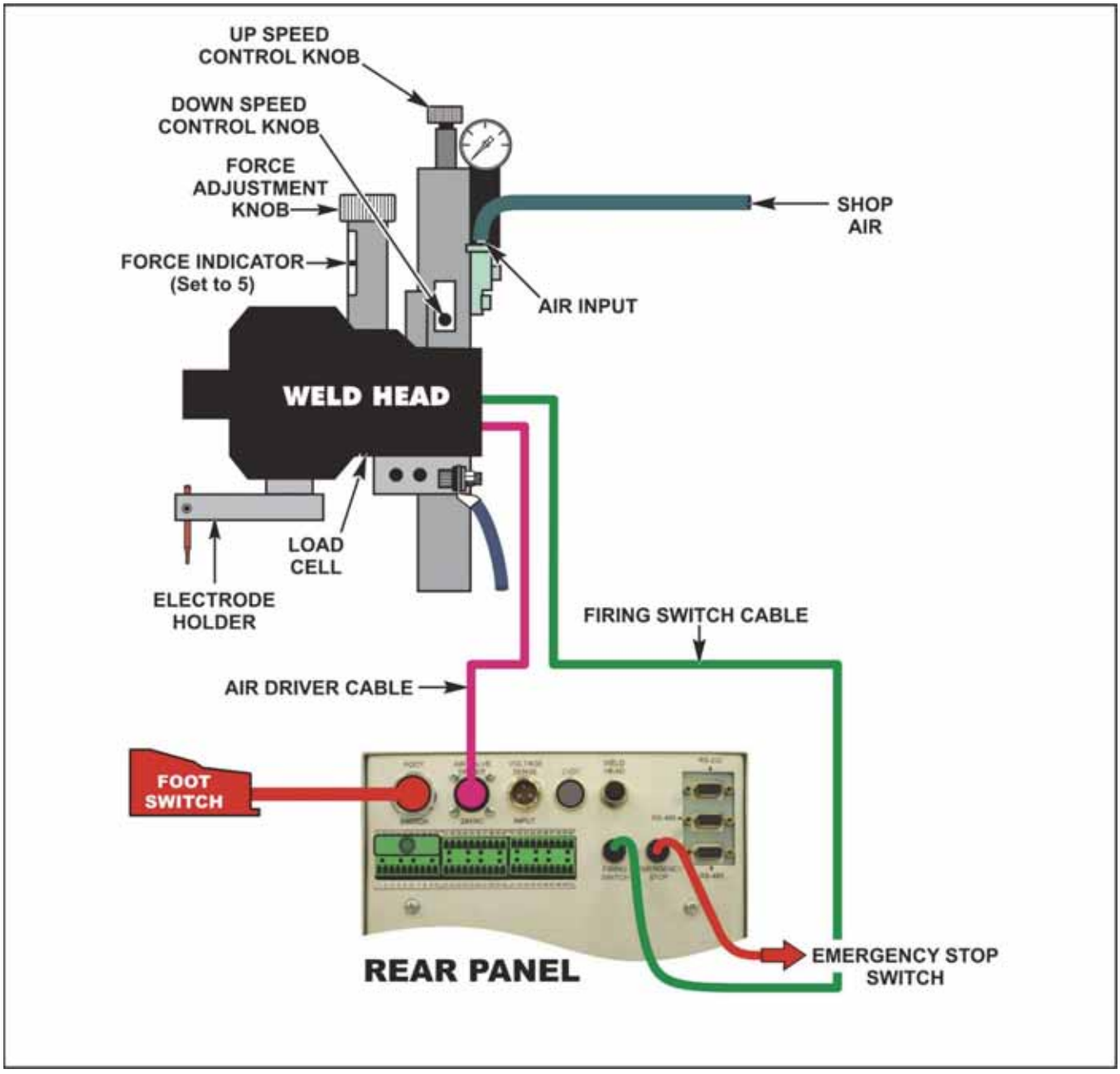
10. Press the foot switch to actuate the first level. The weld head upper electrode should descend smoothly to the DOWN position. When it reaches the down position, release the foot switch and proceed to Step 12. If it does not descend smoothly, proceed to Step 11.

11. Adjust the weld head down speed control knob and repeat Step 10 until the upper electrode descends smoothly.

12. Press the foot switch all the way down to close both levels. The weld head upper electrode should descend smoothly to the DOWN position, and send the firing switch signal back to the Control when the preset electrode force is reached. The upper electrode should then ascend smoothly back to the UP position.

Non-*EZ-AIR* Weld Head Connections

Non-*EZ-AIR* heads may be connected to the Control as shown below, however you should refer to the manual provided with the weld head you are using for specific instructions.



CHAPTER 3
System Configuration

Section I: Getting Started

Before You Start

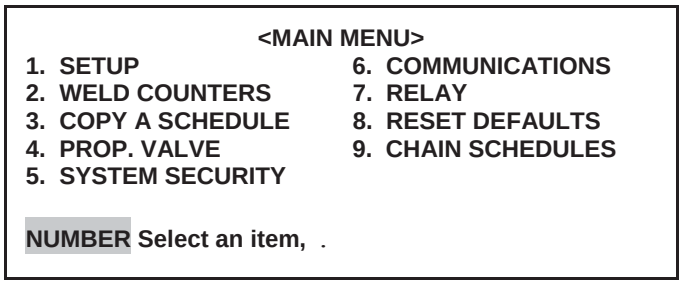
Configuration is simply a matter of selecting various **MENU** options so the Control will work with all the components of your welding system.

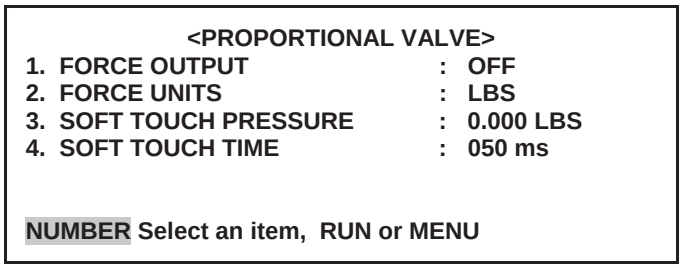
- Verify that all connections have been made according to the instructions in *Chapter 2, Installation and Setup.*
- Turn the Control ON.
- Turn any peripherals such as the Proportional Valve and Load Cell Amplifier ON.
- Turn the shop air supply ON.

Startup

1. Press the **MENU** key.
2. Press **4** for **PROPORTIONAL VALVE**.

NOTE: This feature is ***only*** applicable if the optional Proportional Valve has been installed. If a Proportional Valve has not been installed, skip this section and continue with *Section II, Menus*.





3. Press **1** for **FORCE OUTPUT** to turn the valve output ON.
4. Press **2** to select **FORCE UNITS**. Pressing the **2** key will toggle between **LBS** (pounds), **KG** (kilograms), or **N** (Newtons).
5. Press **3** to adjust the **SOFT TOUCH PRESSURE.**
6. Use the numeric keys to input a force that is 25% of the maximum force of the head. Refer to the manual supplied with the Weld Head for specifications.

   Example: If the maximum force of the head is 20 pounds, set the **SOFT TOUCH** to 5 pounds.
7. Press the ▲ key to accept the setting. The screen will go to the previous page.
8. Press **4** to adjust the **SOFT TOUCH TIME**. Use the numeric keypad to enter a time in milliseconds.

9. Press the ▲ key to accept the setting. The screen will go to the previous page.

   NOTE: After initial settings, you can change the settings above as often as necessary.

10. Press the **RUN** key. The screen will display **SAVING CHANGES** then go back to the **RUN** screen.

11. Press the **FORCE** key on the front panel to get the **FORCE & LIMITS** menu.

12. Enter a value for **PROP VALVE OUTPUT FORCE**.

13. Push the **FORCE** key again to accept these values. The screen will display **SAVING CHANGES.**

<FORCE & LIMITS>
PROP VALVE OUTPUT FORCE : 010.0 LBS

	LO LIM	HI LIM	LAST
WELD START	000.0LBS	000.0LBS	000.0LBS
WELD END	000.0LBS	000.0LBS	000.0LBS

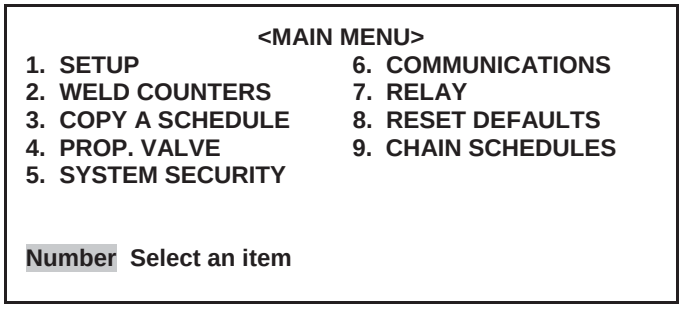
ACTION: CONTINUE

14. Press the **RUN** key to go back to the **RUN** screen. You may now use the foot switch to raise and lower the electrodes.

Section II: Menus

Overview

You program the system settings of the Control through the **MAIN MENU** screen and its sub-menus. You go to the **MAIN MENU** screen by pressing the **MENU** key on the front panel of the Control.
All of the menu screens have similar prompts that tell you how to go to a function on the menu and/or get to the next menu.



- At the **NUMBER** **Select an item** prompt, use the numeric keypad to select one of the functions on the menu.
- Press the down ▲▼ keys to go to the next or previous menu. Each additional menu gives you choices for additional functions.
- Press the **MENU** key to return to the main menu.

Main Menu

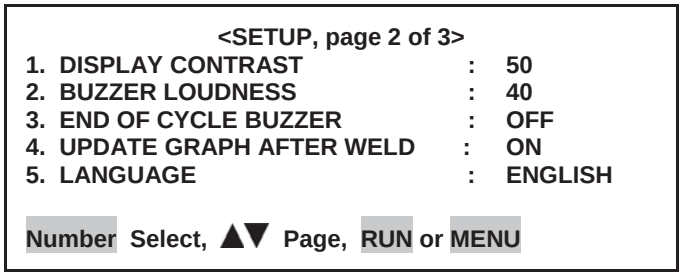
1. SETUP

From the **MAIN MENU** screen, press **1** to go to the **SETUP 1** screen.

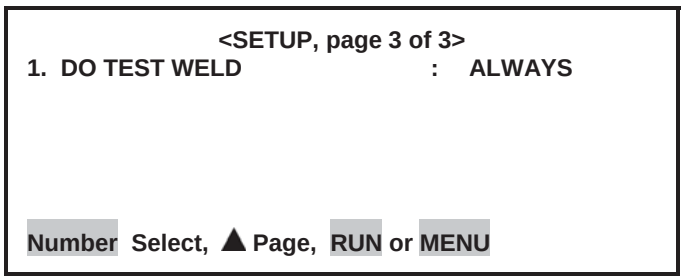
The **SETUP 1** screen is shown on the right with typical settings.

From the **SETUP 1** screen, press the ▼ key.

The **SETUP 2** screen is shown on the right with typical settings.

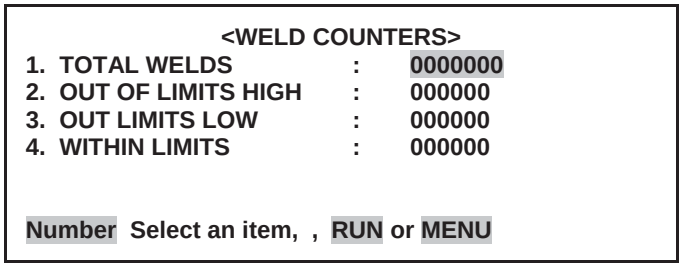


From the **SETUP 2** screen, press the ▼ key.
The **SETUP 3** screen is shown on the right with typical settings.



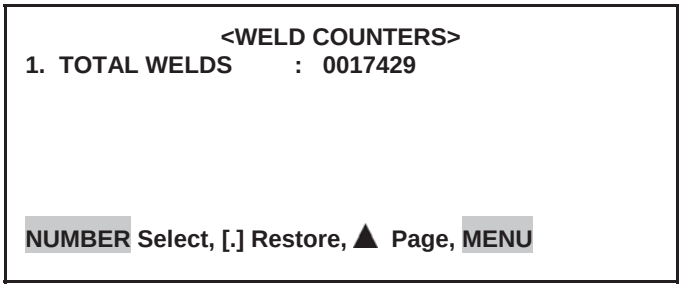
2. WELD COUNTER

1. From the **MAIN MENU**, press the **2** key to go to the **WELD COUNTERS** screen. The total welds counter increments each time a weld is made in any weld schedule.



NOTE: The Control breaks down the weld count into three additional categories, as determined by the energy limits monitor: rejects due to higher than programmed weld energy, rejects due to lower than programmed weld energy, and the number of welds within limits.

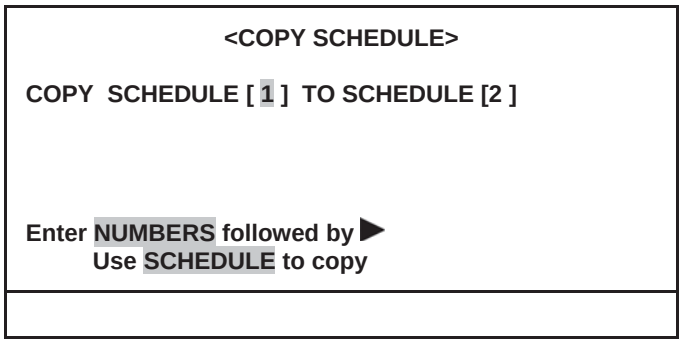
2. To select the weld counters, press the **1**, **2**, **3** or **4** key to select the desired weld counter. The example below shows the **TOTAL WELDS** screen.
3. To reset the counter, press the **0** key.
4. To input a preset number, use the numeric keys.
5. If you accidentally reset the wrong counter, press the period (**.**) key. The original count will reappear. Press the **MENU** key to return to the **MAIN MENU** screen.



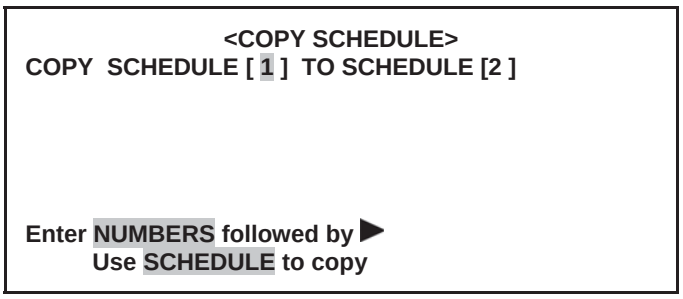
3. COPY A SCHEDULE

The Control can store **99** (numbered **1** through **99**) individual weld energy profiles. This function allows you to copy any weld schedule from one numbered weld schedule to another numbered weld schedule

1. From the **MAIN MENU**, press the **3** key to go to the **COPY SCHEDULE** screen.



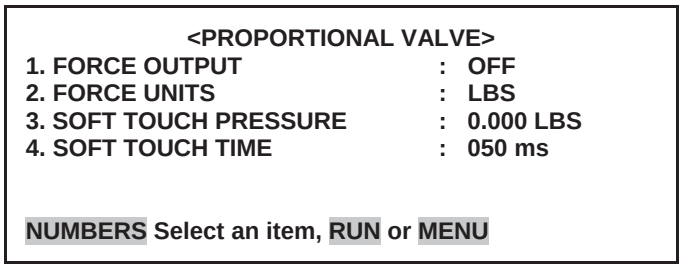
2. Using the numeric keys, enter **1** in the source schedule number field.
3. Press the ▶key to select the destination schedule number field.
4. Using the numeric keys, enter **2** in the destination schedule number field.



5. Press the **SCHEDULE** key to copy the schedule and exit the screen.
6. Press the **MENU** key to return to the main menu. The contents of Weld Schedule 1 will be copied to Weld Schedule 2, overwriting the previous contents of Weld Schedule 2. Note that this function will copy schedule settings, monitor limits and envelope offsets, but it will not copy the reference waveforms for envelope limits.

4. PROP VALVE (Proportional Valve Option)

From the **MAIN MENU**, press the **4** key to go to up **PROPORTIONAL VALVE** screen. This screen allows you to program the features for the force output on the HF27.



1. Force output

The function allows the user to turn the proportional valve output ON or OFF.

2. Force units

This function allows the user to set the units for force measurement. The user can choose among **LBS** (pounds), **KG** (kilogram force), or **N** (Newtons).

3. Soft touch pressure

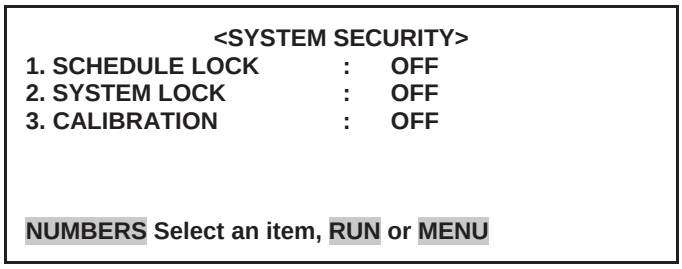
This function allows the user to program a lower pressure that is applied as the weldhead is closing. This soft touch pressure, which is maintained for the soft touch time (see 4. below) causes the weldhead to come down at a slower speed than if the full weld pressure were used. This setting can be used to reduce deformation on round parts, parts with projections, or more delicate parts.

4. Soft touch time

This function allows the user to program the duration of lower pressure that is applied as the weldhead is closing. This time starts as soon as the solenoid valve closes and runs for the user-programmed time. Note that squeeze time will not start until soft touch time is over and the firing switch (if any) is closed.

5. SYSTEM SECURITY

From the **MAIN MENU**, press the **5** key to go to up **SYSTEM SECURITY** screen. With this screen, you can protect the weld schedules from unauthorized changes by programming the Control with a user-defined protection code.



1. Schedule Lock

This function prevents unauthorized users from selecting any weld schedule other than the displayed schedule, and from changing any weld energy/time parameters within the weld schedule.

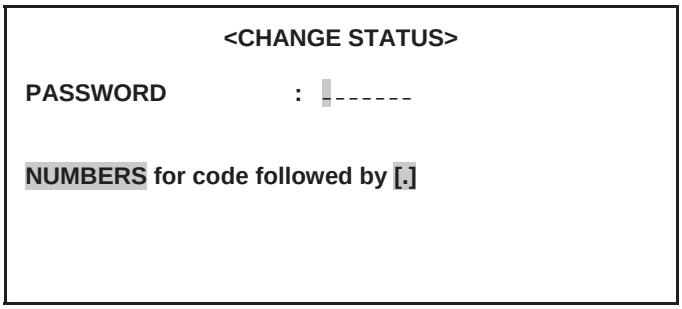
2. System Lock

This function prevents unauthorized users from changing any of the options on the main menu. It also prevents unauthorized users from changing weld energy/time parameters within weld schedules 1-99. Note that schedule 0 is a "scratchpad" and can still be edited when the System Lock is ON. This security level allows you to select different schedules from the front panel.

3. Calibration

This function prevents unauthorized users from modifying any of the calibration settings.

NOTE: All security options use the ***same*** procedure to enter a security code and to turn the security code OFF.



1. Press the **1** key to select **SCHEDULE LOCK**. This will bring up the **CHANGE STATUS** screen, as shown at the right.
2. Enter a 7-digit number, from **0000001** to **9999999**, in the code field, and then enter a period. This will bring up the **SYSTEM SECURITY** menu screen, this time with **SCHEDULE LOCK: ON**.
   With **ON** selected, all other weld schedules are locked out and cannot be modified or used for welding.
3. To unlock the Control from security protection, return to the **CHANGE STATUS** screen and enter the code that you entered in Step 2. This will bring up the **SYSTEM SECURITY** menu screen, this time with **SCHEDULE LOCK: OFF**.
4. If you forget the security code and wish to unlock the Control from security protection:
   - Return to the **CHANGE STATUS** screen.
   - Enter a security code of **280**.

6. COMMUNICATION

The following menu screens tell you how to set the Control's communication and data options. However, to enable the Control to perform these functions, you must install the software from the optional *DC25/UB25/HF27 Datacom Communications Interface Kit*, commonly referred to as "the Datacom kit" or Weldstat in a host computer. The Datacom Operator Manual describes cables, connections, RS-232 operation, RS-485 operation, sample weld reports, data collection, and how to use remote commands. The Datacom Kit allows you to connect a single Control, or multiple Controls, to a printer or a computer in order to:

- Compile, store, view, and print weld history data for detailed analysis.
- Remotely program weld schedules on the Control(s).
- Remotely program menu items on the Control(s).

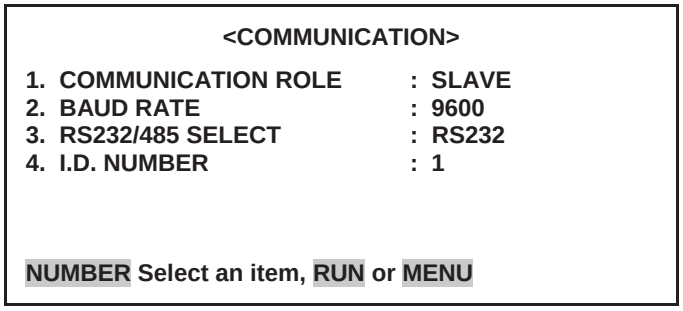
Rear-mounted RS-232 and RS-485 connectors allow for remote programming, weld schedule selection, and data logging for SPC purposes. Data output provides the necessary process documentation for critical applications and permits data logging for SPC purposes.

Appendix E, Communications in this manual lists all of the commands that the Control will respond to, and instructions on how to format commands sent to the Control so it will respond properly.

The Control contains internal software that gives you a great deal of flexibility in the setup and use of your welding system. The Control software displays various menu screens on the LCD, each containing prompts telling you which of the Control's front panel controls to use in order to customize operating parameters, set the Control for use in an automated welding system, and program communication settings for use with data-gathering devices such as a host computer.

1. Communication Role

1. From the **MAIN MENU,** press the **6** key to go to the **COMMUNICATION** menu (shown with default settings).
   From the **COMMUNICATION** menu, toggle the **1** key to select **MASTER** or **SLAVE**. The **COMMUNICATION ROLE** line will now reflect your role selection.



- In the **MASTER** role, the Control will:
  - Send weld data to the host computer after each weld operation.
  - Send text data to a serial printer, providing a printout of the average voltage and current values for each weld, generating a "paper history" of welds performed.
- In the **SLAVE** role, the Control will send weld data only when requested by the host computer. You ***must*** use this role for RS-485 installations with mulitple controls on one communications channel.

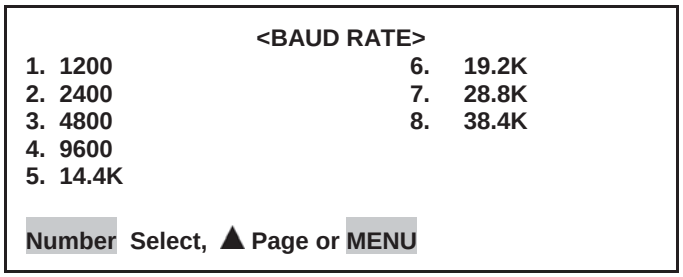
  NOTE: For weld data collection and host computer control information, refer to the Datacom Operator Manual, which describes how to use the **MASTER** and **SLAVE** options.

2. Press **MENU** to return to the **MAIN MENU**.

2. Baud Rate

The baud rate at which the data is sent must match the baud rate of the host computer. To enter the baud rate, proceed as follows:

1. From the **COMMUNICATION** menu, press the **2** key to get the **BAUD RATE** selection screen.
2. Use the numeric keypad to select the baud rate of the receiving device. The display automatically returns to the **COMMUNICATION** menu, which shows the new baud rate.
3. Press **MENU** to return to the **MAIN MENU.**



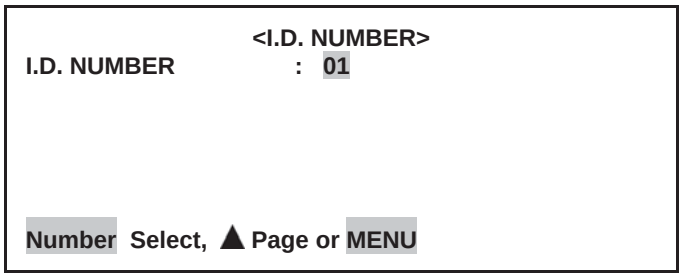
3. RS232/485 SELECT

Pressing the 3 key will alternately select either RS232 or RS485 communications. The default selection is RS232.

4. I.D. Number

The host computer may be used to talk with multiple Controls using a single RS-485 communications line. Each Control sharing that line *must* have a unique identification number. To enter an identification number for the Control, proceed as follows:

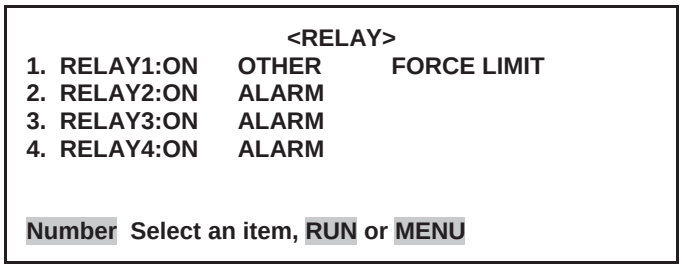
1. From the **MAIN MENU**, press the **6** key to go to the **COMMUNICATIONS MENU.**
2. From the **COMMUNICATIONS MENU** screen, press the **3** key to get the **I.D. NUMBER** entry screen.



3. Enter a two-digit number, from **01** to **30**, in the **I.D. NUMBER** field.
4. Press the **MENU** key to get the **COMMUNICATION** menu screen. This time the **I.D. NUMBER** line will display your I.D. number entry.
5. Press **MENU** to return to the **MAIN MENU.**

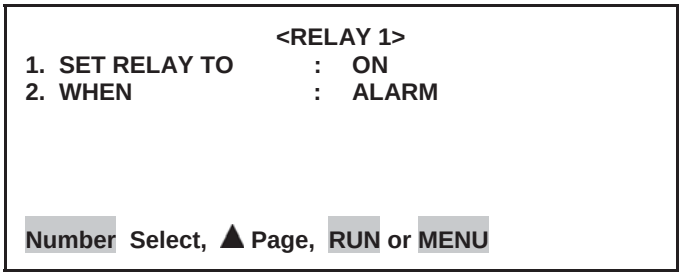
7. RELAY

1. From the **MAIN MENU**, press the **7** key to go to the **RELAY** output state selection menu, shown at the right. The Control has four relays that can provide dry-contact signal outputs under many different conditions.

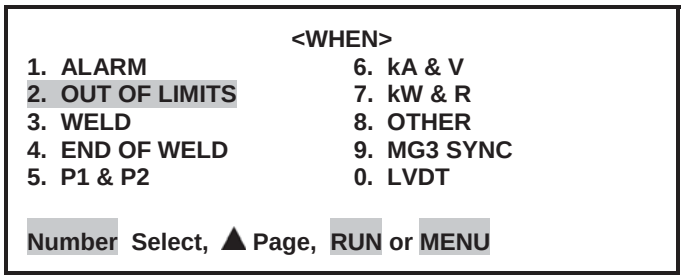


See *Appendix C, System Timing* for the timing diagrams for the four relays.

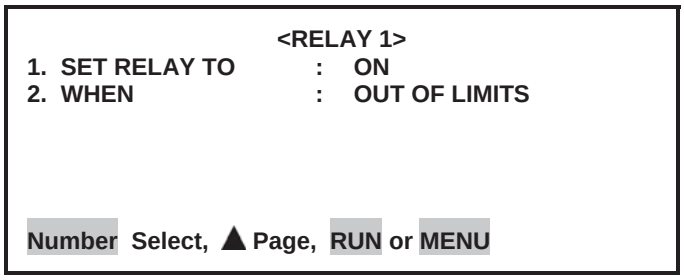
2. From the **RELAY** menu, press the **1** key to go to **RELAY 1** shown at the right.
3. Press the **1** key to toggle the relay contact signal state: **ON** (closed) or **OFF** (open).



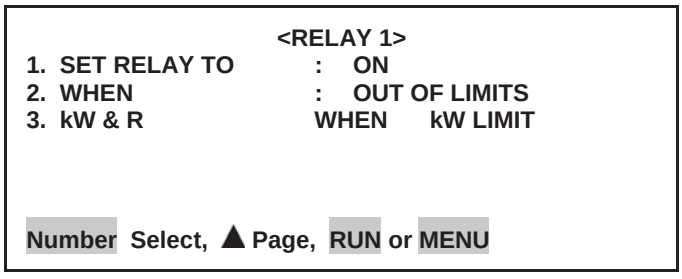
4. Press the **2** key to select the **WHEN** menu, shown at the right.



5. Press the **2** key to select **OUT OF LIMITS** as the condition for initiating the **Relay 1** output signal. This will bring up the **RELAY 1** menu screen, where the **WHEN** line will now reflect **OUT OF LIMITS.**



6. Choosing **WHEN** options **1 - 4** or **9** will complete the relay programming process. Choosing options **5 - 8** or **0** will bring up the **RELAY** (**1, 2, 3,** or **4**) screen with a ***new*** option, number **3**. Press **3** to access the next level menus which are shown on the next page.



<P1 &P2 WHEN>
1. OUT OF LIMITS
2. P1 OUT OF LIMITS
3. P1 HIGH
4. P1 LOW
5. P2 OUT OF LIMITS
6. P2 HIGH
7. P2 LOW

Number Select, ▲ Page, RUN or MENU

Option #5

<kA & V WHEN>
1. kA LIMIT
2. V LIMIT
3. P1 kA HIGH
4. P1 kA LOW
5. P2 kA HIGH
6. P2 kA LOW
7. P1 V HIGH
8. P1 V LOW
9. P2 V HIGH
0. P2 V LOW

Number Select, ▲ Page, RUN or MENU

Option #6

<kW & R WHEN>
1. kW LIMIT
2. R LIMIT
3. P1 kW HIGH
4. P1 kW LOW
5. P2 kW HIGH
6. P2 kW LOW
7. P1 R HIGH
8. P1 R LOW
9. P2 R HIGH
0. P2 R LOW

Number Select, ▲ Page, RUN or MENU

Option #7

<OTHER WHEN>
1. FORCE LIMIT
2. START FORCE
3. END FORCE
4. ENERGY LIMIT
5. ENERGY HI
6. ENERGY LO
7. TIME LIMIT
8. TIME HIGH
9. TIME LOW
0. ENVELOPE LIMIT

Number Select, ▲ Page, RUN or MENU

Option #8

<LVDT WHEN>
1. ANY
2. INITIAL LO
3. INITIAL HI
4. FINAL LO
5. FINAL HI
6. DISPL LO
7. DISPL HI
8. INITIAL NG
9. DISPL NG
0. STOP ENERGY AT

Number Select, ▲ Page, RUN or MENU

Option #9

8. RESET TO DEFAULTS

From the **MAIN MENU**, press the **8** key to go to the **RESET TO DEFAULTS** menu, as shown at the right. Through this menu, you may reset all system programmed parameters and all weld schedules to the original factory default settings (see the table below).

<RESET TO DEFAULTS>
1. RESET SYSTEM PARAMETERS
2. RESET ALL SCHEDULES
3. RESET SCHEDULE LIMITS

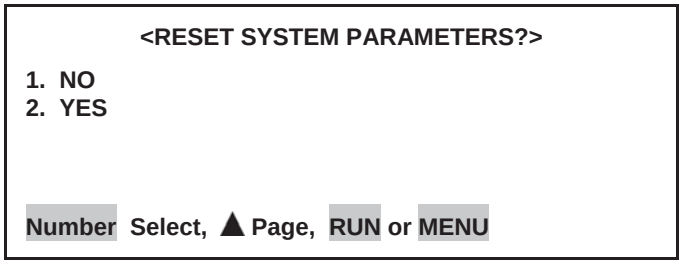
Number Select an item, RUN or MENU

Factory Default System Parameters

System Parameter	Default Setting	System Parameter	Default Setting
Foot Switch Weld Abort	OFF	Weld Counters	All "0"
Switch Debounce Time	10 ms	Force Output	OFF
Firing Switch	AUTO	Force Units	LBS
Display Contrast	50%	Soft Touch Pressure	30.0 LBS
Buzzer Loudness	40%	Soft Touch Time	000 ms
End of Cycle Buzzer	OFF	Communication Role	SLAVE
Update Graph After Weld	ON	Baud Rate	38.4K
Language	ENGLISH	ID Number	1
Do Test Weld	ALWAYS	Relays 1,2,3 and 4	ON WHEN ALARM

1. RESET SYSTEM PARAMETERS

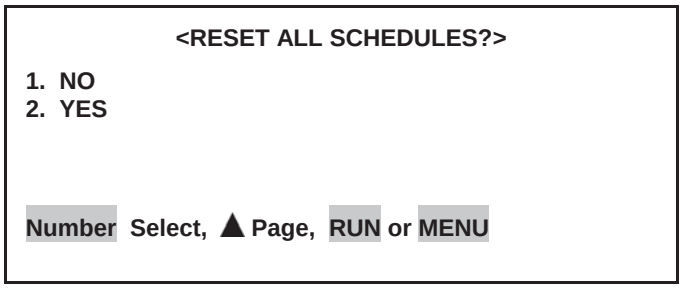
1. With the reset to defaults screen displayed, press the **1** key. This will bring up the **RESET SYSTEM PARAMETERS** query menu, as shown at the right.



2. Press the **2** key to select **YES**. This will automatically reset the system to the factory and return the screen to the **RESET TO DEFAULTS** display.

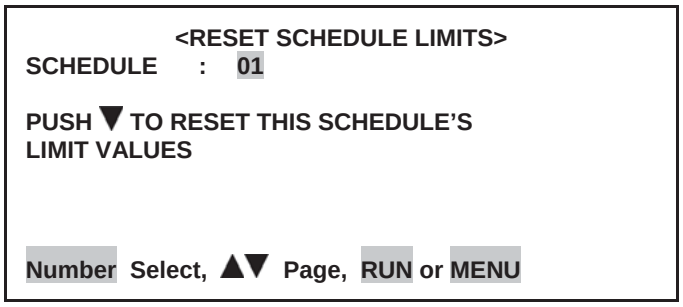
2. RESET ALL SCHEDULES

1. Press the **2** key. This will automatically reset all weld schedule parameters to the factory defaults and return the screen to the **RESET TO DEFAULTS** display.
2. Press the **MENU** key to return to the **MAIN MENU** screen.



3. RESET SCHEDULE LIMITS

1. The last **SCHEDULE** you used will appear as **highlighted**. You may change this to any **SCHEDULE** number you want to reset using the numeric keypad.
2. Press the ▼ key to reset the limits of the schedule you highlighted.



3. Press the **MENU** key to return to the **MAIN MENU** screen.

9. CHAIN SCHEDULES

This feature allows you to automatically change from any weld schedule to any other schedule after a preset count, creating a "chain" of schedules that can accommodate a variety of welding needs. For example:

- A single work piece requires four welds, two weld points require the same weld schedule, each of the other two points require different weld schedules.

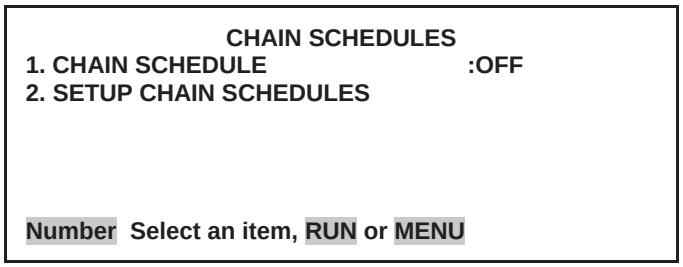
  In this case you would program a sequence, or "chain," that looks like this: **Schedule 01** [2 times] - **Schedule 02** [1 time] - **Schedule 03** [1 time] - **Schedule 01**. This sequence will repeat, or "loop," until you turn **Chain Schedules OFF**.
- Some applications require a lower current for a number of welds after the electrodes have been replaced or resurfaced. Once the electrodes have been "seasoned", the current can be increased as required. If the electrodes require 100 welds to "season", Schedule 01 can be programmed with a lower current and Schedule 02 can be programmed with a higher current. The chain would look like this: **Schedule 01** [100 times] - **Schedule 02** [1 time] - **Schedule 02** [1 time].

  In this chain, **Schedule 02** will just keep repeating ***after*** the 100 welds made using **Schedule 01**. When the electrodes are replaced or resurfaced, you can manually switch back to **Schedule 01** to restart the sequence.

You can program any of the Control's 99 stored schedules to chain to any other schedule, or back to itself as in the second example above. The chain code becomes part of each weld schedule. You can turn the **Chain Schedules** feature **ON** or **OFF**, or re-program chains, any time you want.

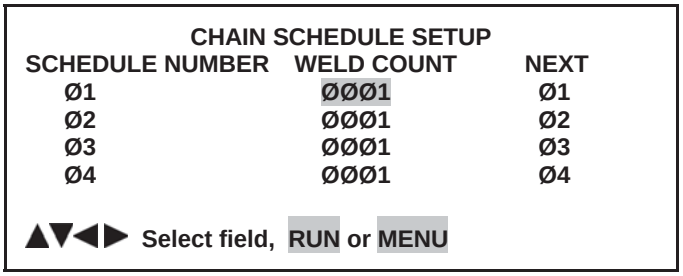
1 From the **MAIN MENU**, press the **9** key to go to the **CHAIN SCHEDULES** menu.

NOTE: You should program, or "setup," the chain of schedules you want ***before*** you turn this feature **ON**.

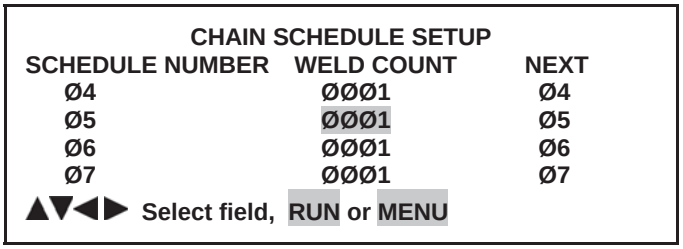


2 Press the **1** key to toggle **CHAIN SCHEDULES ON** or **OFF.**

3 From the **CHAIN SCHEDULES** menu, press the **2** key to go to the **CHAIN SCHEDULE SETUP** menu.

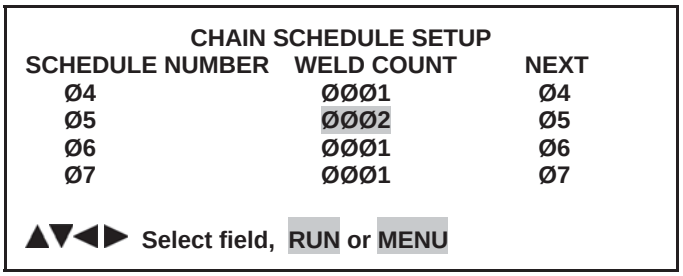


4 Use the ▲▼ (Up/Down) keys on the front panel to scroll vertically through the schedules to **highlight** the weld count for the schedule you want to chain.



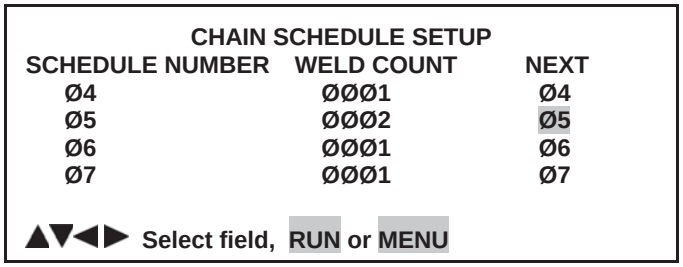
5 Use the numeric keypad to enter the number of times you want this schedule to weld before going to the next schedule.

6 Use the ▶ key to move the highlight horizontally to select **NEXT**.



7 Use the numeric keypad to enter the number of the next schedule in the chain.

8 Use the ◀ key to move the highlight horizontally back to the **WELD COUNT** column. Repeat Steps 4 through 8 to program the rest of the chain.

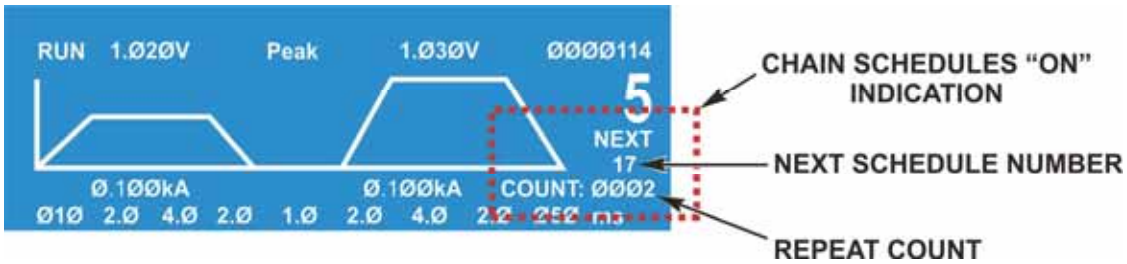


9 When you finish programming the chain, press the **MENU** key to return to the **CHAIN SCHEDULES** menu.

10 Press the **1** key to toggle between **ON** or **OFF**.

11 Press the **RUN** key on the front panel, then use the ▲▼ keys to select the first weld schedule in the chain you want to use. The Control will now weld in the "chain" mode until you turn the **Chain Schedules** feature **OFF**.

NOTE: When **Chain Schedules** is turned **ON**, the LCD screen changes to show the chain information on the right side of the screen.



Below the current schedule number, you can see the number of times the current schedule will be repeated, and the number of the next schedule in the chain.

Setup 1

1. Footswitch Weld Abort

From the **SETUP 1** screen, press the **1** key to toggle between **ON** and **OFF**. This function controls how the Control interfaces with a foot switch, a force firing switch, or a programmable logic control (PLC). Any of these switches could be the weld initiation switch in your system setup.

ON means that the welding process is initiated by closure of the initiation switch and continues to its conclusion while the initiation switch remains closed. If the initiation switch opens during the welding process, the welding process will terminate. The **ON** state is preferred for human operated welding stations since it allows you to abort the weld process by releasing the foot switch (or the foot pedal in the case of a manually actuated weld head).

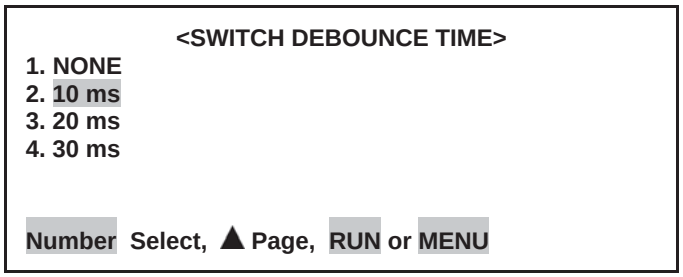
OFF is preferred for computer or PLC controlled welding stations since a single start pulse can be used to initiate the welding process. To select the **ON/OFF** states, press the **1** key. The **FOOTSWITCH WELD ABORT** line will now reflect your selection.

2. Switch Debounce Time

The contacts of single pole mechanical firing switches “bounce” when they close. The switch de-bounce time function allows you to specify that the initiation switch contacts must remain closed for 10,

20, or 30 milliseconds before the weld period can be initiated, thereby avoiding false starts caused by the switch contact bouncing.

1. From the **SETUP 1** screen, press the **2** key to go to the **SWITCH DE-BOUNCE TIME** menu screen.
2. Select the required debounce time by pressing the **1**, **2**, **3** or **4** key. **NONE** represents a debounce time of 0 ms.



Use **NONE** for interfacing with the Miyachi Unitek Model 350C Electronic Weld Force Control.

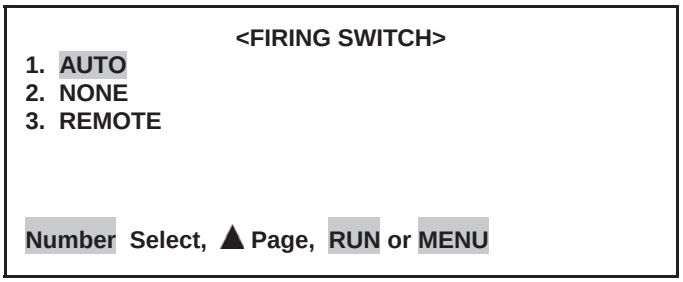
3. The **SWITCH DEBOUNCE TIME** line will now reflect your switch debounce time selection.

3. Firing Switch

With the **SETUP 1** screen displayed, press the **3** key to select this function. The firing switch input, in conjunction with or without inputs from the foot switch input, initiates the weld energy sequence. Select the required switch type by pressing the **1**, **2**, or **3** key. Pressing the numeric keys automatically returns the display to the **SETUP 1** screen.

1. Auto

The Control accepts a single pole, double pole or optical firing switch input from a Miyachi Unitek weld head. Firing switch activation indicates that the weld head has reached the set weld force, thus permitting the weld energy sequence to start.



2. None

When using a non-force fired weld head, weld energy initiation must be supplied with the foot switch input. Additionally, you must select sufficient squeeze time to permit the weld force to stabilize after contacting the weld pieces.

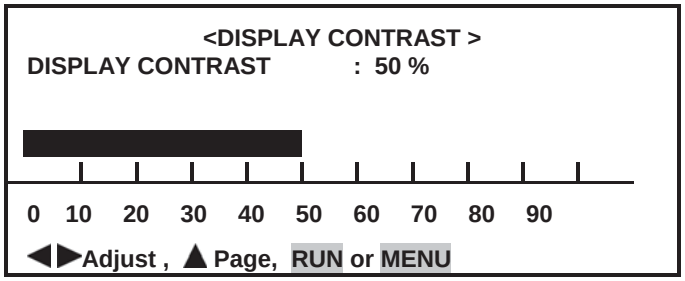
3. Remote

Use this setting in an automation application or when using PLC control. The BCD input lines, via the **CONTROL SIGNALS** connector (see *Appendix B. Electrical and Data Connections*), select weld energy schedules and initiate the weld energy sequence.

Setup 2

1. Display Contrast

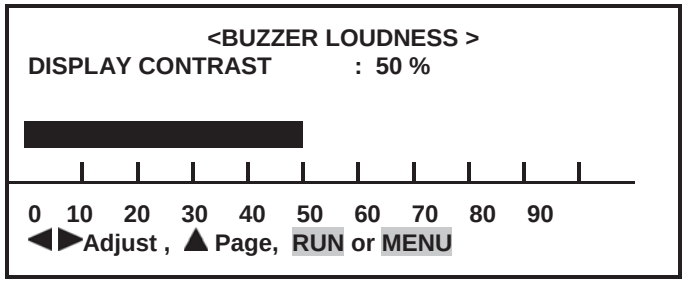
1. From the **SETUP 2** screen, press the **1** key to go to the **DISPLAY CONTRAST** adjustment screen.
2. Use the ◄ and ► keys to adjust the screen contrast for comfortable viewing in the shop environment.



3. Press the ▲ key to return to the **SETUP, PAGE 2** (of 3) screen.

2. Buzzer Loudness

1. From the **SETUP 1** screen, press the **2** key to go to the **BUZZER LOUDNESS** adjustment screen.
2. Use the ◄ and ► keys to adjust the buzzer tone so that it can be heard against shop background noise.



3. Press the ▲ key to return to the **SETUP, PAGE 2** (of 3) screen.

3. End Of Cycle Buzzer

1. With the **SETUP 2** screen displayed, press the **3** key to toggle the end of cycle buzzer **ON** or **OFF**. This function is normally used with manually actuated weld heads. **ON** means that an audible signal will be given at the end of each weld process to signal you to release the foot pedal.
2. To select the **ON/OFF** states, toggle the **3** key. The **END OF CYCLE BUZZER** line will now reflect your state selection.

4. Update Graph After Weld

From the **SETUP 2** screen, press the **4** key to toggle the update graph after weld **ON** or **OFF** function. The **UPDATE GRAPH AFTER WELD** line will now reflect your state selection.

ON means that the actual weld energy profile will overlay the programmed weld profile after each weld is made. The weld graph is useful for detecting weld splash, which is indicated by vertical gaps in the overlap. You can reduce weld splash, and eliminate it in some cases, by using the upslope weld energy profile.

5. Language

Press the **5** key to toggle between English and German. All menu items and instructions on the screen will be in the language selected.

Setup 3

1. DO TEST WELD

In voltage mode, the unit will do a test weld to optimize response to varying weld conditions. Press **1** to bring up the following choices:

1) ALWAYS

A test weld will be done if:

- The voltage level changes
- The time in any element of the schedule changes
- If the weld energy field is highlighted and the **V** key is pressed.

2) ASK

The user will be prompted to choose if a test weld is done or not upon the following conditions:

- The voltage level changes
- The time in any element of the schedule changes
- If the weld energy field is highlighted and the **V** key is pressed.

Section III. Operational States

The Control has seven operational states:

NO WELD	**WELD**	**MENU**	**MONITOR**
TEST	**ALARM**	**RUN**	

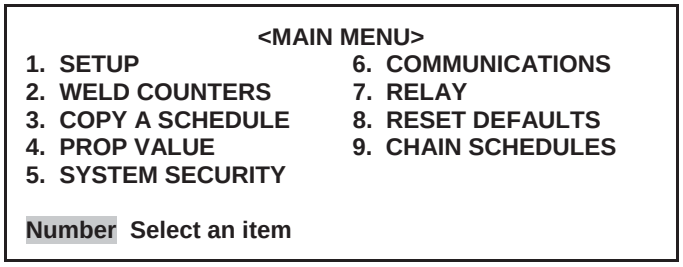
You go to the **NO WELD**, **MENU**, **TEST**, **RUN** and **MONITOR** states through the control panel. The **WELD** and **ALARM** states are functions of the force firing switch and foot switch input states.

No Weld State

Setting the **WELD/NO WELD** switch on the control panel to the **NO WELD** position inhibits the delivery of weld energy if a weld is initiated, and will display a **WELD SWITCH IN NO WELD POSITION** alarm on the screen. But the Control will still go through its electronic weld cycles as programmed into the selected weld schedule. Use the no weld state when adjusting the air regulators on air actuated weld heads.

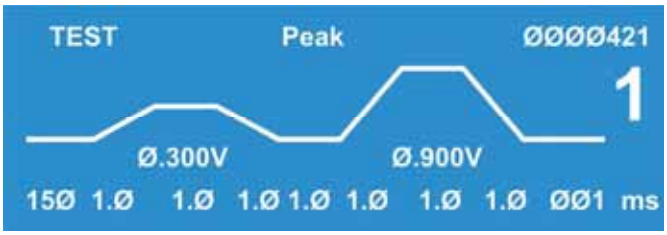
Menu State

Pressing the **MENU** key puts the Control in the menu state. It brings up menu screens that enable you to select various options common to all weld schedules, such as how the Control interfaces with the force firing switch, foot switch and weld head.

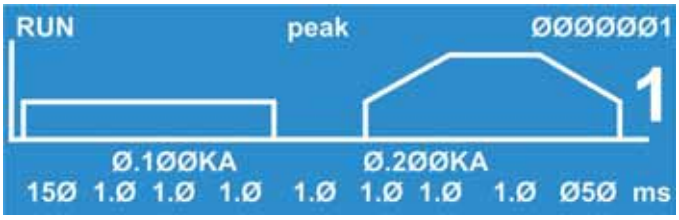


Test State

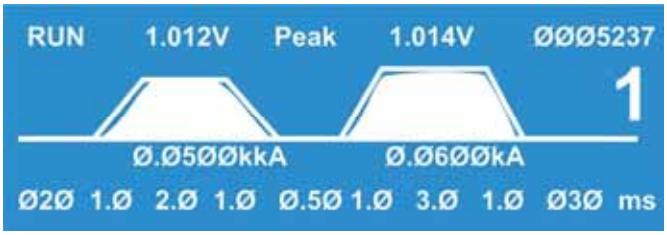
Programming a schedule for a voltage feedback welding mode, or changing the voltage or time settings while in the voltage feedback welding mode, puts the Control in the **TEST** state. After making one weld, the Control internally optimizes the feedback control loop to produce the fastest rise time, minimum overshoot weld pulse. The **TEST** state is automatically replaced by the run state for subsequent welds.



Run State



Pressing the **RUN** key puts the Control in the run state. In the run state, the screen shows a trace that represents your programmed parameters for a given weld schedule. You may select a different weld schedule to be programmed with the **SCHEDULE** key and keypad, or with the up and down arrows. Then, you may program squeeze time, up slope, weld time, weld energy, down slope and cool time with the trace segment selector keys.



In the example on the right, the top line of the screen shows that the Control is in the **RUN** state, the voltage at the voltage sense lead connections for the **PULSE 1** weld period was **1.012** volts, the monitor is set for displaying peak voltage (rather than average voltage), the voltage at the voltage sense input connection for the **PULSE 2** weld period was **1.014** volts, and the total weld count since the weld counter was last reset is **5,237.**

The weld profile trace is an analog display of the electrical parameters programmed with the weld period selector keys. When the weld is initiated, a profile of the actual weld energy delivered during the weld cycle, or both weld cycles, will be overlaid on the trace.

The large-type number **1** is the selected weld schedule.

The values **0.050kA** and **0.060kA** below the trace are respectively the weld current values programmed for **PULSE 1** and **PULSE 2** weld periods. You may optionally program weld energy in volts or kilowatts with the energy units selection keys.

Use the time/energy selector keys to toggle between the weld energy value field and the bottom line of text, which is the weld period time selection field. Use the weld period selector keys to enable the weld periods for programming, and use the numeric pad keys for entering time values in milliseconds.

See *Chapter 5, Operating Instructions* for application-related descriptions of the weld schedule profile.

Weld State

Once weld current is flowing, the Control is in the **WELD** state. You can terminate weld current in five ways:

- Remove the first level of a single-level foot switch, assuming weld abort is ON.
- Remove the second-level of a two-level foot switch, assuming weld abort is ON.
- Input the process stop signal (refer to *Appendix B, Electrical and Data Connections*).
- Open the normally closed switch across the operator emergency stop switch cable.
  NOTE: This action removes all power from the Control.
- Through the action of the monitor settings.

Completion of the firing state is indicated by a profile of actual delivered weld energy superimposed on the programmed weld energy trace, as shown in the example above.

Monitor State

From the **MONITOR** keys section on the front panel, press the **kA**, **V**, **kW** or **Ω** key to go to the monitor state. In this state, when the Control detects an out of limits condition, it will take one of four actions for **PULSE 1**, and one of two actions for **PULSE 2** depending on the selection made with the **MONITOR** display as shown at the right. Also, an alarm message will be displayed and any relay set for **ALARM or OUT OF LIMITS** will be energized.

The selections for **PULSE 1** are:

- **NONE:** The weld cycle will continue.
- **STOP WELD:** The weld cycle will stop immediately. Pulse 2 (if applicable) will not fire.
- **INHIBIT PULSE2:** During the **COOL** time, the Control calculates the average of the Weld1 pulse (including upslope, weld and downslope). If the average of the Weld1 pulse is out of limits, the weld cycle will stop and the Weld2 pulse will be inhibited.
- **PART CONDITIONER (Stop Pulse1)** stops Pulse 1 immediately after upper or lower energy limits are exceeded, but allows Pulse 2 to fire.

The selections for **PULSE 2** are:

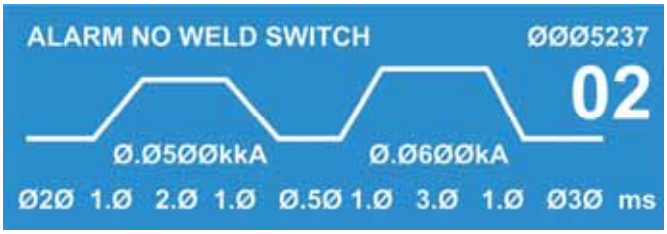
- **NONE:** The weld cycle will continue.
- **STOP WELD:** The weld cycle will stop immediately.

The display shows the actual trace of the weld current, voltage or power, and either the peak or the average value for each weld pulse as selected by pressing the **PEAK/AVERAGE** key.

See *Chapter 4, Using Feedback Modes and Weld Monitoring* for a detailed description of monitor and energy limits operation.

Alarm State

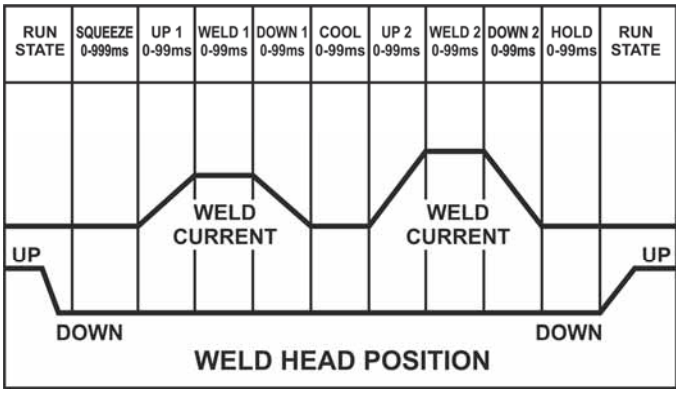
The Control automatically recognizes many alarm conditions. The example **WELD SWITCH IN NO WELD POSITION** alarm screen shown at the right is displayed when you attempt to initiate a weld with the **WELD/ NO WELD** switch in the **NO WELD** position.



Section IV. Weld Functions

Welding Applications

Some welding applications require the use of specialized weld functions. A weld function is a unique heat profile created by weld current, voltage, or power that is applied over a fixed time period, to resistance weld different parts. An example of a fully programmed weld profile is shown at the right.



Applications include parts that:

- Are plated with cadmium, tin, zinc, or nickel
- Have heavy oxide coatings such as aluminum
- Are round or not flat

By programming the appropriate weld period time and weld energy amplitudes for the weld period segments, you can program an appropriate weld schedule profile to perform the above applications. Typical applications and recommended weld schedule profiles are defined in the table below. For more information about resistance welding, see *Appendix F, The Basics Of Resistance Welding* and *Appendix G, Quality Resistance Welding Solutions, Defining The Optimum Process*

Welding Applications

Weld Function	Typical Application
Single Pulse	Make single spot welds on simple flat parts without plating, or on conductive parts such as those made of copper or brass.
Up/Downslope	Weld round parts, parts that are not flat, spring steel parts, or heavily plated or oxidized parts such as aluminum.
Dual Pulse	Use for best control of miniature and small parts spot welding with or without plating.

Weld Head Applicability

The weld functions can be used with Miyachi Unitek force fired, manual weld heads; air actuated weld heads; or Series 300 Weld Heads. **SQUEEZE TIME** is used to allow sufficient time for the electrodes to close and apply the required weld force to the parts before the weld current begins. Weld current begins when the squeeze period ends.

When the weld functions are used with any type of air actuated weld head, the hold period can be used to automatically keep the electrodes closed on the parts after weld current has terminated to provide additional heat sinking or parts cooling.

NOTES:

- **Miyachi Unitek Series 300 Electronic Force Controlled Weld Heads:** The **SQUEEZE TIME** is controlled by the weld head, ***not*** the Control. **SQUEEZE TIME** begins when the force-firing switch closes, therefore you will set the Control **SQUEEZE TIME** to zero and set the **DEBOUNCE TIME** to zero.
- **Air-Actuated Weld Heads:** For force fired, air actuated weld heads, **SQUEEZE TIME** begins when both levels of a two-level foot switch are closed and the force firing switch in the air actuated weld head closes.
- **Manual Weld Heads:** For manually actuated weld heads, **SQUEEZE TIME** begins when the force-firing switch closes. Using **SQUEEZE TIME** is optional, depending on the welding process you have developed.

When To Use Functions

To ensure accurate, consistent welds, the Control delivers extremely precise pulses of energy to the weld head. Each pulse is comprised of weld-time and weld-energy (**voltage**, **current**, or **power**) values pre-programmed by the user. The Control is a closed-loop welding control using internal and external sensors to measure the weld-energy delivered to the weld head. Weld-energy feedback instantly goes to the Control's logic circuits that actively correct the pulse to compensate for any variation in part resistance. The Control also has several monitor functions that give you remarkable control over the welding and production process. Together, these features ensure precise, consistent welds, higher productivity, a lower rejection rate, and longer electrode life.

Before operating the Control, it is important to know how to match the Control's capabilities to specific weld applications. This section provides **Weld** details in the following order:

- **Weld Schedules**
  - **Single-Pulse**
  - **Upslope/Downslope**
  - **Dual-Pulse**

Chapter 5, Operating Instructions, contains the step-by-step instructions on how to program each of the functions above.

Weld Schedule Definition

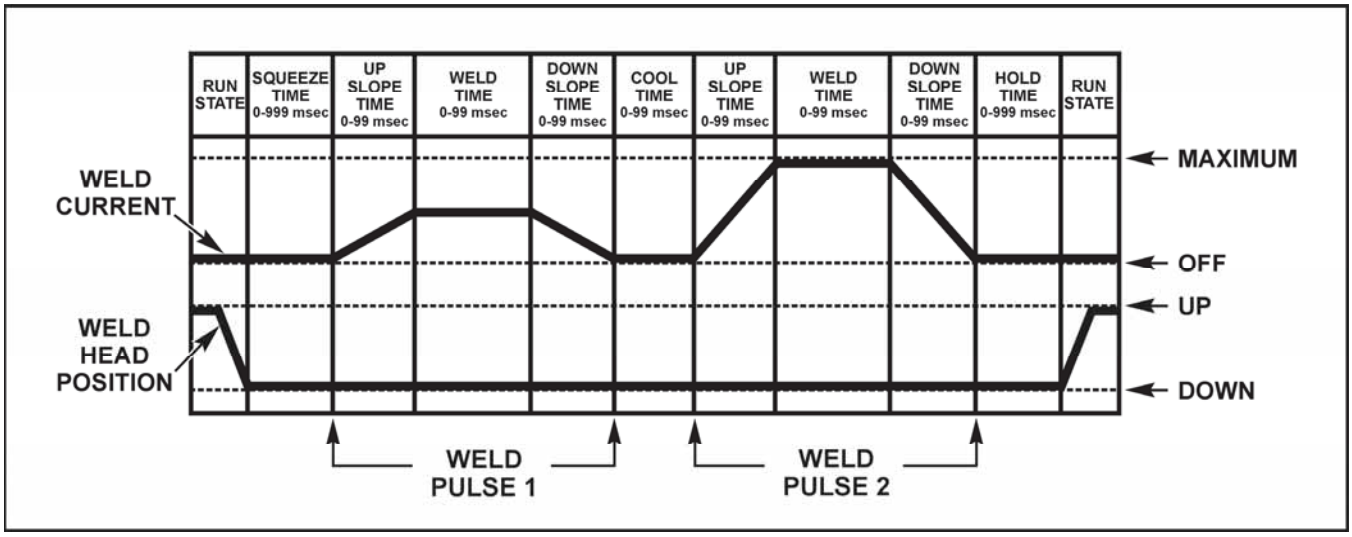
Weld Schedule is the name given to each of 99 separate *weld profiles* stored in the Control, numbered from **01** to **99**. A weld profile is the graphic representation [or *waveform*] of the numeric weld-time and weld-energy values. **NOTE**: There is an additional weld schedule numbered **00**, which can be used as a "scratch pad" to develop new weld schedules.

When time and energy values are entered using the numeric keypad, the Control displays a line-graph of the weld profile on the LCD screen. You can see the graph change as you enter new time and energy values.

Weld profiles may be programmed for **single-pulse**, **upslope/downslope**, or **dual-pulse** operation. Weld schedules may also use special monitoring features of the Control such as **Energy Limit, Active Part Conditioner,** and **Pre-Weld Check**. These features are described later in this chapter.

Weld Sequence Timing

A weld schedule is a unique heat profile programmed in constant **current**, **voltage**, or **power** that is applied over a fixed time period, to resistance weld different parts. The entire weld can include all of the following time periods: Squeeze Time, Upslope 1, Weld Pulse 1, Downslope 1, Cool Time, Upslope 2, Weld Pulse 2, Downslope 2, and Hold Time. The sample dual-pulse profile [or *waveform*] below shows the weld current and the corresponding position of the weld head. The graph labeled **WELD CURRENT** is what displays on the LCD when you schedule a weld profile.



Sample Weld Sequence (Dual-Pulse)

Welding Applications

Weld Pulse Profile		Typical Application
Single-Pulse		Can be used for many of spot-welding applications. Use on flat parts without plating, or on conductive parts such as those made of copper or brass.
Upslope/Downslope		Upslope/Downslope should be used for the majority of spot welding applications. Weld round parts, parts that are not flat, spring steel parts, or heavily plated or oxidized parts.
Dual-Pulse		Use for spot welding parts with plating. First pulse can be used to displace plating or oxides and the second pulse to achieve the weld.

For a detailed coverage of resistance welding theory, please refer to *Appendix D, The Basics of Resistance Welding*.

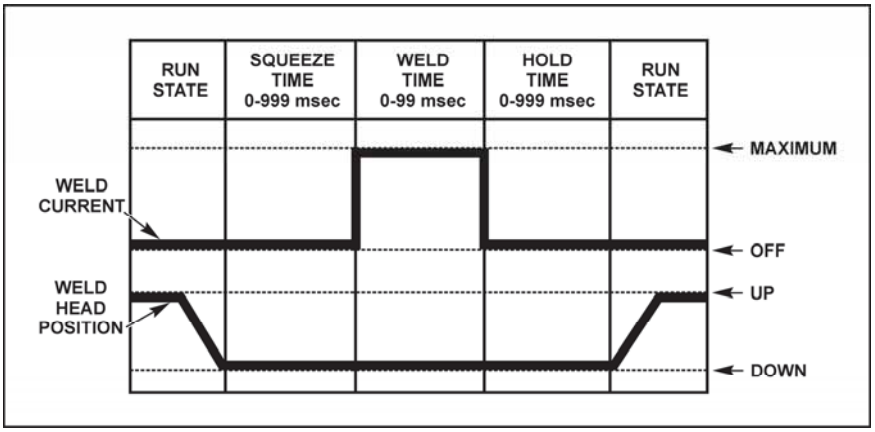
Single-Pulse Weld Profile

Applications

- **Flat parts that do not have any plating or heavy oxides. Conductive parts made of copper or brass.**

Description

Single-Pulse is a term used by the industry to describe the simplest heat profile used for many resistance spot-welding applications.



Single-Pulse Weld Profile

Upslope/Downslope Weld Profile

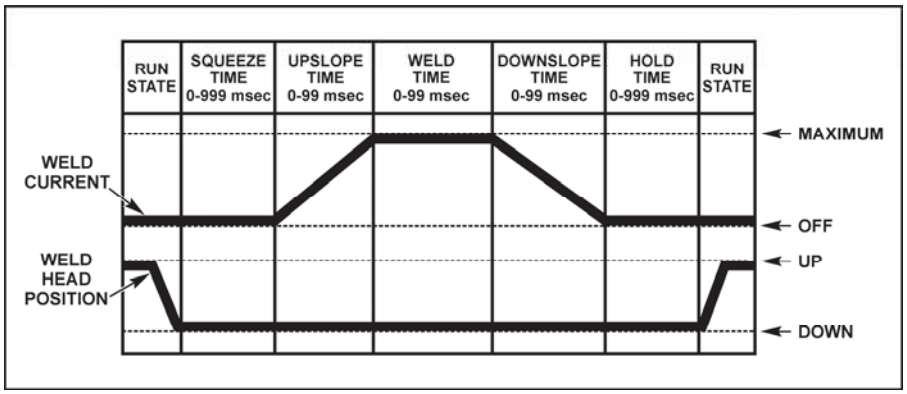
Applications

- **Round or non-flat parts and most resistive materials.**

Description

Upslope allows a gradual application of weld energy which permits the parts to come into better contact with each other reducing the electrode to part contact resistances. Upslope can allow a smaller electrode force to be used, resulting in a cleaner appearance by reducing electrode indentation, material pickup and electrode deformation. It can also be used to displace plating and/or oxides, reduce flashing and spitting, or reduce thermal shock when welding parts containing glass-to-metal seals.

Downslope (annealing) assists in the grain refinement of certain heat-treatable steels, and prevents cracking in aluminum and other materials by reducing the cooling rate. Annealing is not typically used for welding small parts.



Upslope / Downslope Weld Profile

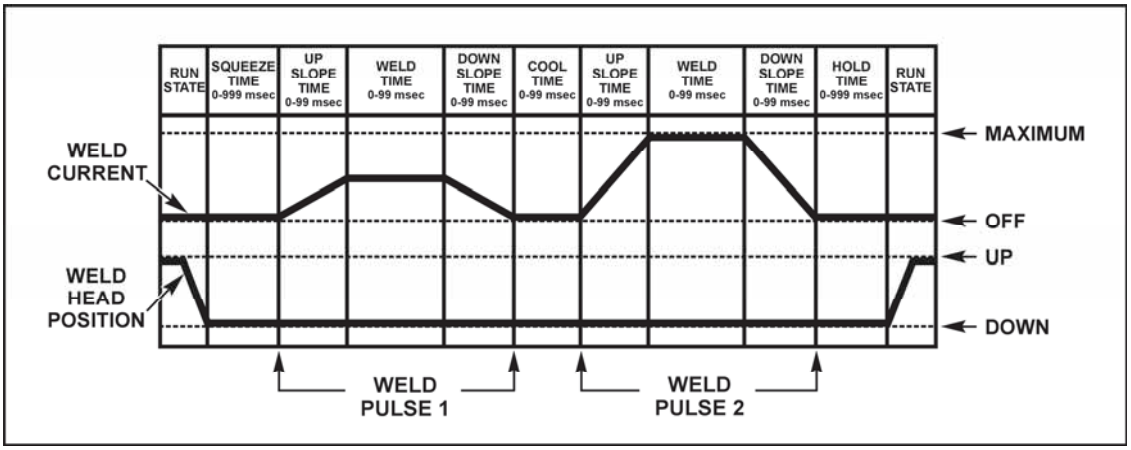
Dual-Pulse Weld Profile

Applications

- **Flat-to-flat parts.**
- **Round-to-round parts.**
- **Round-to-flat small parts that may or may not be plated.**

Description

Adding upslope to the front of both weld periods allows a reduction in electrode force, this results in a cleaner appearance by reducing electrode indentation, material pickup and electrode deformation.



Upslope will also help to displace plating and/or oxides, reduce flashing and spitting, or reduce thermal shock when welding parts containing glass-to-metal seals. In the normal application of dual-pulse, the Pulse 1 weld period provides sufficient heat to displace the plating or oxides, seat the electrodes against the base metals, and force the parts into intimate contact. The cool period allows time to dissipate the heat generated during Pulse 1.

The Pulse 2 weld period completes the structural weld. The Pulse 2 weld current is typically greater than the Pulse 1 weld current by a factor of 3 as the first pulse significantly reduces the resistance of the interface between the parts. The only use for the downslope period following the Pulse 1 or Pulse weld period is to control grain refinement in brittle parts by slowly reducing the weld current to zero during the downslope period.

The dual-pulse weld profile is very valuable for pre-checking gross parts positioning problems and reducing parts scrap. Use the Pulse 1 weld at 0.050 kA [or less] and 2.0 ms as a pre-check pulse. Experiment with upper and lower limit values that you can use to inhibit the Pulse 2 weld if the test conditions measured by the Pulse 1 weld are out of limits.

NOTE: Upslope is required when a lower limit value is programmed.

CHAPTER 4
Introduction to Feedback Modes and Monitoring

Section 1. Programmable Feedback Modes

Introduction

The feedback mode (**current**, **voltage**, **power or combo**) is one of the selections entered when programming a weld schedule. Programming weld schedules is explained in *Chapter 5, Operating Instructions*.

Current Mode

Application

- **Flat parts where the part-to-part and electrode-to-part contact is controlled and consistent**

Description

This mode delivers the programmed current regardless of work piece resistance changes. This compensates for slight changes in part thickness without affecting weld quality. Set monitoring limits on voltage.

Voltage Mode

Application

- **Ideal for welding round or non-flat parts**

Description

This mode controls the voltage across the work piece during welding. It helps to compensate for part misplacement and force problems and automatically reduces weld splash, which is often associated with non-flat parts and wire welds. Set monitoring limits on current.

Power Mode

Application

- **Breaking through surface oxides and plating**
- **Automated applications where part or electrode surface conditions can vary over time.**

Description

This mode precisely varies the weld current and voltage to supply consistent weld energy to the parts. The power mode has been shown to extend electrode life in automated applications. Set monitoring limits on current or voltage.

Combo Mode

Application

- **Ideal or welding round parts or projections – especially those with poor initial fit-up or oxides.**
- **Breaking through surface oxides and plating**

Description

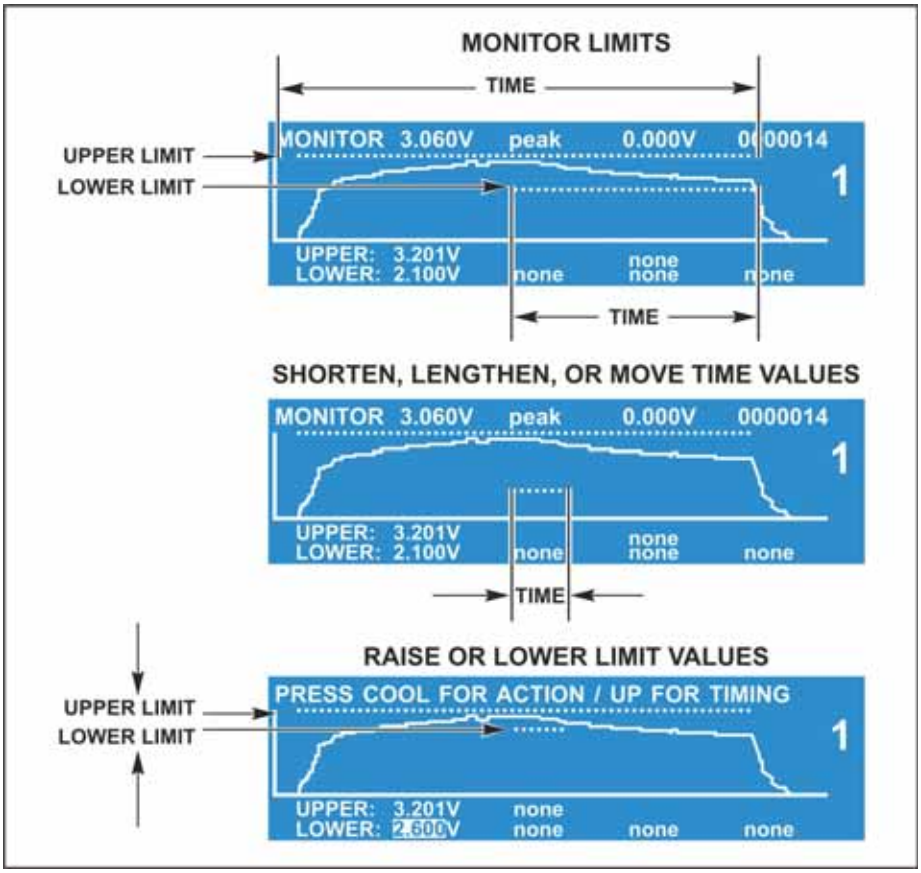
Combo mode starts out in either constant voltage or constant power control. When the current produced by that voltage or power control mode exceeds a user-programmed limit for up to 0.2 milliseconds, the unit switches to constant current control at that level. This weld mode is ideal for parts that start off with oxides or parts whose current-carrying cross section changes significantly during the weld. For welds that start out in voltage control, set monitor limits on power. For welds that start out in power, set monitor limits on voltage.

NOTE: In a Dual-Pulse weld profile, a different feedback mode can be used for each pulse. For example, a constant power first pulse can be used to break through plating in combination with a constant current second (welding) pulse.

Section II. Weld Monitoring

Introduction

The Control's feedback sensors not only control weld energy output, but they can also be used to monitor each weld. The Control's **MONITOR** features allow you to view graphic representations of welds, visually compare programmed welds to actual welds, look at peak or average energy values, set upper and lower limits for welds, and vary the time periods for these limits during the weld pulse. These limits can be used for several purposes. Common uses for **out-of-limits** welds are to stop a weld, or to trigger a relay to remove parts with bad welds from the production line. These functions are accessed using the **MONITOR** buttons on the front panel. To use these functions, see *Chapter 5, Operating Instructions*.



PEAK and AVERAGE MONITORING

The Control is ***always*** monitoring both the **PEAK** and **AVERAGE** of current, voltage, power, and resistance at the same time. When you press the **PEAK↔AVERAGE** key, the top line in the LCD simply toggles back and forth so you can ***view*** either **PEAK** or **AVERAGE** values whenever you choose.

Current, Voltage, Power, and Resistance Limits

With the **RUN** screen selected, you can select what you want to monitor by pressing the following **MONITOR** keys above: **kA** = **current**, **V** = **voltage**, and **kW** = **power**, and **Ω = resistance**. These monitors allow you to program upper and lower limits for **PULSE 1** and for **PULSE 2**. These limits will display as dotted lines on the LCD screen. Pushing either **PULSE** button will toggle between upper and lower limits. **PULSE 1** and for **PULSE 2** can be programmed to monitor the same units or monitor separate units. For example, **PULSE 1** can monitor **kA** and **PULSE 2** can monitor **V**.

NOTE: Whichever unit you select, the upper and lower limits for a single pulse must be in the ***same*** units, such as **kW**.

Force Limits

To access **FORCE & LIMITS**, press the **FORCE** button on the front screen. However, the **PROP VALVE OUTPUT FORCE** function will ***only*** work if you have an optional Proportional Valve connected to the weld head and connected to the Control. The **LO LIM** (low limit), **HI LIM** (high limit), and **LAST** functions will ***only*** work if you have an optional Load Cell installed in the weld head and a Load Cell Amplifier (Signal Conditioner) connected to the Control.

Installation and setup instructions for the Proportional Valve, Load Cell, and Load Cell Amplifier (Signal Conditioner) are supplied by the manufacturers of these devices. Instructions for making electrical connections to the Control are in *Appendix B, Electrical and Data Connections*.

NOTE: You can use a Proportional Valve without using a Load Cell and you can use a Load Cell without using a Proportional Valve.

Distance Limits

To access **DISTANCE LIMITS**, press the **DISTANCE** button on the front screen, however it will ***only*** be operational if you have an optional LVDT on the weld head and connected to the Control. This function allows you to set high and low limits for **INITIAL THICKNESS**, **FINAL THICKNESS**, and **FINAL DISPLACEMENT.** It also allows you to weld to a specific thickness by entering a thickness value in the **STOP ENERGY AT** field.

Time Limits

To access **TIME CUT OFF**, press the **TIME** button on the front screen. This function verifies that not only are the other values you programmed consistent, but the ***time it takes to reach them*** are consistent. The time displayed in the **STOP ENERGY AT** field for the limits shown above is the programmed time. The actual weld time may vary. The **TIME CUT OFF** function allows you to "fine tune" the actual weld time by placing high and low limits around the time a weld pulse is stopped.

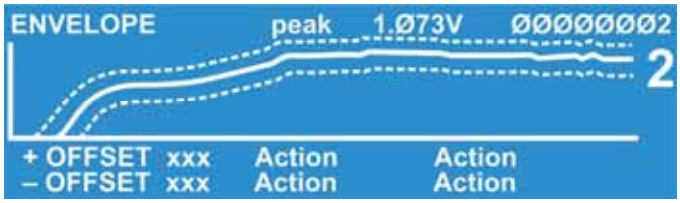
Example: The time entered for the **STOP ENERGY AT** field is programmed for a 10 millisecond pulse. Actual weld times run at 5 ms but vary between 4-6 ms. You can then put a low limit of 3 ms and a high limit of 7 ms. If any weld is outside these time limits an **OUT OF LIMITS** alarm will sound.

Energy Limits

To access **ENERGY LIMITS**, press the **ENERGY** button on the front screen. The Control monitors **ENERGY** as the combination of power multiplied by time throughout the weld measure in kJ (killi Joules). This function allows you to put high and low limits around the energy of **PULSE 1** and **PULSE 2**.

Envelope Limits

To access **ENVELOPE LIMITS**, press the **ENVELOPE** button on the front screen. Instead of setting "flat" upper and lower limits, this function sets limits above and below an actual weld pulse as you can see by the dotted lines on the right.



The LCD screen will prompt you to press the **SELECT** key on the front panel to choose a reference pulse for both **PULSE 1** and **PULSE 2**. Any pulse outside the envelope limits will sound an **OUT OF LIMITS ALARM**.

Process Tools

These "*tools*" are proven ***methods*** to use the monitor and limit functions described above in order to achieve specific results. There are five commonly defined *Process Tools*.

1. **Active Part Conditioner (APC)**
2. **Resistance Set**
3. **Pre-Weld Check**
4. **Weld To A Limit**
5. **Weld Stop**

1. Active Part Conditioner (APC)

Application

- **Displace surface oxides and contamination**
- **Reduce contact resistances before delivering the main weld energy.**

Description

In the production environment, it is common to see large variations in:

- Oxide and contamination
- Plating thickness and consistency
- Shape and fit up
- Contact resistances due to varying part fit up

In order for a weld to occur, the surface oxides and contamination must be displaced to allow proper current flow through the parts. Levels of oxide and contamination vary from part to part over time, which can have an adverse effect on the consistency of the welding process.

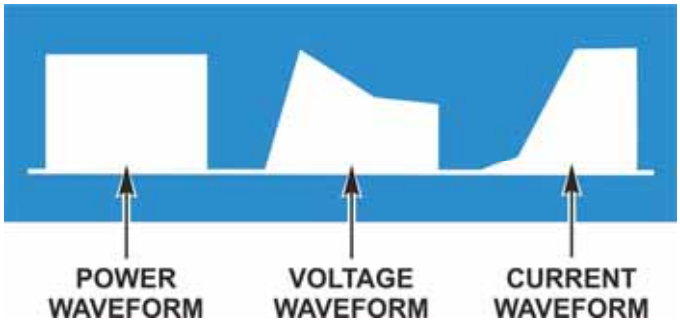
If production parts are plated, there can also be a plating process variation over time resulting in inconsistent welds. These minor material variations are a major cause of process instability, and it is best welding practice to seek to minimize their effect.

Active Part Conditioner is designed to cope with material contamination, variation and can be programmed to apply the exact power to the parts required to displace oxide or contaminants. In addition, the "Part Conditioner" pulse will terminate at a precise current flow preventing the sudden high flow, which occurs when the oxide is displaced. This prevents weld splash and material expulsion, which occurs as a result of an excessively fast heating rate. Part conditioning can help to reduce variations in contact resistance from part to part caused by different fit up of parts. It will stabilize the contact resistances before the main welding pulse, therefore reducing variation from weld to weld.

How It Works

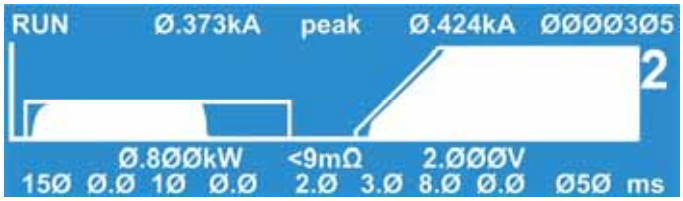
Both **constant current** feedback and **constant voltage** feedback modes are limited in their ability to deal with varying levels of part contamination and oxide. If **constant current** feedback were used, the power supply would ramp the voltage to very high levels in order to achieve current flow through the oxide. This rapid input of current is likely to cause splash, especially with round parts. **Constant voltage** mode is not ideal for this purpose either, as the voltage will be restricted from reaching sufficient levels to break down the oxide.

Constant power is ideal for this purpose. As the power supply tries to achieve constant power to the weld, it raises the voltage to high levels early in the output waveform, since current cannot flow due to the oxide. As the high voltage breaks down the oxide layer, more current flows to the weld and the voltage and resistance drop. It will achieve this in a controlled fashion to maintain constant power to the weld.



Constant Power Waveform With Corresponding Voltage and Current Waveforms

Active Part Conditioning uses a dual-pulse output. The first pulse is programmed for **constant power**, and the second for either **constant current, constant voltage**, or **constant power**. (**Constant voltage** is used if there is still a chance of weld splash). The purpose of a dual-pulse operation is to enable the first pulse to target displacement of oxides and good fit up; the second pulse achieves the weld.



Active Part Conditioning Waveform

The use of a current limit monitor for the first pulse enables the pulse to be terminated when a predetermined amount of current flow is achieved. The rise of the current waveform is proof positive that the oxide is breaking down and the parts are fitting up together, ready to weld. The first pulse, therefore, should be programmed to be much longer than generally required. The power supply will terminate the pulse based on the reading of current in the power supply's monitor.

2. Resistance Set

Application

- Reduce variations in Resistance prior to the weld
- Reduce contact resistances before delivering the main weld energy.

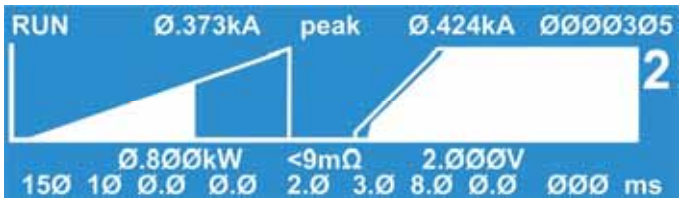
Description

Resistance Set is used when parts vary in initial resistance due to:

- Shape and part fit up
- Very small parts

Resistance Set is very similar to **APC** except that there are applications where you do not want a high voltage at the beginning of the pulse. Instead, you want to start both voltage and current low and build on an upslope. This would be used primarily where resistance would vary from weld to weld, coping with material contamination, and variation due to part fit up problems. It can be programmed to apply the exact power to the parts required to reduce the resistance to a consistent level for every weld.

Resistance Set uses a dual-pulse output. The first pulse is programmed for **upslope power**, and the second for either **constant current, constant voltage**, or **constant power**. (**Constant voltage** is used if there is still a chance of weld splash). The purpose of a dual-pulse operation is to enable the first pulse to target variations in resistance; the second pulse achieves the weld.



Resistance Set Waveform

The use of a current limit monitor for the first pulse enables the pulse to be terminated when a predetermined amount of current flow is achieved. The rise of the current to a consistent level ensures a

consistent resistance at the beginning of the second pulse. Depending on the initial resistance, the amount of time required to bring the resistance down will vary from weld to weld. The first pulse, therefore, should be programmed to be much longer than generally required to ensure that the current limit is always reached. The power supply will terminate the pulse based on the reading of current in the power supply's monitor.

3. Pre-Weld Check

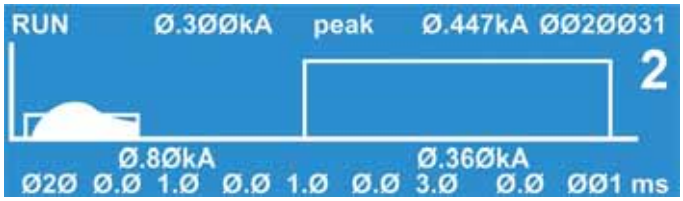
Application

- **Detect Misaligned or Missing parts.**

Function

This is used to see if parts are misaligned or missing ***before*** a welding pulse is delivered to the weld head. If a part is missing or misaligned, you do ***not*** want the machine to weld because the result would be an unacceptable weld and/or damaged electrodes.

When using a **Pre-Weld Check,** Pulse 1 should be very **short** (1-2 milliseconds), and the current should be **low**, about 10% of the Pulse 2 current. Pulse 1 should be used as a measurement pulse and should ***not*** perform a weld.



Pre-Weld Check Waveform

Example: To detect misaligned parts, use constant current and set upper and lower voltage limits for Pulse 1 If parts are **misaligned**, the work piece resistance will be higher, so the voltage will be higher. If parts are **missing**, voltage will be lower. In either case, the Pulse 1 upper or lower limits will be exceeded, and Pulse 1 can be inhibited.

NOTE: You ***must*** have **upslope** programmed into the pulse in order to set a lower limit.

In addition to inhibiting the weld, the Control has four programmable relay outputs, which can be used to trigger alarms to signal operators of weld faults or signal automation equipment to perform pre-programmed actions, such as stopping the assembly line so the faulty weld piece can be removed.

4. Weld To A Limit

Applications

- **Parts with narrow weld window**
- **Part-to-part positioning problems**
- **Electrode-to-part positioning problems**

Function

To stop the weld when a sufficient **current**, **voltage**, or **power** level is reached. Using limits in this way ensures a more consistent input of energy, which produces consistently good welds.

Description

This function terminates the weld energy during the welding process if pre-set weld **current**, **voltage**, or **power** limits are exceeded. In addition to inhibiting the weld, the Control has four programmable relay outputs which can be used to trigger alarms to signal operators of weld faults, or signal automation equipment to perform pre-programmed actions, such as stopping the production line so the faulty weld piece can be removed.

The monitor measures the weld energy parameters during the weld period and compares the measurements against the programmed limits. If any of the programmed limits are exceeded, the energy limits monitor sets the Control to a state selected from the **OUT OF LIMITS ACTION** menu. In addition, the Control's relays can be programmed to trigger alarms, or trigger an action in an automated welding system.

In the profile above, the weld current limit is at a sufficient level to get a good weld. In this case, the operator has selected the option to terminate the weld energy under this condition, so the energy limits monitor terminates the Pulse 1 weld and inhibits the Pulse 2 weld if it had been programmed.

NOTE: When using the energy limits monitor, always select a monitor mode that is ***different*** from the feedback mode. For example:

- If you are welding in constant current, monitor voltage.
- If you are welding in constant voltage, monitor current.
- If you are welding in constant power, monitor current or voltage.

5. Weld Stop

Applications

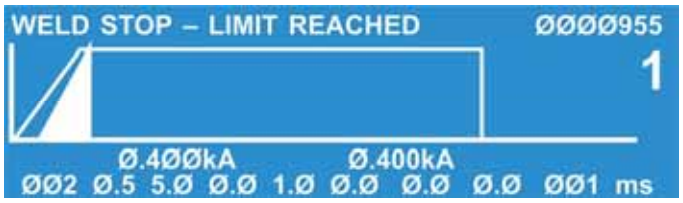
- **Part-to-part positioning problems**
- **Electrode-to-part positioning problems**

Function

To detect work piece resistance changes that occur when parts are positioned incorrectly at the weld head. In this case, the energy limits will prevent blowouts, parts damage, and electrode damage. Limits can be set to terminate the weld if this occurs.

Description

This function terminates the weld energy during the welding process if pre-set weld **current**, **voltage**, or **power** limits are exceeded. In addition to inhibiting the weld, the Control has four programmable relay outputs which can be used to trigger alarms to signal operators of weld faults, or signal automation equipment to perform pre-programmed actions, such as stopping the production line so the faulty weld piece can be removed.



In the profile above, the weld current is exceeding the selected upper limit before the end of the welding cycle. The spike in the current waveform indicates that parts were misplaced. In this case, the operator has selected the option to terminate the weld energy under this condition, so the energy limits monitor terminates the Pulse 1 weld and inhibits the Pulse 2 weld if it had been programmed.

The monitor measures the weld energy parameters during the weld period and compares the measurements against the programmed limits.

NOTE: When using the energy limits monitor, always select a monitor mode that is ***different*** from the feedback mode. For example:

- If you are welding in constant current, monitor voltage.
- If you are welding in constant voltage, monitor current.
- If you are welding in constant power, monitor current or voltage.

CHAPTER 5
Operating Instructions

Section I: Introduction

Before You Start

Before operating the Control, you must be familiar with the following:

- The **location** and **function** of Controls and Indicators. For more information, see *Chapter 1* of this manual.
- How to **select** and **use** the Control functions for your specific welding applications. For more information, see *Chapter 3, System Configuration*.
- The principles of resistance welding and the use of programmed weld schedules. For more information, see *Appendix E, The Basics of Resistance Welding.* For additional information on the welding process, see *Appendix F, Quality Resistance Welding Solutions, Defining the Optimum Process*.

Pre-Operational Checks

Always perform these checks ***before*** attempting to operate the Control.

Connections

Verify that the Control has been connected to a manual or air-actuated weld head as described in *Chapter 2* of this manual. Verify that the Emergency Stop Switch shorting wires are connected ***or*** verify that an Emergency Stop Switch is connected properly.

Power

Verify that power is connected as described in *Chapter 2* of this manual.

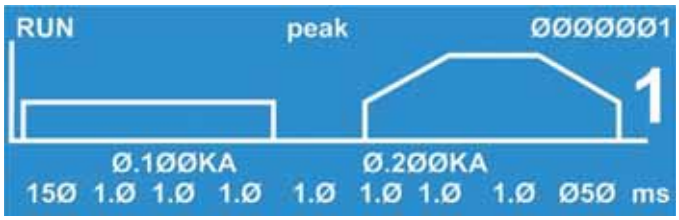
Compressed Air

If you are using an air-actuated weld head, verify that compressed air is connected as described in the appropriate sections of your weld head manual. Turn the compressed air ON**,** and adjust it according to the instructions in your weld head manual.

Initial Setup

1. Adjust the weld head force adjustment knob for a force appropriate for your welding application. A good starting point is the mid-point in the range of the weld head force.
2. Set the **WELD/NO WELD** switch on the Control front panel to the **NO WELD** position. In this position, the Control will operate the weld head ***without*** producing weld energy.

   NOTE: When you are ready to perform a weld, be sure to set this switch back to the **WELD** position.
3. Turn the **ON/OFF** switch on the rear panel of the Control to the **ON** position. The default **RUN** screen will be displayed. You will use this screen to enter welding parameters.



Default RUN Screen

Section II. Operation

Single-Pulse Weld Schedule

NOTE: If you are using the optional LVDT, you ***must*** perform the procedures described in *Appendix 3, Calibration, Section II, Calibrating the LVDT* ***in addition*** to the procedures below.

1. 

Press the **SCHEDULE** key, then select a Weld Schedule using **either** the ▲▼ arrows **or** the numeric keypad.

2. 
Press the **SQUEEZE** key to enter the squeeze time before the weld. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **999** milliseconds. If using the LVDT, enter a time between **1** and **999** milliseconds. If using a relay for MG3 synchronization, enter a time between **50** and **999** milliseconds **NOTE**: We recommend 150 milliseconds.

3. 
Press the **PULSE 1 UPSLOPE** key to enter the amount of time for the Weld Pulse 1 **upslope**. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter **0** milliseconds.

4. 
Press the **PULSE 1 WELD** key to highlight the **bottom line** of the LCD to enter the weld time. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **99** milliseconds.

5. 
Press the **PULSE 1 WELD** key again to highlight the **middle line** of the LCD to enter **weld energy**. Use the numeric keypad to enter the **energy level** or use the ▲▼ arrows. The Control output ranges are:
   - **Current:** from 0.1 → 2.4 kA
   - **Voltage:** 0.2 → 9.999 V
   - **Power:** 0.05 → 9.999 kW
   - **Combo:** The pulse starts in either Voltage or Power using the above limits, and has a current limit as shown above.

6. Perform ***one*** of the following:
   - 

From the **CONTROL** keys section on the front panel, press the **kA** key to program **current** as the feedback mode.
   - 

From the **CONTROL** keys section on the front panel, press the **V** key to program **voltage** as the feedback mode.
   - 

From the **CONTROL** keys section on the front panel, press the **kW** key to program **power** as the feedback mode.
   - 

From the **CONTROL** keys section on the front panel, press the **COMBO** key to program **combo** as the feedback mode.

7. 
Press the **PULSE 1 DOWNSLOPE** key to enter the amount of time for the Weld Pulse 1 **downslope**. Use the numeric keypad or the ▲▼ arrows. Enter **0** milliseconds. Note that in combo mode when the unit reaches a constant current, any time programmed in this segment will be added to the weld at the constant current level.

8.  Press the **COOL** key to enter the amount of time for the cool period after Pulse 1. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter **0.5** milliseconds.

9. Program Pulse 2 by repeating Steps 3 through 7 above using the keys for Pulse 2, entering the value **0** in each step.

10.  Press the **HOLD** key to enter the amount of time for the hold period after the weld. Use the numeric keypad or the ▲▼ arrows. Enter a time between **0** and **999** milliseconds. We recommend at least **50** milliseconds as weld strength is formed in the hold time.

Upslope/Downslope Weld Schedule

NOTE: If you are using the optional LVDT, you ***must*** perform the procedures described in *Chapter 6, Calibration, Section II, Calibrating the LVDT* ***in addition*** to the procedures below.

1. 

Press the **SCHEDULE** key, then select a Weld Schedule using **either** the ▲▼ arrows **or** the numeric keypad.

2. 
Press the **SQUEEZE** key to enter the squeeze time before the weld. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **999** milliseconds. If using the LVDT, enter a time between **1** and **999** milliseconds. If using a relay for MG3 synchronization, enter a time between **50** and **999** milliseconds **NOTE**: We recommend 150 milliseconds.

3. 
Press the **PULSE 1 UPSLOPE** key to enter the amount of time for the Weld Pulse 1 **upslope**. Use the numeric keypad or the ▲▼ arrows to enter the time. Enter a time between **0** and **99** milliseconds. A good starting point is **5** milliseconds.

4. 
Press the **PULSE 1 WELD** key to highlight the **bottom line** of the LCD to enter the weld time. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **99** milliseconds.

5. 
Press the **PULSE 1 WELD** key again to highlight the **middle line** of the LCD to enter **weld energy**. Use the numeric keypad to enter the **energy level** or use the ▲▼ arrows. The Control output ranges are:
   - **Current:** from 0.1 → 2.4 kA
   - **Voltage:** 0.2 → 9.999 V
   - **Power:** 0.05 → 9.999 kW
   - **Combo:** The pulse starts in either Voltage or Power using the above limits, and has a current limit as shown above.

6. Perform ***one*** of the following:
   - 

From the **CONTROL** keys section on the front panel, press the **kA** key to program **current** as the feedback mode.
   - 

From the **CONTROL** keys section on the front panel, press the **V** key to program **voltage** as the feedback mode.
   - 

From the **CONTROL** keys section on the front panel, press the **kW** key to program **power** as the feedback mode.
   - 

From the **CONTROL** keys section on the front panel, press the **COMBO** key to program **combo** as the feedback mode.

7. 
Press the **PULSE 1 DOWNSLOPE** key to enter the amount of time for the Weld Pulse 1 **downslope**. Use the numeric keypad or the ▲▼ arrows to enter the time. Enter a time between **0** and **99** milliseconds. A good starting point is **5** milliseconds. Note that in combo mode when the unit reaches a constant current, any time programmed in this segment will be added to the weld at the constant current level.

8.  Press the **COOL** key to enter the amount of time for the cool period after Pulse 1. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter **0.5** milliseconds.

9. Program Pulse 2 by repeating Steps 3 through 7 above using the keys for Pulse 2, entering the value **0** in each step.

10.  Press the **HOLD** key to enter the amount of time for the hold period after the weld. Use the numeric keypad or the ▲▼ arrows. Enter a time between **0** and **999** milliseconds. We recommend at least **50** milliseconds as weld strength is formed in the hold time.

Dual-Pulse Weld Schedule

NOTE: If you are using the optional LVDT, you ***must*** perform the procedures described in *Appendix D, LVDT Option, Section 4, Operating Instructions* **in addition** to the procedures below.

1. 

Press the **SCHEDULE** key, then select a Weld Schedule using **either** the ▲▼ arrows **or** the numeric keypad.

2. 
Press the **SQUEEZE** key to enter the squeeze time before the weld. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **999** milliseconds. If using the LVDT, enter a time between **1** and **999** milliseconds. If using a relay for MG3 synchronization, enter a time between **50** and **999** milliseconds **NOTE**: We recommend 150 milliseconds.

3. 
Press the **PULSE 1 UPSLOPE** key to enter the amount of time for the Weld Pulse 1 **upslope**. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **99** milliseconds.

4. 
Press the **PULSE 1 WELD** key to highlight the **bottom line** of the LCD to enter the weld time. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **99** milliseconds.

5. 
Press the **PULSE 1 WELD** key again to highlight the **middle line** of the LCD to enter **weld energy**. Use the numeric keypad to enter the **energy level** or use the ▲▼ arrows. The Control output ranges are:
   - **Current:** from 0.1 → 2.4 kA
   - **Voltage:** 0.2 → 9.999 V
   - **Power:** 0.05 → 9.999 kW
   - **Combo:** The pulse starts in either Voltage or Power using the above limits, and has a current limit as shown above.

6. Perform ***one*** of the following to program the Pulse 1 feedback mode:
   - 

From the **CONTROL** keys section on the front panel, press the **kA** key to program **current** as the feedback mode.
   - 

From the **CONTROL** keys section on the front panel, press the **V** key to program **voltage** as the feedback mode.
   - 

From the **CONTROL** keys section on the front panel, press the **kW** key to program **power** as the feedback mode.
   - 

From the **CONTROL** keys section on the front panel, press the **COMBO** key to program **combo** as the feedback mode.

7. 
Press the **PULSE 1 DOWNSLOPE** key to enter the amount of time for the Weld Pulse 1 **downslope**. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **99** milliseconds. Note that in combo mode when the unit reaches a constant current, any time programmed in this segment will be added to the weld at the constant current level.

8.  Press the **COOL** key to enter the amount of time between Pulse 1 and Pulse 2. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **99** milliseconds. We recommend at least 2 milliseconds.

9. Program Pulse 2 by repeating Steps 3 through 7 above using the keys for Pulse 2, entering appropriate values for Pulse 2.

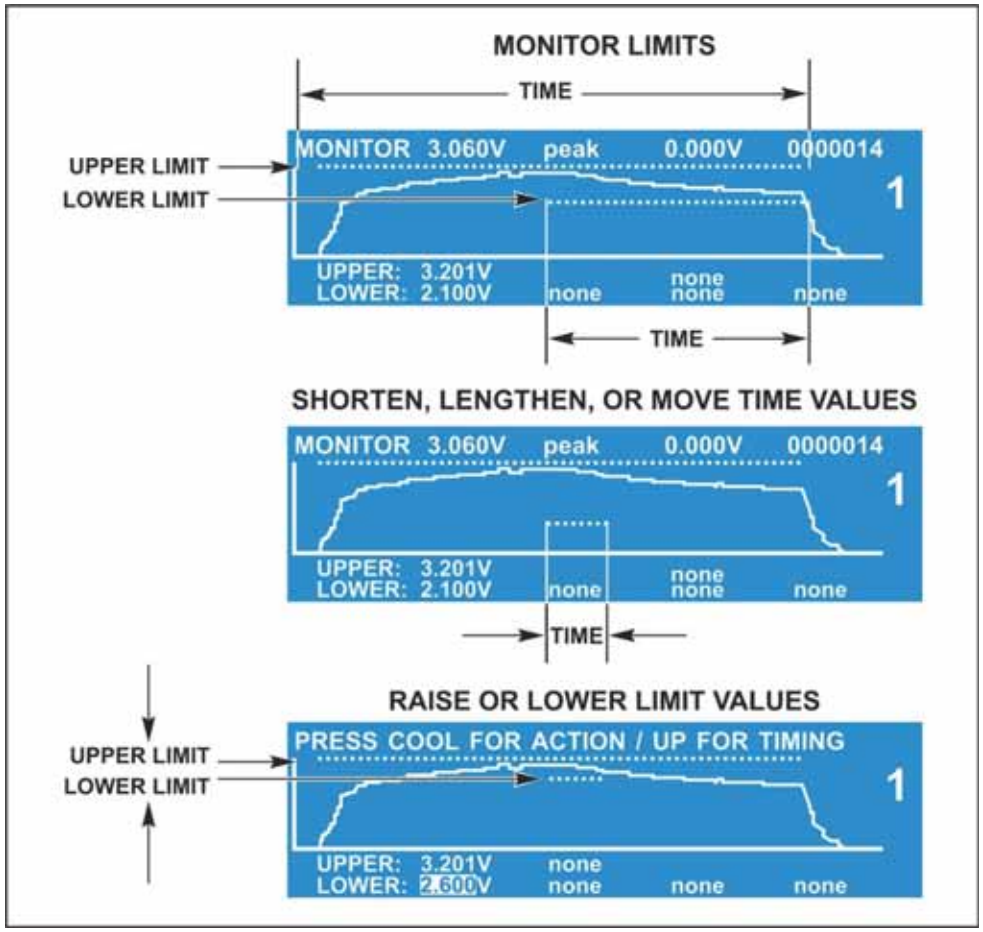
10.  Press the **HOLD** key to enter the amount of time for the hold period after the weld. Use the numeric keypad to enter the time or use the ▲▼ arrows. Enter a time between **0** and **999** milliseconds. We recommend at least **50** milliseconds.

Section III. Using the Weld Monitor

Overview

The Control allows you to adjust extremely precise limits for the amount of energy and weld time. Like all welding processs development, you'll need to make several test welds, and view the waveforms and limits of actual welds in order to "fine tune" the limits to your needs.

The energy limits appear as horizontal dotted lines on the LCD screen. The **UPPER LIMIT** line is longer than the lower limit line because it includes the **UPSLOPE**, **WELD**, and **DOWNSLOPE** portions of the actual weld waveform. The **LOWER LIMIT** line is shorter because it only includes the **WELD** portion of the waveform. If the line of either limit crosses the weld energy waveform, the Control can trigger an alarm, inhibit the second pulse, or stop the weld energy. See *Chapter 4, Using Feedback Modes and Weld Monitoring* for more details.



As you can see by the LCD screens above, you can shorten the length of the time of the **LOWER LIMIT** so it will not cross the weld waveform. This allows you to raise or lower the **LOWER LIMIT** closer to the peak of the actual waveform ***without*** crossing the weld waveform. For some welds it may be very important to get up to the peak voltage or current to get the right melting and get there at the right time during the pulse. Every millisecond could be very important.

1. SCHEDULE Press the **SCHEDULE** key, then select a Weld Schedule using **either** the ▲▼ arrows **or** the numeric keypad. Fire the welder and view the output waveform (shaded graph) on the display.

2. From the **MONITOR** keys section on the front panel, press the kA, V, kW, or Ω key to view the desired waveform. Note that the other monitor keys do not have graphical waveforms.

3. Toggle the Pulse 1 weld time/energy selector key to select the **upper** limit field for the weld period. Use the numeric keypad or the ▲▼ arrows to enter the **upper limit** value for the Pulse 1 weld period.

4. Perform ***one*** of the following to program the Pulse 1 monitor limit mode:
   - kA Press the **kA** key to program **current** as the limit mode.
   - V Press the **V** key to program **voltage** as the limit mode.
   - kW Press the **kW** key to program **power** as the limit mode.
   - Ω Press the **Ω** key to program **resistance** as the limit mode.

5. Toggle the Pulse 1 weld time/energy selector key to select the **lower limit** field for the weld period. Enter the lower limit value for the Pulse 1 weld period.

   NOTE: In order for a Pulse 1 **lower limit** to be programmed, you must ***first*** program a Pulse 1 upslope in the weld schedule.

   The lower limit mode (current, voltage, or power) will automatically be the same as the upper limit mode programmed in Step 4.

6. Press the **COOL** weld period key. This will bring up the **PULSE 1 OUT OF LIMITS ACTION** screen. This screen allows you to select the action that the Control will take if the Pulse 1 upper or lower limits are exceeded. You have **four** choices:

PULSE 1 OUT OF LIMITS ACTION
1. none
2. STOP WELD
3. INHIBIT PULSE2
4. PART CONDITIONER (Stop Pulse1)

NUMBER Select, MENU Previous menu

   - **NONE** takes no action if upper or lower energy limits are exceeded.
   - **STOP WELD** stops the weld immediately during Pulse 1, and prevents Pulse 2 from firing (if applicable).
   - **INHIBIT PULSE2** stops the weld at the end of Pulse 1, and prevents Pulse 2 from firing. This function will not operate if both pulses are joined ***without*** a cool time.

- **PART CONDITIONER (Stop Pulse1)** stops Pulse 1 immediately after upper or lower energy limits are exceeded, but allows Pulse 2 to fire. This function will not operate if both pulses are joined ***without*** a cool time.

  NOTE: See *Section IV, Programming For Active Part Conditioning.*

7. After making your selection the display will automatically return to the monitor screen.

8. Program the upper and lower limits for Pulse 2 by repeating Steps 4 through 6 above using the keys for Pulse 2, entering appropriate values for Pulse 2.

   NOTES:

   - The monitor limit mode (current, voltage, power or resistance) for Pulse 2 can be different than the monitor limit mode for Pulse 1.
   - To "fine tune" the monitor limits to very precise values, see *Chapter 4, Introduction to Feedback Modes and Monitoring*.

9. 

   Press the **HOLD** period key. This will bring up the **PULSE 2 OUT OF LIMITS ACTION** screen. This screen allows you to select the action that the Control will take if the Pulse 2 upper or lower limits are exceeded. You have **two** choices:

   PULSE 2 OUT OF LIMITS ACTION

   1. none
   2. STOP WELD

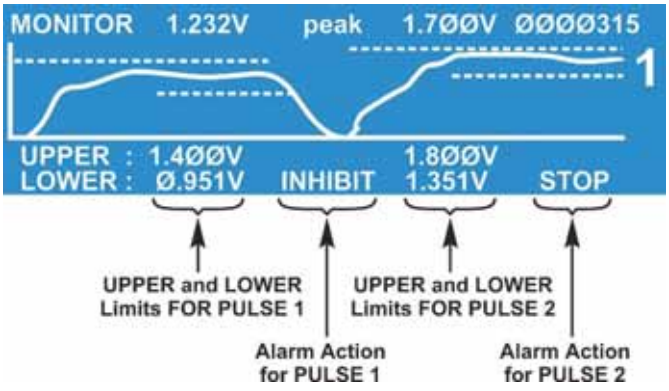
   NUMBER Select, MENU Previous menu

   - **NONE** takes no action if upper or lower energy limits are exceeded.
   - **STOP WELD** stops **PULSE 2** immediately after upper or lower energy limits are exceeded.

10. After you have made your selection the display will automatically return to the **MONITOR** screen.

    NOTE: The Control adds dotted lines to the appropriate graph to show the ***programmed limits***.

    The screen on the right shows how the **Limits** and **Alarm** actions appear when an actual weld trace is displayed on the LCD.



11. After entering or changing monitor limits, you must press either the appropriate **MONITOR** or **RUN** buttons to save the changes. If this is not done, the last input field will remain highlighted, and the changes will not be saved to memory. Any welds done in this condition will use the older, unedited values still stored in the memory.

NOTE: All lower limits apply only to the Pulse 1 and Pulse 2 **WELD** periods. Lower limits do ***not*** cover any upslope or downslope periods. All upper limits apply to the entire Pulse 1 and Pulse 2 periods, including their upslope and downslope periods.

1. Set an **UPPER LIMIT** and **LOWER LIMIT** using the procedures in *Section III, Programming the Weld Monitor.*
2. Perform a weld to see how the limits (dotted lines) appear compared to the weld graph.
3. Raise or lower the **UPPER LIMIT** and **LOWER LIMIT** as necessary using the procedures in *Section III, Programming the Weld Monitor*.
4. To lengthen or shorten the time periods, go to the **MONITOR** screen.
5. Press the **UPSLOPE** key for **PULSE 1** or **PULSE 2** to get the **MONITOR LIMITS** screen.

NOTE: INGNORE 1st deletes time from the beginning of the limit, **IGNORE LAST** deletes time from the end of the limit. This will not only shorten the limit time, but depending on the amount of time deleted on each end of the limit, the limit will appear to move horizontally across the screen. This allows you to fit the **LOWER LIMIT** precisely into the waveform graph.

```
< PULSE 1 MONITOR LIMITS >
1. LOWER LIMIT  IGNORE 1ST   :   0.0ms
2. LOWER LIMIT  IGNORE LAST  :   2.5ms
3. UPPER LIMIT  IGNORE 1ST   :   0.0ms
4. UPPER LIMIT  IGNORE LAST  :   0.0ms

NUMBER Select an item, ENERGY Monitor screen
```

6. Use the numerical keypad to select the number of the limit you want to change.
7. When the value is highlighted (Example: **2.5ms**), use the numerical keypad to type in a new value. You must leave a minimum time of 0.5 ms in order for the changes to be saved in memory.
8. Press the **RUN or monitor** key when you have finished entering new values.
9. Raise or lower the **UPPER LIMIT** and **LOWER LIMIT** as necessary using the procedures in *Section III, Programming the Weld Monitor*.
10. Return to the **RUN** screen and make a test weld in order to view the waveform to see where the new limits appear compared to the waveform graph.
11. Repeat steps 1 ➔ 10 until the limits are where you want them.

NOTE: Lower limits apply to the programmed weld time ***only***. Programming a longer upslope extends the time before a lower limit applies in the monitoring screen.

Section IV. Active Part Conditioning

1. SCHEDULE Press the **SCHEDULE** key, then select a Weld Schedule using **either** the ▲▼ arrows **or** the numeric keypad.

2. Program a single pulse for **Constant Power** operation. Program the power level and weld time to cause slight sticking between the two parts. Make a few welds and pull them apart. Increase or decrease the power setting until a light tack weld is achieved.

3. V From the **MONITOR** keys section on the front panel, press the voltage **V** key and observe the high peak of the voltage waveform.

4. Ω From the **MONITOR** keys section on the front panel, press the **Ω** (resistance) key and observe the resistance waveform. This should appear to begin high, then start to drop as a tack weld is made and oxides are removed.

5. kA From the **MONITOR** keys section on the front panel, press the **kA** (current) key and observe the current waveform starting to rise as the oxidization breaks down. If the current waveform starts to flatten, this is an indication that the resistance has stabilized and the parts have come into closer contact.

6. RUN Push **RUN** and optimize the energy and time setting of Pulse 1 (constant power) to provide an adequate tack weld and also a current waveform (view in the monitor screen) that has started to flatten out, but is still rising. This indicates that a full melt has not yet occurred.

7. kA From the **MONITOR** keys section on the front panel, press the **kA** key to program an upper current limit on the **MONITOR** screen.

NOTE: You can toggle between **PEAK** and **AVERAGE** readings by pressing the **PEAK/AVERAGE** key.

8. Press the **COOL** weld period key. This will bring up the **PULSE 1 OUT OF LIMITS ACTION** screen.

9. Select **4. PART CONDITIONER (Stop Pulse1).**

PULSE 1 OUT OF LIMITS ACTION

1. **none**
2. **STOP WELD**
3. **INHIBIT PULSE2**
4. **PART CONDITIONER (Stop Pulse1)**

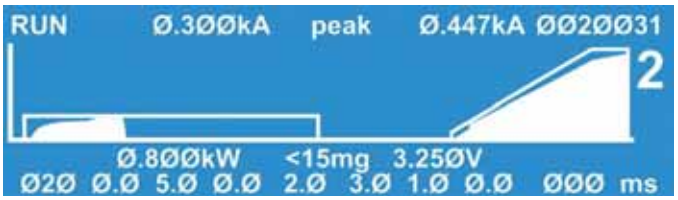
NUMBER Select, MENU Previous menu

NOTE: For more details on this process, see **Active Part Conditioner** in *Chapter 4, Using Feedback Modes and Weld Monitoring.*

10. RUN Since different levels of oxide require different amounts of time to reach the current limit, return to the **RUN** screen and extend the programmed weld time (usually double the time works). This will ensure that there will be enough time for the current to rise and reach the limit, even with heavily oxidized parts.

11. Try welds with varying oxide (clean and dirty). The power supply terminates the first pulse when your programmed current is reached. A clean part will reach the current limit sooner and the pulse will terminate early. A dirty part will require more time before the oxide is broken down and current can flow.

12. Program your second welding pulse as normal to achieve a strong weld. Constant voltage is recommended for round parts and constant current for flat parts. An upslope may be required to restrict the current flow early in the second pulse and avoid weld splash.



Section V. Resistance Set

Note: The **Resistance Set** tool is very similar to the **Active Part Conditioning** tool. The difference is that the first pulse is programmed as all Upslope for Resistance Set, where it is programmed as all Weld Time (Square Wave) for Active Part Conditioning. The Resistance Set pulse is programmed as all Upslope to keep both the Voltage and Current low at the beginning of the pulse.

1. 

Press the **SCHEDULE** key, then select a Weld Schedule using **either** the ▲▼ arrows **or** the numeric keypad.

2. Program a single pulse for **Constant Power** operation, but program the time in the Upslope portion of Pulse 1. Program the Weld Time and Downslope of Pulse 1 to 0.0 ms. Program the power level and Upslope time to cause slight sticking between the two parts. Make a few welds and pull them apart. Increase or decrease the power setting until a light tack weld is achieved.

3. 

From the **MONITOR** keys section on the front panel, press the voltage **V** key and observe gradual rise of the voltage waveform.

4. 

From the **MONITOR** keys section on the front panel, press the **Ω** (resistance) key and observe the resistance waveform. This should appear to begin high, then start to drop as a tack weld is made and the resistance decreases.

5. 

From the **MONITOR** keys section on the front panel, press the **kA** (current) key and observe the current waveform starting to rise as the resistance decreases. If the current waveform starts to flatten, this is an indication that the resistance has stabilized and the parts have come into closer contact.

6. 

Push **RUN** and optimize the energy and time setting of Pulse 1 to provide an adequate tack weld and also a current waveform (view in the monitor screen) that has started to flatten out, but is still rising. This indicates that a full melt has not yet occurred.

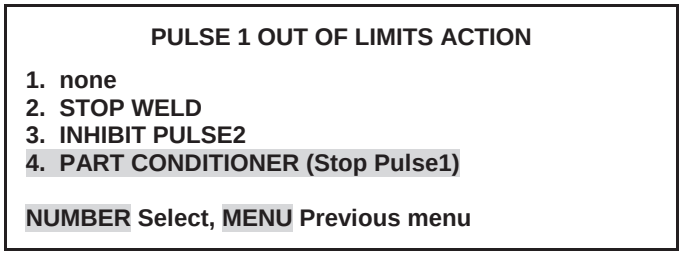
7. 

From the **MONITOR** keys section on the front panel, press the **kA** key to program an upper current limit on the **MONITOR** screen.

NOTE: You can toggle between **PEAK** and **AVERAGE** readings by pressing the **PEAK/AVERAGE** key.

8. 
Press the **COOL** weld period key. This will bring up the **PULSE 1 OUT OF LIMITS ACTION** screen.

9. Select **4. PART CONDITIONER (Stop Pulse1)**



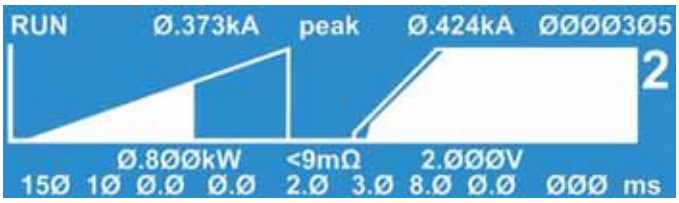
NOTE: For more details on this process, see **Resistance Set** in *Chapter 4, Using Feedback Modes and Weld Monitoring.*

10. 

Since different levels of resistance require different amounts of time to reach the current limit, return to the **RUN** screen and extend the programmed weld time (usually double the time works). This will ensure that there will be enough time for the current to rise and reach the limit, even with wide variations in initial resistance.

11. The power supply terminates the first pulse when your programmed current is reached. A low resistance part will reach the current limit sooner and the pulse will terminate early. A highly resistive part will require more time before the resistance decreases and current can flow.

12. Program your second welding pulse as normal to achieve a strong weld. Constant voltage is recommended for round parts and constant current for flat parts. An upslope may be required to restrict the current flow early in the second pulse and avoid weld splash.



Section VI. Pre-Weld Check

Note: The **Pre-Weld Check** function is used to detect misaligned or missing parts before the weld is performed. Therefore, the Pre-Weld Check function should only be programmed after the welding schedule has been developed. The welding schedule includes the time and energy settings as well as the electrode force required to produce strong, consistent welds.

1. 

Press the **SCHEDULE** key, then select a Weld Schedule using **either** the ▲▼ arrows **or** the numeric keypad.

2. Program the second pulse as required to produce strong, consistent welds. Then, program the first pulse for **Constant Current** operation. Program the first pulse current level to approximately 10% of the second pulse current. Program the first pulse upslope time to 1 ms and first pulse weld time to 2 ms. Program 2 ms of cool time between the pulses. Make a few welds and verify that the welds are strong and consistent.

3. 

From the **MONITOR** keys section on the front panel, press the voltage **V** key and observe the peak voltage reading of the first pulse. Make several more welds and observe the range of first pulse peak voltage readings from weld to weld.

4. 
Press the Pulse 1 weld key to highlight the **upper** limit field for the weld period. Use the numeric keypad to enter the **upper limit** value for the Pulse 1 weld period. Program a voltage level that is slightly higher than the voltages observed in step 3 above.

5. 

Press the voltage **V** key to save the setting as an upper voltage limit.

6. 
Press the **COOL** weld period key. This will bring up the **PULSE 1 OUT OF LIMITS ACTION** screen.

Select **1. STOP WELD**

PULSE 1 OUT OF LIMITS ACTION

1. none
2. STOP WELD
3. INHIBIT PULSE2
4. PART CONDITIONER (Stop Pulse1)

NUMBER Select, MENU Previous menu

7. 
Toggle the Pulse 1 weld key to highlight the **lower** limit field for the Pulse 1 weld period. Use the numeric keypad to enter a **lower limit** value with a voltage level that is slightly lower than the voltages observed in step 3 above.

8. 

Press the voltage **V** key to save the setting as a lower voltage limit.

9. Make several more welds and verify that under normal circumstances, the limits are not reached and the welds are not aborted. If the limits are reached under normal welding conditions, adjust the levels and times of the upper and lower voltage limits accordingly.

10. 

Return to the **RUN** screen and make several welds. Observe that under normal conditions, the welds are not aborted, and that consistent, strong welds can be produced.

11. Try making welds with only one part present. Also try making welds with misaligned parts. Observe that the power supply terminates the weld during the first pulse as soon as the voltage limits are reached. If the voltage limits are not being reached with these conditions present, return to the voltage monitor screen and adjust the limits accordingly. You may also have to adjust the Pulse 1 current from the RUN screen if needed to optimize the Pre-Weld Check settings.

12. The Pre-Weld Check function can now be used to detect misaligned or missing parts before the Pulse 2 welding current is delivered to the parts.

Pre-Weld Check Waveform

Section VII. Weld To A Limit

NOTE: The **Weld to a Limit** function is used to stop the weld when a specific **current**, **voltage**, or **power** level, sufficient to produce good welds, is reached. Using limits in this way ensures a more consistent input of energy, which produces consistently good welds for some applications. The Weld to a Limit function should only be programmed after a welding schedule, which produces acceptable results, has been developed. The welding schedule includes the time and energy settings as well as the electrode force setting. In the following steps, a **Constant Voltage** weld is used as an example to show how the Weld to a Limit function is programmed.

1. 

Press the **SCHEDULE** key, then select a Weld Schedule using **either** the ▲▼ arrows **or** the numeric keypad.

2. Program a single pulse for **Constant Voltage** operation as required to make strong welds. Make a few welds and verify that the welds are acceptable.

3. 

From the **MONITOR** keys section on the front panel, press the **kA** (current), **V** (voltage), **kW** (power), and **Ω** (resistance) keys and observe the resulting waveforms.

   NOTE: You can toggle between **PEAK** and **AVERAGE** readings by pressing the **PEAK/AVERAGE** key.

4. 

Press the **kA** (current) key and observe the current waveform. If the current waveform is still rising at the end of the pulse, the Weld to a Limit function may work well for the application. If the current waveform quickly rises and flattens out early in the pulse, the Weld to a Limit function is not appropriate for the application.

5. Observe the peak current reading on the current monitor screen. Make several more welds and observe the range of peak current readings from weld to weld.

6. 
Press the Pulse 1 weld key to highlight the **upper** limit field for the weld period. Use the numeric keypad to enter the **upper limit** value for the Pulse 1 weld period. Program a current level that is the same as the peak current readings observed in step 5 above.

7. 

Press the current **kA** key to save the setting as an upper current limit.

8. 
Press the **COOL** weld period key. This will bring up the **PULSE 1 OUT OF LIMITS ACTION** screen.

9. Select **1. STOP WELD**

PULSE 1 OUT OF LIMITS ACTION

1. none
2. STOP WELD
3. INHIBIT PULSE2
4. PART CONDITIONER (Stop Pulse1)

NUMBER Select, MENU Previous menu

10. Return to the **RUN** screen and increase the weld time by 1-2 ms. Make several welds and verify that the upper voltage limit is reached for every weld, and the weld pulse stops before the end of the programmed weld time.

Weld to a Limit Waveform

11. Make several more welds and inspect them for consistency of weld quality and/or weld strength.

NOTE: When using the Weld to a Limit function, always select a monitor mode that is ***different*** from the feedback mode. For example:

- If you are welding in constant current, put limits on voltage.
- If you are welding in constant voltage, put limits on current.
- If you are welding in constant power, put limits on current or voltage.

Section VIII. Weld Stop

Note: The **Weld Stop** function is similar to the **Pre-Weld Check** function, as both are used to detect missing or misaligned parts. Both functions are used to stop the weld when a specific **current**, **voltage**, or **power** level is reached. The Weld Stop function stops the weld in the actual welding pulse; the Pre-Weld Check uses a small pre-pulse to stop the weld. The Weld Stop function should only be programmed after a welding schedule, which produces acceptable results, has been developed. The welding schedule includes the time and energy settings as well as the electrode force setting. In the following steps, a **Constant Current** weld is used as an example to show how the Weld Stop function is programmed.

1. 

Press the **SCHEDULE** key, then select a Weld Schedule using **either** the ▲▼ arrows **or** the numeric keypad.

2. Program a single pulse for **Constant Current** operation as required to make strong, consistent welds. Make a few welds and verify that the welds are acceptable.

3. 

From the **MONITOR** keys section on the front panel, press the **kA** (current), **V** (voltage), **kW** (power), and **Ω** (resistance) keys and observe the resulting waveforms.

NOTE: You can toggle between **PEAK** and **AVERAGE** readings by pressing the **PEAK/AVERAGE** key.

4. 

Press the **V** (voltage) key and observe the voltage waveform.

5. Observe the peak and average readings on the voltage monitor screen. Make several more welds and observe the range of voltage readings from weld to weld.

6. 
Press the Pulse 1 weld key to highlight the **upper** limit field for the weld period. Use the numeric keypad to enter the **upper limit** value for the Pulse 1 weld period. Program an upper voltage limit that is slightly above the peak voltage readings observed in step 5 above.

7. 

Press the voltage **V** key to save the setting as an upper voltage limit.

8. 
Press the **COOL** weld period key. This will bring up the **PULSE 1 OUT OF LIMITS ACTION** screen.

9. Select **1. STOP WELD**

PULSE 1 OUT OF LIMITS ACTION

1. none
2. STOP WELD
3. INHIBIT PULSE2
4. PART CONDITIONER (Stop Pulse1)

NUMBER Select, MENU Previous menu

10. 
Toggle the Pulse 1 weld key to highlight the **lower** limit field for the Pulse 1 weld period. Use the numeric keypad to enter a **lower limit** value with a voltage level that is slightly lower than the voltages observed in step 3 above.

11. 

Press the voltage **V** key to save the setting as a lower voltage limit.

12. Make several more welds and verify that under normal circumstances, the limits are not reached and the welds are not aborted. If the limits are reached under normal welding conditions, adjust the levels and times of the upper and lower voltage limits accordingly.

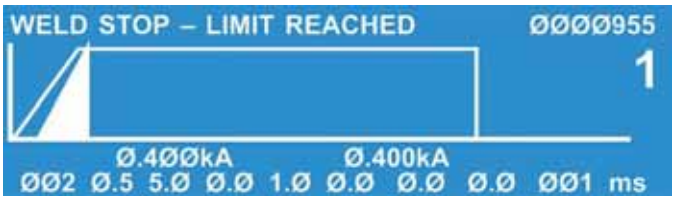
13. 

Return to the **RUN** screen and make several welds. Observe that under normal conditions, the welds are not aborted, and that consistent, strong welds can be produced.

14. Try making welds with only one part present. Also try making welds with misaligned parts. Observe that the power supply terminates the weld as soon as the voltage limits are reached. If the voltage limits are not being reached with these conditions present, return to the voltage monitor screen and adjust the limits accordingly.

15. 

Return to the **RUN** screen and make several welds. Verify that the Weld Stop function detects missing and misaligned parts.



Weld Stop Waveform

NOTE: When using the Weld Stop function, always select a monitor mode that is ***different*** from the feedback mode. For example:

- If you are welding in constant current, put limits on voltage.
- If you are welding in constant voltage, put limits on current.
- If you are welding in constant power, put limits on current or voltage.

Section IX. Energy Monitor

Press the **ENERGY** key and the screen on the right appears.

In this screen you can program upper and lower watt second limits for the first and second pulse. The display will show the calculated watt second values for the first and second pulse.

Refer to **Section III** of this chapter for specific instructions on setting upper and lower limits and out of limit actions.

Note: The upper limit applies to the entire upslope, weld and downslope time. The lower limit applies for, and is checked only, at the end of P1 and the end of P2. Note that the energy is cumulative through both pulses. The energy displayed at the end of P2 is the sum of the energy delivered during P1 and P2.

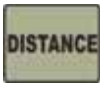
Section X. Distance Monitor

Distance Limits

Displacement

Displacement is how far the weld pieces collapsed during the weld – the difference between the initial part thickness and the final part thickness. You can place high and low limits around displacement as well.

LVDT Main Screen



From the **LVDT** keys section on the front panel, press the **DISTANCE** key and the screen on the right appears.

LVDT	POSITION +092			3600277
	LO LIM	HI LIM	LAST	
INITIAL	+000	000	+000	CONT
FINAL	+000	+000	+000	
DISPLC	+000	000	+000	XX%
STOP ENERGY AT		000	XXXX	IN/1000
NEW ELECTRODE:		IS SET		

▲▼◀▶ Arrows to select field, RUN or, MENU

NOTES:

- **POSITION** in the top row indicates the position of the top electrode relative to the bottom electrode.

  This screen shows +092, which means that the top electrode is 0.092" away (up) from the bottom electrode. The 7-digit number on the right side of the screen (**3600277** in this example) indicates the number of welds made.
- The xx% number shows the displacement as a percentage of the initial thickness
- The xxxx after the **WELD TO** limit shows the time at which the limit was reached.
- The large **1** indicates which weld schedule is currently selected.
- **SCHEDULE** in the bottom line indicates that you press the **SCHEDULE or DISTANCE** button in order to edit the LVDT screen.
- In order to get accurate initial thickness readings, squeeze time must be set to ***at least*** 1 msec.
- When you first press the **SCHEDULE** button, the **INITIAL LO LIM** is **highlighted** and the bottom line changes as shown on the right
- **RUN** in the bottom line indicates that you press the **RUN** button in order to leave the LVDT screen and return to the **RUN** screen.
- If you wish to remain in the LVDT screen, press the **DISTANCE** button ***instead of*** the **RUN** button. This will remove **highlighting**, but leave you in the LVDT screen.

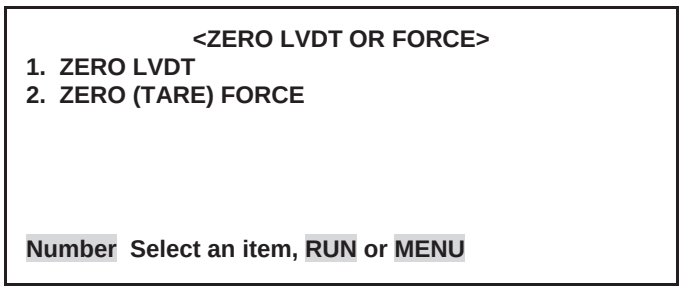
Before You Start: Set New Electrodes to "Zero"

The LVDT must have a ***zero*** reference point (for example, when the two electrodes touch each other, there is **zero** distance between them). All distances calculated by the LVDT are measured from this *zero*. When you change electrodes in your weld head or agressiveley clean the electrodes, the electrodes may not be in the same exact position as the old electrodes, so *zero* may no longer be the same, therefore you must set a new *zero*.

There are two ways to set a new *zero*: Either perform the quick calibration procedure detailed above or perform the new zero procedure detailed below. The preferred method is to set a new zero and recalibrate as detailed above.

To set a new zero ***without*** recalibration:

1. From the monitor keys section on the front panel, press the **ZERO** key. The screen on the right appears. Select option 1 for **ZERO LVDT**.

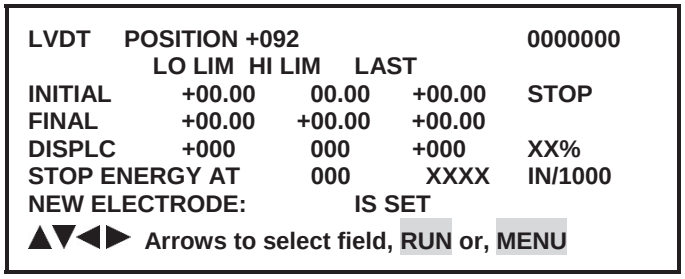


2. During the next weld, the initial position will be set to **0**.
3. The screen should now show **NEW ELECTRODE: IS SET.**

Changing from Inches to Millimeters (MM)

Before programming LVDT screens, select inches (**IN**) or millimeters (**MM**) as your units of measurement. The default is **IN**. To change to **MM**:

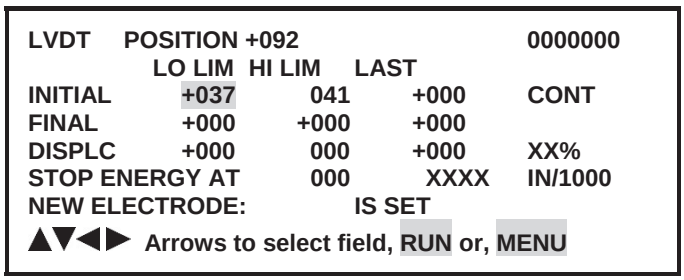
1. Press the ▲▼ buttons to scroll down to the **STOP ENERGY AT** line.



2. Press the ◀▶ keys to scroll right to **highlight IN/1000.**
3. Press the **SELECT** key to change to **MM**. This will change all fields to mm**.** Limits and last measurement data will be zeroed.

High and Low Limits for Initial Thickness

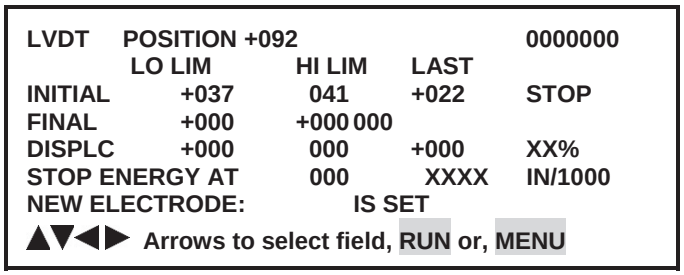
Initial thickness of the parts is measured in 1/1000 of an inch (or 1/100 of a mm). As the electrode goes down, the numbers decrease towards **zero**. Initial thickness is measured at the end of squeeze time before the weld energy flows.



1. From the main LVDT screen, press the **SCHEDULE** button to edit the screen.
2. Scroll to **INITIAL LO LIM**.
3. Use the numerical keypad on the front of the Control to enter a numerical value.
4. Scroll to **INITIAL HI LIM**.
5. Use the numerical keypad on the front of the Control to enter a numerical value.
6. Scroll to **CONT** for "Continue." If the initial thickness is out of the high or low limits, you may choose to have welding continue or stop by pressing the **PEAK/AVERAGE** button (it toggles between stop and continue).

   NOTE: If you select **CONT**, it will continue to weld even if it is out of limits. If you choose **STOP**, it will stop and not weld.
7. Verify that the weld schedule has at least 1 msec squeeze time. Amada Miyachi America recommends 150 msec.

Example: In the screen on the right, The **INITIAL LO LIM** was set to **037.0**, the **HI LIM** was set to **041.0**, and "Continue" was set to "Stop" if the parts were out of limits. This weld was stopped because the **LAST** shows only **0.022** inch, *lower* than the **INITIAL LO LIM**. This indicates a weld piece was missing or too thin.

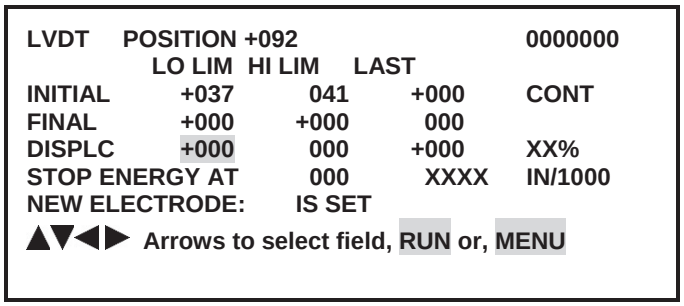


NOTE: See *Section XIV, Programming Relays* for setting relay actions.

High and Low Limits for Final Thickness

FINAL thickness is measured at the end of hold time after the weld. You can put high and low limits around final thickness. The Control will give you an alarm on the screen, which says out of limits. See *Section XIV, Programming Relays* for setting relay actions.

1. Scroll to **FINAL LO LIM**.
2. Use the numerical keypad on the front of the Control to enter a numerical value.
3. Scroll to **FINAL HI LIM**. Use the numerical keypad on the front of the Control to enter a numerical value.



High and Low Limits for Displacement

DISPLACEMENT is the change or difference between the **INITIAL** and **FINAL** thickness. You can put high and low limits around displacement. The Control will give you an alarm on the screen, which says out of limits. The percentage value shown on the right is for reference only. See *Section XIV, Programming Relays* for setting relay actions.

1. Scroll to **DISPLC LO LIM**.
2. Use the numerical keypad on the front of the Control to enter a numerical value.
3. Scroll to **DISPLC HI LIM**.

LVDT	POSITION +092			0000000
	LO LIM	HI LIM	LAST	
INITIAL	+037	041	+000	CONT
FINAL	+000	+000	000	
DISPLC	+000	000	+000	XX%
STOP ENERGY AT		000	XXXX	IN/1000
NEW ELECTRODE:		IS SET		

▲▼◀▶ Arrows to select field, RUN or, MENU

4. Use the numerical keypad on the front of the Control to enter a numerical value.

STOP ENERGY AT: (Weld to a Specific Displacement)

You can program the LVDT to stop the current flow in the middle of the weld once it has reached a specific displacement.

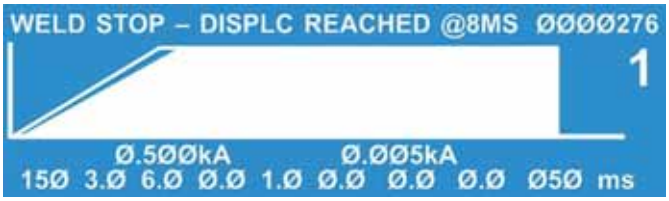
1. From the main LVDT screen, press the **SCHEDULE** button to edit the screen.
2. Scroll to **WELD TO.**
3. Use the numerical keypad on the front of the Control to enter a numerical value of the displacement when you want the weld energy to stop.

Example: On the LVDT screen, the results show that the **STOP ENERGY AT** displacement was programmed for **003"**. The **STOP ENERGY AT** number will always be less than the actual displacement. The actual displacement was **+010"** as shown in the **LAST** column (Last Weld). The time at which the weld reached the displacement limit is shown in the **LAST** column.

WELD STOP-DISPLC REACHED			@8MS	0000283	
	LO LIM	HI LIM	LAST		
INITIAL	+000	000	+056	CONT	2
FINAL	+000 +	+000	+046		
DISPLC	+000	000	+010	18%	
STOP ENERGY AT		003	008	IN/1000	
NEW ELECTRODE:		IS SET			

▲▼◀▶ Arrows to select field, RUN or, MENU

On the **RUN** screen, the same information is displayed on the right. The current (shaded graph) was turned OFF before the programmed time because the **WELD TO** thickness was reached.



NOTE: See relay screens for options to signal operators or automation of errors.

Section XI. Force Monitor

Force Limits

Description

Force Control (**FORCE OUTPUT**) can control one electronic pressure regulator. This electronic pressure regulator is often referred to as a proportional valve. Output Force is programmed in **lbs**, **kg** or **N** using front panel controls. Once the Operator calibrates the output and programs the Output Force, the Control converts this to the correct voltage to be sent to the electronic pressure regulator in order to get the desired force. Calibration is a simple 2-step procedure using front panel controls, See *Appendix C, Calibration* for details.

Operation

The electronic pressure regulator attached to the Control should have an association of 0-5V = 0-100 psi or 0-10V = 0-100 psi depending on the type of regulator used. To measure force a sensor has to be connected to the Control (0 – 5V or 0 – 10V, depending on the sensor type). See *Appendix B, Electrical and Data Connections* for details on making the **FORCE SET** and **FORCE READ** connections.

FORCE & LIMITS Main Screen

Press the **FORCE** key and the screen on the right appears.

```
                < FORCE & LIMITS >
PROP VALVE OUTPUT FORCE : 010.0 LBS

                LO LIM      HI LIM      LAST
WELD START      000.0LBS    000.0LBS    000.0LBS
WELD END        000.0LBS    000.0LBS    000.0LBS
ACTION: CONTINUE
```

- **PROP VALVE OUTPUT FORCE:** Enter the desired force at the electrode.
- **WELD START Force Limits:** Enter the desired low and high force limits. The force will be measured at the end of **SQUEEZE** and displayed in the **LAST** position.
- **WELD END Force Limits:** Enter the desired low and high force limits. The force will be measured at the end of **HOLD** and displayed in the **LAST** position.
- **ACTION:**
  - **CONTINUE** will allow the weld to continue and only give an **OUT OF LIMIT** message.
  - **STOP** will stop the weld process.

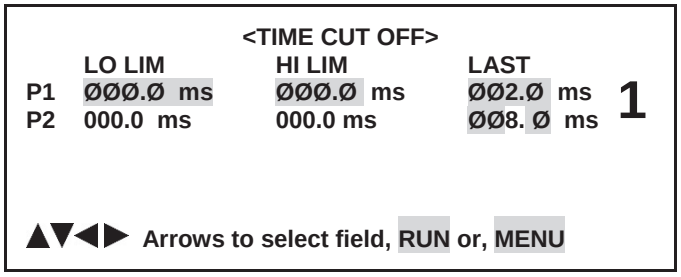
Section XII. Time Limits

Time

The function of the time screen is to allow the user to program limits around the Cut Off time. The Cut Off time is defined as the time when the control system commands current to turn off because it reached a user-programmed limit. For both P1 and P2, this time is measured from the start of the first pulse. Setting a value to zero turns off that limit.

In order for this function to accept limits, a monitor limit must be set. They can be based on current, voltage, power, energy, resistance, envelope or displacement. If multiple limits are set for "weld to" the time cut off limits will apply to the value that actually terminates the weld.

There are upper and lower limits for Cut Off time for P1 and for P2. See Chapter 3 to program relay actions corresponding to these time limits.

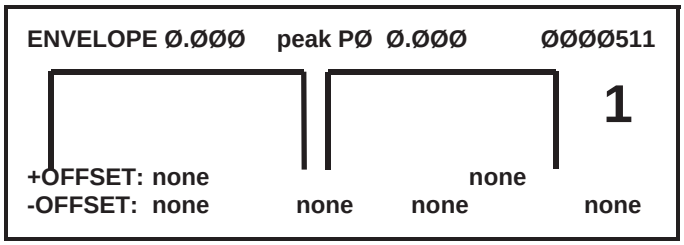


Section XIII. Envelope Limits

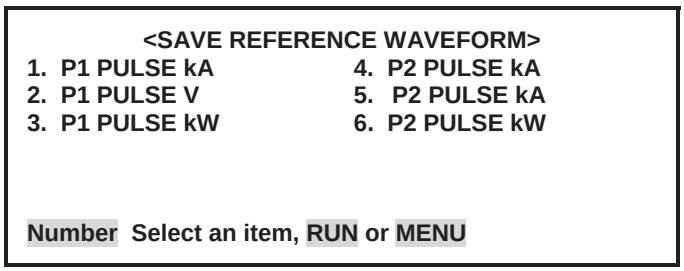
Operation of Envelope

The user can program a limit around a reference waveform for current, voltage or power for **Pulse 1** and **Pulse 2**. Different modes can be selected for **Pulse 1** and **Pulse 2**.

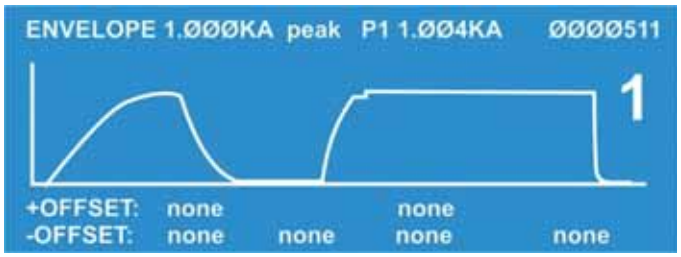
1. Press the **ENVELOPE** button to call up the envelope screen.
2. Push **SELECT to choose a reference waveform for Pulse 1 and Pulse 2**



3. Press **1**, **2** or **3** to select the reference waveform for **Pulse 1**. Press **4**, **5** or **6** to select the reference waveform for **Pulse 2**.



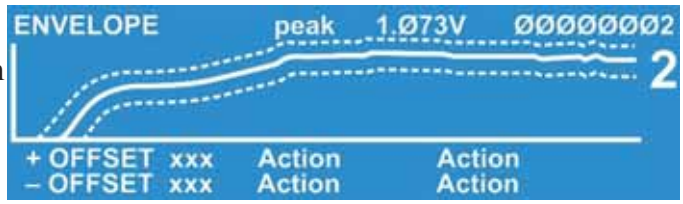
4. The screen on the right shows a current reference waveform for both **P1** and **P2**.



5.  Press the **P1 Time/Energy Selector** key to input the ***upper*** offset from the reference waveform for **P1**.
6. Press the **P1 Time/Energy Selector** key again to input the ***lower*** offset from the reference waveform for **P1**.
7. Repeat this process for **P2** if desired.
8. Push the **Upslope** key to adjust the time over which these limits apply.

NOTES:

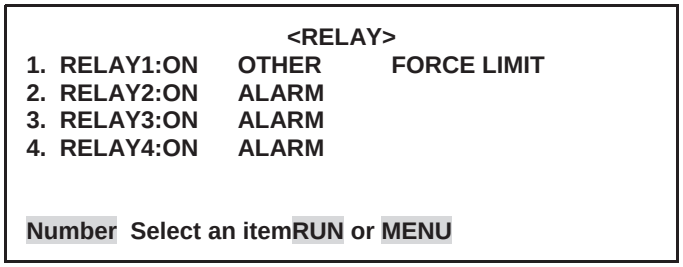
- The Graphic will scale to fit the screen as positive and negative offsets are programmed.



- From any **RUN** screen pushing the envelope key will bring up the envelope type limit for the first pulse. Pressing it again will switch to the From the **RUN** screen, you will go directly to whichever mode has the envelope limits.

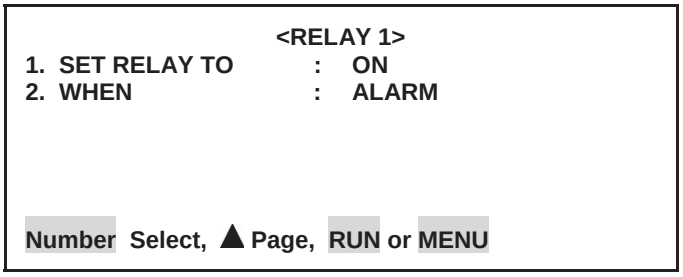
Section XIV. Programming Relays

1. From the **MAIN MENU**, press the **7** key to go to the **RELAY** output state selection menu, shown at the right. The Control has four relays that can provide dry-contact signal outputs under many different conditions.

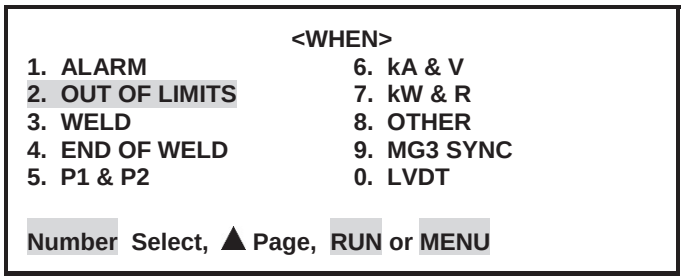


See *Appendix C, System Timing* for the timing diagrams for the four relays.

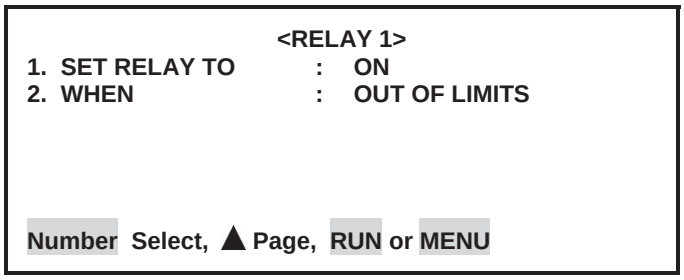
2. From the **RELAY** menu, press the **1** key to go to **RELAY 1** shown at the right.
3. Press the **1** key to toggle the relay contact signal state: **ON** (closed) or **OFF** (open).



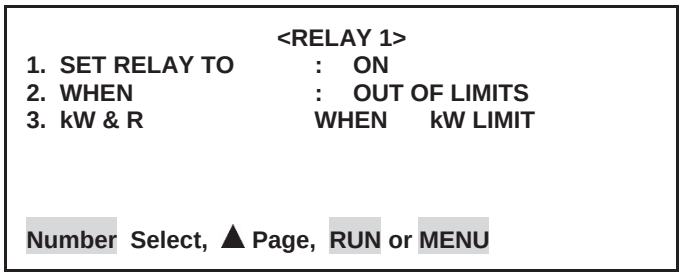
4. Press the **2** key to select the **WHEN** menu, shown at the right.

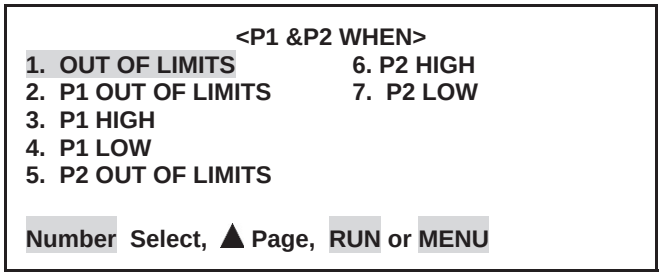


5. Press the **2** key to select **OUT OF LIMITS** as the condition for initiating the **Relay 1** output signal. This will bring up the **RELAY 1** menu screen, where the **WHEN** line will now reflect **OUT OF LIMITS.**

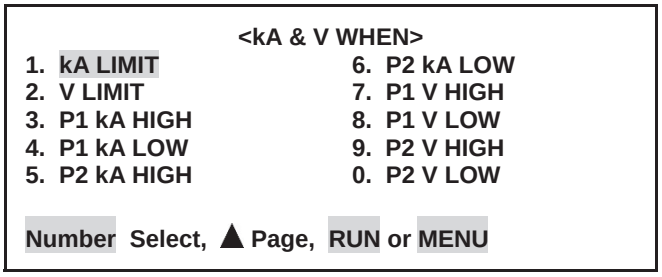


6. Choosing **WHEN** options **1 - 4** or **9** will complete the relay programming process. Choosing options **5 - 8** or **0** will bring up the **RELAY** (**1, 2, 3,** or **4**) screen with a ***new*** option, number **3**. Press **3** to access the next level menus which are shown on the next page.

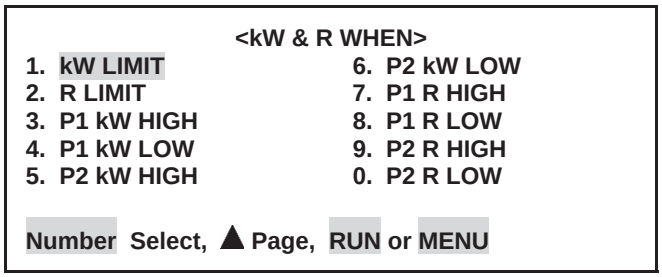




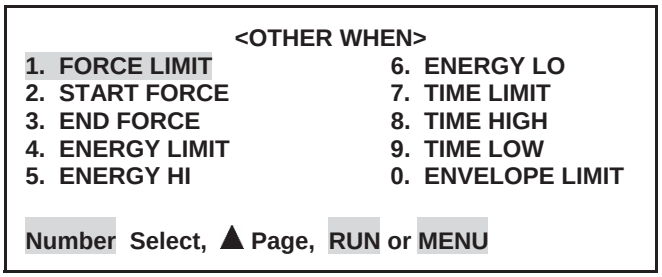
Option #5



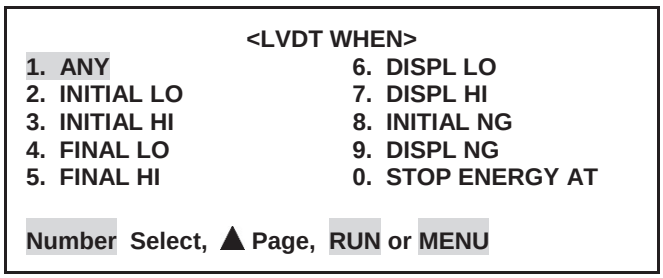
Option #6



Option #7



Option #8



Option #9

CHAPTER 6
Maintenance

Section I. Introduction

General Kinds of Problems

It has been our experience that most resistance welding power supply 'problems' are caused by lack of material control, process control and electrode tip surface maintenance. The problems that you might encounter fall into two groups:

- **Soft** — The problem is transient, and you can correct it by resetting the system or parameter limits. For example, you should ensure that:
  - Correct force is set at the weld head
  - Correct weld energy and time is set at the Control
  - The equipment is set up properly
  - All electrical connections are tight
  - Electrode alignment allows flush contact with the weld pieces
  - Electrodes are properly dressed
- **Hard** — The problem is embedded in the system and some form of repair will be needed. For example, repair might include replacing a broken weld head flexure.

Alarm Messages

Built-in automatic self-test and self-calibration routines will bring up alarm messages on the display screens. These messages will usually let you know what action is required of you to correct the reason for the alarm. For a complete listing of the alarm messages, what they mean, and corrective actions, see *Section II, Troubleshooting*.

Section II. Troubleshooting

Troubleshooting

Problem	Cause (in order of probability)	Problem	Cause (in order of probability)
Electrode Damage	1. Excessive current/energy set at HF27/25 1. Excessive or insufficient weld head force 1. Wrong electrode tip shape 2. Excessive weld time set at HF27/25 2. Contaminated weld piece surface/ plating 2. Wrong electrode material 2. Contaminated electrode surface	Electrode Sparking	1. Excessive current/energy set at HF27/25 1. Insufficient weld head force 1. Slow weld head follow-up 1. Incompatible weld piece projection design 1. Contaminated weld piece surface/ plating 1. Wrong electrode tip shape 2. Wrong electrode material 2. Contaminated electrode surface
Electrode Sticking	1. Contaminated weld piece surface/ plating 1. Wrong electrode material/ tip shape 1. Insufficient weld head force 2. Excessive current/energy set at HF27/25 2. Excessive weld time set at HF27/25 2. Contaminated electrode surface 3. Slow weld head follow-up	Weld Piece Warping	1. Excessive weld time set at HF27/25 1. Excessive weld head force 1. Incompatible weld piece projection design 2. Incompatible weld piece materials 2. Wrong electrode tip shape 3. Excessive current/energy set at HF27/25
Insufficient Weld Nugget	1. Insufficient current/ energy set at HF27/25 1. Wrong electrode material/ tip shape 1. Worn/mushroomed electrodes 2. Insufficient weld time set at HF27/25 2. Incorrect weld head polarity 2. Contaminated weld piece surface/ plating 2. Excessive weld head force 3. Insufficient weld head force 3. Contaminated electrode surface 3. Incompatible weld piece projection design 3. Slow weld head follow-up 4. Incompatible weld piece materials 4. No cover gas on weld piece	Metal Expulsion	1. Excessive current/energy set at HF27/25 1. Insufficient weld head force 1. Slow weld head follow-up 1. Incompatible weld piece projection design 2. Contaminated weld piece surface/ plating 2. Incompatible weld piece materials 2. Contaminated electrode surface 2. Wrong electrode tip shape 3. No cover gas on weld piece 4. Excessive weld time set at HF27/25

Problem	Cause (in order of probability)	Problem	Cause (in order of probability)
Weld Piece Over-heating	1. Excessive weld time set at HF27/25 2. Excessive current/energy set at HF27/25 2. Insufficient weld head force 3. Incompatible weld piece materials 3. Wrong electrode material/tip shape 4. Contaminated electrode surface	Weld Piece Discoloration	1. Excessive weld time set at HF27/25 1. No cover gas on weld piece 2. Excessive current/energy set at HF27/25 3. Insufficient weld head force 3. Contaminated weld piece surface/ plating 4. Wrong electrode material/tip shape 4. Contaminated electrode surface

Alarm Messages

Alarm Message	Description	Corrective Action
#01 CHECK CONTROL SIGNALS INPUT STATUS	One or more of the I/O input control signals is preventing the HF27/25 from continuing to operate.	Remove the I/O input control signal condition preventing further HF27/25 operation. **NOTE:** The correct removal action depends on how the control signal select in the Setup 1 menu was programmed by the user.
#02 CHECK INPUT SWITCH STATUS	All bits on the remote schedule input port are set ON.	Hardware problem. Repeated displays of this message should be diagnosed and fixed by a technician.
#03 FIRING SWITCH BEFORE FOOT SWITCH	The Firing Switch input has been activated before the Foot Switch has been activated, preventing weld current from flowing.	Check the weld head for an improperly adjusted firing switch. Automation Only - Check the timing on the PLC control lines to the Firing Switch and Foot Switch inputs.
#04 EMERGENCY STOP ON CONTROL SIGNALS INPUT	The Process Stop signal on the CONTROL SIGNALS connector has been activated, immediately terminating weld current.	Remove the Process Stop activating signal from the CONTROL SIGNALS connector.
#05 POWER TRANSISTOR OVERHEATED	The power dissipated by the power transistors has exceeded the HF27/25 specified capability.	Reduce duty cycle. Reduce weld time.
#06 EMERGENCY STOP - OPERATOR ACTIVATED	The Operator Emergency Stop switch has been activated. All power to the HF27/25 is immediately terminated.	Remove any unsafe operating conditions at the welding electrodes. Reset the Operator Emergency Stop switch. Turn off power to the HF27/25, then turn it on again
#07 FIRING SWITCH DIDN'T CLOSE IN 10 SECONDS	The Firing Switch on a Miyachi Unitek air actuated weld head did not activate within 10 seconds after the Foot Switch was initially activated.	Press RUN and readjust the air pressure to the Miyachi Unitek air actuated weld head.

Alarm Message	Description	Corrective Action
#08 WELD TRANSFORMER OVERHEATED	Software detected that the welding transformer is too hot.	Allow transformer to cool. If repeated displays of this message, allow more cool time between welds or, if practical, weld at a lower heat setting.
#9 Test Weld	The voltage mode PID's will be adjusted when the next weld is done.	None.
#10 VOLTAGE SELECTION PLUG IS MISSING	The Voltage Selection Plug on the Weld Transformer is missing or improperly connected.	Verify the Voltage Selection Plug connection on the Weld Transformer.
#11 INHIBIT CONTROL SIGNALS ACTIVATED	The Inhibit input control signal is activated, preventing the HF27/25 from continuing to operate. **NOTE:** Activating the Inhibit input terminates only future operations. It does NOT terminate any present HF27/25 operation.	Remove the Inhibit signal condition preventing further HF27/25 operation. **NOTE:** The correct removal action depends on how the control signal I/O logic was programmed by the user.
#13 NO CURENT READING	Previous weld current was below minimum value.	Check current pickup.
#14 NO VOLTAGE READING	Previous weld voltage was below minimum value.	Check voltage pickup.
#15 LOAD RESISTANCE TOO HIGH	The total electrical resistance, comprised of the weld cables, weld head, and parts to be welded, has exceeded the drive capability of the HF27/25. The HF27/25 will not be able to maintain the user set weld parameters.	Reduce the total electrical resistance by reducing the weld cable length. Reduce the total electrical resistance by increasing the weld cable diameter. Check cable and weld head connections. Verify that all three phases from the input power lines are functioning
#16 NO WELD TRANSFORMER DETECTED	Cable connecting the Control and Power PCB's is open. Cable connecting the Power PCB to the Weld Transformer is open.	Verify installation of the welding transformer/rectifier module connections.
#17 WELD SWITCH IN NO WELD POSITION	User has tried to activate the HF27/25 with the Weld/No Weld Switch in the No Weld Position. No weld current will flow.	Set the Weld/No Weld switch to the Weld position.
#18 CHECK INPUT SWITCH STATUS	One or more of the Firing or Foot Switch input signals is preventing the HF27/25 from continuing to operate.	Remove the I/O input control signal condition preventing further HF27/25 operation. **NOTE:** The correct removal action depends on how the INPUT SWITCH SELECT in the Setup 1 menu was programmed by the user.

Alarm Message	Description	Corrective Action
#18 CHECK VOLTAGE CABLE	No electrode voltage measurement was made.	Verity that the Voltage Sense Cable is properly connected to the electrodes or electrode holder. **NOTE:** Polarity is not important for the cable connection.
#19 CALIBRATION VALUES RESET TO DEFAULT	User entered calibration values reset to factory default values.	Execute the built-in calibration procedure to get the correct setting.
#20 LOWER LIMIT GREATER THAN UPPER LIMIT	The user has tried to program a Lower Limit value that is greater than the Upper Limit value for Weld1 or Weld2 time periods.	Re-program the invalid Lower Limit value.
#23 SYSTEM & SCHEDULE RESET TO DEFAULTS	User programmed the HF27/25 to automatically reset all 100 weld schedules, I/O and other system parameters to their factory set default values.	**CAUTION:** Be careful when using the MENU default features. There is no way to restore a default action.
#26 SAFE ENERGY LIMIT REACHED	The HF27/25 internal power dissipation has exceeded the HF27/25 specified capability.	Reduce duty cycle. Reduce weld time.
#31 UPSLOPE REQUIRED FOR LOWER LIMIT	User has programmed a Lower Limit value for Weld1 or Weld2 periods without using an upslope period. The HF27/25 will automatically stop when activated because the starting weld energy will always be lower than the Lower Limit.	Delete the Weld1 or Weld2 Lower Limit value. Add an upslope period before Weld1 or Weld2 if a Lower Limit value is desired.
#32 INPUT TOO LARGE	The user has attempted to program a weld energy or time that exceeds the capability of the HF27/25.	Re-program welding parameters to be within the capability of the HF27/25.
#33 INPUT TOO SMALL	The user has attempted to program a weld energy or time that is below the capability of the HF27/25.	Re-program welding parameters to be within the capability of the HF27/25.
#38 LIMIT DELAYS RESET TO 0	Sum of Pulse 1 or Pulse 2 delays exceeded scheduled time for a pulse limit check.	Revisit Pulse 1 or Pulse 2 delays and set them to acceptable values.
#39 ACCESS DENIED! SYSTEM SECURITY ON	Operator tried to change a weld schedule number, individual weld schedule parameters, I/O switch functions, and calibration parameters.	Press MENU, select System Security, then enter the correct access code to turn off the System or Calibration Lock protection features. **NOTE:** Entering a security code of 280 will always unlock the system.

Alarm Message	Description	Corrective Action
#40 ILLEGAL SECURITY CODE ENTERED	The wrong security code was entered to de-activate the System, Schedule, or Calibration Lock protection features.	Press MENU, select System Security, then enter the correct access code to turn off System, Schedule, or Calibration Lock protection features. **NOTE:** Entering a security code of 280 will always unlock the system.
#47 ACCESS DENIED! SCHEDULE LOCK ON	Operator tried to change a weld schedule or individual weld parameters.	Press MENU, select System Security, then enter your access code to turn off System Security. **NOTE:** Entering a security code of 280 will always unlock the system.
#48 INITIAL THICKNESS – LO	At start of weld, the LVDT position was outside the lower limit.	Check/Calibrate LVDT. At the Distance Screen, consider a lower initial LO LIM or removing this limit check by setting it to zero.
#49 INITIAL THICKNESS – HI	At start of weld, the LVDT position was outside the upper limit.	Check/Calibrate LVDT. At the Distance Screen, consider a higher initial HI LIM or removing this limit check by setting it to zero.
#50 FINAL THICKNESS – LO	At end of of weld, the LVDT position was outside the lower limit.	Check/Calibrate LVDT. At the Distance Screen, consider a lower final LO LIM or removing this limit check by setting it to zero.
#51 FINAL THICKNESS – HI	At end of weld, the LVDT position was outside the upper limit.	Check/Calibrate LVDT. At the Distance Screen, consider a higher final HI LIM or removing this limit check by setting it to zero.
#52 DISPLACEMENT – LO	Measured displacement from start of weld to end of weld was less than the expected lower limit.	Check/Calibrate LVDT. At the Distance Screen, consider a setting wider initial/final limits or removing this limit checks altogether by setting them to zero.
#53 DISPLACEMENT – HI	Measured displacement from start of weld to end of weld was more than the expected upper limit.	Check/Calibrate LVDT. At the Distance Screen, consider a setting wider initial/final limits or removing this limit checks altogether by setting them to zero.
#54 WELD STOP DISPLACEMENT REACHED	Weld was terminated when the measured displacement reached the weld stop limit.	None required, if this action is desired. Otherwise, clear the weld stop displacement action on the Distance Screen by setting STOP ENERGY AT to zero.
#55 P1 CURRENT 1 > THAN UPPER LIMIT	Actual weld current is greater than the user set Upper Limit value for Weld1 at the Current Monitor screen	Reset the Upper Limit for Weld1 to a larger value.
#56 P1 CURRENT 1 < THAN LOWER LIMIT	Actual weld current is less than the user set Lower Limit value for Weld1 at the Current Monitor screen.	Weld splash can cause the actual weld current to drop below the user set Lower Limit for Weld1. Add upslope to reduce weld splash. Reset the lower Limit for Weld1 to a smaller value.

Alarm Message	Description	Corrective Action
#57 P1 VOLTAGE > THAN UPPER LIMIT	Actual weld voltage is greater than the user set Upper Limit value for Weld1 at the Voltage Monitor screen.	Weld splash can cause the actual weld voltage to exceed the user set Upper Limit for Weld1. Add upslope to reduce weld splash. Reset the Upper Limit for Weld1 to a larger value.
#58 P1 VOLTAGE < THAN LOWER LIMIT	Actual weld voltage current is less than the user set Lower Limit value for Weld1 at the Voltage Monitor screen.	Reduce the weld cable length or increase the diameter of the weld cables. Reset the Lower Limit for Weld1 to a smaller value.
#59 P1 POWER 1 > THAN UPPER LIMIT	Actual weld power is greater than the user set Upper Limit value for Weld1 at the Power Monitor screen.	Weld splash can cause the actual weld power to exceed the user set Upper Limit for Weld1. Add upslope to reduce weld splash. Reset the Upper Limit for Weld1 to a larger value.
#60 P1 POWER 1 < THAN LOWER LIMIT	Actual weld power is less than the user set Lower Limit value for Weld1 at the Power Monitor screen.	Weld splash can cause the actual weld power to drop below the user set Lower Limit for Weld1. Add upslope to reduce weld splash. Reset the Lower Limit for Weld1 to a smaller value.
#61 P1 RESISTANCE > THAN UPPER LIMIT	Actual weld resistance is greater than the user set Upper Limit value for Weld1 at the Resistance Monitor screen.	Weld splash can cause the actual weld resistance to exceed the user set Upper Limit for Weld1. Add upslope to reduce weld splash. Reset the Upper Limit for Weld1 to a larger value.
#62 P1 RESISTANCE < THAN LOWER LIMIT	Actual weld resistance is less than the user set Lower Limit value for Weld1 at the Resistance Monitor screen.	Reduce the electrical resistance of the material being welded.. Reset the Lower Limit for Weld1 to a smaller value.
#65 SCHEDULES ARE RESET	User programmed the HF27/25 to automatically reset all 100 weld schedules to their factory set default values.	**CAUTION:** Be careful when using the MENU default features. There is no way to restore a default action.
#66 SYSTEM PARAMETERS ARE RESET	User programmed the HF27/25 to automatically reset all I/O and other system parameters to their factory set default values.	**CAUTION:** Be careful when using the MENU default features. There is no way to restore a default action.
#69 WELD TIME TOO SMALL	The user has attempted to program zero for all upslope, weld, and downslope time periods.	Re-program the welding parameters to be within the capability of the HF27/25.
#71 P1 CURRENT 2 > THAN UPPER LIMIT	Actual weld current is greater than the user set Upper Limit value for Weld2 at the Current Monitor screen.	Reset the Upper Limit for Weld2 to a larger value.

Alarm Message	Description	Corrective Action
#72 CURRENT 2 < THAN LOWER LIMIT	Actual weld current is less than the user set Lower Limit value for Weld2 at the Current Monitor screen.	Weld splash can cause the actual weld current to drop below the user set Lower Limit for Weld2. Add upslope to reduce weld splash. Reset the lower Limit for Weld2 to a smaller value.
#73 P2 VOLTAGE > THAN UPPER LIMIT	Actual weld voltage is greater than the user set Upper Limit value for Weld2 at the Voltage Monitor screen.	Weld splash can cause the actual weld voltage to exceed the user set Upper Limit for Weld2. Add upslope to reduce weld splash. Reset the Upper Limit for Weld2 to a larger value.
#74 P2 VOLTAGE < THAN LOWER LIMIT	Actual weld voltage current is less than the user set Lower Limit value for Weld2 at the Voltage Monitor screen.	Reduce the weld cable length or increase the diameter of the weld cables. Reset the Lower Limit for Weld2 to a smaller value.
#75 P2 POWER 2 > THAN UPPER LIMIT	Actual weld power is greater than the user set Upper Limit value for Weld2 at the Power Monitor screen.	Weld splash can cause the actual weld power to exceed the user set Upper Limit for Weld2. Add upslope to reduce weld splash. Reset the Upper Limit for Weld2 to a larger value.
#76 P2 POWER < THAN LOWER LIMIT	Actual weld power is less than the user set Lower Limit value for Weld2 at the Power Monitor screen.	Weld splash can cause the actual weld power to drop below the user set Lower Limit for Weld2. Add upslope to reduce weld splash. Reset the Lower Limit for Weld2 to a smaller value.
#80 WELD STOP - LIMIT REACHED	The user set Upper Limit value has been exceeded and automatically terminated the weld energy.	This is a MONITOR LIMITS feature activated by the selecting the ENERGY key, then programming the Upper Limit values for Weld1 and Weld2. If the terminated weld energy is not adequate for the weld, re-set the Upper Limit values for Weld1 and Weld2.
#93 THIN MUST BE LESS THAN THICK	During LVDT gauge calibration, the thin value is greater than or equal to the thick value.	Restart LVDT gauge calibration procedure.
#94 THICK TOO SMALL	During LVDT gauge calibration, the LVDT calibration thickness < minimum delta.	Restart LVDT gauge calibration procedure.
#95 P1 JOULES > UPPER LIMIT	Pulse 1 energy in Joules exceeded the upper limit.	Joules is power over time. If welds are good and message consistently happens, decrease the power, shorten the time, or change the limit.
#96 P1 JOULES < LOWER LIMIT	Pulse 1 energy in Joules did not reach the lower limit.	Joules is power over time. If welds are good and message consistently happens, increase the power, increase the time, or change the limit.

Alarm Message	Description	Corrective Action
#97 P2 JOULES > UPPER LIMIT	Pulse 2 energy in Joules exceeded the upper limit.	Joules is power over time. If welds are good and message consistently happens, decrease the power, shorten the time, or change the limit.
#98 P2 JOULES < LOWER LIMIT	Pulse 2 energy in Joules did not reach the lower limit.	Joules is power over time. If welds are good and message consistently happens, increase the power, increase the time, or change the limit.
#100 P1 CUTOFF TIME > UPPER LIM	Pulse 1 ended after the cutoff time upper limit.	This message usually signals a bad weld. If it consistently happens and the welds are good, set the time limits broader or remove them altogether.
#101 P1 CUTOFF TIME < LOWER LIM	Pulse 1 ended before the cutoff time lower limit.	This message usually signals a bad weld. If it consistently happens and the welds are good, set the time limits broader or remove them altogether.
#102 P2 CUTOFF TIME > UPPER LIM	Pulse 2 ended after the cutoff time upper limit.	This message usually signals a bad weld. If it consistently happens and the welds are good, set the time limits broader or remove them altogether.
#103 P2 CUTOFF TIME < LOWER LIM	Pulse 2 ended before the cutoff time lower limit.	This message usually signals a bad weld. If it consistently happens and the welds are good, set the time limits broader or remove them altogether.
#105 P1 FORCE > UPPER LIMIT	Measured force during Pulse 1 was greater than the upper force limit.	Check force calibration. If welds are good and message consistently happens, set force limits broader or remove them altogether.
#106 P1 FORCE < LOWER LIMIT	Measured force during Pulse 1 was less than the lower force limit.	Check force calibration. If welds are good and message consistently happens, set force limits broader or remove them altogether.
#107 P2 FORCE > UPPER LIMIT	Measured force during Pulse 2 was greater than the upper force limit.	Check force calibration. If welds are good and message consistently happens, set force limits broader or remove them altogether.
#108 P2 FORCE < LOWER LIMIT	Measured force during Pulse 2 was less than the user lower force limit.	Check force calibration. If welds are good and message consistently happens, set force limits broader or remove them altogether.
#109 NEED TO SET MONITOR LIMIT	AN ATTEMPT TO SET A LIMIT ON THE TIME/ENERGY SCREEN FAILED BECAUSE A MONITOR LIMIT MUST BE PRESENT BEFORE THIS ACTION IS ALLOWED.	Set a monitor limit. Re-do the action that failed.

Alarm Message	Description	Corrective Action
#110 ACCESS DENIED! CALIBRATION LOCK ON	System security has locked out calibration changes.	Unlock calibration changes at the system security screen.
#111 SQUEEZE TIME INCREASED	Squeeze time increased for the MG3. The MG3 must have a squeeze time of at least 50ms. If programmed squeeze time is less than this it is forced to that value.	None.
#112 P1 kA > ENV UPPER LIMIT	Pulse 1 current exceeded the envelope upper limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#113 P1 kA < ENV LOWER LIMIT	Pulse 1 current did not reach the envelope lower limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#114 P1 VOL > ENV UPPER LIMIT	Pulse 1 voltage exceeded the envelope upper limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#115 P1 VOL < ENV LOWER LIMIT	Pulse 1 voltage did not reach the envelope lower limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#116 P1 PWR > ENV UPPER LIMIT	Pulse 1 power exceeded the envelope upper limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#117 P1 PWR < ENV LOWER LIMIT	Pulse 1 power did not reach the envelope lower limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#118 P1 DISP > ENV UPPER LIMIT	Pulse 1 LVDT displacement exceeded the envelope upper limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#119 P1 DISP < ENV LOWER LIMIT	Pulse 2 LVDT displacement did not reach the envelope lower limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#120 P2 kA > ENV UPPER LIMIT	Pulse 2 current exceeded the envelope upper limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#121 P2 kA < ENV LOWER LIMIT	Pulse 2 current did not reach the envelope lower limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#122 P2 VOL > ENV UPPER LIMIT	Pulse 2 voltage exceeded the envelope upper limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#123 P2 VOL < ENV LOWER LIMIT	Pulse 2 voltage did not reach the envelope lower limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.

Alarm Message	Description	Corrective Action
#124 P2 PWR > ENV UPPER LIMIT	Pulse 2 power exceeded the envelope upper limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#125 P2 PWR < ENV LOWER LIMIT	Pulse 2 power did not reach the envelope lower limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#126 P2 DISP > ENV UPPER LIMIT	Pulse 2 LVDT displacement exceeded the envelope upper limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.
#127 P2 DISP < ENV LOWER LIMIT	Pulse 2 LVDT displacement did not reach the envelope lower limit.	If welds are good and message consistently happens, set envelope limits broader or remove them altogether.

Section III. Maintenance

Electrode Maintenance

When a welding schedule has been suitable for a particular welding application over many welds, but poor quality welds are now resulting, electrode deterioration could be the problem. If you need to increase welding current to maintain the same weld heat, the electrode tip has probably increased in surface area (mushroomed), effectively increasing weld current density, thus cooling the weld. Try replacing the electrodes.

The rough surface of a worn electrode tip tends to stick to the work pieces. So, periodic tip resurfacing (dressing) is required to remove pitting, oxides and welding debris from the electrode. You should limit cleaning of an electrode on the production line to using a #400-600 grit electrode polishing disk. If you must clean a badly damaged tip with a file, you must use a polishing disk after filing to ensure the electrode faces are smooth.

The best method of preventing electrode problems is to regularly re-grind electrode tip surfaces and shapes in a certified machine shop.

Parts Replacement

Below is a list of the replacement parts for the Control. All items listed are a quantity of 1 each.

WARNING: Only qualified technicians should perform internal adjustments or replace parts. Removal of the unit cover could expose personnel to high voltage and may void the warranty.

Part Description	Amada Miyachi America Part Number	Location
Input Power Line Protection Fuses F1 and F2:		Rear Panel
HF27/240	330-071	
HF27/400	330-092	
HF27/480	330-092	
Control Power Protection Fuse F1	330-078	Power PCB
Input Power Selection Plug Set:		Welding Transformer Chassis
240 Volts	4-34314-01	
400 Volts	4-34315-01	
480 Volts	4-34316-01	

Section III. Repair Service

If you have problems with your Control that you cannot resolve, please contact our service department at the address, phone number, or e-mail address indicated in the Foreword of this manual.

APPENDIX A
Technical Specifications

NOTE: The specifications listed in this appendix may be changed without notice.

Power

Input Power Line ..... 50-60 Hz, 3 phase

Input Voltage Range at Maximum Output Current

HF27/240 .....216-264 VAC at 25A
HF27/400 .....360-440 VAC at 20A
HF27/480 .....432-528 VAC at 13A

Input kVA (Demand) .....30 kVA max at 3% duty cycle

Output Power at 12% Duty Cycle and a Combined PULSE 1 and PULSE 2 Pulse Width of 50 ms .....6.0 kW max

Maximum Output Current 2400A

Max Peak Output Voltage at Max Peak Output Current.....5.2V

Duty Cycle at Max Peak Output Current..... 3%

Max Load Resistance for Max Output Current..... 2.1mΩ

Output Adjustment Range, Resolution and Accuracy

NOTE: Actual maximum and minimum current, voltage or power achievable depends on transformer and load resistance.

Parameter	Adjustment Range	Resolution (Steps)	Accuracy
Current	100 - 2400 A	0.001 kA	± (2% of setting +2A)
Voltage	0.2 - 9.99 V	0.001 V	± (2% of setting +0.02V)
Power	0.05-9.99 kW	0.001 kW	± (5% of setting +10W)
Weld Periods	0.0 - 9.9 ms 10 - 99 ms	0.1 ms 1.0 ms	± 20 µs

Physical Specifications

Size: .....(see illustration)

Weight ..... 62 lbs. (28 kg)

Performance Capabilities

Number of Weld Schedules.....100

Programmable Weld Periods:

Squeeze .....0 - 999 ms
Upslope 1 .....0 - 99 ms
Weld 1 .....0 - 99 ms
Downslope 1 .....0 - 99 ms
Cool .....0 - 99 ms
Upslope 2 .....0 - 99 ms
Weld 2 .....0 - 99 ms
Downslope 2 .....0 - 99 ms
Hold .....0 - 999 ms

Weld Energy Limits Monitoring

Energy Limit Mode: Terminate weld energy upon reaching the programmed current, voltage, power or resistance alarm level.

Weld Pre-Check Mode: Inhibit second weld pulse when first test pulse exceeds programmed limits.

Measurement Parameters: Current, voltage and power.

Measurement Selection: Peak or average.

Measurement Range and Accuracy:

Parameter	Range	Accuracy
Current	0.1 - 2.4 kA	± (2% of setting +2A)
Voltage	0.2 - 9.999 V	± (2% of setting +0.02V)
Power	0.05 - 9.999 kW	± (5% of setting +10W)

Limit Ranges: Same as the measurement ranges

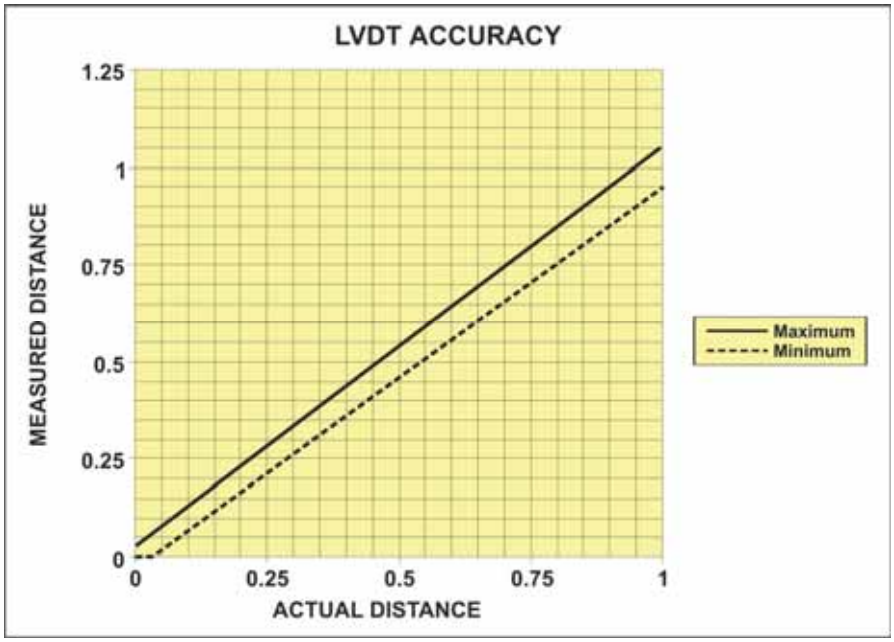
Alarms: Display alert and four programmable AC/DC relay contact outputs.

Force Specifications

Force Set Output Range: 0 – 5 VDC and 0-10 VDC
Force Set Output Accuracy: +/- (3.0% + 0.1 lb)
Force Read Input Range: 0 – 5 VDC and 0-10 VDC
Force Read Input Accuracy: +/- (3.0% + 0.1 lb)

LVDT Specifications

Stroke: 1.0” (25.4mm) maximum
Absolute Accuracy: See Following Graph
Weld Displacement Accuracy: 0.003” (0.076mm)
Displayed Resolution: 0.001” (0.01mm)
Measurement Resolution: 0.00025” (0.006mm)
Repeatability: 1%
Maximum Weld Rate: 2 weld per second



NOTE: The suggested minimum weld force to use with the LVDT is **2 lbs**. (0.9 kgf).

Weld Head System Compatibility

Force Fired, Foot Actuated

Force Fired, Single Valve Air Actuated

Non Force-Fired, Single Valve Air or Cam Actuated

Force Fired, EZ Air Kit

Plug-and-Play 24VDC EZ-AIR weld head

301/350 Series Electronic Weld Heads

Input Signals

NOTE: Except where parenthetically noted below, all input signals accept 5 to 24 VDC, normally open or normally closed, positive or negative logic. Inputs are optically isolated.

Firing Switch Initiation: 1-level foot switch, 2-level foot switch or opto firing switch.

Remote Control Barrier Strip: Remote weld schedule select, process inhibit, emergency stop and force set (0 - 5 VDC or 0 -10 VDC) and force read (0 - 5 VDC or 0 – 10 VDC).

RS232: Change weld schedules and individual weld parameters.

RS485: Change weld schedules and individual weld parameters. "Daisy chain" RS485 input with RS485 output from other HF25 controls and host computer.

Voltage: Weld voltage signal for voltage feedback operation (0 to 10 volt peak).

Weld Head: Plug-and-play connector with Firing and Foot switch inputs, Voltage Sense input and 24VDC Air Valve Driver output.

Output Signals

Monitor: Internal analog voltage signals representing secondary current feedback (0-5 VDC), primary current (0-4 VDC), or weld voltage (0-5VDC).

Air Valve Driver: 24 VAC, 1 amp; timing controlled by the HF27. No weld over-force protection.

Alarm Relay: Four programmable mechanical relays: 24 VAC/VDC at 1 amp**.**

RS232: Monitor weld parameter data. Download and upload schedules.

RS485: Monitor weld parameter data. "Daisy chain" RS485 input with RS485 output from other HF25 Controls and host computer. Download and upload schedules.

24V_OUT: 24 VDC power supply, polyfused at 1 amp.

APPENDIX B
Electrical and Data Connections

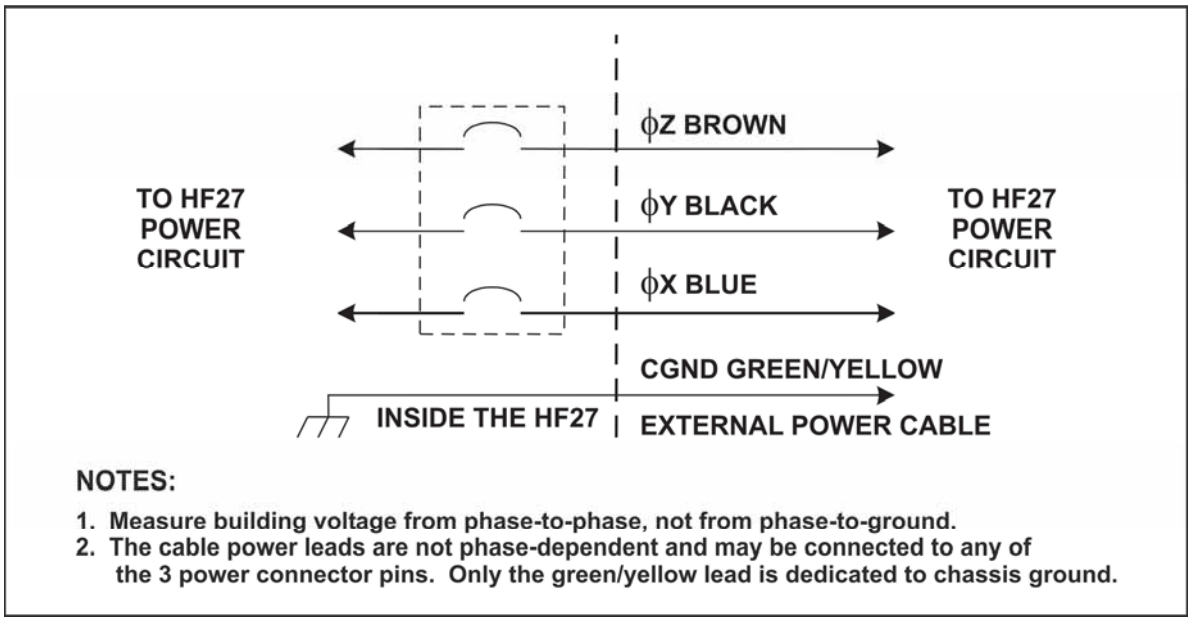
Section I. Electrical Connection

Input Power

As described in *Chapter 2*, you need to supply a connector for the Control input power cable (see diagram below).

Connect the Control power cable to a 3-phase, 50/60Hz power source. The voltage range for each model is set at the factory by a set of two jumper plugs. One jumper plug is installed on power connector **J23**, located on the center chassis plate. The other jumper plug, **P22**, plugs into welding transformer cable connector **J22**. The jumper plug set determines the power wiring configuration between the power board and the welding transformer.

Input Power Wiring Diagram



CAUTIONS:

- Be sure that the shop source power is appropriate for your Control model.
- If the blue phase wire is ***not*** connected, ***no*** alarm will occur and the weld control will produce more than 20% ripple in the weld output waveform.

Section II. I/O Connectors

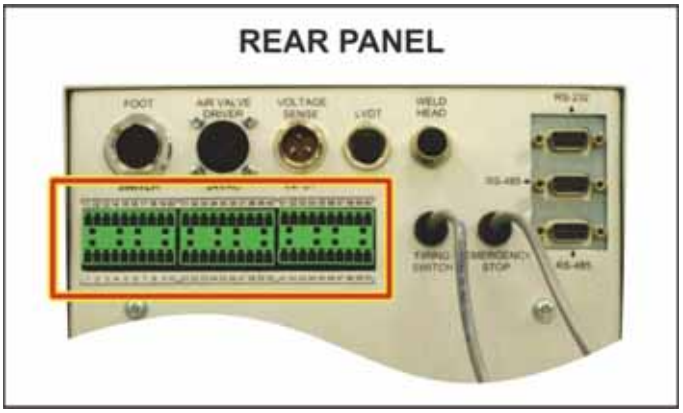
Overview

The control can be configured several different ways in order to match your welding needs. Configuration is achieved by using the pre-wired **Configuration Plug** and by fabricating your own I/O cables using five un-wired plugs. All of these connectors are supplied in the Ship Kit. Complete connection information is in *Section III, I/O Configuration.*

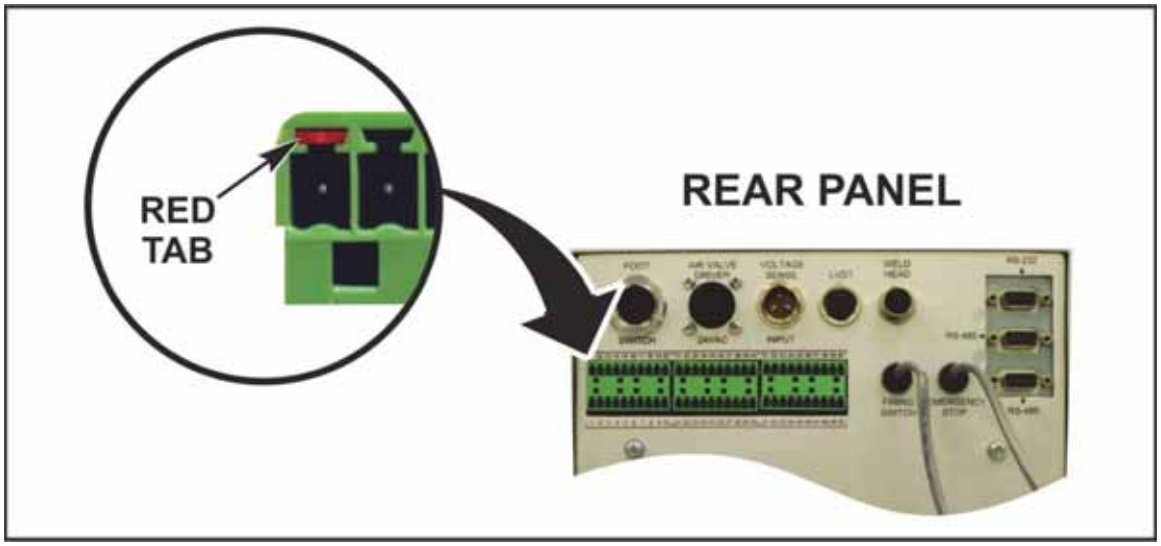
Before fabricating I/O cables, you should be familiar with the physical characteristics of the Control's I/O connectors.

60-Pin Connector

The 60-pin I/O connector is located on the Control's rear panel as shown on the right. This connector can accommodate six 10-pin plugs, including the factory-supplied **Configuration Plug**.

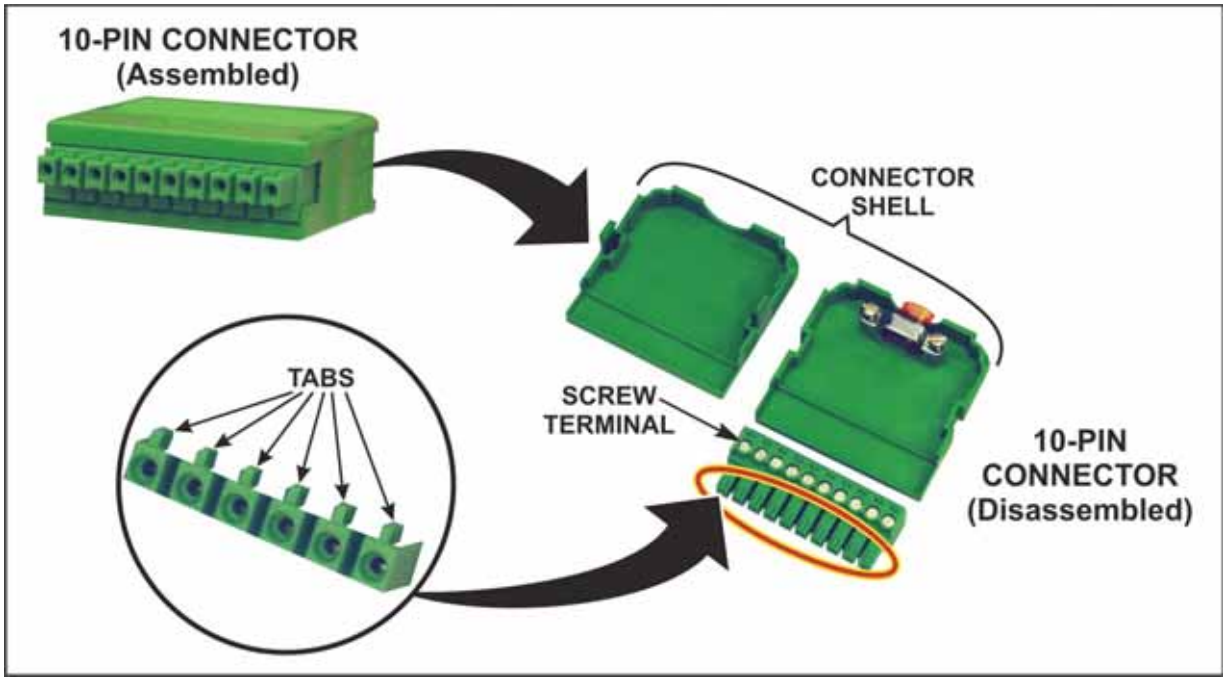


Selected pins contain red inserts as shown below. These inserts prevent properly configured 10-pin plugs from being plugged into the wrong sections of the 60-pin connector.

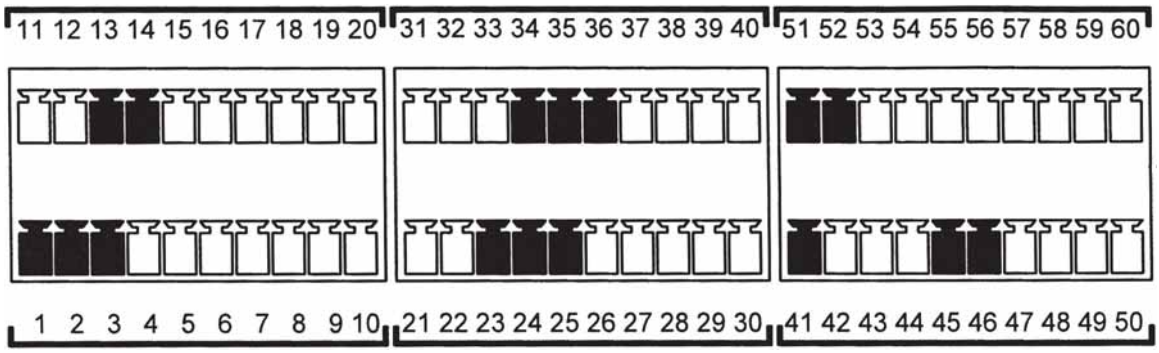


10-Pin Connectors

Five un-wired, "blank" 10-pin connectors are supplied in the Ship Kit. These connectors are used for the configurations described in *Section III, I/O Configuration.* These connectors easily snap apart and use screw-terminal wire connections so no soldering is required. Each pin of this connector has a tab on top as shown below.



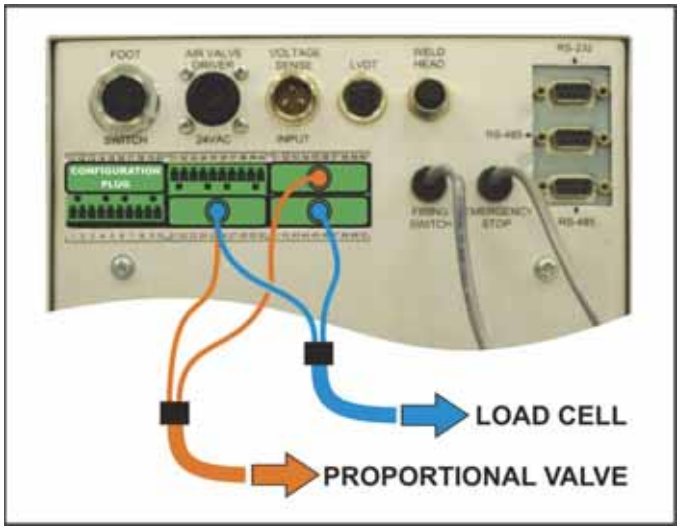
When you fabricate I/O cables according to the configuration instructions, ***you must also cut off the tabs on the top of specific pins as indicated by the black shading below***.



Example: To fabricate a connector for pins **31 → 40**, you must remove the tabs for pins **34**, **35**, and **36**. If you do not remove the appropriate tabs, you will ***not*** be able to insert the plug into the Control.

NOTE: Depending on the peripheral equipment you use, you may be connecting wires from different devices to the same plug in order to match pins on the plugs to the pins on the 60-pin connector.

Example: As shown on the right, some wires from the **LOAD CELL** and the **PROPORTIONAL VALVE** both go to the plug connected to pins **21 ➔ 30**.



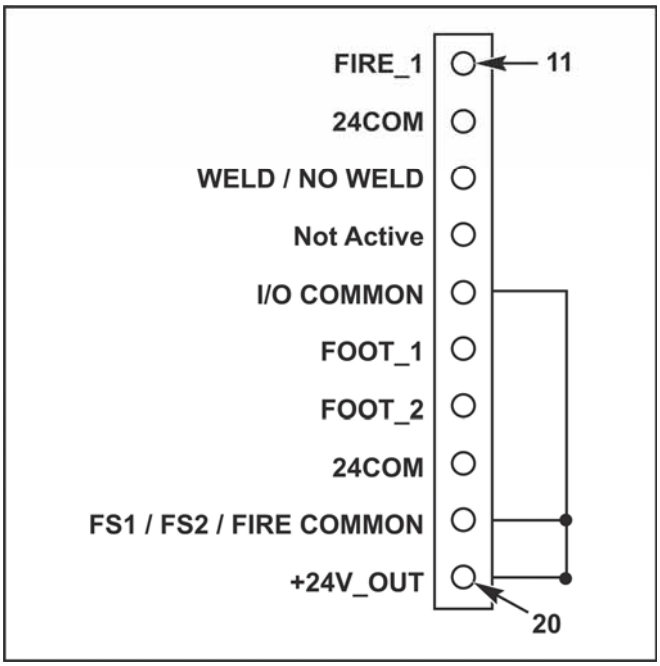
Section III. I/O Configuration

Factory Configuration Plug

A pre-wired **CONFIGURATION PLUG** is supplied in the **Ship Kit** which allows the use of Miyachi Unitek standard foot switches and weld heads without any further configuration.

Before normal use, this plug should be connected to pins **11** through **20** on the 60-pin connector as shown above. In addition, five un-wired plugs are supplied in the Ship Kit so you may fabricate your own custom I/O cables.

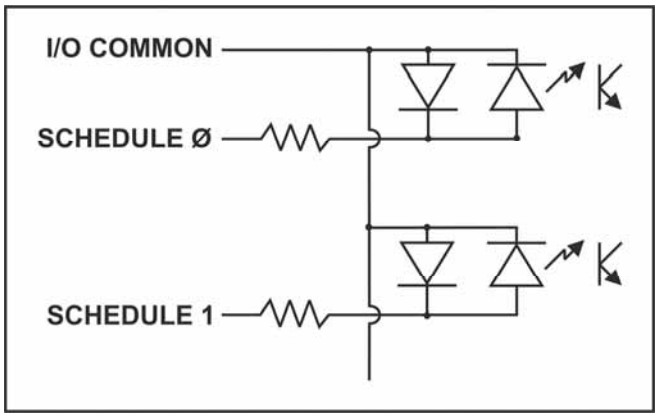
The factory default setting is **0VDC**. The plug's internal wiring is shown on the right.



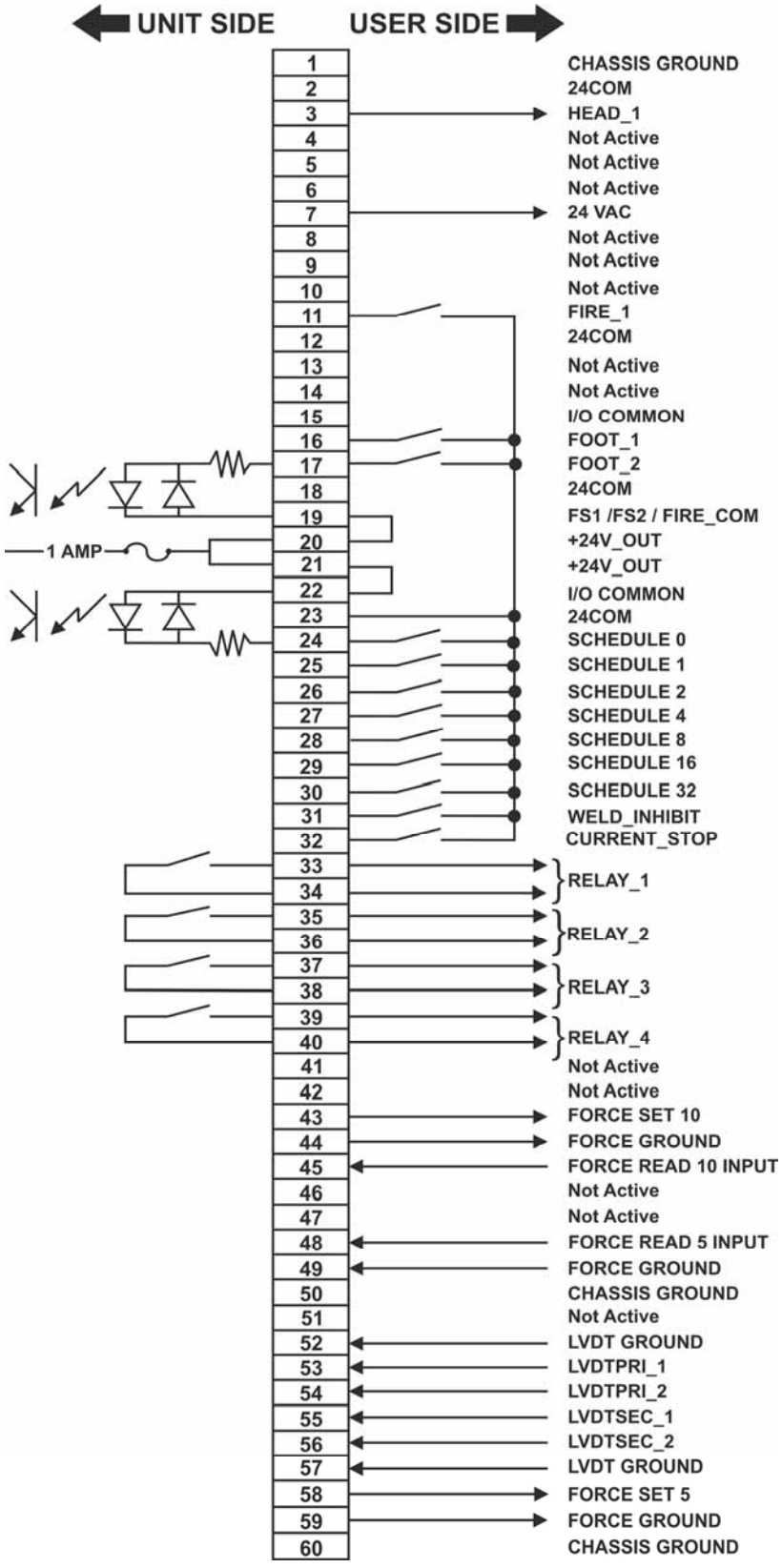
Input Section Example

This Control employs bi-directional opto isolators which allow the user to configure the inputs to sink current, i.e. +24VDC active, or source current, i.e. 0VDC active. A typical input section is shown on the right.

See *Modification of I/O Configuration* on page B-6 for both complete input sections.



I/O Signal Interface General Description



Input/Output Signals

Pin	Signal Name	Description
1	CHASSIS GROUND	Chassis Ground
2	24COM	NEGATIVE of internal 24 VDC power supply
3	HEAD_1	COMMON for air valve solenoid, switched For 24VDC operation: Connect other end of solenoid to +24V_OUT For 24VAC operation: Connect other end of solenoid to 24VAC
4-6	Not active	
7	24VAC	24VAC power supply
8-10	Not active	
11	FIRE 1	Fires Control
12	24COM	NEGATIVE of internal 24 VDC power supply
13-14	Not active	
15	I/O COMMON	COMMON terminal for pins 24 - 31
16	FOOT 1	Activates foot level stage 1
17	FOOT 2	Activates foot level stage 2
18	24COM	NEGATIVE of internal 24 VDC power supply
19	FS1/FS2/FIRE_COM	COMMON terminal for pins 10-13, 16, 17, 32
20-21	+24V_OUT	+24 VDC output of internal power supply, polyfused at 1 amp
22	I/O COMMON	COMMON terminal for pins 24 - 31
23	24COM	NEGATIVE of internal 24 VDC power supply
24	SCHEDULE 0	Binary Schedule input terminals, used for schedule selection
25	SCHEDULE 1	
26	SCHEDULE 2	
27	SCHEDULE 4	
28	SCHEDULE 8	
29	SCHEDULE 16	
30	SCHEDULE 32	
31	WELD_INHIBIT	Inhibits weld
32	CURRENT_STOP	Interrupts weld current Interrupts weld current (< 100 µs from current_stop trigger to end-of-weld current with debounce set to Ø)
33	RELAY_1	Relay 1 output, dry contact, programmable Contact rating: 24VDC/AC, 1 amp
34	RELAY_1R	
35	RELAY_2	Relay 2 output, dry contact, programmable

Pin	Signal Name	Description
36	RELAY_2R	Contact rating: 24VDC/AC, 1 amp
37	RELAY_3	Relay 3 output, dry contact, programmable Contact rating: 24VDC/AC, 1 amp
38	RELAY_3R	
39	RELAY_4	Relay 4 output, dry contact, programmable Contact rating: 24VDC/AC, 1 amp
40	RELAY_4R	
41-42	Not Active	
43	FORCE SET 10	Proportional valve output, 0-10V (use pin 44, 49 or 59 as ground reference)
44	FORCE GROUND	Force input/proportional valve output ground
45	FORCE READ 10 INPUT	Force input, 0-10V, (use pin 44, 49 or 59 as ground reference) (DO NOT USE 0-5V FORCE INPUT AT THE SAME TIME)
46-47	Not Active	
48	FORCE READ 5 INPUT	Force input, 0-5V, (use pin 44, 49 or 59 as ground reference) (DO NOT USE 0-10V FORCE INPUT AT THE SAME TIME)
49	FORCE GROUND	Force input/proportional valve output ground
50	CHASSIS GROUND	Chassis ground
51	Not Active	
52	LVDT GND	LVDT Connections
53	LVDTPRI_1	
54	LVDTPRI_2	
55	LVDTSEC_1	
56	LVDTSEC_2	
57	LVDT GND	
58	FORCE SET 5	Proportional valve output, 0-5V (use pin 44, 49 or 59 as ground reference)
59	FORCE GROUND	Force input/proportional valve output ground
60	CHASSIS GROUND	Chassis ground

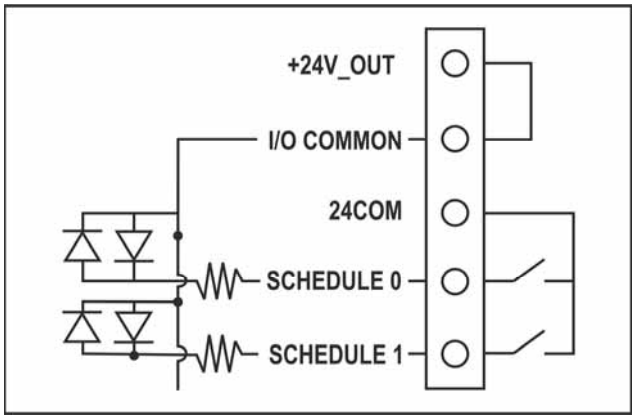
Modification of I/O Configuration:

The inputs of this Control are grouped into two major blocks, which can be independently configured.

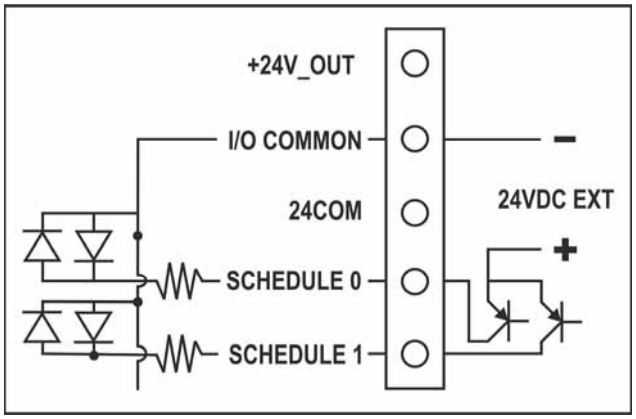
SCHEDULE INPUTS		
Common	**Input**	**Pin Number**
I/O COMMON	SCHEDULE 0	24
	SCHEDULE 1	25
	SCHEDULE 2	26
	SCHEDULE 4	27
	SCHEDULE 8	28
	SCHEDULE 16	29
	SCHEDULE 32	30
	WELD INHIBIT	31

FOOT SWITCH/FIRE SWITCH INPUTS		
Common	**Inputs**	**Pin Number**
FS1/FS2/FIRE_COM	FIRE_1	11
	FOOT_1	16
	FOOT_2	17
	WELD ABORT	10
	WELD/NO WELD	13
	CURRENT STOP	32

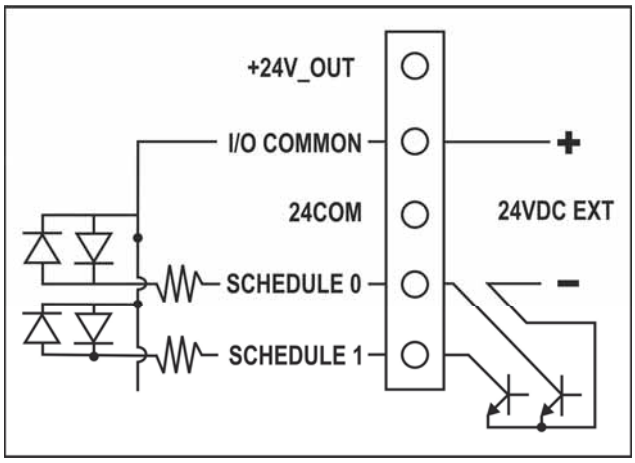
Configuration for Common Input Connections:



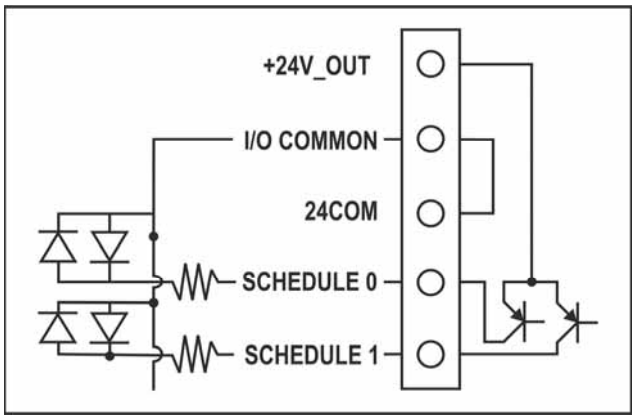
Dry Contact Input



Common Positive Input (External Power)



Common Negative Input (External Power)



Common Positive Input (Internal Power)

NOTE: The preceding configuration methods can be used for both input blocks.

Two-Level Foot Switch Connector

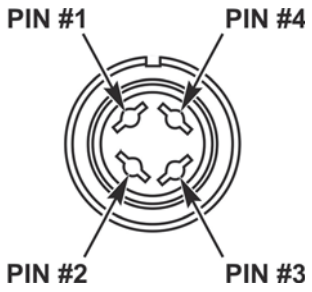
When you press the foot switch to the first level, the Control energizes the air actuated weld head. This causes the upper electrode to descend and apply force to the weld pieces. If you release the foot switch before pressing it to the second level, the Control will automatically return the upper electrode to its UP position so that you may re-position the weld pieces.

If you do not release the foot switch at the first level and proceed to the second level, the force-firing switch in the weld head will close. Weld current will flow, and the Control will automatically return the upper electrode to its UP position.

Using the supplied Configuration plug on Pins 11 – 20 allows the use of the Miyachi Unitek 2-level footswitch directly. If a PLC or other means of trigger is used, refer to the *I/O Signal Interface General Description* on page B-3.

Foot Switch Connector

Pin	Description
1	Chassis Ground
2	Foot_1 (to activate Foot Switch Level 1, connect to pin 4)
3	Foot_2 (to activate Foot Switch Level 2, connect to pin 4)
4	24COM



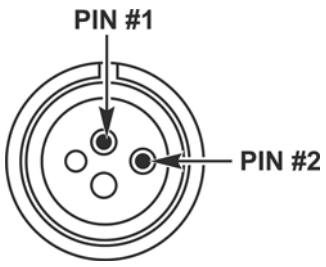
Standard Air Valve Driver Output Connector

The air valve driver output (24VAC) is initiated when Foot Switch Level 1 is initiated.

Using the supplied Configuration plug on Pins 11 – 20 allows the use of the Miyachi Unitek 2-level footswitch directly. If a PLC or other means of trigger is used, refer to the I/O Signal Interface General Description on page B-3. The mating connector is an AMP type 206429-1, using cable clamp AMP type 206358-2. The two male pins used are Amp type 66361-2.

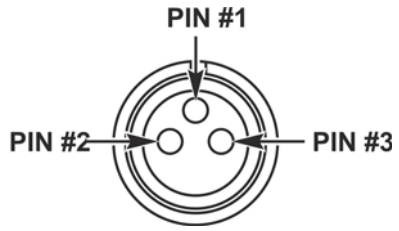
Air Valve Driver 24 VAC Connector

Pin	Description
1	24VAC (for solenoid)
2	HEAD_1 (Switched 24V common)



Voltage Sense Input Connector

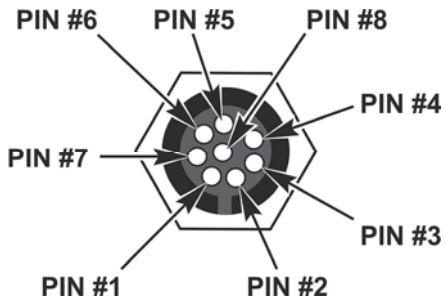
The voltage leads are connected to the electrode holders to sense weld voltage.

Voltage Sense Input Connector		
Pin	**Description**	
1	Not Used	
2	VOLT_IN	
3	VOLT_COM	

Weld Head Connector

The Weld Head Connector combines all the inputs and outputs necessary to connect a plug-and-play EZ-AIR Miyachi Unitek weld head

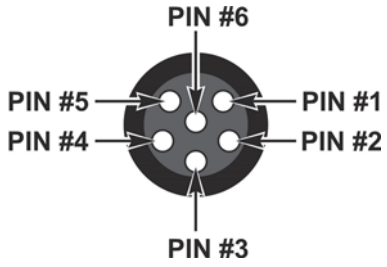
Using the supplied Configuration plug on Pins 11 – 20 allows the use of the Miyachi Unitek 2-level footswitch directly. If PLC or other means of trigger is used, refer to the *I/O Signal Interface General Description* on page B-3.

Weld Head Connector		
Pin	**Description**	
1	HEAD_1 (switched 24V common for solenoid)	
2	24V_OUT (24VDC for solenoid)	
3	24COM	
4	FIRE_1	
5	VOLT_IN	
6	VOLT_COM	
7	AIRHEAD	
8	Not used	

LVDT Connector

The LVDT connector provides the inputs for the LVDT sensor.

LVDT Connector	
Pin	**Description**
1	LVDTPRI_1
2	LVDTPRI_2
3	LVDTSEC_1
4	LVDT GND
5	LVDT GND
6	LVDTSEC_2



Force Firing Switch Cable Input

Function

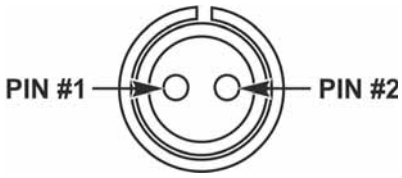
The force-firing switch input to the Control from the weld head signals that the selected pressure has been applied to the weld pieces. Note that a mechanical firing switch is subject to contact bounce, which can cause false weld starts. The effects of switch bounce can be avoided at low weld speeds by using the switch debounce function on the Control main menu. If welding speeds are to exceed 1.5 welds per second, use an optical firing switch.

Connections

The firing switch cable is 5 feet long, Type 2/C, 600-volt cable containing two shielded, twisted pair 22 AWG stranded leads.

The firing switch cable connector is a 2-pin Amphenol Type 80-MC2FI. It mates with the weld head firing switch connector, which is a 2-Pin Amphenol Type 80-MC2M.

Firing Switch Connector	
Pin	**Description**
1	24COM
2	FIRE_1 (to fire Control, connect to pin 2)



Operator Emergency Stop Cable Switch Input

Function

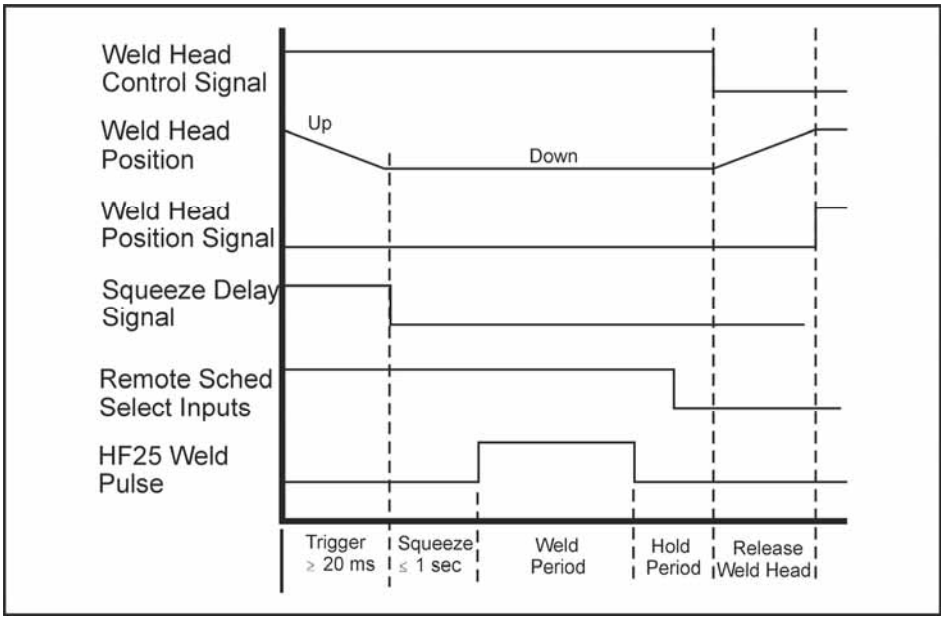
You must connect a normally closed, single-pole switch across both cable leads, otherwise the Control cannot be turned ON. Use the switch during Control operation as an emergency stop switch. When operated (opened), it will immediately halt the weld process.

NOTE: You must press the **RUN** key on the front panel to reset the Control following an emergency stop operation.

Connections

Connect an approved, normally closed emergency stop switch across the 2-foot (61 cm) operator emergency stop switch cable. When the switch is operated (opened), it de-energizes the main power contactor, removing three-phase input power to the Control.

PLC Timing Diagram



BCD Welding Schedule Selection Scheme

Weld Schedule No.	Bit 2^0 Pin 1	Bit 2^1 Pin 2	Bit 2^2 Pin 3	Bit 2^3 Pin 4	Bit 2^4 Pin 12	Bit 2^5 Pin 5	Bit 2^6 Pin 14
0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0
2	0	1	0	0	0	0	0
3	1	1	0	0	0	0	0
4	0	0	1	0	0	0	0
5-98	BCD progression from 5 to 98						
99	1	1	0	0	0	1	1

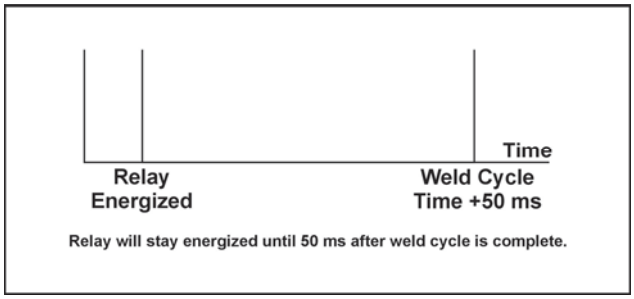
Relay Outputs

Function

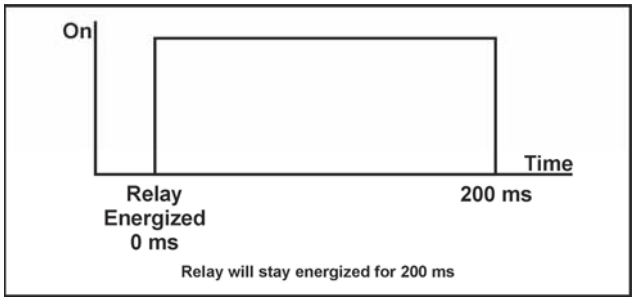
Four mechanical relays on the control board can be independently programmed to supply alarm or weld status contact signal outputs. You can access the programming function through the main menu, as described in *Chapter 3*. The events that you can program for each relay and their timing diagrams are as follows:

Relay contacts closed or open in the energized state. Relays are energized when:

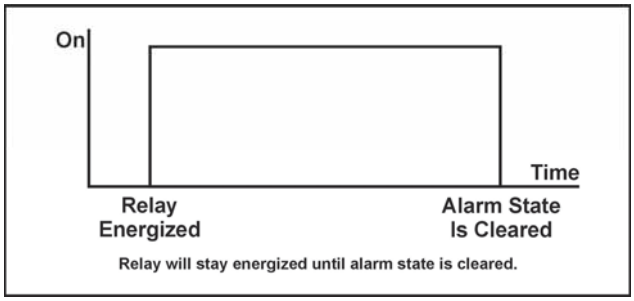
1. Weld cycle starts.



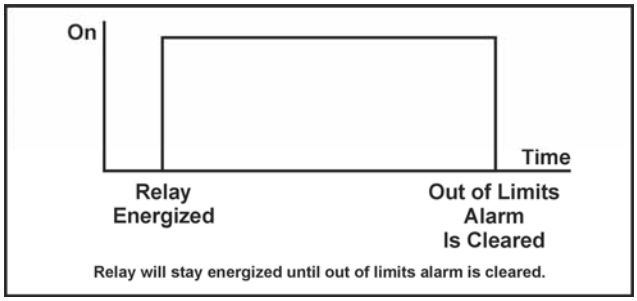
2. Weld cycle ends.



3. Alarm state is detected.



4. Weld is out of programmed limits.



APPENDIX C
Calibration

Section I. Calibrating the Control

Overview

The Control is calibrated by the software, using inputs from a calibration setup during a weld process. Following a few calibration inputs, the Control will adjust itself and store the calibration values in RAM, where they will be used as standards for the operational welding parameters.

CAUTION: Only authorized personnel should perform this procedure.

Calibration Equipment Required

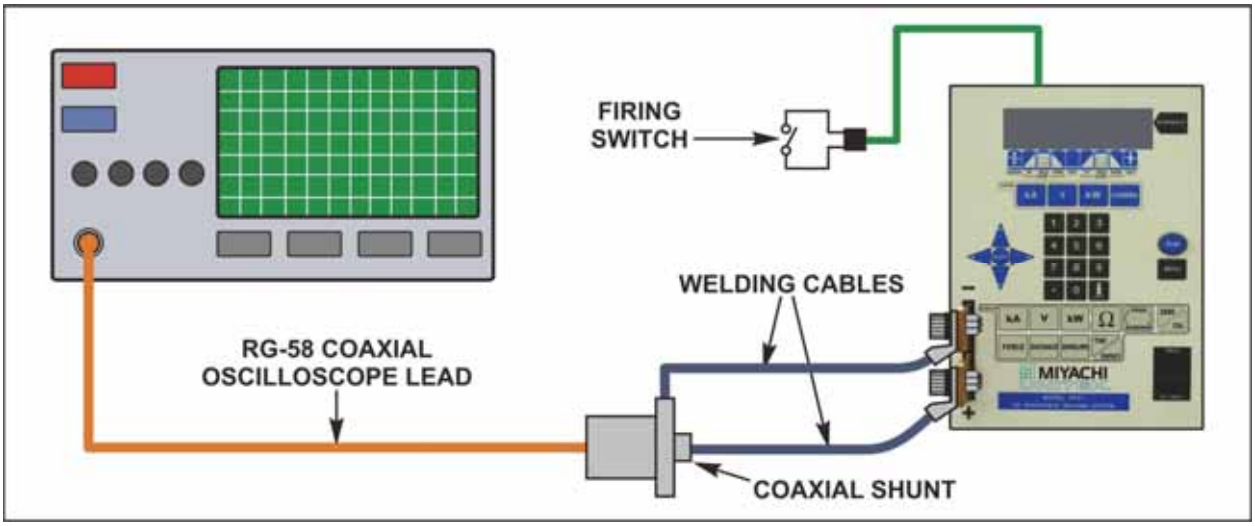
The required equipment for the setup is as follows:

- 2 weld cables, No. 2/0, 1 ft (30 cm) long, PN 2/0 BB11
- 1000μΩ coaxial shunt resistor accurate to ±0.2%.

  Source for shunt resistor: Model R7500-8

  T & M Research Products, Inc.
  139 Rhode Island Street NE
  Albuquerque, NM 87108
  Telephone: (505) 268-0316
- Shielded voltage sense cable, PN 4-32998-01
- Digital oscilloscope, *Tektronix* 724C or equivalent
- Male BNC to dual binding post
- 2-wire, normally open switch for weld initiation, mating connector PN 520-011
- Coaxial BNC-to-BNC cable

Calibration Procedure



Initial Calibration Setup

1. Connect the calibration setup to the Control as shown.
2. Turn the Control ON.
3. From the **MONITOR** keys section on the front panel, press the **CAL** key and the menu on the right will appear.

<CALIBRATION>
1. HF27 CALIBRATION
2. LVDT GAUGE
3. LVDT CALIBRATION
4. LVDT QUICK CALIBRATION
5. FORCE CALIBRATION

Number Select an item, Run or Menu

4. Press **1** for **HF27 CALIBRATION** which will bring up the **CAUTION** screen on the right.

CAUTION
CALIBRATION SHOULD BE PERFORMED BY A QUALIFIED TECHNICIAN ONLY.
REFER TO MANUAL FOR CALIBRATION SETUP.

▼ next, MENU menu

5. Press **2** to calibrate the Control.

<PRE-CALIBRATION>

1. TEST HF27 (T-232 REQUIRED)
2. CALIBRATE HF27
3. RESET CALIBRATION
4. SET SHUNT VALUE

Number Select an item, Run or Menu

6. The first calibration screen is the **CAUTION** screen. If you are qualified to proceed with the calibration press ▼ to continue.

7. The next page is for the **CALIBRATION SHUNT**. This screen asks for the actual value of the 1000 micro-ohm shunt.

<CALIBRATION SHUNT>

Shunt value : 0987.6 µΩ

Number change ▼ Proceed

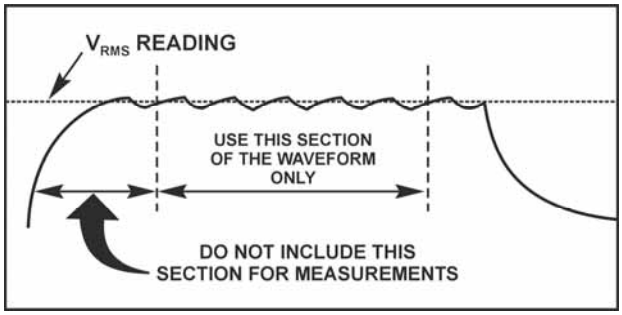
The actual value is printed on the exterior of the R7500-8 shunt. Enter this value using the number keys, and press ▼ to continue.

NOTE: The next calibration screen is the **CURRENT SHUNT**. It is not necessary to change the current shunt value unless the internal welding transformer was changed. If it was changed, remove the top cover and enter the shunt value, which is stamped on the copper conductor connected to the transformer. Press ▼ to continue.

8. The next two screens are **1. CALIBRATE D/A HIGH** and **2. CALIBRATE D/A LOW**. Following the screen instructions, adjust the energy output using the measuring parameter feature of the oscilloscope.

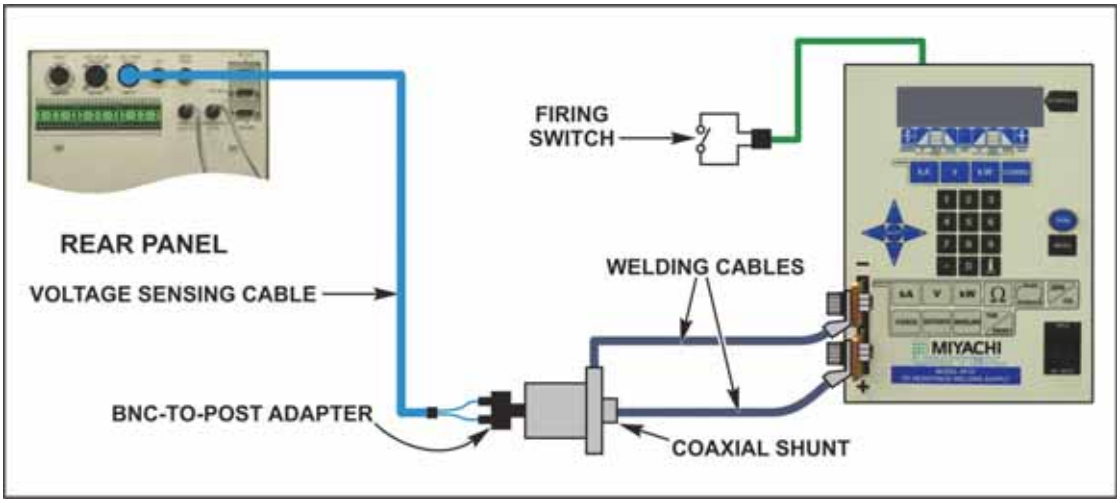
   NOTE: Do ***not*** use a visual assessment.

   Press the period [.] key to advance to the next step.



Calibration Signal

9. The next calibration screen is **CALIBRATE HIGH**. Disconnect the oscilloscope from the shunt resistor and connect the output of the shunt resistor to the **VOLTAGE SENSE INPUT** connector using the male BNC to binding post adapter and voltage sense cable. Follow the screen instructions for this step and the next step, **4. CALIBRATION LOW**.



Final Calibration Setup

10. The last calibration screen is **5. END OF CALIBRATION.** Press the **MENU** key. Calibration is now complete.

Section II. Calibrating the LVDT

Before You Start

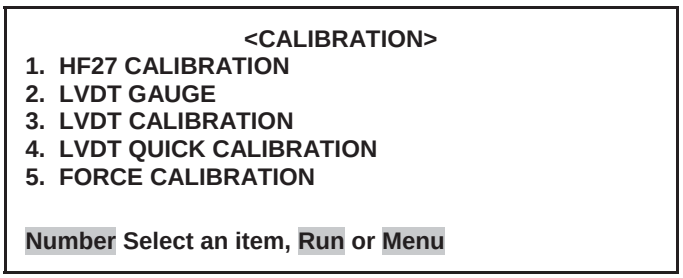
Before using the LVDT during welding, it is extremely important to calibrate the LVDT in order to verify that the measurements displayed on the LCD screen match the actual distance between the electrodes. The only equipment required for LVDT calibration is a calibration gauge or piece of metal machined to an ***exact known thickness***. This will be placed between the electrodes as a reference. The recommended calibration gauge thickness is shown below.

Recommended Gauge Thickness:

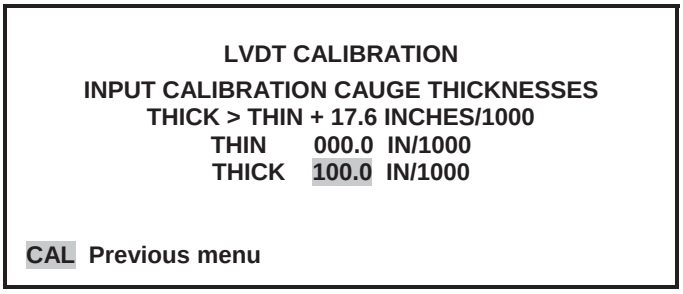
Part Thickness	80 Series Heads	Other Heads
< 0.025" (< 0.63mm)	0.100" (2.54mm)	0.025" (0.63mm)
0.025" to 0.100" (0.63 to 2.54mm)	0.100" (2.54mm)	Similar to part
Over 0.100"	Similar to part	Similar to part

Before LVDT calibration, you ***must*** tell the unit the thickness of the calibration gauge you will be using.

1. From the **MONITOR** keys section on the front panel, press the **CAL** key for the menu on the right.
2. Press **2** for **LVDT GAUGE**.



3. Input the gauge thickness for the **THICK** gauge (***required***). Note that the **THICK** gauge must be at least 0.0176" greater than the thin gauge value programmed in step 4.
4. Input the gauge thickness for the **THIN** gauge (***optional***). If you are ***not*** using a thin gauge, input **000**.



Example: Using a gauge that is 0.100" thick, enter the numbers **1**, **0**, and **0**. They will display as thousands of an in as shown on the right.

5. From the **MONITOR** keys section on the front panel, press **CAL** to return to the **CALIBRATION** menu.

After the calibration gauge thickness is entered, there are two ways to calibrate the LVDT:

Full Calibration (Selection 3)

Quick Calibration (Selection 4)

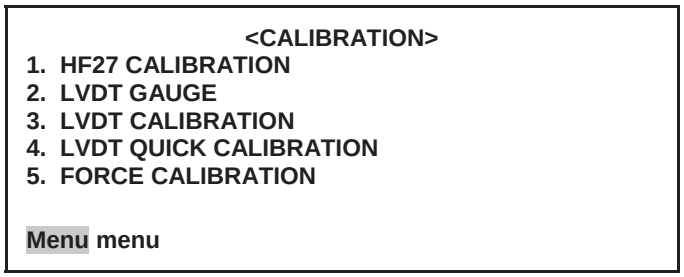
The **Quick Calibration** procedure is designed to expedite the calibration of air operated Miyachi Unitek heads. Otherwise, use the **Full Calibration**. Both processes are detailed below.

Full Calibration

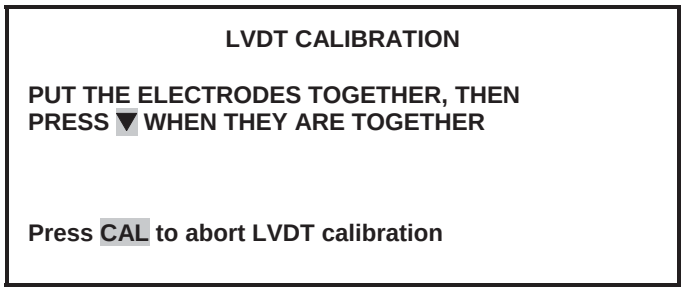
This procedure does ***not*** set a new zero point. It merely establishes the calibration for the LVDT. Use this procedure on automated machinery or in cases where the Miyachi Unitek gauge will ***not*** fit between the electrodes. For best accuracy, the weldhead should be set to the force that will be used for welding.

NOTE: To set a new zero point, see *Set New Electrodes to Zero* following this procedure.

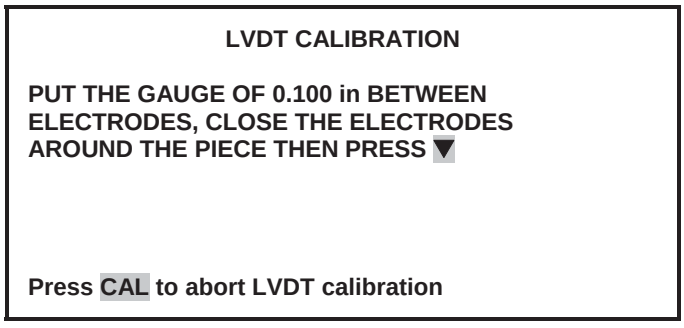
1. From the **MONITOR** keys section on the front panel, press the **CAL** key for the menu on the right, then press 3



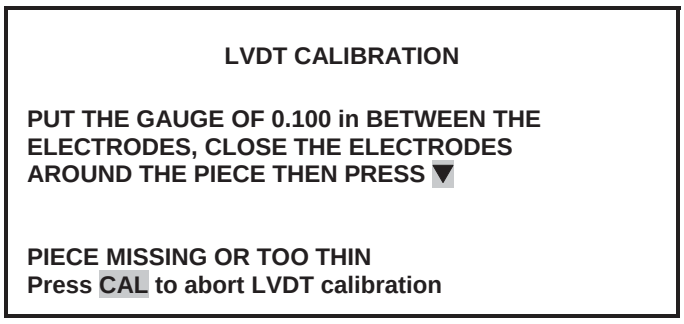
2. Verify that the electrodes are securely installed in the electrode holders.
3. Manually adjust the weld head so the electrodes are touching, then press the ▼ button on the front panel as shown on the screen on the right.



4. Open the electrodes.
5. Insert the calibration gauge of the value requested between the electrodes.
6. Manually adjust the weld head so the electrodes are touching the part, then press the ▼ button on the front panel as shown on the screen on the right.



NOTE: If your reference piece is too thin, or not properly placed between the electrodes, you will see the prompt at the bottom of the screen on the right.

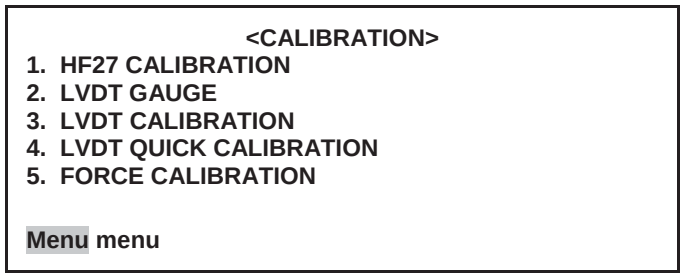


7. When you have finished, press the **MENU** key to return to the previous menu.

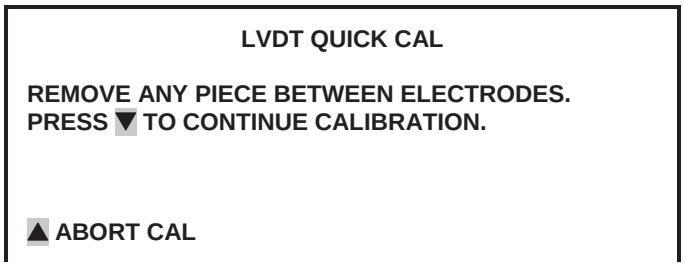
Quick Calibration (Quick Cal)

The procedure sets a new zero position and recalibrates the LVDT. For best accuracy, the weldhead should be set to the force that will be used for welding.

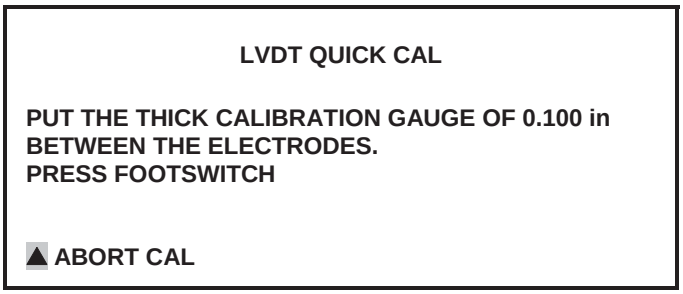
1. From the **MONITOR** keys section on the front panel, press the **CAL** key for the menu on the right.



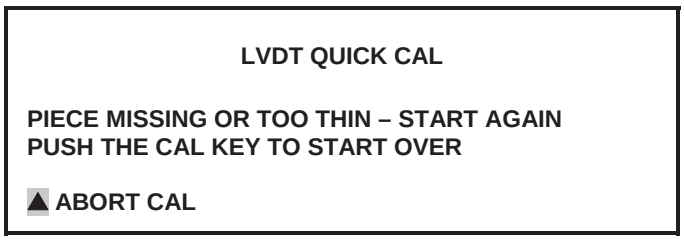
2. Press **4** for **QUICK CALIBRATION**. Follow the instructions on these screens.



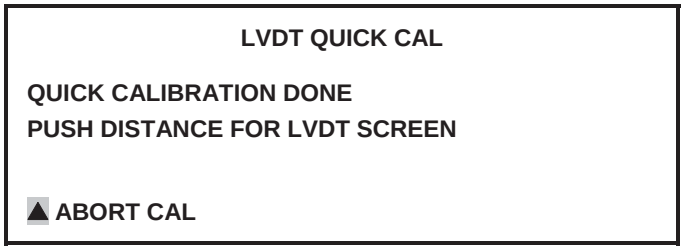
3. A message will then flash to release the footswitch. Do so and the screen on the right appears. Verify the electrodes are securely installed in the electrode holders. Place the calibration piece between the electrodes and press the footswitch.



NOTE: if your reference piece is too thin, or not properly placed between the electrodes, you will see the prompt at the bottom of the screen on the left. **QUICK CAL** will restart from the beginning



4. Release the footswitch to complete the quick calibration procedure. The screen on the right appears.



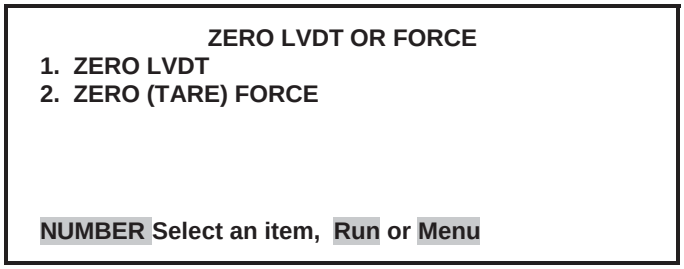
Set New Electrodes to "Zero"

The LVDT must have a ***zero*** reference point (for example, when the two electrodes touch each other, there is **zero** distance between them). All distances calculated by the LVDT are measured from this *zero*. When you change electrodes in your weld head or agressiveley clean the electrodes, the electrodes may not be in the same exact position as the old electrodes, so *zero* may no longer be the same, therefore you must set a new *zero*.

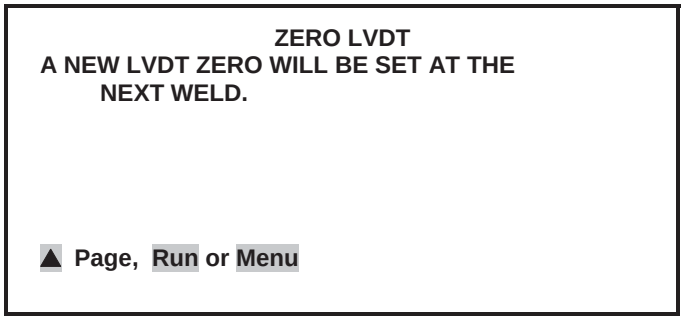
There are two ways to set a new *zero*: Either perform the quick calibration procedure detailed above or perform the new zero procedure detailed below.

To set a new zero ***without*** recalibration:

1. From the **MONITOR** keys section on the front panel, press the **ZERO** key and the menu on the right will appear.



2. **To zero the LVDT**, press **1** and the screen on the right will appear. During the next weld, the initial position will be set to **0**.
3. Press ▲ to return to the previous menu, or press **Run** to continue welding, or press **Menu** for the **MAIN MENU**



Section III. Force Calibration

Overview

The following procedures calibrate the **Proportional Valve** and the **Load Cell**. The **Proportional Valve** controls the force, the **Load Cell** monitors the force. Both must be calibrated simultaneously in order for the Control to perform accurately.

Force Calibration

CAUTION: Make sure to connect the electronic pressure regulator according to its voltage range (0 – 5V or 0 – 10V). 0V corresponds to 100 psi and full voltage corresponds to 100 psi. Lo psi during calibration will be about 30 psi and Hi psi will be about 80 psi. Make sure the force gauge used and the electrodes can withstand the force of the weldhead at 80 psi.

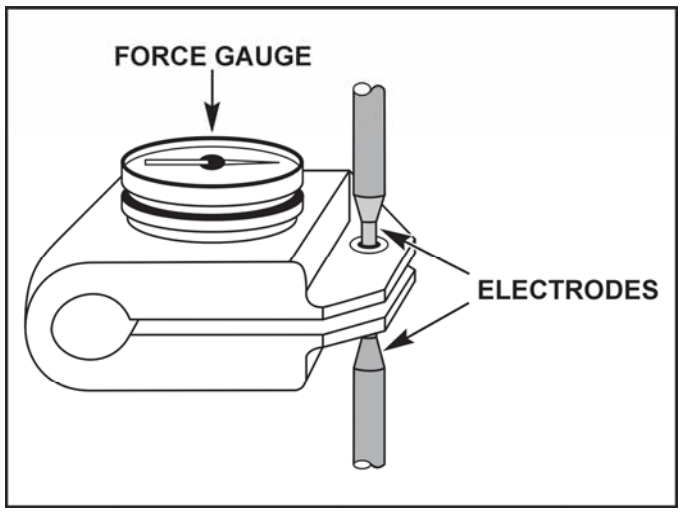
1. Press the **CAL** key on the front panel to get the Calibration menu
2. Press **5** for the **FORCE** Calibration
3. Move the cursor to **LOW GAUGE FORCE**.
4. Place a force gauge between the electrodes.
5. Press the **SCHEDULE** button on the Control Panel to close the electrodes.

   NOTE: In **FORCE CALIBRATION** mode, the Control will ***not*** send weld current to the electrodes.
6. Let the force stabilize, then check the force on the force gauge. Press the **SCHEDULE** button to release the weldhead.

```
<FORCE CALIBRATION>
1. FORCE UNITS     :  LBS
2. FORCE UNITS IN  :  Ø1535

LOW GAUGE FORCE          HIGH GAUGE FORCE
     ØØ8.2                    Ø17.6

Press SCHEDULE to start
```



7. Repeat steps 3 and 4 to be sure the value has stabilized. Enter the number of measured force under **LOW GAUGE FORCE** on the LCD screen.
7. Select **HIGH GAUGE FORCE** on the control. Place a force gauge between the electrodes.
8. Press the **SCHEDULE** button on the Control Panel to close the electrodes.
9. Let the force stabilize, then check the force on the force gauge. Press the **SCHEDULE** button to release the weldhead.

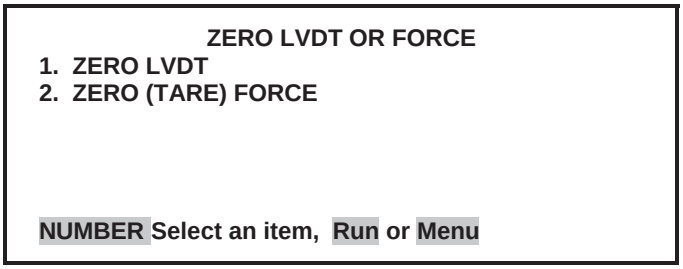
10. Repeat steps 7 and 8 to make sure the force has stabilized. Enter the measured force under **HIGH GAUGE FORCE** on the LCD screen. Press the **FORCE** button to save this information. FORCE Calibration is now complete

    Example: As shown above on the **FORCE CALIBRATION** screen, **Low Gauge force** was **7.2 lbs**, **High Gauge Force** was **17.6 lbs.**

Set Force (tare) to "Zero"

To set a new zero ***without*** recalibration:

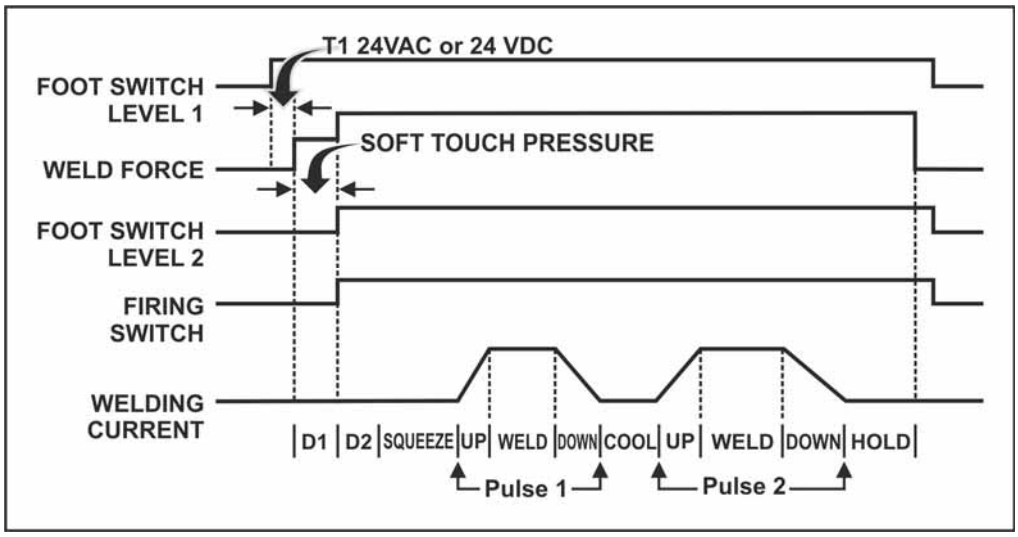
1. From the **MONITOR** keys section on the front panel, press the **ZERO** key and the menu on the right will appear.



2. **To zero the FORCE** (Tare), press **2** and the screen on the right will appear.
3. Press ▲ to return to the previous menu, or press **Run** to continue welding, or press **Menu** for the **MAIN MENU**

APPENDIX D
System Timing

Basic Weld Operation: Air Head System with Two-Level Foot Switch



NOTE: "**SOFT TOUCH PRESSURE**" only applies when a Proportional Valve is being used.

Definitions

T1 Delay time from Foot Switch Level 1 closure to Weld Force start. Maximum delay time is 1 ms plus switch debounce time. Switch debounce time can be set to none, 10, 20, or 30 ms with the **SETUP 1** menu screen.

D1 Delay time from Weld Force start to Firing Switch closure. Maximum D1 time is 10 seconds. If the firing switch does not close within 10 seconds, the message **FIRING SWITCH DIDN'T CLOSE IN 10 SECONDS** will be displayed.

D2 Delay time from Firing Switch closure and Foot Switch Level 2 closure to squeeze time (SQZ). Maximum D2 time is 2 ms plus switch debounce time.

SQZ Squeeze time. Selectable range is 0 to 999 ms.

UP Up slope time. Selectable range is 0.0 to 99.0 ms.

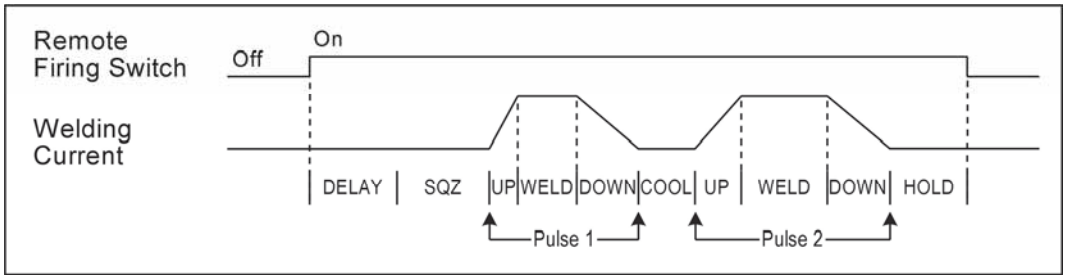
WELD Weld time. Selectable range is 0.0 to 99.0 ms.

DOWN Down slope time. Selectable range is 0.0 to 99.0 ms.

COOL Cool time: Selectable range is 0.0 to 99.0 ms.

HOLD Hold time. Selectable range is 0 to 999 ms.

Basic Weld Operation: Manual Head System with Firing Switch Operation



Definitions

DELAY Delay time from firing switch closure to the start of the weld sequence (that is, start of **SQZ**). Maximum **DELAY** time is 2 ms, plus switch debounce time.

SQZ Squeeze time. Selectable range is 0 to 999 ms.

UP Up slope time. Selectable range is 0.0 to 99.0 ms.

WELD Weld time. Selectable range is 0.0 to 99.0 ms.

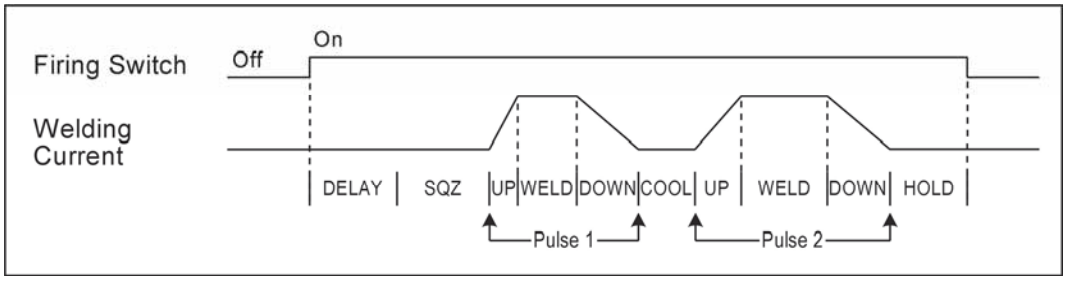
DOWN Down slope time. Selectable range is 0.0 to 99.0 ms.

COOL Cool time. Selectable range is 0.0 to 99.0 ms.

HOLD Hold time. Selectable range is 0 to 999 ms.

Basic Weld Operation: System with Remote Firing Switch

NOTE: The firing switch mode is selected under the Setup 1 menu.



Definitions

DELAY Delay time from Remote Schedule Select Signal ON to the start of the weld sequence (that is, start of **SQZ**). **DELAY** time is 23 ms.

SQZ Squeeze time. Selectable range is 0 to 999 ms.

UP Up slope time. Selectable range is 0.0 to 99.0 ms.

WELD Weld time. Selectable range is 0.0 to 99.0 ms.

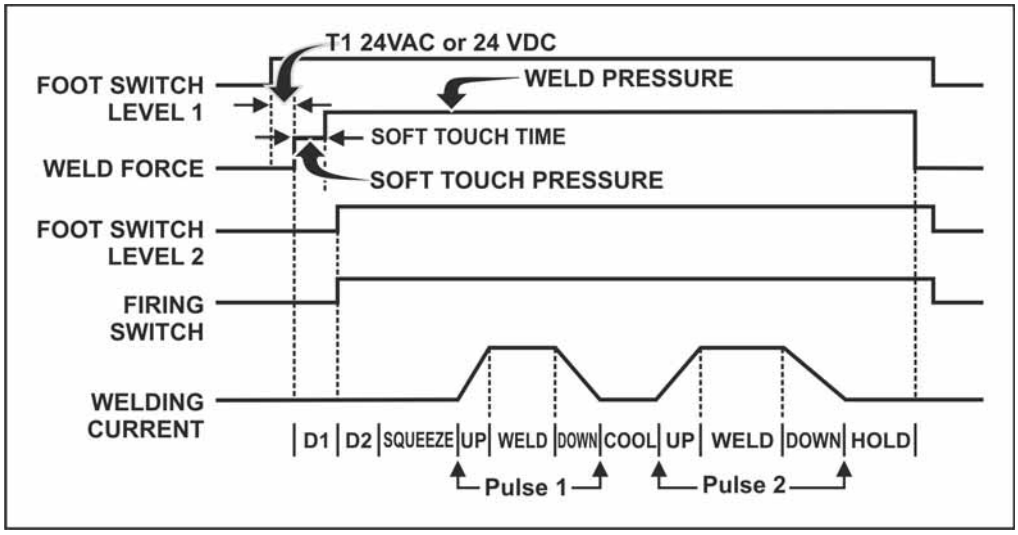
DOWN Down slope time. Selectable range is 0.0 to 99.0 ms.

COOL Cool time. Selectable range is 0.0 to 99.0 ms.

HOLD Hold time. Selectable range is 0 to 999 ms.

.

Basic Weld Operation: Air Head System with Two-Level Foot Switch and Proportional Valve



Definitions

T1 Delay time from Foot Switch Level 1 closure to Weld Force start. Maximum delay time is 1 ms plus switch debounce time. Switch debounce time can be set to none, 10, 20, or 30 ms with the **SETUP 1** menu screen.

T2 Soft touch time.

D1 Delay time from Foot Switch Level 2 to Firing Switch closure. Maximum D1 time is 10 seconds. If the firing switch does not close within 10 seconds, the message **FIRING SWITCH DIDN'T CLOSE IN 10 SECONDS** will be displayed.

D2 Delay time from Firing Switch closure and Foot Switch Level 2 closure to squeeze time (SQZ). Maximum D2 time is 2 ms plus switch debounce time.

SQZ Squeeze time. Selectable range is 0 to 999 ms. Note that for SQZ to start, Foot Switch level 2 must be ON, Soft touch time must be complete and the firing switch must be closed.

UP Up slope time. Selectable range is 0.0 to 99.0 ms.

WELD Weld time. Selectable range is 0.0 to 99.0 ms.

DOWN Down slope time. Selectable range is 0.0 to 99.0 ms.

COOL Cool time: Selectable range is 0.0 to 99.0 ms.

HOLD Hold time. Selectable range is 0 to 999 ms.

APPENDIX E
Communications

Overview

The Control has the ability to communicate with a host computer or with automation control system. The communications option uses either RS-232 to connect one control to one host, or RS-485 multi-drop architecture to connect up to 30 controls to one host on a single channel. Amada Miyachi America's optional *Weld-Stat* software will allow you to connect a single or multiple Controls to a computer in order to:

- Compile, store, view, and print weld history data for detailed analysis.
- Check the status of the Control(s).
- Remotely program weld schedules on the Control(s).
- Remotely program menu items on the Control(s).

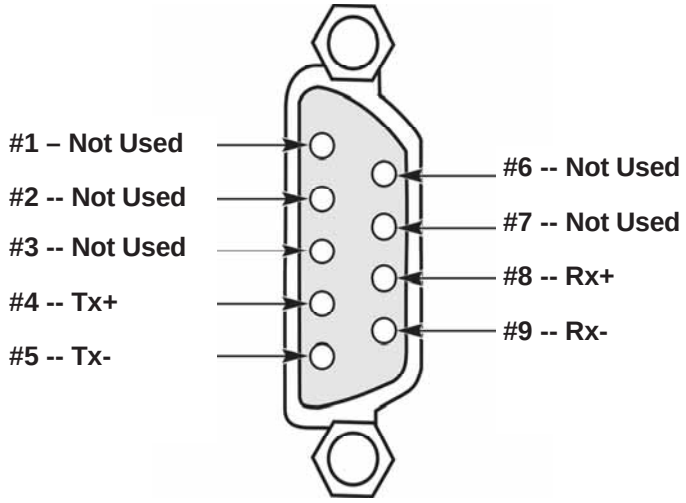
Remote Programming

Most users will find the *Weld-Stat* software functions sufficient for collecting and using weld history information and remote schedule programming. However, advanced users may wish to perform additional programming for custom welding applications. The codes needed to perform remote programming are listed in *Section II. Communications Protocol and Commands*. Using these codes, users can write customized software for controlling all functions of the welding control and interfacing the unit to automation control systems.

For more information on the *Weld-Stat* Kit (Amada Miyachi America Part Number 10-600-06), call or e-mail us using the **Contact Us** information in the front of this manual.

RS-485 Connectors

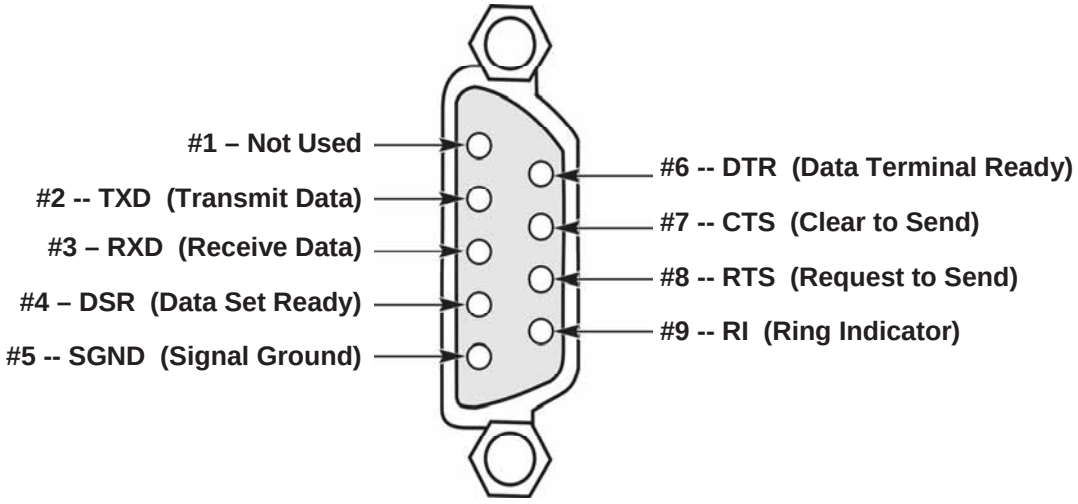
The unit has two DB-9 (female) connectors wired as follows:



A terminating resistor assembly is supplied with the unit. If only one unit is connected to the host, the terminating resistor assembly must be installed in that unit. If multiple units are connected to the host, only one unit (the unit furthest from the host) must have the terminating resistor assembly installed.

RS-232 Serial Connector Information

The serial port pin assignment is as follows:



Host settings

Baud Rate	1.2k, 2.4k, 4.8k, 9.6k, 14.4k, 19.2k, 28.8k, 38.4k (set on the unit)
Data bits	8
Stop bit	1
Parity	None

NOTES:

- The host must be set to the same baud rate as the unit. The computer hardware and operating system needed to support communication depends upon the RS-485 adapter (or converter box) used.
- For a microprocessor-based conversion (such as the Edgeport USB converter from Inside Outside Networks), the host computer should be at least a Pentium II-233 running Windows 98, Windows ME, Windows 2000, Windows XP or Windows NT 4.0. For a hardware-based converter without an internal microprocessor (such as the Telebyte model 285), the host computer should be at least a Pentium III-550 running Windows 98, Windows ME, Windows 2000, Windows XP or Windows NT 4.0.

For RS-485 communication, do ***not*** exceed the capacity of each channel. The product of:

(total number welds per second on all welders on that channel)

times

(total number of bytes exchanged per weld)

times

(8 bits per byte)

must in all cases remain ***less*** than the theoretical maximum capacity of the channel – the baud rate selected on the unit. This capacity is not an issue on RS-232 channels.

A good guideline is that on a line free of electrical noise, the number calculated above must remain less that 70% of the theoretical maximum capacity. Electrical noise on the communications lines will further reduce this capacity. Shielded cables are recommended.

Several commands require the unit to be in **HOST** mode for the unit to accept them. Those commands include the **REPORT** command and all **SET** commands. See the **MASTER CNTL** command in *Chapter 3* and the **REMOTE** command below for more information.

Section II. Communications Protocol and Commands

Command Format

#*ID* **KEYWORD** *parameters* <crlf><lf>

UNIT IDENTIFICATION: *#ID* (*ID* is any number from “00” to “30”, must be a two digit number).

COMMAND KEYWORDS: **BOLD.**

VARIABLE: *italics.*

REQUIRED PARAMETERS: {enclosed in braces} (one required and only one parameter allowed).

CHOICE OF PARAMETERS: separated by vertical bar "|" indicates one *OR* another of choices presented.

REQUIRED/OPTIONAL PARAMETERS: [enclosed in brackets] (one or more allowed, used in the **SET** parameter)(zero allowed in the **READ** parameter).

RANGE OF PARAMETERS: *low_end - high_end* (separated by hyphen).

END OF PARAMETER TERMINATOR: **<crlf>** (carriage return followed by linefeed).

TERMINATION OF COMMAND: **<lf>** (linefeed - must be preceded by the end of line terminator <crlf>).

Each unit identifier, command keyword, and parameters must be separated by one or more spaces except the termination of command <lf> must follow the end of parameter terminator<crlf> immediately. I. E. **“<crlf><lf>”**

Computer Originated Commands

These are the commands sent by the host computer, via RS-485 or RS-232 to a Control.

Command **STATUS**<crlf><lf>

Control State Any

Description Requests the Control to report the status of the weld data buffer. Control returns **STATUS** with either "**OK**" or "**OVERRUN.**"

Command **TYPE**<crlf><lf>

Control State Any

Description Requests the Control to return the type of welder, release number, and revision letters.

Command **COUNT**<crlf><lf>

Control State Any

Description Requests the Control to report the number of weld data accumulated since the last data collection. Control returns the COUNT even if there is no weld data available.

Command **ERASE**<crlf><lf>

Control State Any

Description Requests the Control to erase all the weld reports.

Command **SYNC**<crlf><lf>

Control State Any

Description Provides synchronization of the commands. The Control returns SYNC command back to the host computer.

Command **CURRENT**<crlf><lf>

Control State Any

Description Requests the Control to report the sampled Current data of the last weld. Control shall return with CURRENT report. See CURRENT command under Control Originating Commands section.

Command **VOLTAGE** <crlf><lf>

Control State Any

Description Requests the Control to report the sampled Voltage data of the last weld. Control shall return with a VOLTAGE report. See VOLTAGE command under Control Originating Commands section.

Command **POWER** <crlf><lf>

Control State Any

Description Requests the Control to report the sampled Power data of the last weld. Control shall return with POWER report. See POWER command under Control Originating Commands section.

Command **OHMS** <crlf><lf>

Control State Any

Description Requests the Control to report the sampled resistance data of the last weld. Control shall return with OHMS report. See OHMS command under Control Originating Commands section.

Command **STATE {READ | RUN | MENU**}<crlf><lf>

Control State Any

Description Commands the Control to identify its current state ("READ" keyword, see STATE under CONTROL ORIGINATED COMMANDS section) or go to either RUN state or PROGRAM state.

Command **LOAD** {*schedule_number*}<crlf><lf>

Control State RUN state

Description Selects the schedule_number as the currently loaded schedule. schedule_number may be any number from 0 to 99. There must be a space between LOAD and schedule_number.

Command **COUNTERS {READ | SET}** {**TOTAL | HIGH | LOW | GOOD}**<crlf><lf>

Control State Any

Description Requests the Control to return the Control weld counter contents.

TOTAL: Returns the total number of weld counter.

HIGH: Returns the out of limits high counter.

LOW: Returns the out of limits low counter.

GOOD: Returns the within limits counter.

Command **REPORT {ALL | P1 | P2 | LVDT | ERASE}** ***number*** <crlf><lf>

Control State Any

Description Requests the Control to send the weld report.

All : a request to send the number of oldest weld reports, all fields, since the last data collection. The reported weld data will not be erased.

P1: a request to send the number of oldest weld reports, only pulse 1 related fields, since the last data collection. The reported weld data will not be erased.

P2: a request to send the number of oldest weld reports, only pulse 2 related fields, since the last data collection. The reported weld data will not be erased.

LVDT: a request to send the number of oldest weld reports, only the LVDT related fields, since the last data collection. The reported weld data will not be erased.

Description **ERASE:** a request to erase the number of oldest welds.

(Continued) ***number:*** the number of weld data to be sent.

If the number is greater than the number of weld data in the buffer, less than the number of weld data will be sent.

NOTE: There must be at least one space between each of the three fields.

Command **COPY {***from_schedule_number***} {***to_schedule_number***}**<crlf><lf>

Control State Any

Description Allows one schedule to be copied to another schedule number. From_schedule_number and to_schedule_number may be any number from 0 to 99. Copying a schedule to itself has no effect other than to invoke a schedule printout when "PRINT SCHEDULES/PROGRAMS" is enabled.

Command **COMBO {READ | SET}** <crlf>
[*parameter_name value*<crlf>]
<lf>

Control State RUN state.

Description Provides control over the Control schedule parameters. When used with the "READ" keyword, all parameters pertaining to the currently loaded schedule are returned (see SCHEDULE under Control ORIGINATED COMMANDS). When the "SET" keyword is used, the host may set (change) the value of one or more of the parameters pertaining to the currently loaded schedule. The following is a list of valid literal substitutions for the parameter_name and value variables:

TYPE1	**KA**	feedback type for combo P1
TYPE2	**KA**	feedback type for combo P2
ENG1	**{** *weld_energy* **}**	combo cutoff energy for pulse 1
ENG2	**{** *weld_energy* **}**	combo cutoff energy for pulse 2

Command **SCHEDULE**<crlf><lf>

Control State Any state ***except*** while welding.

Description Requests the Control to return the currently selected schedule number.

Command **SCHEDULE {READ | SET}** <crlf>
[*parameter_name value*<crlf>]
<lf>

Control State RUN state.

Description Provides control over the Control schedule parameters. When used with the "READ" keyword, all parameters pertaining to the currently loaded schedule are returned (see SCHEDULE under Control ORIGINATED COMMANDS). When the "SET" keyword is used, the host may set (change) the value of one or more of the parameters pertaining to the currently loaded schedule. The following is a list of valid literal substitutions for the parameter_name and value variables:

FEEDBACK1	**{ KA | V | KW}**	feedback type for pulse 1
FEEDBACK 2	**{ KA | V | KW}**	feedback type for pulse 2
SQUEEZE	{ *squeeze_time* }	squeeze time
UP1	{ *weld_time* }	up slope time of pulse 1
WELD1	{ *weld_time* }	weld time of pulse 1
DOWN1	{ *weld_time* }	down slope time of pulse 1
COOL	{ *weld_time* }	cool time
UP2	{ *weld_time* }	up slope time of pulse 2
WELD2	{ *weld_time* }	weld time of pulse 2
DOWN2	{ *weld_time* }	down slope time of pulse 2
HOLD	{ *hold_time* }	hold time
ENG1	**{** *weld_energy* **}**	energy amount for pulse 1
ENG2	{ weld_energy }	energy amount for pulse 2
RINDEX1	{ *resistance index* }	index value into PID resistance table for pulse 1
RINDEX2	{ *resistance index* }	index value into PID resistance table for pulse 2
EINDEX1	{ *energy index* }	index value into PID energy table for pulse 1
EINDEX2	{ *energy index* }	index value into PID energy table for pulse 2

NOTES:

squeeze_time and ***hold_time*** are the parameter that defines the time for the given period in 1 msec. Valid range is from 0 to 999.

weld_time is the parameter that defines the time for the given period. . Each count of ***weld_*** time is equivalent to 0.01 for increments from 0.1 to 0.99 msec and increments of 0.1 msec for 1.0 to 9.9 msec and increments of 1.0 msec for 10.0 to 99.0 msec. (see table next page)

HOST		CONTROL	
Increments	**Range**	**Time Range**	**Increments**
0.01	0.1-0.99	0.1-0.99 ms	0.01 ms
0.1	1.00-9.90	1.0-9.9 ms	0.1 ms
1.0	10.00-99.0	10.0-99.0 ms	1 ms

weld_energy is the parameter that specifies the amount of weld energy. In the current feedback mode, *weld_energy* is in unit of 0.001KA. In the voltage feedback mode, *weld_energy* is in units of 0.001V. In the power feedback mode, *weld_energy* is in units of 0.001kW.

volt multiplier is an index value for a table of resistance vs. a PID multiplier for voltage mode.

NOTE: Not used in versions where **RINDEXx** and **EINDEXx** are present.

resistance index is an index value into a table of resistance vs. energy PID tables. If 0, then a test pulse will occur on the next weld to determine the actual resistance (Note: customer control of this value is ***not*** recommended).

energy index is an index value into a PID energy vs. PID values table. (**NOTE:** customer control of this value is ***not*** recommended).

Command

MONITOR {READ | SET}<crlf>
[*parameter_name value*<crlf>]
<lf>

Control State

Any except while welding

Description

Provides control over the basic weld monitor settings of the Control schedule. When used with the "READ" keyword, the basic weld monitor settings of the currently loaded schedule are returned (see MONITOR under Control ORIGINATED COMMANDS). When the "SET" keyword is used, the host may set (change) the value of one or more of the parameters of the basic weld monitor settings pertaining to the currently loaded schedule. The following is a list of valid literal substitutions for the parameter_name and value variables:

MONTYPE1	**{ KA | V | KW| R }**	Monitor Type for pulse 1
ACTION1	**{ none | STOP | INHIBIT | APC }**	Out of Limit Action for pulse 1
UPPER1	**{** *limit_value* **}**	Upper Limit for pulse 1
LOWER1	**{** *limit_value* **}**	Lower Limit for pulse 1
MONTYPE2	**{ KA | V | KW| R }**	Monitor Type for pulse 2
ACTION2	**{ none | STOP }**	Out of Limit Action for pulse 2
UPPER2	**{** *limit_value* **}**	Upper Limit for pulse 2
LOWER2	**{** *limit_value* **}**	Lower Limit for pulse 2
P1LDLY1	{delay_value}	Pulse 1 Lower Delay Start Time For Lower Limit
P1LDLY2	{delay_value}	Pulse 1 Lower Delay End Time For Lower Limit
P1UDLY1	{delay_value}	Pulse 1 Upper Delay Start Time For Upper Limit
P1UDLY2	{delay_value}	Pulse 1 Upper Delay End Time For Upper Limit
P2LDLY1	{delay_value}	Pulse 2 Lower Delay Start Time For Lower Limit
P2LDLY2	{delay_value}	Pulse 2 Lower Delay End Time For Lower Limit
P2UDLY1	{delay_value}	Pulse 2 Upper Delay Start Time For Upper Limit
P2UDLY2	{delay_value}	Pulse 2 Upper Delay End Time For Upper Limit

limit_value is the parameter that specifies the range of the valid readings. If the reading was within the range of the *limit_value*, no alarm will occur. If the reading was out of the valid range, an alarm will occur. If the monitor type is KA, the *limit_value* is in unit of 1A. If the monitor type is V, the *limit*_value is in unit of 1mV. If the monitor type is kW, the *limit*_value is in unit of 1W. The valid number for *limit_value* is 1 through 9999 and 0 is for none.

The ***delay_value*** is the parameter that defines the time for the given period in 0.1ms. Valid range is from 0 to 99. Lower delay value is only valid during WELD time. Upper delay value is valid during UP time, WELD time, and DOWN time.

Command

ENVLIMIT {READ | SET}<crlf>
[*parameter_name value*<crlf>]
<lf>

Control State

Any

Description

Provides control over the basic welding envelope limit settings of the current schedule. When used with the "READ" keyword, the basic welding envelope limit settings for the currently loaded schedule are returned (see ENVLIMIT under Control ORIGINATED COMMANDS). When the "SET" keyword is used, the host may set (change) the value of one or more of the parameters of the basic welding envelope limit settings pertaining to the currently loaded schedule. The following is a list of valid literal substitutions for the parameter_name and value variables of valid literal substitutions for the parameter_name and value variables:

TYPE1	**{ KA | V | KW }**	Energy Type for pulse 1
UPPER1	**{** *limit_value* **}**	Upper Limit for pulse 1
LOWER1	**{** *limit_value* **}**	Lower Limit for pulse 1
ACTION1	**{ none | STOP | INHIBIT | APC }**	Out of Limit Action for pulse 1
TYPE2	**{ KA | V | KW }**	Energy Type for pulse 2
UPPER2	**{** *limit_value* **}**	Upper Limit for pulse 2
LOWER2	**{** *limit_value* **}**	Lower Limit for pulse 2
ACTION2	**{ none | STOP }**	Out of Limit Action for pulse 2
P1LDLY1	{delay_value}	Pulse 1 Lower Delay Start Time For Lower Limit
P1LDLY2	{delay_value}	Pulse 1 Lower Delay End Time For Lower Limit
P1UDLY1	{delay_value}	Pulse 1 Upper Delay Start Time For Upper Limit
P1UDLY2	{delay_value}	Pulse 1 Upper Delay End Time For Upper Limit
P2LDLY1	{delay_value}	Pulse 2 Lower Delay Start Time For Lower Limit
P2LDLY2	{delay_value}	Pulse 2 Lower Delay End Time For Lower Limit
P2UDLY1	{delay_value}	Pulse 2 Upper Delay Start Time For Upper Limit
P2UDLY2	{delay_value}	Pulse 2 Upper Delay End Time For Upper Limit

Command **ENVWAVE READ** *pulse_number*<crlf><lf>

ENVWAVE SET *number_of_data_points pulse_number type* <crlf>

data <crlf> . . . *data*<crlf>

<lf>

Control State Any

Description Requests the Control to report the stored envelope.

When used with the "READ" keyword, the current stored envelope waveform is returned (see WAVEFORM under Control ORIGINATED COMMANDS). When the "SET" keyword is used, the host may set (change) the stored envelope waveform. The following is a list of valid literal substitutions for the parameter_name and value variables:

number_of_data_points: Total count of data points in this waveform.

pulse_number:

P1	data for pulse 1 to follow.
P2	data for pulse 2 to follow.

type: **{ KA | V | KW }** Envelope Type for pulse.

NOTE: At least one space should be placed between each field in the title before the first <crlf>.

Command **RELAY {READ | SET}** <crlf>
[*parameter_name value*<crlf>]
<lf>

Control State Any except while welding

Description Provides control over the Control schedule parameters for relay settings. When used with the "**READ**" keyword, the relay settings of the currently loaded schedule are returned (see **RELAY** under Control ORIGINATED COMMANDS). When the "**SET**" keyword is used, the host may set (change) the value of one or more of the relay settings of the currently loaded schedule. The following is a list of valid literal substitutions for the *parameter_name* and *value* variables:

ACTIVE1	**{ HIGH | LOW }**	Relay 1 Active High or Active Low
CONDITION1	*condition_value*	Relay 1 Active Conditions
SUBCOND1	*extended_condition_value*	Relay 1 Extended Conditions.
ACTIVE2	**{ HIGH | LOW }**	Relay 2 Active High or Active Low
CONDITION2	*condition_value*	Relay 2 Active Conditions
SUBCOND2	*extended_condition_value*	Relay 2 Extended Conditions.
ACTIVE3	**{ HIGH | LOW }**	Relay 3 Active High or Active Low
CONDITION3	*condition_value*	Relay 3 Active Conditions
SUBCOND3	*extended_condition_value*	Relay 3 Extended Conditions.
ACTIVE4	**{ HIGH | LOW }**	Relay 4 Active High or Active Low
CONDITION4	*condition_value*	Relay 4 Active Conditions
SUBCOND4	*extended_condition_value*	Relay 4 Extended Conditions.

condition_value: **{ ALARM | LIMITS | WELD | END | P1+P2 | KA+V | KW+R | OTHER | MG3 | DISP}**

NOTE:

extended_condition_value not valid unless ***condition_value*** is:
P1+P2 or **KA+V** or **KW+R** or **OTHER** or **DISP.**

extended_condition_value:

for P1+P2: { LIMITS | P1OUT | P1HI | P1LOW | P2OUT | P2HI | P2LOW}

for KA+V: { KALIMIT | VLIMIT | P1KAHI | P1KALOW | P2KAHI | P2KALOW | P1VHI | P1VLOW | P2VHI | P2VLOW}

for KW+R: { KWLIMIT | RLIMIT | P1KWHI | P1KWLOW | P2KWHI | P2KWLOW | P1RHI | P1RLOW | P2RHI | P2RLOW}

for OTHER: { FRLIMIT | STFORCE | EDFORCE | EGLIMIT | EGHI | EGLOW | TMLIMIT | TMHI | TMLOW | ENVLIM}
for DISP: {ANY | ILO | IHI | FLO | FHI | DLO | DHI | INI | DSP | SEA}
NOTES:

P1+P2 condition value explanations**:**

LIMITS:	Pulse 1 or Pulse 2 out of limits.
P1OUT:	Pulse 1 out of limits.
P1HI, P1LOW:	Pulse 1 hi/low limit reached.
P2OUT:	Pulse 2 out of limits.
P2HI, P2LOW:	Pulse 2 hi/low limit reached.

KA+V condition value explanations**:**

KALIMIT	Current Limit Reached.
VLIMIT	Voltage Limit Reached**.**
P1KAHI, P1KALOW:	Pulse 1 Current hi/low error.
P2KAHI, P2KALOW:	Pulse 1 Current hi/low error.
P1VHI, P1VLOW:	Pulse 2 Voltage hi/low error.
P2VHI, P2VLOW:	Pulse 2 Voltage hi/low error.

KW+R condition value explanations**:**

KWLIMIT:	Power Limit Reached
RLIMIT:	Resistance Limit Reached
P1KWHI, P1KWLOW:	Pulse 1 Power hi/low error
P2KWHI, P2KWLOW:	Pulse 1 Power hi/low error
P1RHI, P1RLOW:	Pulse 2 Resistance hi/low hi error
P2RHI, P2RLOW:	Pulse 2 Resistance hi/low error

OTHER condition value explanations**:**

FRLIMIT	
STFORCE:	Starting force limit reached.
EDFORCE :	Ending force limit reached.
EGLIMIT:	Energy limit reached.
EGHI, EGLOW:	Energy hi/low limit reached.
TMLIMIT:	Time limit reached.
TMHI, TMLOW:	Time hi/low limit reached.

DISP condition value explanations:

ANY	Any displacement error.
ILO, IHI	Initial thickness low/hi error.
FLO, FHI	Final thickness low/hi error.
DLO, DHI	Final displacement low/hi error.
INI	Initial thickness error.
DSP	Any final displacement error.
SEA	Stop energy at error.

Command **SYSTEM {READ | SET}**<crlf>
[*parameter_name value*<crlf>]

<lf>

Control State Any

Description Provides control over the Control's system parameters. When used with the "**READ**" keyword, all system parameters are returned (see **SYSTEM** under CONTROL ORIGINATED COMMANDS). When used with the "**SET**" keyword, the host may set (change) the value of one or more of the system parameters.

The following is a list of valid literal substitutions for the *parameter_name* and *value* variables:

LIGHT	**{ *light_value* }**	LCD contrast
LOUDNESS	**{ *loudness_value* }**	Buzzer Loudness
BUZZER	**{ OFF | ON }**	End of cycle buzzer
DISPLAY	**{ PEAK | AVG }**	Display mode
SWSTATE	**{ switch_state }**	Input Switch Type
FIRESW	**{ AUTO | REMOTE | NONE }**	Firing Switch Type
CTSTATE	**{ *switch_state* }**	Control Signals Type
GRAPH	**{ OFF | ON }**	Update Graph
WELDABORT	**{ OFF | ON }**	Footswitch weld abort
DEBOUNCE	**{ NONE | 10 | 20 | 30 }**	Switch debounce time in Msec

These parameters pertain to the settings of the option menus available via the front panel user interface.

light_value is a number 0 to 100 for brightness of the LCD. 0 is dark and 100 is the brightest.

loudness_value is a number 0 to 100 for buzzer loudness. 0 is off and 100 is the loudest.

switch_state: **{ MECHOPEN | MECHCLOSED | OPTOOPEN | OPTOCLOSED | PLC0V | PLC24V}**

Command **ALARM {READ | CLEAR | SET** *error_number* **| DISPLAY** *alarm_message_string***}**<crlf><lf>

Control State Any

Description Provides access to the Control alarm logic. When used with the "READ" keyword, the current error condition value is returned. See *Appendix A* for list of alarm messages. When the "CLEAR" keyword is used, all alarm conditions are canceled. When the "SET" keyword is used, the host may invoke an error identified by error_number. When the "DISPLAY" keyword is used, an error condition can be created with any message desired. The length of the error message must be limited to 40 characters or less. No help message will be available in connection with this created error message.

Command **TIME {READ | SET}** <crlf>
[*parameter_name value*<crlf>]
<lf>

Control State RUN state.

Description Provides control over the Control schedule parameters. When used with the "READ" keyword, all parameters pertaining to the currently loaded schedule are returned (see SCHEDULE under Control ORIGINATED COMMANDS). When the "SET" keyword is used, the host may set (change) the value of one or more of the parameters pertaining to the currently loaded schedule. The following is a list of valid literal substitutions for the parameter_name and value variables:

UPPER1	**{** *limit*_**value }**	Upper Time Limit for pulse 1
LOWER1	**{** limit_*value* **}**	Lower Time Limit for pulse 1
UPPER2	**{** limit_*value* **}**	Upper Time Limit for pulse 2
LOWER2	**{** *limit*_value **}**	Lower Time Limit for pulse 2

Command **FORCE {READ | SET}** <crlf>
[*parameter_name value*<crlf>]
<lf>

Control State RUN state.

Description Provides control over the Control schedule parameters. When used with the "READ" keyword, all parameters pertaining to the currently loaded schedule are returned (see SCHEDULE under Control ORIGINATED COMMANDS). When the "SET" keyword is used, the host may set (change) the value of one or more of the parameters pertaining to the currently loaded schedule. The following is a list of valid literal substitutions for the parameter_name and value variables:

UPPER	**{** *limit_value* **}**	Upper Force Limit
LOWER	**{** *limit_value* **}**	Lower Force Limit.
FIRE	**{** *limit_value* **}**	Upper Force Limit.
ACTION	**{ none | STOP }**	Out of Limit Action for force

Command **VALVE {READ | SET}** <crlf>
[*parameter_name value*<crlf>]
<lf>

Control State RUN state.

Description Provides control over the Control schedule parameters. When used with the "READ" keyword, all parameters pertaining to the currently loaded schedule are returned (see SCHEDULE under Control ORIGINATED COMMANDS). When the "SET" keyword is used, the host may set (change) the value of one or more of the parameters pertaining to the currently loaded schedule. The following is a list of valid literal substitutions for the parameter_name and value variables:

SOFT	**{** *value* **}**	Soft pressure value
TIME	**{** *time* **}**	Soft Pressure time.
FINAL	**{** *value* **}**	Final Pressur

Command **SECURITY {OFF | F | C | Y | A}**<crlf><lf>

Control State Any

Description Allows control of the system security mode.

F = “OFF” sets all security status Control to “OFF.”

C = “SCHEDULE” sets the schedule lock to “ON.”

Y = “SYSTEM” sets the system lock to “ON.”

A = “CALIBRATION” sets the calibration lock to “ON.”

Command **DISP {READ | SET}** <crlf>
[*parameter_name value*<crlf>]

<lf>

Control State ***Any except while welding***

Description Provides control over the displacement limit check parameters. When used with the "**READ**" keyword, all parameters pertaining to the currently loaded schedule are returned (see **DISP** under *Control Originated Commands*). When the "**SET**" keyword is used, the host may set (change) the value of one or more of the parameters pertaining to the currently loaded schedule. The following is a list of valid literal substitutions for the parameter_name and value variables:

INITLO	**{** *initial_thick_lo* **}**	low limit for initial thickness
INITHI	**{** *initial_thick_hi* **}**	high limit for initial thickness
FINALLO	**{** *final_thick_lo* **}**	low limit for final thickness
FINALHI	**{** *final_thick_hi* **}**	high limit for final thickness
DISPLO	**{** *displacement_lo* **}**	low limit for final displacement
DISPHI	**{** *displacement_hi* **}**	high limit for final displacement
DISPWT	**{** *displacement_wtd* **}**	limit for “weld to” displacement
UNITS	**{ IN/1000 | MM }**	displacement limit units
INITERR	**{ CONT | STOP }**	initial thickness error action

NOTES:

The units of the limit fields parameters depend on the value of the **UNITS** parameter as follows:

IN/1000: 1 = 0.001 inches; 10 = 0.01 inches

MM: 1 = 0.01 mm; 10 = 0.1 mm

Initial and final thicknesses are positive if the electrodes move farther apart and negative if they move closer together (in relation to the "zero setting"). The reference "zero setting" for thickness measurements may be set using the **DISPZERO** command.

Displacement is positive if the electrodes moved closer together during the weld and negative if they moved further apart.

INITERR controls the HF25 action if an Initial Thickness limit is reached. **CONT** continues the weld and gives an alarm at the end of the weld. **STOP** terminates the weld operation after squeeze time (when the initial thickness is measured).

Command **DISPZERO {READ | CLEAR}**<crlf>
<lf>

Control State Any except while welding

Description Provides control over the Control's displacement measuring "zero setting". When used with the "**READ**" keyword, the a/d converter counts (not actual position) for the current zero setting of the upper electrode are returned When used with the "**CLEAR**" keyword, the host may clear the zero setting and the upper electrode position at the start of the next weld will establish the new zero setting.

NOTE: This zero setting is the reference position for the initial and final thickness measurements.

Control Originated Commands

These are the commands sent from a Control to a host computer.

Command **STATUS** *state_name* <crlf><lf>

Control State Any

Description Identifies the current status of the weld data buffer. May be in response with **"OK"** or **"OVERRUN." "OK"** means that the Control weld buffer did not over-run since the last data collection and all the data are intact. **"OVERRUN"** means that the Control weld buffer did over-run since the last data collection and only the latest 900 weld data are available to report.

Command **TYPE** *type, release numbers, revision letters*<crlf><lf>

Control State Any

Description Returns "HF27 1.00 A 37232" for the first release of an HF27.

Command **COUNT** *number* <crlf><lf>

Control State Any

Description Returns the number of weld data available in Control. The total number of weld data that the Control holds in the buffer is 900.

Command **NAME** *schedule_name*<crlf><lf>

Control State Any

Description Returns the current schedule's name up to a maximum of 20 charters.

Command **STATE** *state_name*<crlf><lf>

Control State Any

Description Identifies the current state of operation of the Control. May be in response to the **STATE READ** Command sent by the host, or may be sent as a result of a state change from the Control front panel.

state_name may be "**RUN",** "**MENU**" or "**PROG**".

Command **COUNTER**<crlf>
TOTAL *number*<crlf>
HIGH *number*<crlf>
LOW *number*<crlf>
GOOD *number*<crlf>
<lf>

Control State Any

Description Returns the requested current Control weld counter values.

Command **ALARM** *error_message*<crlf><lf>

Control State Any

Description Identifies the current error condition of operation of the Control. May be in response to the **ALARM READ** command sent by the host, or may be sent as a result of an error condition occurring in the Control. ***error_message*** is a text string describing the error message, which is the same error message that is displayed to the screen.

Command **CURRENT** *number_of_data* <crlf>
data <crlf> data <crlf> . . . . *data* <crlf><lf>

Control State Any

Description Returns the Current waveform data of the last weld. First field is the number of data to be sent. Then follows the packets of data. Each data is separated by <crlf> and this command ends with <crlf><lf>.

number_of_data: This is the number of data that shall be included in this command. The Control samples current every 40 μs. For a weld less than 80 ms weld time, the number of data will be approximately: *total weld time* ÷ 40 *μs.* This number will **always** be less than 2000.

data: an integer number in unit of A.

Command **VOLTAGE** *number_of_data* <crlf>
data <crlf> data <crlf> . . . . *data* <crlf><lf>

Control State Any

Description Returns the Voltage waveform data of the last weld. First field is the number of data to be sent. Then follows the packets of data. Each data is separated by <crlf> and this command ends with <crlf><lf>.

number_of_data: This is the number of data that shall be included in this command. The Control samples Voltage every 40 μs. For a weld less than 80 ms weld time, the number of data will be approximately: *total weld time* ÷ 40 *μs.* This number will **always** be less than 2000.

data: An integer number in unit of mV.

Command **POWER** *number_of_data* <crlf>
data <crlf> data <crlf> . . . . *data* <crlf><lf>

Control State Any

Description Returns the Power waveform data of the last weld. First field is the number of data to be sent. Then follows the packets of data. Each data is separated by <crlf> and this command ends with <crlf><lf>.

number_of_data: This is the number of data that shall be included in this Command. The Control samples Current and Voltage every 40 μs. For a weld less than 80 ms weld time, the number of data will be approximately: *total weld time* ÷ 40 *μs.* This number will be always less than 2000.

data: An integer number in unit of W.

Command **OHMS** *number_of_data* <crlf>
data <crlf> data <crlf> . . . . *data* <crlf><lf>

Control State Any

Description Returns the Resistance waveform data of the last weld. First field is the number of data to be sent. Then follows the packets of data. Each data is separated by <crlf> and this command ends with <crlf><lf>.

number_of_data: This is the number of data that shall be included in this Command. The Control samples Current and Voltage every 40 µs. For a weld less than 80 ms weld time, the number of data will be approximately: *total weld time ÷ 40 µs.* This number will be always less than 2000.

data: An integer number in unit of mOhms.

Command **ENERGY** *number_of_data* <crlf>
data <crlf> data <crlf> . . . . *data*<crlf><lf>

Control State Any

Description Returns the energy waveform data of the last weld. First field is the number of data to be sent. Then follows the packets of data. Each data is separated by <crlf> and this command ends with <crlf><lf>.

number_of_data: This is the number of data that shall be included in this Command. The Control samples Current and Voltage every 40 µs. For a weld less than 80 ms weld time, the number of data will be approximately: *total weld time ÷ 40 µs.* This number will be always less than 2000.

Data: An integer number in units of joules.

Command **SYNC** <crlf><lf>

Control State Any

Description The Control return SYNC command back to the host computer when the SYNC command is received from the host computer.

Command **COMBO**<crlf>
TYPE1 **KA**<crlf>
TYPE2 **KA**<crlf>
ENG1 **{** *weld_energy* **}**<crlf>
ENG2 **{** *weld_energy* **}**<crlf>
<lf>

Control State RUN state.

Description Returns the Combo energy limits set for the current schedule.

Command **TIME**<crlf>
UPPER1 **{** *limit_value* **}**<crlf>
LOWER1 **{** *limit_value* **}**<crlf>
UPPER2 **{** *limit_value* **}**<crlf>
LOWER2 **{** *limit_value* **}**<crlf>
<lf>

Control State RUN state.

Description Returns the time limits set for the current schedule.

Command **FORCE**<crlf>
UPPER **{** *limit_value* **}**<crlf>
LOWER **{** *limit_value* **}**<crlf>
FIRE **{** *limit_value* **}**<crlf>
ACTION **{ none | STOP }**<crlf>
<lf>

Control State RUN state.

Description Returns the force limits.

Command **VALVE**<crlf>
SOFT **{** *value* **}**<crlf>
TIME **{** *time* **}**<crlf>
FINAL **{** *value* **}**<crlf>
<lf>

Control State RUN state.

Description Returns the pressure limits.

Command **SYSTEM** <crlf>
LIGHT **{ *light_value* }**<crlf>
BUZZER **{ OFF | ON }**<crlf>
LOUDNESS **{ *loudness_value* }**<crlf>
DISPLAY **{ PEAK | AVG }**<crlf>
SWSTATE **{ *switch_state* }**<crlf>
FIRESW **{ AUTO | REMOTE | NONE }** <crlf>
CTSTATE **{ *switch_state* }**<crlf>
GRAPH **{ OFF | ON }** <crlf>
WELDABORT **{ OFF | ON }** <crlf>
DEBOUNCE **{NONE | 10 | 20 | 30 }** <crlf>
<lf>

Control State Any

Description Reports the current settings of the Control system parameters.

light_value is a number 0 to 99 for brightness of the LCD. 0 is dark and 100 is the brightest.

loudness_value is a number 0 to 99 for buzzer loudness. 0 is off and 100 is the loudest.

switch_state: **{ MECHOPEN | MECHCLOSED | OPTOOPEN | OPTOCLOSED | PLC0V | PLC24V}**

Command

ENVLIMIT<crlf>
TYPE1 **{ KA | V | KW }**<crlf>
UPPER1 **{** *limit_value* **}**<crlf>
LOWER1 **{** *limit_value* **}**<crlf>
ACTION1 **{ none | STOP | INHIBIT | APC }**<crlf>
TYPE2 **{ KA | V | KW }**<crlf>
UPPER2 **{** *limit_value* **}**<crlf>
LOWER2 **{** *limit_value* **}**<crlf>
ACTION2 **{ none | STOP }**<crlf>
P1LDLY1 **{** *delay_value* **}**<crlf>
P1LDLY2 **{** *delay_value* **}**<crlf>
P1UDLY1 **{** *delay_value* **}**<crlf>
P1UDLY2 **{** *delay_value* **}**<crlf>
P2LDLY1 **{** *delay_value* **}**<crlf>
P2LDLY2 **{** *delay_value* **}**<crlf>
P2UDLY1 **{** *delay_value* **}**<crlf>
P2UDLY2 **{** *delay_value* **}**<crlf>
<lf>

Control State Any

Description Returns the envelope limits that are set for this schedule.

Command **ENVWAVE** *number_of_data_points* **{ P1 | P2 }**<crlf>

data <crlf> . . . *data*<crlf>

<lf>

Control State Any

Description Returns the reference envelope waveform.

Command	**REPORT** *type_of_report number_of_reports* <crlf> *report* <crlf> report <crlf> . . . . *report* <crlf><lf>
Control State	Any

Description

Returns the requested number of weld reports. First field is the type of reports to be sent. The second field is the number of reports sent. Then follows the packets of report. One report pack holds the information about the weld requested. Each report packet is separated by <crlf> and this Command ends with <crlf><lf>.

Type_of_report: This field defines the type of report that was requested by the host computer.

ALL: This defines that a returned report will contain all fields of weld data. The fields in the report packet are separated with a comma and all fields are in integer format. There are always 37 fields in this report packet.

Report: {*unit_number*, *schedule_number , weld_status, average_current_1 , average_voltage_1, peak_current_1 , peak_voltage_1, average_power_1 , peak_power_1, average_resistance_1, peak_resistance_1, time_1, null_1, average_current_2 , average_voltage_2, peak_current_2 , peak_voltage_2, average_power_2 , peak_power_2, average_resistance_2, peak_resistance_2, time_2, null_2, disp_units, disp_initial, disp_final, disp_displacement, monitor_limit, disp_SEA_flag, disp_SEA_time, off_time_1, off_time_2, energy_1, energy_2, start_force, end_force, weld_count}*

P1: This defines that a returned report will contain only fields pertaining to Pulse 1 of the weld data. The fields in the report packet are separated with a comma and all fields are in integer format. There are always 17 fields in this report packet.

Report: {*unit_number*, *schedule_number , weld_status, average_current_1 , average_voltage_1,*

peak_current_1 , peak_voltage_1, average_power_1 , peak_power_1, average_resistance_1, peak_resistance_1, time_1, off_time_1, energy_1, start_force, end_force, weld_count}

P2: This defines that a returned report will contain only fields pertaining to Pulse 2 of the weld data. The fields in the report packet are separated with a comma and all fields are in integer format. There are always 17 fields in this report packet.

Report: {*unit_number*, *schedule_number , weld_status, average_current_2 , average_voltage_2, peak_current_2 , peak_voltage_2, average_power_2 , peak_power_2, average_resistance_2, peak_resistance_2, time_2, off_time_2, energy_2, start_force, end_force, weld_count}*

LVDT: This defines that a returned report will contain only fields pertaining to displacement weld data. The fields in the report packet are separated with a comma and all fields are in integer format. There are always 10 fields in this report packet.

Report: {*unit_number*, *schedule_number , weld_status, disp_units, disp_initial, disp_final, disp_displacement, monitor_limit, disp_SEA_flag, disp_SEA_time}*

Number_of_reports: This is the number of reports that shall be included in this command. If the host computer requests more weld data than is available in the weld data buffer, the Control sends only the weld reports in the weld buffer and the *number_of_reports* is the number of weld reports available in the weld data buffer. After the report is sent to the host computer, the Control does not erase the weld data sent to the host from the weld data buffer. You must use the **REPORT ERASE #** command to erase weld data from the weld buffer.

unit_number:	The unit number assigned to the unit.
Schedule_number:	The schedule number of the weld.
weld_status:	The status of the weld.
Average_current_1:	The average current of pulse 1 (in A).
Average_voltage_1:	The average voltage of pulse 1(in mV).
peak_current_1:	The peak current of pulse 1 (in A).
peak_voltage_1:	The peak voltage of pulse 1 (in mV).

average_power_1: The average power of pulse 1 (in W).
peak_power_1: The peak power of pulse 1 (in W).
average_resistance_1: The average resistance of pulse 1 (in $10^{-5}\Omega$).
peak_resistance_1: The peak resistance of pulse 1 (in $10^{-5}\Omega$).
time_1: APC or MG3 cutoff time.
null_1: The field is always zero.
average_current_2: The average current of pulse 2 (in A).
average_voltage_2: The average voltage of pulse 2(in mV).
peak_current_2: The peak current of pulse 2 (in A).
peak_voltage_2: The peak voltage of pulse 2 (in mV).
average_power_2: The average power of pulse 2 (in W).
peak_power_2: The peak power of pulse 2 (in W).
average_resistance_2: The average resistance of pulse 2 (in $10^{-5}\Omega$).
peak_resistance_2: The peak resistance of pulse 2 (in $10^{-5}\Omega$).
time_2: MG3 cutoff time.
null_2: The field is always zero.
disp_units: The displacement measurement units (0=inches/1000, mm)
disp_initial: The displacement initial thickness value.
Disp_final: The displacement final thickness value.
Disp_displacement: The displacement value (initial minus final).
Monitor_limit: The time reached in ms.
Disp_SEA_flag: The SEA limit reached (0=FALSE, 1=TRUE).
Disp_SEA_time: The limit time in ms.
off_time_1: The error cutoff time
off_time_2: The error cutoff time
energy_1: The total energy for pulse 1.
Energy_2: The total energy for pulse 2.
Start_force: The force at the start of the weld.
end_force: The force at the end of the weld.
Weld_count: The number of this weld assigned by the unit.

NOTE:
disp_xxxx values are signed integer values that have units that depend on **disp_units** as follows:
units = 0 = inches/1000: 1 = 0.001 inches; 10 = 0.01 inches
units = 1 = mm: 1 = 0.01 mm, 10 = 0.10 mm

WELD STATUS CODES

Number	Status Message
0	GOOD
1	CHECK CONTROL SIGNALS INPUT STATUS
2	CHECK INPUT SWITCH STATUS
3	FIRING SWITCH BEFORE FOOT SWITCH
4	STOP ON CONTROL SIGNALS INPUT
5	POWER TRANSISTOR OVERHEATED
6	EMERGENCY STOP - OPERATOR ACTIVATED
7	FIRING SWITCH DIDN'T CLOSE IN 10 SECOND
8	WELD TRANSFORMER OVERHEATED
9	TEST WELD
10	VOLTAGE SELECTION PLUG IS MISSING
11	INHIBIT CONTROL SIGNALS ACTIVATED
12	LOW BATTERY
13	NO CURRENT READING
14	NO VOLTAGE READING
15	LOAD RESISTANCE TOO HIGH
16	NO WELD TRANSFORMER DETECTED
17	WELD SWITCH IN NO WELD POSITION
18	CHECK VOLTAGE CABLE & SECONDARY CIRCUIT
19	CALIBRATION RESET TO DEFAULT
20	LOWER LIMIT GREATER THAN UPPER LIMIT
21	COOL TIME ADDED FOR DIFFERENT FEEDBACK
22	ENERGY SETTING TOO SMALL
23	SYSTEM & SCHEDULE RESET TO DEFAULTS
24	LIMITS ROUND UP
25	CHAINED TO NEXT SCHEDULE
26	SAFE ENERGY LIMIT REACHED
27	P1 LOWER LIMIT DELAYS ADJUSTED
28	P1 UPPER LIMIT DELAYS ADJUSTED
29	P2 LOWER LIMIT DELAYS ADJUSTED
30	P2 UPPER LIMIT DELAYS ADJUSTED
31	UPSLOPE REQUIRED FOR LOWER LIMIT
32	INPUT TOO LARGE

WELD STATUS CODES

Number	Status Message
33	INPUT TOO SMALL
34	PRESS RUN BEFORE WELDING
35	ERASE FAILED
36	PROGRAM FAILED
37	NO LOWER LIMIT WITH STOP P1 ACTION
38	LIMIT DELAYS RESET TO 0
39	ACCESS DENIED! SYSTEM SECURITY ON
40	ILLEGAL SECURITY CODE ENTERED
41	NOT USED
42	NOT USED
43	NOT USED
44	NOT USED
45	NOT USED
46	NOT USED
47	ACCESS DENIED! SCHEDULE LOCK ON
48	INITIAL THICKNESS LOW
49	INITIAL THICKNESS HIGH
50	FINAL THICKNESS LOW
51	FINAL THICKNESS HIGH
52	DISPLACEMENT LOW
53	DISPLACEMENT HIGH
54	WELD STOP DISP. REACHED
55	CURRENT1 > UPPER LIMIT
56	CURRENT1 < LOWER LIMIT
57	VOLTAGE1 > UPPER LIMIT
58	VOLTAGE1 < LOWER LIMIT
59	POWER1 > UPPER LIMIT
60	POWER1 < LOWER LIMIT
61	RESISTANCE1 > UPPER LIMIT
62	RESISTANCE1 < LOWER LIMIT
63	P1 LFCD DISP > UPPER LIMIT
64	P1 LFCD DISP < LOWER LIMIT
65	SCHEDULES ARE RESET

WELD STATUS CODES

Number	Status Message
66	SYSTEM PARAMETERS ARE RESET
67	P2 ENV DISP > UPPER LIMIT
68	P2 ENV DISP < LOWER LIMIT
69	WELD TIME TOO SMALL
70	NOT USED
71	CURRENT2 > UPPER LIMIT
72	CURRENT2 < LOWER LIMIT
73	VOLTAGE2 > UPPER LIMIT
74	VOLTAGE2 < LOWER LIMIT
75	POWER2 > UPPER LIMIT
76	POWER2 < LOWER LIMIT
77	RESISTANCE2 > UPPER LIMIT
78	RESISTANCE2 < LOWER LIMIT
79	INHIBIT 2ND PULSE
80	WELD STOP - LIMIT REACHED
81	SYSTEM ERROR: BUS ERROR
82	SYSTEM ERROR: SOFTWARE INTERRUPT
83	SYSTEM ERROR: ILLEGAL INSTRUCTION
84	SYSTEM ERROR: DIVIDED BY ZERO
85	SYSTEM ERROR: SPURIOUS INTERRUPT
86	COOL TIME MINIMUM
87	TEST WELD? [MENU]=NO [RUN]=YES
88	CAPACITY LIMIT EXCEEDED P1
89	CAPACITY LIMIT EXCEEDED P2
90	STABILITY LIMIT EXCEEDED P1
91	STABILITY LIMIT EXCEEDED P2
92	WELD FIRE LOCKOUT
93	THIN MUST BE LESS THAN THICK
94	THICK TOO SMALL
95	P1 JOULES > UPPER LIMIT
96	P1 JOULES < LOWER LIMIT
97	P2 JOULES > UPPER LIMIT
98	P2 JOULES < LOWER LIMIT

WELD STATUS CODES

Number	Status Message
99	FORCE TIMED OUT > 10 SEC.
100	P1 CUTOFF TIME > UPPER LIMIT
101	P1 CUTOFF TIME < LOWER LIMIT
102	P2 CUTOFF TIME > UPPER LIMIT
103	P2 CUTOFF TIME < LOWER LIMIT
104	SELECTED SCHEDULE LIMITS ARE RESET
105	P1 FORCE > UPPER LIMIT
106	P1 FORCE < LOWER LIMIT
107	P2 FORCE > UPPER LIMIT
108	P2 FORCE < LOWER LIMIT
109	NEED TO SET MONITOR LIMIT
110	ACCESS DENIED! CALIBRATION LOCK ON
111	SQUEEZE TIME INCREASED
112	P1 kA > ENV UPPER LIMIT
113	P1 kA < ENV LOWER LIMIT
114	P1 VOL > ENV UPPER LIMIT
115	P1 VOL < ENV LOWER LIMIT
116	P1 PWR > ENV UPPER LIMIT
117	P1 PWR < ENV LOWER LIMIT
118	P1 DISP > ENV UPPER LIMIT
119	P1 DISP < ENV LOWER LIMIT
120	P2 kA > ENV UPPER LIMIT
121	P2 kA < ENV LOWER LIMIT
122	P2 VOL > ENV UPPER LIMIT
123	P2 VOL < ENV LOWER LIMIT
124	P2 PWR > ENV UPPER LIMIT
125	P2 PWR < ENV LOWER LIMIT
126	P2 DISP > ENV UPPER LIMIT
127	P2 DISP < ENV LOWER LIMIT
128	SCREEN UPDATES ARE OFF

Command **SCHEDULE** *schedule_number* <crlf><lf>

Control State Any

Description Returns the current schedule number to the host. schedule_number may be any number from 0 to 99.

Command

SCHEDULE	***schedule_number*** <crlf>
FEEDBACK1	**{ KA | V | KW }** <crlf>
FEEDBACK2	**{ KA | V | KW }** <crlf>
SQUEEZE	***squeeze_time*** <crlf>
UP1	***weld_time*** <crlf>
WELD1	***weld_time*** <crlf>
DOWN1	***weld_time*** <crlf>
COOL	***weld_time*** <crlf>
UP2	***weld_time*** <crlf>
WELD2	***weld_time*** <crlf>
DOWN2	***weld_time*** <crlf>
HOLD	***hold_time*** <crlf>
ENG1	***weld_energy*** <crlf>
ENG2	***weld_energy*** <crlf>
RINDEX1	**resistance_index<crlf>**
RINDEX2	**resistance_index<crlf>**
EINDEX1	**energy_index<crlf>**
EINDEX2	**energy_index<crlf>**

<lf>

Control State Any

Description Reports the settings of the currently loaded Control schedule parameters. The ***schedule_number*** variable identifies which schedule is currently loaded, and may be any value from 0 to 99.

squeeze_time and ***hold_time*** are the parameter that defines the time for the given period in 1 msec. Valid range is from 0 to 999.

weld_time is equivalent to 0.01 for Increments from 0.1 to 0.99 msec and increments of 0.1 msec for 1.0 to 9.9 msec and increments of 1.0 msec for 10.0 to 99.0 msec. (see table below)

HOST		CONTROL	
Increments	**Range**	**Time Range**	**Increments**
0.01	0.1-0.99	0.1-0.99 ms	0.01ms
0.1	1.00-9.90	1.0-9.9 ms	0.1 ms
1.0	10.00-99.0	10.0-99.0 ms	1 ms

weld_energy is the parameter that specifies the amount of weld energy.

- **Current Feedback** mode: the *weld_energy* range for the HF27 is from 10 to 2.400A (10-2400). .
- **Voltage Feedback** mode: *weld_energy* for the HF27 is in units of 0.001 V, and the range is from 0.200 to 9.9V (200 to 9900).
- (**NOTE:** Maximum attainable voltage is dependent on the HF27 model and the load resistance).
- **Power Feedback** mode: *weld_energy* for the HF27 is in units of 1W, and the range is from 10W to 9900W (10 to 9900).

volt multiplier is the index value for a table of resistance vs. a PID multiplier for voltage mode (used for the last weld). Note: Not used in versions where **RINDEXx** and **EINDEXx** are present.

resistance index is the index value into a table of resistance vs. energy PID tables used for the last weld.

energy index is the index value into a PID energy vs. PID values table used for the last weld.

Command

MONITOR	*schedule_number*<crlf>
MONTYPE1	**{ KA | V | KW | R }**<crlf>
ACTION1	**{ none | STOP | INHIBIT | APC }**<crlf>
UPPER1	**{** *limit_value* **}**<crlf>
LOWER1	**{** *limit_value* **}**<crlf>
MONTYPE2	**{ KA | V | KW | R }**<crlf>
ACTION2	**{ none | STOP }**<crlf>
UPPER2	**{** *limit_value* **}**<crlf>
LOWER2	**{** *limit_value* **}**<crlf>
P1LDLY1	{*delay_value*}<crlf>
P1LDLY2	{*delay_value*}<crlf>
P1UDLY1	{*delay_value*}<crlf>
P1UDLY2	{*delay_value*}<crlf>
P2LDLY1	{*delay_value*}<crlf>
P2LDLY2	{*delay_value*}<crlf>
P2UDLY1	{*delay_value*}<crlf>
P2UDLY2	{*delay_value*}<crlf>

<lf>

Control State Any

Description Reports the settings of the weld monitor of the currently loaded Control schedule. The ***schedule_number*** variable identifies which schedule is currently loaded, and may be any value from 0 to 99. The possible value for all variables listed after their parameter name correspond to the values listed under **MONITOR** in *Host Originated Commands* of this manual.

Command

RELAY <crlf>
ACTIVE1 **{ HIGH | LOW }**<crlf>
CONDITION1 {*condition_value*}<crlf>
SUBCOND1 {*extended_condition_value*}<crlf>
ACTIVE2 **{ HIGH | LOW }**<crlf>
CONDITION2 {*condition_value*}<crlf>
SUBCOND2 {*extended_condition_value*}<crlf>
ACTIVE3 **{ HIGH | LOW }**<crlf>
CONDITION3 {*condition_value*}<crlf>
SUBCOND3 {*extended_condition_value*}<crlf>
ACTIVE4 **{ HIGH | LOW }**<crlf>
CONDITION4 {*condition_value*}<crlf>
SUBCOND4 {*extended_condition_value*}<crlf>
<lf>

condition_value: **{ ALARM | LIMITS | WELD | END | P1+P2 | KA+V | KW+R | OTHER | MG3 | DISP}**

NOTE:

extended_condition_value not valid unless ***condition_value*** is:
P1+P2 or **KA+V** or **KW+R** or **OTHER** or **DISP.**

extended_condition_value:

for P1+P2: **{ LIMITS | P1OUT | P1HI | P1LOW | P2OUT | P2HI | P2LOW}**

for KA+V: **{ KALIMIT | VLIMIT | P1KAHI | P1KALOW | P2KAHI | P2KALOW | P1VHI | P1VLOW | P2VHI | P2VLOW}**

for KW+R: **{ KWLIMIT | RLIMIT | P1KWHI | P1KWLOW | P2KWHI | P2KWLOW | P1RHI | P1RLOW | P2RHI | P2RLOW}**

for OTHER: **{ FRLIMIT | STFORCE | EDFORCE | EGLIMIT | EGHI | EGLOW | TMLIMIT | TMHI | TMLOW | ENVLIM}**

for DISP: **{ANY | ILO | IHI | FLO | FHI | DLO | DHI | INI | DSP | SEA}**

NOTES:

P1+P2 condition value explanations**:**

LIMITS:	Pulse 1 or Pulse 2 out of limits.
P1OUT:	Pulse 1 out of limits.
P1HI, P1LOW:	Pulse 1 low/hi limit reached.
P2OUT:	Pulse 2 out of limits.
P2HI, P2LOW:	Pulse 2 low/hi limit reached.

KA+V condition value explanations**:**

KALIMIT	Current Limit Reached.
VLIMIT	Voltage Limit Reached**.**
P1KAHI, P1KALOW:	Pulse 1 Current low/hi error.
P2KAHI, P2KALOW:	Pulse 1 Current low/hi error.
P1VHI, P1VLOW:	Pulse 2 Voltage low/hi error.
P2VHI, P2VLOW:	Pulse 2 Voltage low/hi error.

KW+R condition value explanations**:**

KWLIMIT:	Power Limit Reached
RLIMIT:	Resistance Limit Reached
P1KWHI, P1KWLOW:	Pulse 1 Power low/hi error
P2KWHI, P2KWLOW:	Pulse 1 Power low/hi error
P1RHI, P1RLOW:	Pulse 2 Resistance low/hi error
P2RHI, P2RLOW:	Pulse 2 Resistance low/hi error

OTHER condition value explanations**:**

FRLIMIT	
STFORCE:	Starting force limit reached.
EDFORCE :	Ending force limit reached.
EGLIMIT:	Energy limit reached.
EGHI, EGLOW:	Energy low/hi limit reached.
TMLIMIT:	Time limit reached.
TMHI, TMLOW:	Time low/hi limit reached.

DISP condition value explanations:

ANY	Any displacement error.
ILO, IHI	Initial thickness low/hi error.
FLO, FHI	Final thickness low/hi error.
DLO, DHI	Final displacement low/hi error.
INI	Initial thickness error.
DSP	Any final displacement error.
SEA	Stop energy at error.

Control State Any

Description Reports the relay settings.

Command **SECURITY**<crlf>
SCHEDULE { ON | OFF }<crlf>
SYSTEM { ON | OFF }<crlf>
CALIBRATION { ON | OFF }<crlf><lf>

Control State Any

Description Returns the current status of the security settings.

Command **DISP** ***schedule_number*** <crlf>
INITLO **{ *initial_thick_lo* }** <crlf>
INITHI **{ *initial_thick_hi* }** <crlf>
FINALLO **{ *final_thick_lo* }** <crlf>
FINALHI **{ *final_thick_hi* }** <crlf>
DISPLO **{ *displacement_lo* }** <crlf>
DISPHI **{ *displacement_hi* }** <crlf>
DISPWT **{ *displacement_wtd* }** <crlf>
UNITS **{ IN/1000 | MM }** <crlf>
INITERR **{ CONT | STOP }** <crlf>
<lf>

Control State ***Any except while welding***

Description Reports the current settings of the Control system displacement limit checking parameters.

NOTES:

The units of the limit fields parameters depend on the value of the **UNITS** parameter as follows:

IN/1000: 1 = 0.001 inches; 10 = 0.01 inches

MM: 1 = 0.01 mm; 10 = 0.1 mm

Initial and final thickness are positive if the electrodes move farther apart and negative if they move closer together (in relation to the "zero setting"). The reference "zero setting" for thickness measurements may be set using the **DISPZERO** command (see *Host Originated Commands* section).

Displacement is positive if the electrodes moved closer together during the weld and negative if they moved further apart.

Command **DISPZERO** ad_counts<crlf><lf>

Control State Any except while welding

Description Reports the current "zero setting" of the Control system displacement measuring device.

This value is in a/d converter counts (not actual position). If zero, the position of the upper electrode at the start of the next weld will establish the new zero setting.

NOTE: This zero setting is the reference position for the initial and final thickness measurements.

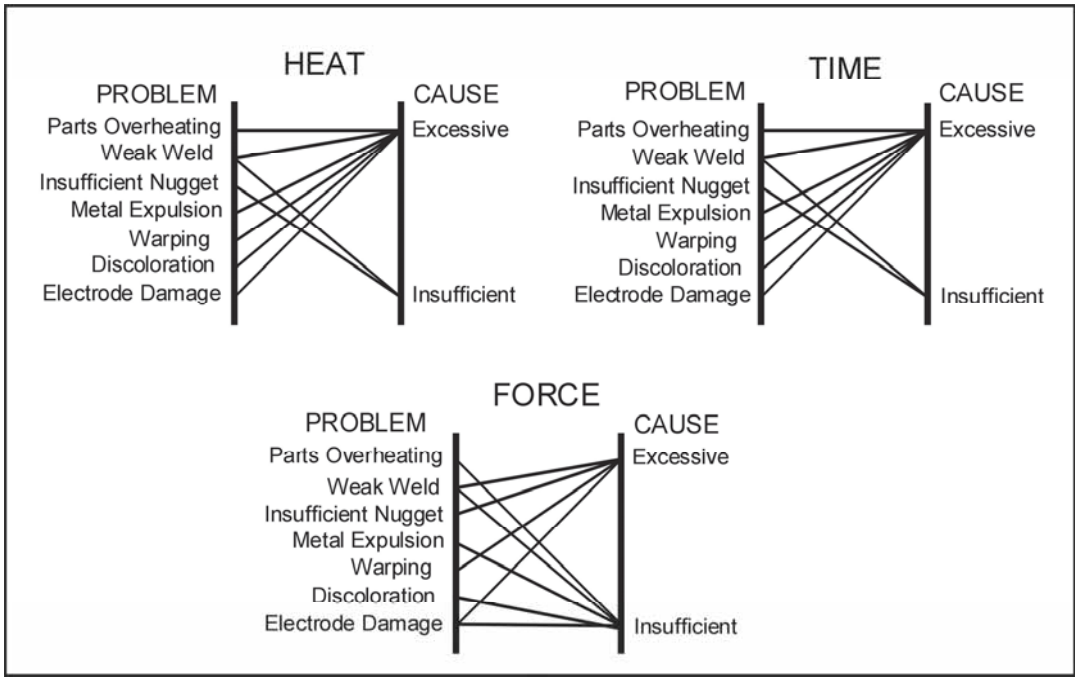
APPENDIX F
The Basics Of Resistance Welding

Resistance Welding Parameters

Resistance welding heat is produced by passing electrical current through the parts for a fixed time period. The welding heat generated is a function of the magnitude of the weld current, the electrical resistance of the parts, the contact resistance between the parts, and the weld force applied to the parts. Sufficient weld force is required to contain the molten material produced during the weld. However, as the force is increased, the contact resistance decreases. Lower contact resistance requires additional weld current, voltage, or power to produce the heat required to form a weld.

The higher the weld force, the greater the weld **current**, **voltage**, **power**, or **time** required to produce a given weld. The formula for amount of heat generated is $\mathbf{I^2RT}$ -- the square of the weld current [**I**] times the workpiece resistance [**R**] times the weld time [**T**].

Welding Parameter Interaction



Interaction of Welding Parameters

Electrode Selection

Correct electrode selection strongly influences how weld heat is generated in the weld area. In general, use conductive electrodes such as a RWMA-2 (Copper alloy) when welding electrically resistive parts such as nickel or steel so that the weld heat is generated by the electrical resistance of the parts and the contact resistance between the parts. Use resistive electrodes such as RWMA-13 (Tungsten) and RWMA-14 (Molybdenum) to weld conductive parts such as copper and gold because conductive parts do not generate much internal heat so the electrodes must provide external heat. Use the following Electrode Selection Table for selecting the proper electrode materials.

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Alumel	-2	Alumel	-2
Alumel	-2	Chromel	-2
Alumel	-2	Dumet	-2
Aluminum	-1	Aluminum	-1
Aluminum	-1	Aluminum Alloys	-1
Aluminum	-1	Cadmium Plating	-1
Aluminum	-1	Tinned Brass	-14
Aluminum	-1	Tinned Copper	-14
Aluminum	-1	Gold Plated Dumet	-2
Aluminum	-1	Gold Plated Kovar	-2
Aluminum	-1	Kovar	-2
Aluminum	-1	Magnesium	-1
Aluminum	-1	Cold Rolled Steel	-2
Aluminum	-1	Stainless Steel	-2
Beryllium Copper	-2	Beryllium Copper	-2
Beryllium Copper	-2	Brass	-2, -14
Beryllium Copper	-2	Copper	-14
Beryllium Copper	-2	Tinned Copper	-14
Beryllium Copper	-2	Nickel	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Beryllium Copper	-2	Cold Rolled Steel	-2
Beryllium Copper	-2	Stainless Steel	-2
Brass	-2, -14	Brass	-2, -14
Brass	-2, -14	Tinned Brass	-14
Brass	-2, -14	Consil	-2
Brass	-2, -14	Constantan	-2
Brass	-2, -14	Copper	-14
Brass	-2, -14	Tinned Copper	-14
Brass	-2, -14	Dumet	-2
Brass	-2, -14	Nichrome	-2
Brass	-2, -14	Nickel	-2
Brass	-2, -14	NiSpan C	-2
Brass	-2, -14	Paliney 7	-2
Brass	-2, -14	Silver	-11, -14
Brass	-2, -14	Cold Rolled Steel	-2
Brass	-2, -14	Stainless Steel	-2
Bronze	-2, -11	Bronze	-2, -11
Bronze	-2, -11	Tinned Copper	-14
Bronze	-2, -11	Iron	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Bronze	-2, -11	Nichrome	-2
Bronze	-2, -11	Nickel	-2
Chromel	-2	Chromel	-2
Chromel	-2	Constantan	-2
Chromel	-2	Copel	-2
Chromel	-2	Copper	-14
Chromel	-2	Tinned Copper	-14
Chromel	-2	Dumet	-2
Chromel	-2	Nichrome	-2
Chromel	-2	Cold Rolled Steel	-2
Consil	-2	Consil	-2
Consil	-2	Tinned Copper	-14
Consil	-2	Dumet	-2
Constantan	-2	Constantan	
Constantan	-2	Copper	-14
Constantan	-2	Tinned Copper	-14
Constantan	-2	Iron	-2
Constantan	-2	Nichrome	-2
Constantan	-2	Nickel	-2
Copper	-14	Copper	-14
Copper	-14	Dumet	-2
Copper	-14	Invar	-2
Copper	-14	Karme	-2
Copper	-14	Manganin	-2
Copper	-14	Nichrome	-2
Copper	-14	Nickel	-2
Copper	-14	Paliney 7	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Copper	-14	Silver	-11, -14
Copper	-14	Cold Rolled Steel	-2
Copper	-14	Stainless Steel	-2
Dumet	-2	Dumet	-2
Dumet	-2	Nichrome	-2
Dumet	-2	Nickel	-2
Dumet	-2	Platinum	-2
Dumet	-2	Cold Rolled Steel	-2
Evanohm	-14	Copper	-14
Gold	-14	Gold	-14
Gold	-14	Kovar	-2
Hastalloy	-2	Titanium	-2
Inconel	-2	Inconel	-2
Inconel	-2	Kulgrid	-2
Invar	-2	Invar	-2
Iridium	-2	Iridium	-2
Iridium	-2	Platinum	-2
Iron	-2	Iron	-2
Karma	-2	Karma	-2
Karma	-2	Nickel	-2
Karma	-2	Platinum	-2
Kovar, Gold Plate	-2	Kovar, Gold Plate	-2
Kovar, Gold Plate	-2	Kulgrid	-2
Kovar, Gold Plate	-2	Nickel	-2
Kovar, Gold Plate	-2	Silver	-11, -14
Kovar, Gold Plate	-2	Stainless Steel	-2
Magnesium	-1	Magnesium	-1

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
Molybdenum	-2	Nickel	-2
Molybdenum	-2	Tungsten	-2
Nichrome	-2	Nichrome	-2
Nichrome	-2	Nickel	-2
Nichrome	-2	Cold Rolled Steel	-2
Nichrome	-2	Stainless Steel	-2
Nickel	-2	Nickel	-2
Nickel	-2	Cold Rolled Steel	-2
Nickel	-2	Stainless Steel	-2
Nickel	-2	Tantalum	-2
Nickel	-2	Tungsten	-2
Nickel Alloy	-2	Nickel Alloy	-2
Nickel Alloy	-2	Tinned Brass	-14
Nickel Alloy	-2	Beryllium Copper	-2
Nickel Alloy	-2	Consil	-2
Nickel Alloy	-2	Tinned Copper	-14
Nickel Alloy	-2	Nichrome	-2
Nickel Alloy	-2	Nickel	-2
Nickel Alloy	-2	Cold Rolled Steel	-2

MATERIAL	ELECT RWMA TYPE	MATERIAL	ELECT RWMA TYPE
NiSpan C	-2	NiSpan C	-2
NiSpan C	-2	Cold Rolled Steel	-2
NiSpan C	-2	Stainless Steel	-2
Niobium	-2	Niobium	-2
Platinum	-2	Platinum	-2
Paliney 7	-2	Paliney 7	-2
Silver	-11, -14	Silver	-11, -14
Silver	-11, -14	Cadmium	-13
Cold Rolled Steel	-2	Cold Rolled Steel	-2
Cold Rolled Steel	-2	Stainless Steel	-2
Cold Rolled Steel	-2	Tantalum	-2
Stainless Steel	-2	Stainless Steel	-2
Stainless Steel	-2	Tungsten	-2
Tantalum	-2	Tantalum	-2
Titanium	-2	Titanium	-2
Tungsten	-2	Tungsten	-2
Tungsten	-2	henium	-2
Zinc	-14	Zinc	-14

Electrode Maintenance

Depending on use, periodic tip resurfacing is required to remove oxides and welding debris from electrodes. Cleaning of electrodes on production line should be limited to use of #400-600 grit electrode polishing disks. For less critical applications, a file can be used to clean a badly damaged tip. However, after filing, polishing disks should then be used to ensure that the electrode faces are smooth. If this is not done, the rough surface of the electrode face will have a tendency to stick to the work piece.

Weld Schedule Development

Developing a weld schedule is a methodical procedure, which consists of making sample welds and evaluating the results. The first weld should be made at low energy settings. Adjustments are then made to each of the welding parameters ***one at a time*** until a successful weld is made.

1 Install the correct electrodes in the electrode holders on the Weld Head. See the preceding Table for electrode material recommendations.

2 Use a flat electrode face for most applications. Use a "domed" face if surface oxides are a problem. If either of the parts is a wire, the diameter of the electrode face should be equal to or greater than the diameter of the wire. If both parts are flat, the face should be at least one-half the diameter of the electrodes. Pencil point electrodes cause severe electrode sticking to the parts, unexplained explosions, and increase the weld heat substantially because of the reduced electrode-to-part contact area.

3 Use the Force Adjustment Knob on the Weld Head to set the Firing Force and adjust an Air Actuated Weld Head.

4 Program a weld schedule, then make your first weld. Always observe safety precautions when welding and wear safety glasses. For a complete procedure on making welds, refer to *Operating Instructions*.

5 Use pliers to peel the welded materials apart. A satisfactory weld will show residual material pulled from one material to the other. Tearing of base material around the weld nugget indicates a material failure NOT a weld failure. Excessive electrode sticking and/or "spitting" should define a weld as unsatisfactory and indicates that too much weld current, voltage, power, or time has been used.

6 If the parts pull apart easily or there is little or no residual material pulled, the weld is weak. Increase the weld time in 1 msec increments. Increase weld current, voltage, or power if a satisfactory weld achieved using 10 msec of weld time.

NOTE: Actual weld strength is a user-defined specification.

7 Polarity, as determined by the direction of weld current flow, can have a marked effect on the weld characteristics of some material combinations. This effect occurs when welding materials with large differences in resistivity, such as copper and nickel or when welding identical materials with thickness ratios greater than 4 to 1. The general rule is that the more resistive material or the thinner material should be placed against the negative (-) electrode. Polarity on the Control can only be changed by reversing the Weld Cables.

Weld Strength Testing

Destructive tests should be performed on a random basis using actual manufacturing parts. Destructive tests made on spot welds include tension, tension-shear, peel, impact, twist, hardness, and macro-etch tests. Fatigue tests and radiography have also been used. Of these methods torsional shear is preferred for round wire and a 45-degree peel test for sheet stock.

Weld Strength Profiles

Creating a weld strength profile offers the user a scientific approach to determining the optimum set of welding parameters and then displaying these parameters in a graphical form.

1 Start at a low weld current, voltage, or power, making five or more welds, then perform pull tests for each weld. Calculate the average pull strength. Increase weld current, voltage, or power and repeat this procedure. Do not change the weld time, weld force, or electrode area.

2 Continue increasing weld current, voltage, or power until any unfavorable characteristic occurs, such as sticking or spitting.

3 Repeat steps 1 through 3 for different weld forces, then create a plot of part pull strength versus weld current, voltage, or power for different weld forces as shown in the illustration on the next page, *Typical Weld Strength Profile*.

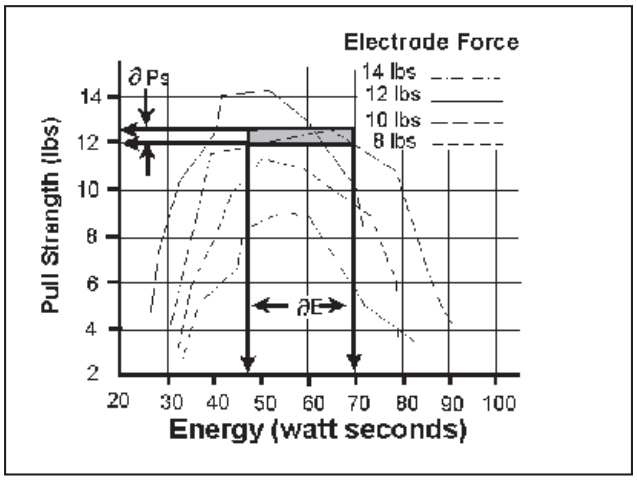
4 Repeat steps 1 through 3 using a different but fixed weld time.

Typical Weld Strength Profile

The picture on the right illustrates a typical weld strength profile. The 14 lb electrode force curve shows the highest pull strengths but the lowest tolerance to changes in weld current, voltage, or power. The 12 lb electrode force curve shows a small reduction in pull strength, but considerably more tolerance to changes in weld energy. Weld heat will vary as a result of material variations and electrode wear.

The 12 lb electrode force curve is preferred. It shows more tolerance to changes in weld current, voltage, or power and has nearly the same bond strength as the 14 lb electrode force curve.

A comparison of weld schedules for several different applications might show that they could be consolidated into one or two weld schedules. This would have obvious manufacturing advantages.



Typical Weld Strength Profile

APPENDIX G

Quality Resistance Welding Solutions: Defining the Optimum Process

Introduction

A quality resistance welding solution both meets the application objectives and produces stable, repeatable results in a production environment. In defining the optimum process the user must approach the application methodically and consider many variables. In this article we will look at the following key stages and principles to be considered when defining the optimum resistance welding process:

- Materials and their properties
- Basic resistance welding
- principles
- Weld profiles
- Approach to development
- Common problems
- Use of screening DOE's
- Use of factorial DOE's

Resistance Welding -- A Material World

The first consideration in designing a quality welding solution is the properties of the materials to be joined and the quality requirements of the desired welded joint. At this stage, it is worthwhile to review the way the resistance welding process works and the likely outcome when the parts are resistance welded.

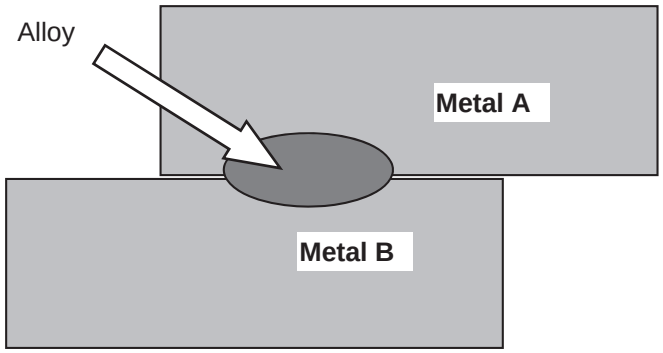
There are four main types of structural materials:

- Metals (silver, steel, platinum)
- Ceramic (alumina, sand)
- Plastics/polymers (PVC, teflon)
- Semiconductors (silicon, geranium)

Of these, only metals can be resistance welded because they are electrically conductive, soften on heating, and can be forged together without breaking.

APPENDIX G: DEFINING THE OPTIMUM PROCESS

Alloys are a mixture of two or more metals. An alloy is normally harder, less conductive, and more brittle than the parent metal which has bearing on the type of joint one can expect when resistance welding a combination of different metals.



Metals atoms are naturally attracted to other metal atoms even in different parent materials. Metals and alloys will bond together once surface contaminants such as dirt, grease, and oxides removed. Resistance welding generates heat at the material interface, which decomposes the dirt and grease and helps to break up the oxide film. The resultant heat softens or melts the metal and the applied force brings the atoms on either side into close contact to form the bond. The strength of the joint develops as it cools and a new structure is formed.

There are three main types of bonds that can be formed using the resistance welding process:

- **Solder or Braze Joint**

  A filler material such as a solder or braze compound is either added during the process or present as a plating or coating. Soldered joints are typically achieved at temperatures less than 400°C and brazed joints such as Sil-Phos materials melt at temperatures above 400°C.

- **Solid-State Joint**

  A solid state joint can be formed when the materials are heated to between 70-80% of their melting point.

- **Fusion Joint**

  A fusion joint can be formed when both metals are heated to their melting point and their atoms mix.

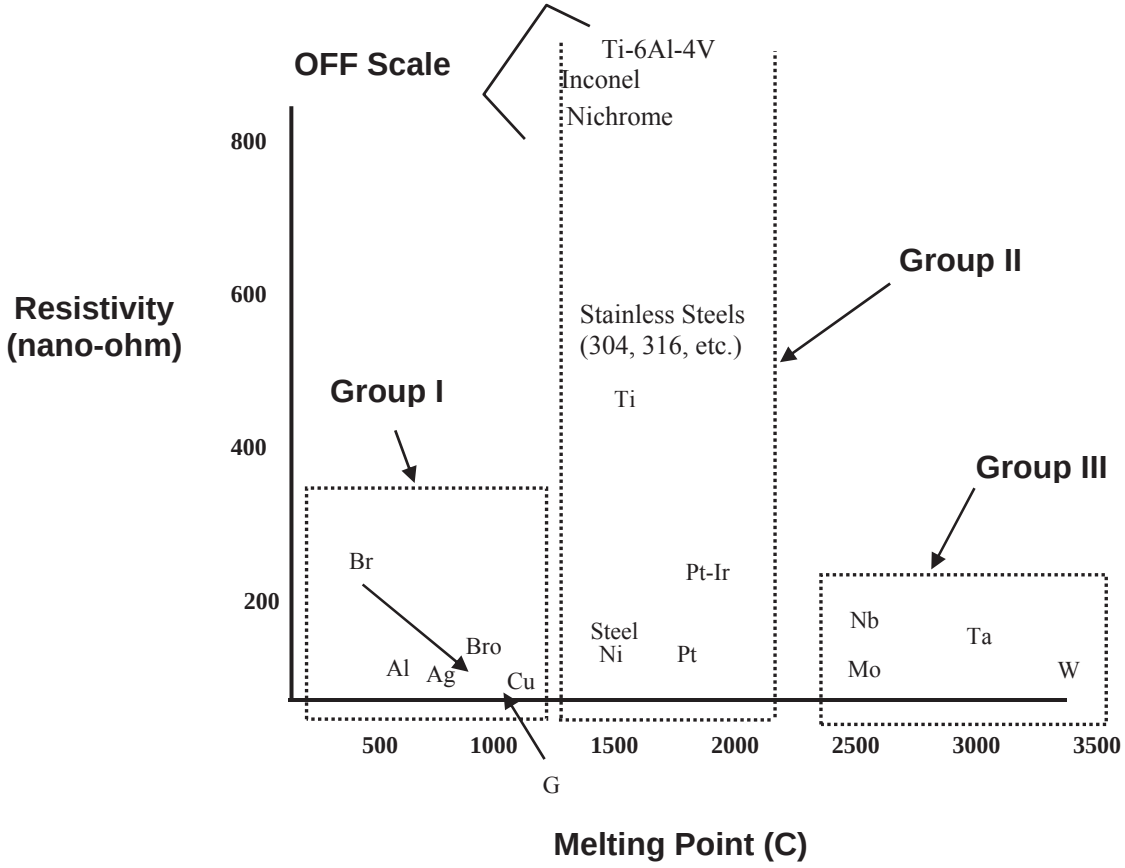
Many micro-resistance welding challenges involve joining dissimilar metals in terms of their melting points, electrical conductivity, and hardness. A solid-state joint can be an ideal solution for these difficult applications; there is no direct mixing of the two materials across the weld interface thus preventing the formation of harmful alloys that could form brittle compounds that are easily fractured. Remember that in a solid-state joint, the metals are only heated to 70-80% of their respective melting points, resulting in less thermal stress during heating and subsequent joint cooling in comparison to a fusion weld. As there is no real melting of the materials in a solid-state joint, there is less chance of weld splash or material expulsion. A weld nugget can still be achieved with a solid-state joint.

Consider the Material Properties

The important material properties to be considered in the resistance welding process are:

- ***Electrical and thermal conductivity***
- ***Plating and coating***
- ***Hardness***
- ***Melting point***
- ***Oxides***

The figure below illustrates the variance in resistivity and melting points for some of the more common materials used in micro resistance welding today.



The materials can be grouped into three common categories. The types of joints achievable within each of the main groups are detailed below:

- **Group I – Conductive Metals**

  Conductive metals dissipate heat and it can be difficult to focus heat at the interface. A solid-state joint is therefore preferred. Typically, resistive electrode materials are used to provide additional heating.

- **Group II – Resistive Metals**

  It is easier to generate and trap heat at the interface of resistive metals and therefore it is possible to form both solid state and fusion welds depending on time and temperature. Upslope can reduce contact resistances and provide heating in the bulk material resistance.

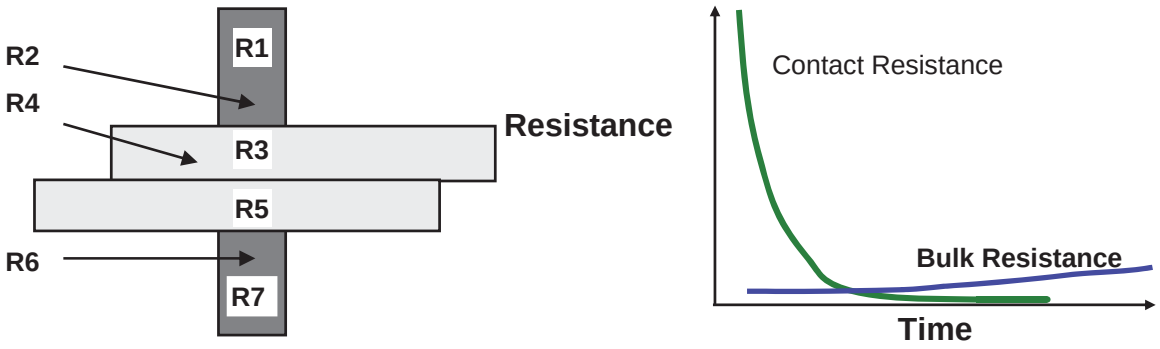
- **Group III – Refractory Metals**

  Refractory metals have very high melting points and excess heating can cause micro-structural damage. A solid-state joint is therefore preferred.

The chart below gives some guidance on the type of joint that can be expected and design considerations required when joining materials from the different groups.

	Group I	Group II	Group III
Group I (Copper)	• Solid-State • W/Mo electrodes	• Solid-State • Projection on Group I	• Solid-State • Fine projections on Group III
Group II (Steel)		• Solid-State or Fusion	• Solid-state or braze of II on III • Projection on III
Group III (Moly)			• Solid-State

Basic Principles



The figure above shows the key resistances in a typical opposed resistance weld and the relationship between contact resistances and bulk resistances over time, during a typical resistance weld:

R1 & R7 The electrode resistances affect the conduction of energy and weld heat to the parts and the rate of heat sinking from the parts at the end of the weld.

R2, R4 & R 6 The electrode-to-part and part-to-part "Contact Resistances" determine the amount of heat generation in these areas. The contact resistances decline over time as the parts achieve better fit up.

R3 & R5 The metal "Bulk Resistances" become higher during the weld as the parts are heated.

If a weld is initiated when the contact resistances are still high, the heat generated is in relation to the level and location of the contact resistances, as the materials have not had a chance to fit up correctly. It is common for the heat generated at the electrode-to-part and part-to-part resistances to cause multiple welding problems when welding resistive materials including:

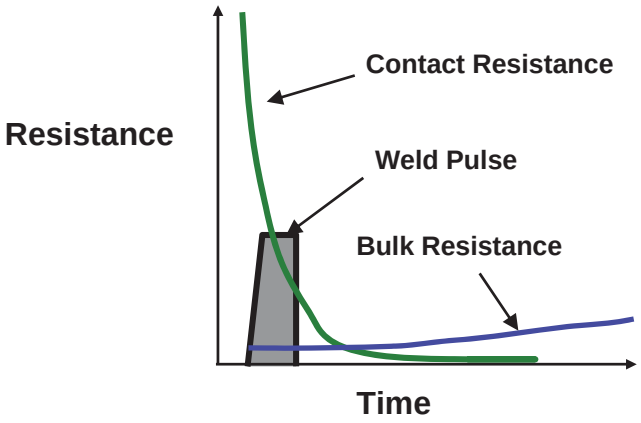
- Part marking and surface heating
- Weld splash or expulsion
- Electrode sticking
- Weak welds

Alternately, conductive materials can be welded by using high contact resistance and fast heating because their bulk resistance is not high and cannot be relied upon for heat generation.

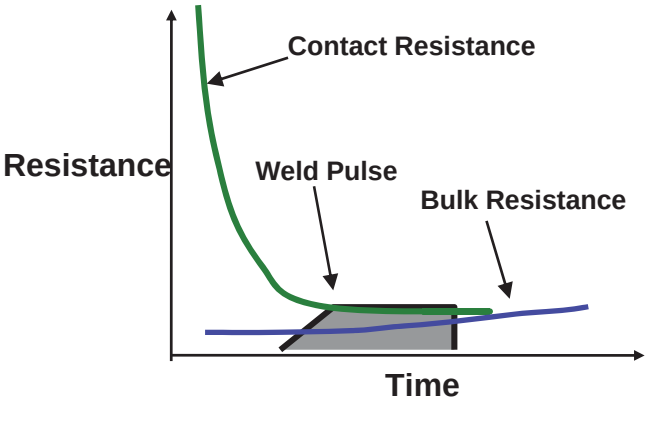
If a weld is initiated when both parts and electrodes are fitted up correctly, the contact resistance is lower and bulk resistance now controls the heat generation. This type of weld is achieved with a slower heating rate and normally longer time is preferred for welding resistive materials, which can generate heat through their bulk resistance.

The contact resistances present at the weld when the power supply is fired have a great impact on the heat balance of a weld and, therefore, the heat affected zone.

The figure below shows a weld that is fired early on in the weld sequence when the contact resistance is still quite high.



The figure shows a weld that is initiated when the contact resistance is lower; in this example, we are using bulk resistance to generate our weld heat.

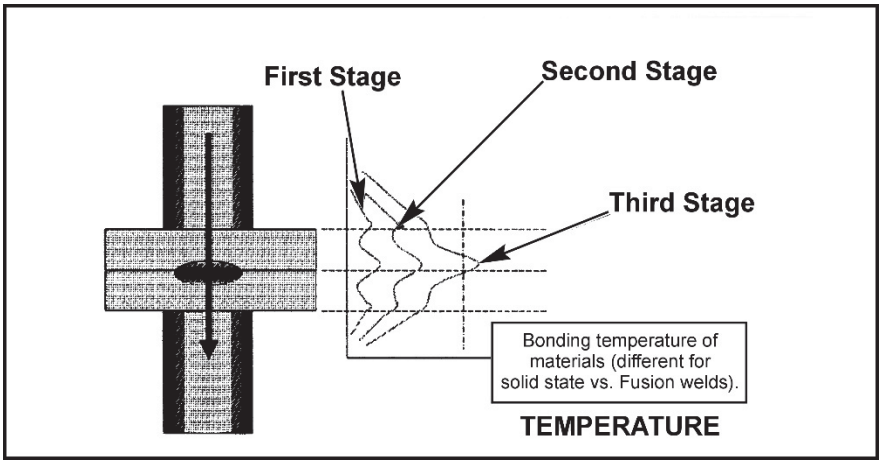


Heat Affected Zone

(NOTE: Larger nuggets are possible with longer weld times when using bulk resistance.)

In general, conductive materials benefit from a faster heating rate, as the higher contact resistances assist heat generation in the weld. Resistive materials benefit from slower heating rates which allow the contact resistances to reduce significantly. Bulk resistances, therefore, become the major source for heat generation. The heat-affected zone is also much smaller in this case producing a weld with less variation.

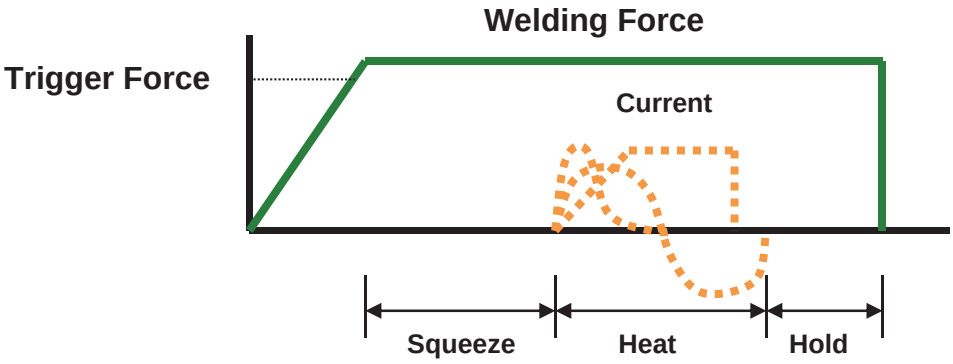
The following figure shows the three stages of heat generation for resistive materials in a fusion weld. In the first stage, the heat is focused in the part-to-part and electrode-to-part contact areas, since contact resistance is high relative to bulk resistance. In the second stage, contact resistance decreases as the electrodes seat better to the parts. Less heat is generated in the electrode-to-part contact areas, and a greater amount of heat is generated in the parts as the bulk resistance increases. In the third stage, the bulk resistance becomes the dominant heat-generating factor and the parts can reach their bonding temperature at the part-to-part interface. The stages of heat generation for conductive materials will be similar to that of resistive materials, but there will be less heat generated in the bulk resistance due to the conductivity of the materials.



Weld Profiles

The basic welding profile (or schedule) consists of a controlled application of energy and force over time. Precision power supplies control the energy and time and therefore heating rate of the parts. The weld head applies force from the start to finish of the welding process.

The figure on the right shows a typical welding sequence where the force is applied to the parts; a squeeze time is initiated which allows the force to stabilize before the current is fired. Squeeze time also allows time for the contact resistances to reduce as the materials start to come into closer contact at their interface. A hold time is initiated after current flows to allow the parts to cool under pressure before the electrodes are retracted from the parts. Hold time is important as weld strength develops in this period. This basic form of weld profile is sufficient for the majority of small part resistance welding applications.



Power supply technology selection is based on the requirements of both the application and process. In general, closed loop power supply technologies are the best choice for consistent, controlled output and fast response to changes in resistance during the weld (for further details comparison see the Miyachi Unitek “slide rule” tool).

Approach to Weld Development

The first stage in developing a quality welding process is to fix as many of the variables as possible in the welding equipment set up. The welding variables can be grouped in the following categories:

- **Material Variables**
  - Base material
  - Plating
  - Size
  - Shape
- **Weld Head & Mechanical Variables**
  - Force, squeeze, hold
  - Actuation method
  - Electrode material and shape
- **Power Supply Variables**
  - Energy
  - Time (squeeze, weld, hold)
- **Process Variables**
  - Tooling, level of automation
  - Repetition rate
  - Part positioning
  - Maintenance, electrode cleaning
- **Quality Requirements**
  - Pull strength
  - Visual criteria
  - Test method, other weld joint requirements

The first stage in developing a quality welding process is to fix as many of the variables as possible in the welding equipment set up. Welding variables can be grouped in the following categories:

Initial Welding Trials -- The “Look See” Tests

“Look see” welding tests are a series of mini welding experiments designed to provide a starting point for further statistical development of the welding parameters. The user should adjust the key welding variables (energy, force, time) in order to identify the likely good “weld window.” Close visual inspection of the weld parts will promote better understanding of the heating characteristics of the application.

The mini-experiments should also be used to understand the weld characteristics from both application and process perspective. Key factors in this understanding are as follows:

Application Perspective

- Materials: Resistivity, melting point, thermal mass, shape, hardness, surface properties.
- Heat balance: Electrode materials, shape, Polarity, heating rate (upslope).
- Observation: visual criteria, cross section, and impact of variables on heat balance.

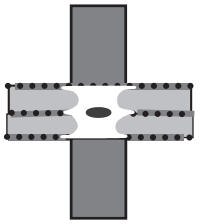
Process Perspective

- What are the likely variables in a production process?
- How will operators handle and align the parts?
- What tooling or automation will be required?
- How will operators maintain and change the electrodes?
- What other parameters will operators be able to adjust?
- What are the quality and inspection requirements?
- What are the relevant production testing methods and test equipment?
- Do we have adequate control over the quality of the materials?

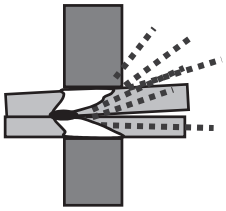
Common Problems

During this stage of process development, it is important to understand that the majority of process problems are related to either materials variation, or part-to-electrode positioning. Some examples are shown below.

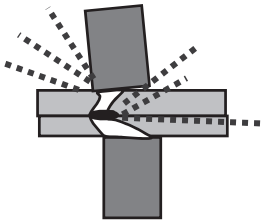
Material Control



Part-To-Part Positioning

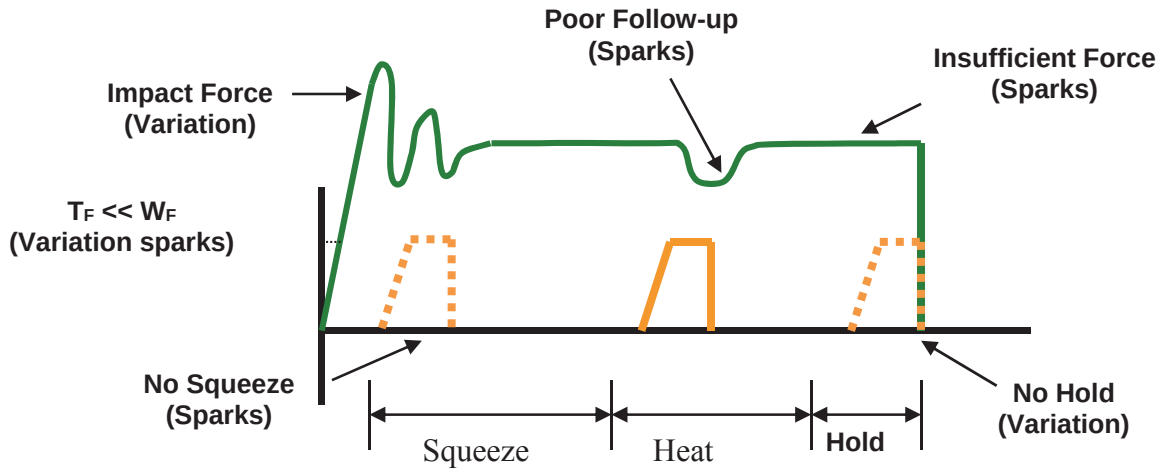


Electrode-To-Part Positioning



The changes detailed above generally result in a change in contact resistance and always affect the heat balance of the weld. During weld development these common problems must be carefully monitored so as not to mislead the course and productivity of the welding experiments.

In summary, the “look see” welding experiments should be used to fix further variables from an application and process perspective and also to establish a “weld window” for energy, time and force. This part of weld development is critical in order to proceed to a statistical method of evaluation (Design of Experiments or “DOEs”). Random explosions or unexpected variables will skew statistical data and waste valuable time.



Common welding problems can often be identified in the basic set up of the force, energy, and time welding profile shown above. These problems can lead to weld splash, inconsistency, and variation (contact Amada Miyachi America for further information and support).

What are Screening DOE'S?

The purpose of a Screening DOE is to establish the impact that welding and process parameters have on the quality of the weld. Quality measurement criteria should be selected based on the requirements of the application. A Screening DOE will establish a relative quality measurement for the parameters tested and the variation in the welded result. This is important, as identifying variation in process is critical in establishing the best production settings. Typically, welded assemblies are assessed for strength of joint and variation in strength.

A Screening DOE tests the high, low settings of a parameter, and will help establish the impact of a parameter on the process. A Screening DOE is a tool that allows the user to establish the impact of a particular parameter by carrying out the minimum number of experiments to gain the information. A five-factor screening DOE can be accomplished in as few as 24 welds, with three welds completed for each of 8 tests. By comparison, it would take 96 welds to test every combination. The DOE promotes understanding of many variables in a single experiment and allows the user to interpret results, thus narrowing the variables for the next level of statistical analysis. If many variables are still not understood, multiple Screening DOE's may be required. Amada Miyachi America provides a simple Screening DOE tool that is run in Excel® and is sufficient for the majority of possible applications (contact Amada Miyachi America for details). Sophisticated software is also available from other vendors designed specifically for this purpose.

Criteria for Success

Before running the series of experiments, the user must establish an acceptable window for energy, time, and force, thus preventing voided results. It is common practice to include one or all of the above variables in a Screening DOE. This is only recommended if sufficient understanding has been established for the other application and process variables that can impact quality Users should first try to screen out all common application and process variables that require further exploration from the results of the "look see" mini experiments and then include the three key welding variables (energy, force and time). Several Screening DOE's may be required.

Results should be interpreted carefully. Typically, one would look for the highest result in terms of quality with the least variation. A Screening DOE provides only a measurement that indicates the relative importance of a parameter and not the ideal setting. Factorial DOE's should be used to establish the correct or best setting for a parameter once many of the other variables have been screened and fixed. This is also the time to assess the measurement accuracy and consistency of the test method and procedure. Variation in test method can invalidate the test and lead to misinterpretation of results.

What are Factorial DOE's?

The purpose of a Factorial DOE is to narrow in on the optimal setting for a particular parameter. This method is generally used when the critical or main key variables have been identified, and we need to establish the best settings for the process. A factorial DOE may also give an indication as to how wide the acceptable weld window is in relation to quality requirements. We recommend data be gathered from a monitoring perspective so that this can provide a starting point for establishing a relationship between quality and the monitored measurement parameter.

Criteria for Success

Critical parameters should be identified from the list of unfixed variables left from the Screening DOE's. A mini-experiment may be required establishing reasonable bounds for the combination of parameters to be tested. This will prevent void data and wasted time. At this stage, it is useful to record multiple relevant quality measurement or inspection criteria so that a balanced decision can be reached. For example, if part marking and pull strength are the relevant criteria, a compromise in ideal setting may be required.

As with all experiments, the test method should be carefully assessed as a potential source of variation and inconsistency. Once the optimum parameters have been established in this series of experiments, a validation study can be run which looks at the consistency of results over time. It is good practice to build in variables such as electrode changes and cleaning, as well as equipment set up by different personnel. This will ensure that the solution is one that can run in a real production environment. Welded assemblies should be tested over time and under real use conditions to ensure that all functional criteria will be met. Validation testing is usually required to prove the robustness of the process under production conditions.

Conclusion

The resistance welding process can deliver a reliable and repeatable joining solution for a wide range of metal joining applications. Defining the optimum welding process and best production settings can be achieved through a methodical and statistical approach. Time spent up front in weld development will ensure a stable welding process and provide a substantial return in quality and long term consistency. Welding problems can more easily be identified and solved if sufficient experimental work is carried out to identify the impact of common variables on the quality and variation of the welded assembly. Amada Miyachi America frequently uses the Screening DOE tool to establish the impact of key variables and to assist customers with troubleshooting. Often, the testing described above will provide the information and understanding to predict common failure modes and causes. A troubleshooting guide can be requested in the form of a slide rule, to assist users in identification of welding problems and likely causes.

APPENDIX H
Compatibility and Comparison

Compatibility

While the **HF27** contains advanced technology and improved features, from an operational standpoint it performs the same as older Miyachi Unitek Controls. Older **HF27** Models (1-287-01, 1-287-01-01, 1-287-01-02), require a ***different*** User's Manual (Part Number 990-335). For information on getting that manual, use the phone number or e-mail address listed under **Contact Us** in the front of this manual.

Below is a *Quick Look* comparison showing the differences between ***old*** HF25A / HF25DA / HF27A (Models 1-280-xx, 1-285-xx, 1-287-xx) and ***new*** HF25 / HF27 (Models 1-315-xx, 1-320-xx). The HF25DA features have been incorporated into the HF27.

FEATURES	OLD HF25A / HF25DA / HF27A	NEW HF25 / HF27
Supply voltages	240/400/480VAC	SAME
Footswitch connector	YES	SAME
Air Valve Driver connector	YES	SAME
Voltage Sense connector	YES	SAME
LVDT connector	HF25A: NO HF25DA: YES HF27A: YES	HF25: NO HF25D: Not available HF27: SAME
Weld Head connector	NO	YES, new 8-pin connector incorporating Firing switch, voltage sense and 24VDC (!) valve output for new plug-and-play weld heads, used with new *EZ-AIR* plug-and-play weld heads.
RS232/485	YES	SAME
Firing Switch cable	YES	SAME
Emergency Stop cable	YES	SAME
60-pin Phoenix connectors	YES	Physically smaller size. *Appendix B, Electrical and Data Connections* describes
Software selection for polarity of input and mech/opto type	YES	Eliminated, no longer necessary.
Force output range	-10V to +10V	HF27 ONLY 0 to 10V and 0 to 5V
Force input range	HF25DA and HF27 ONLY -10 to +10V	HF27 ONLY 0 to 10V and 0 to 5V
24VDC output for customer use	YES, limited to about 500mA with voltage drop	YES, polyfused to 1 amp without voltage drop
Upgrade from HF25 to HF27	N/A	YES, at factory

I/O Comparison

While most of the improvements in the Controls are transparent to the user, new technology and internal components have changed some of the 60-pin I/O connections. As a result, they are ***not*** the same as older models. To make these new connections quick and easy, "blank" (un-wired) connectors with screw terminals are provided in the Ship Kit.

Below is a *Quick Look* comparison showing the differences between the old and new I/O connections. See *Appendix B, Electrical and Data Connections* for complete details.

Pin	OLD HF25 / HF27	NEW HF25 / HF27	NOTES
1	Chassis GND	Chassis GND	Same
2	24V COMMON	24COM	Same
3	HEAD1+	HEAD_1	Old *EZ AIR* no longer supported
4	HEAD2+	NOT ACTIVE	
5	HEAD3+	NOT ACTIVE	
6	HDDT1	NOT ACTIVE	
7	HDDT2	24VAC	
8	HEAD4+ (air head)	NOT ACTIVE	Use pin 7 (24VAC) on new unit
9	HEAD4- (air head return)	NOT ACTIVE	Use pin 3 (HEAD_1, switched) on new unit
10	NOT ACTIVE	NOT ACTIVE	Same
11	FIRE_1	FIRE_1	Same
12	GND	24COM	Same
13	NOT ACTIVE	NOT ACTIVE	Same
14	OPTOP power (24VDC)	NOT ACTIVE	Use pin 20 or 21 (+24V_OUT) on new unit
15	CHASSIS GND	I/O COMMON	Use pin 1, 50 or 60 on new unit
16	FOOT_1	FOOT_1	Same
17	FOOT_2	FOOT_2	Same
18	GND	24COM	Same
19	SPOWER	FS1/FS2/FIRE_COM	Same
20	+24V OUT	+24V_OUT	Same
21	+24V OUT	+24V_OUT	Same
22	24V PULL UP	I/O COMMON	Same
23	24V COM	24COM	Same
24	SCH 0	SCHEDULE O	Same
25	SCH 1	SCHEDULE 1	Same
26	SCH 2	SCHEDULE 2	Same
27	SCH 4	SCHEDULE 4	Same

Pin	OLD HF25 / HF27	NEW HF25 / HF27	NOTES
28	SCH 8	SCHEDULE 8	Same
29	SCH 16	SCHEDULE 16	Same
30	SCH 32	SCHEDULE 32	Same
31	INHIBIT	WELD_INHIBIT	Same
32	STOP	CURRENT_STOP	Same
33	RELAY 1	RELAY_1	Same
34	RELAY 1R	RELAY_1R	Same
35	RELAY 2	RELAY_2	Same
36	RELAY 2R	RELAY_2R	Same
37	RELAY 3	RELAY_3	Same
38	RELAY 3R	RELAY_3R	Same
39	RELAY 4	RELAY_ 4	Same
40	RELAY 4R	RELAY_4R	Same
41	Con Ret for EMO	NOT ACTIVE	Use EMO cable on new unit
42	24VAC for EMO	NOT ACTIVE	
43	NOT ACTIVE	FORCE SET 10	Output range 0-10V, HF27 ONLY option
44	NOT ACTIVE	FORCE GROUND	
45	NOT ACTIVE	FORCE READ 10 INPUT	Input range 0-10V, HF27 ONLY option
46	+ 15VDC power	NOT ACTIVE	No +15VDC available on new unit
47	- 15VDC power	NOT ACTIVE	No -15VDC available on new unit
48	FORCE INPUT	FORCE READ 5 INPUT	Different input range (0-5V), HF27 ONLY option
49	GND	FORCE GROUND	Same
50	CHASSIS GND	CHASSIS GND	Same
51	NOT ACTIVE	NOT ACTIVE	Same
52	LVDTPRI1	LVDTGND	Different, HF27 ONLY option
53	LVDTPRI2	LVDTPRI1	Different, HF27 ONLY option
54	LVDTSEC1	LVDTPRI2	Different, HF27 ONLY option
55	LVDTSEC2	LVDTSEC1	Different, HF27 ONLY option
56	LVDTCG	LVDTSEC2	Different, HF27 ONLY option
57	NOT ACTIVE	LVDTGND	Different, HF27 ONLY option
58	FORSET	FORCE SET 5	Different output range (0-5V), HF27 ONLY option
59	GND	FORCE GROUND	Same
60	CHASSIS GND	CHASSIS GND	Same

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