

## M100 POWER SUPPLY

The power supply features microcontroller electronics and closed-loop circuitry to precisely control output current. The software is accessible using the M100 operator display and keypad or the remote keypad. The data recording printer prints program information as well as welded outputs. The PC card may be used to store weld data and transfer data to a PC for QA/QC records.

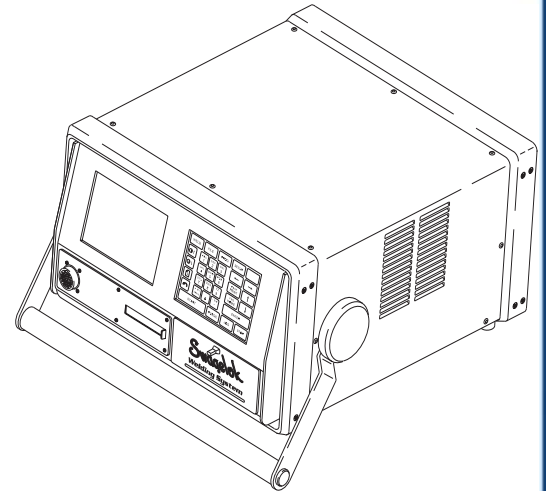


Figure 1 Power Supply

The power supply uses screen-prompted software for weld parameter control. See Figure 2. The appropriate settings are generally defined by the work pieces to be welded and are refined using test welds. The correct settings used for a specific job are developed into a weld procedure guideline. The guideline is used to maintain repeatability and quality control for subsequent jobs of the same type.

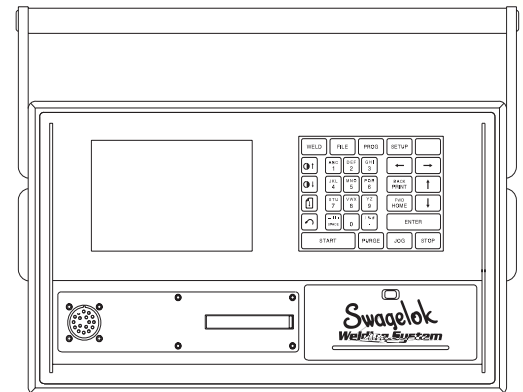


Figure 2 Power Supply Operator Display and Keypad

## Installation

### Tools and Accessory Requirements

You need the following tools and accessories to install and operate your SWS.

Tool/Accessory	Included?	Provided with
Hex Wrenches (0.050 in. to 5/32 in.)	Yes	Weld Head
Electrode Package	Yes	Weld Head
Arc Gap Gage	Yes	Weld Head
Flat Blade Screw Driver	Yes	Weld Head
Centering Gage	Yes	Fixture Block
Quick-Connect Stem	Yes	Power Supply
Secondary Solenoid Bypass Plug	Yes	Power Supply
Dial/Digital Calipers or Micrometer	No	-
Purge Connector(s)	No	-
Shielding/Purge Gas Lines <sup>①</sup>	No	-
Shielding/Purge gas Source <sup>②</sup>	No	-
Pressure Regulator	No	-
Internal Purge Gas Flow Meter	No	-
Shielding Gas Flow Meter	No	-
Internal Pressure Gage	No	-

**Note:**

*The Series 40 weld head does not include an arc gap gage, centering gage, or electrode package.*

<sup>①</sup>All lines used for shielding/purge gas should be the low moisture absorption type.

<sup>②</sup>A compressed gas bottle or liquid Dewar source can be used. Argon is the gas most frequently used.

### Electrical Requirements

*Table 1 Power Supply Electrical Requirements*

Power Supply Model	Voltage Requirement	Service Current
SWS-M100-1	115 V*(ac)	20 A
SWS-M100-2	230 V (ac)	15 A

\* If the input voltage is 100 V or less, the output power capabilities may be reduced.

Follow the electrical system guidelines below for power supply installation.

- All wiring and related components must be installed according to local code and National Electrical Code.
- The power supply must be grounded.
- A dedicated electrical circuit may be desired due to current need.



**WARNING!**

**THE POWER SUPPLY MUST BE GROUNDED. IF IT IS NOT GROUNDED, ELECTRICAL SHOCK CAN OCCUR.**

## Using an Extension Cord

If it is necessary to use an extension cord, follow the guidelines below.

- Use only extension cords that meet the specifications indicated in Table 29.
- Extension cords longer than 100 ft (30m) are not recommended.



### Caution!

The voltage drop in an extension cord 100 ft long may affect the output performance of the SWS.

## Unpacking the Power Supply

The SWS power supply is packaged in a plastic shipping container. The power supply part number and serial number are located on a label on the outside of the container.

### Note:

Keep the shipping container for storing and/or shipping.

Table 2 Shipping Container Contents

Part Description	Part No.	Qty.
Welder Power Supply	SWS-M100-*	1
Power Cord	CWS-CORD-*	1
1/4 in. Male Quick-Connect	SS-QC4-S-400	1
Secondary Solenoid Bypass Plug	-	1
Swagelok Welding System User's Manual	SWS-MANUAL-M100-**	1
PC Memory Card	SWS-PCCARD-1MB	1
PC Interface Cable	SWS-PC-CABLE	1

\* Denotes Model

\*\* Denotes Language

Remove the contents of the shipping container by performing the following steps:

1. Remove the following items:
  - Swagelok Welding System User's Manual
  - Swagelok Quick-Connect stem
  - Secondary solenoid bypass plug
  - Power Cord
  - PC Memory card
  - PC interface cable
2. Remove the power supply by lifting it by the handle. Place the power supply on a stable cart, platform, or table.

3. Check the power supply and accessories for damage. Check that a roll of thermal printing paper is installed in the data-recording printer.
4. Check that the serial number on the rear panel of the power supply matches the serial number on the shipping container label.
5. Record the model number, serial number, and the delivery date on the Registration Information page in the Regulatory Module.

## Installing the Power Supply

To get the maximum performance and reliability from your SWS, it must be set up and installed properly.

To install the power supply, follow these steps:

1. Position the power supply so that the front and rear panel controls are easily accessible.
2. Locate the power cord. Insert the cord into the polarized receptacle on the rear of the power supply. See Figure 3.
3. Tighten the connector lock at the base of the receptacle to secure the cord in the receptacle.
4. Ensure that the power cord reaches an electrical outlet. Do not connect the power cord to the outlet at this time.

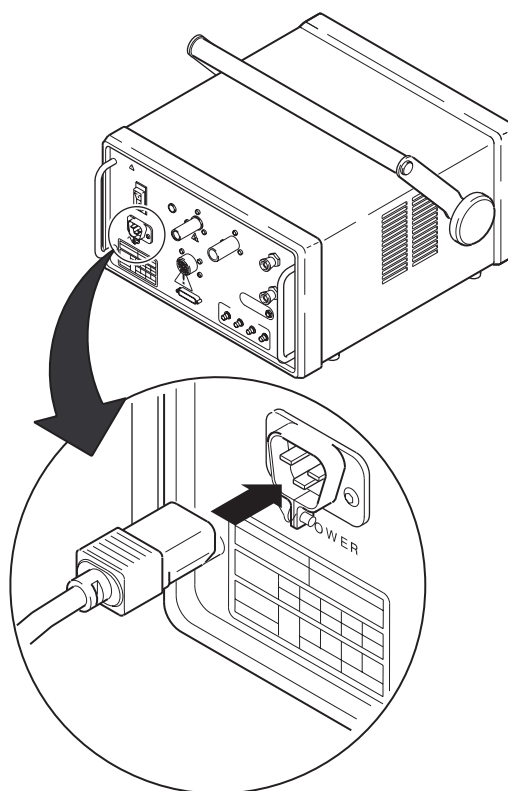


Figure 3 Insert the Power Cord Here

5. Turn off the power supply circuit breaker on the rear panel of the unit. See Figure 4.

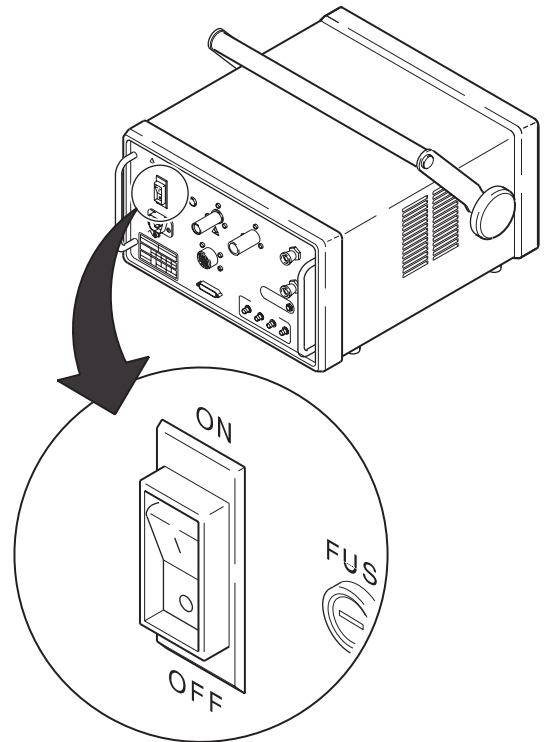


Figure 4 Turn Off Circuit Breaker

## Installing the Weld Head

The weld head assembly has four connectors that plug into the power supply. See Figure 5.

The four connectors on the cable are:

- Fixture
- Electrode (red)
- Work (green)
- Weld head shielding gas.

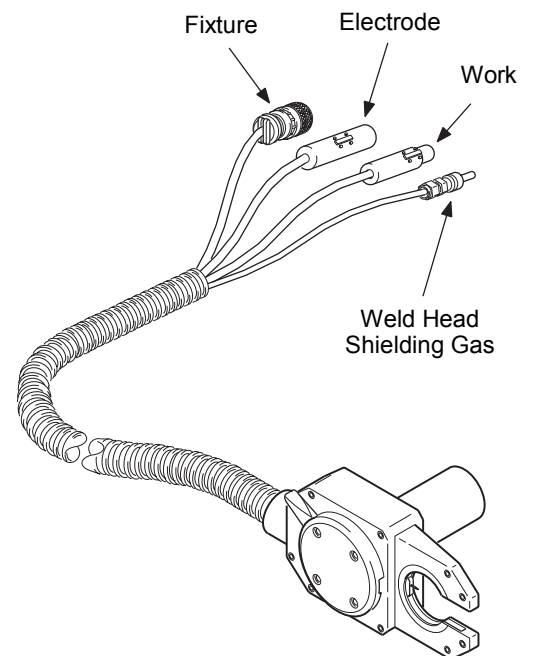


Figure 5 Weld Head Assembly

Connect the four connectors to the rear panel of the power supply by performing the following steps (see Figure 6):

1. Locate the weld head assembly.
2. Align the notch on the multi-pin connector with the small tab in the mating socket on the rear panel labeled **FIXTURE**. Insert the connector in the socket. Turn the connector sleeve clockwise by hand until it is tight. This connection provides the control signals to drive the weld head.
3. Insert and fully seat the red connector into the socket on the rear panel labeled **ELECTRODE**. Twist the connector 1/4-turn clockwise to lock it into place. This connection is the negative (-) terminal of the weld head.
4. Insert the green connector into the socket on the rear panel labeled **WORK**. Twist the connector 1/4-turn clockwise to lock it into place. This connection is the positive (+) terminal of the weld head.
5. Insert the weld head shielding gas connector into the Swagelok Quick-Connect stem labeled **TO WELD HEAD**. Ensure that the connector is firmly attached. This connection provides shielding gas to the weld head through a solenoid valve in the power supply.

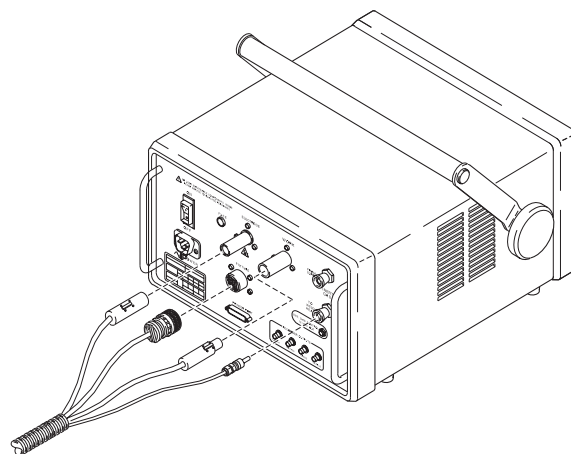


Figure 6 Weld Head Connectors



### Caution!

**Ensure that the fixture connector is fully seated in the mating socket and the threaded sleeve is tight.**

### Note:

*The weld head shielding gas connector must be a single-end shut-off (SESO) Swagelok Quick-Connect stem (SS-QC4-S-400).*

## Installing the Gas Delivery System

The gas delivery system provides shielding gas to the weld head to reduce oxidation or contamination of the weld puddle, tungsten electrode, and Heat Affected Zone (HAZ).

There are two types of gas delivery systems commonly used. For a typical gas delivery system, refer to the installation procedure beginning on this page.

For a gas delivery system using a secondary shielding gas solenoid valve, see *Optional Gas Delivery System* beginning on page 9.

### Typical Shielding/Purge Gas Delivery System

Figure 7 shows a typical system. Be sure to adhere to the following precautions:

- Ensure that the gas storage container(s) are secured before using them.
- Ensure all connections are tight and do not leak.
- Use only a Swagelok single-ended shut-off Quick-Connect stem on the shield/purge line for the shielding gas connector.
- Adjust the low-pressure regulator gage to reduce the gas storage container source pressure to 25 to 50 psig (1,9 to 3,5 bar).

When complete, continue to the *Preliminary Check* procedure beginning on page 11.

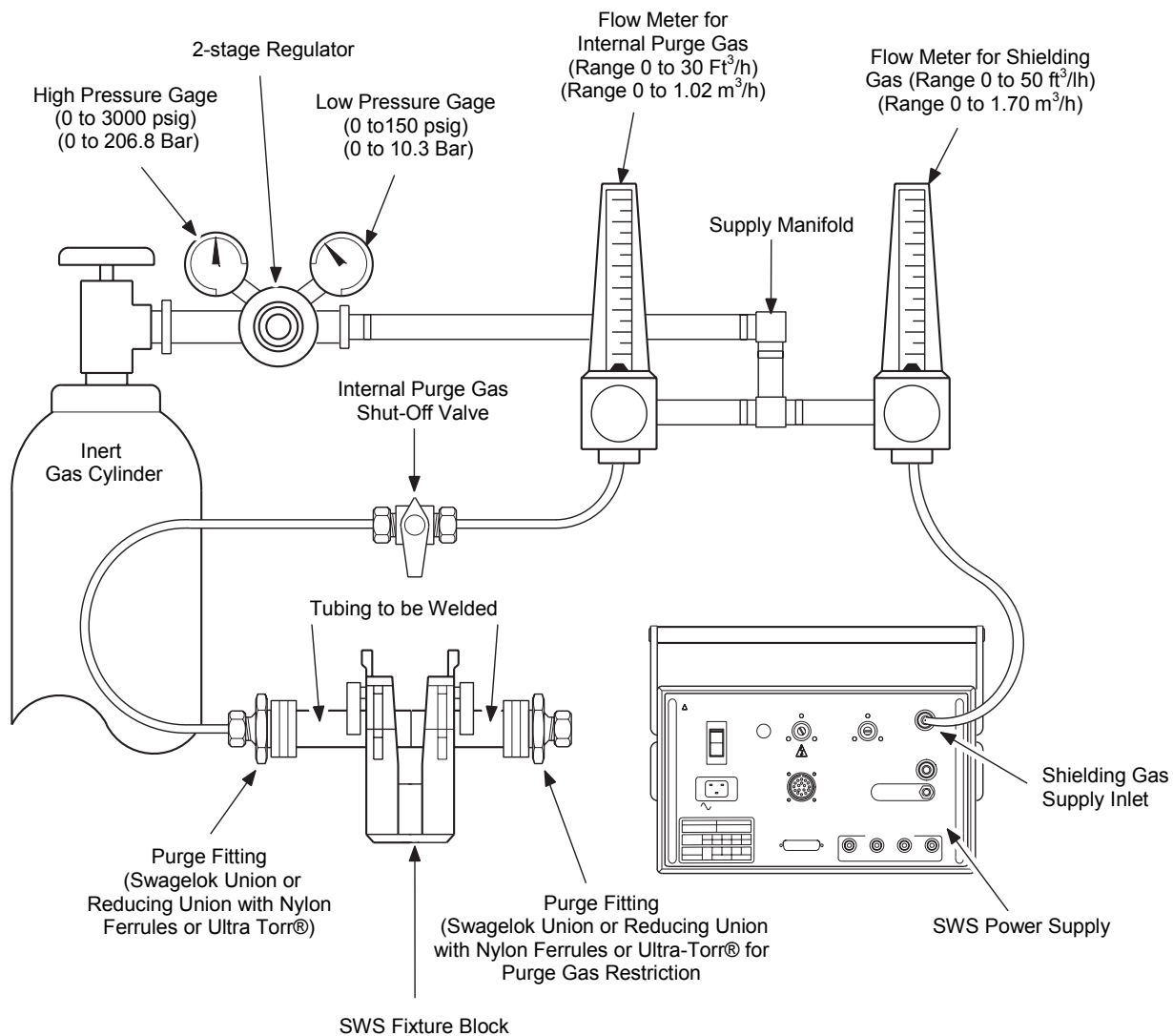


Figure 7 Typical Gas Delivery System



## Optional Gas Delivery System

The optional gas delivery system is generally used in Ultra High Purity (UHP) gas systems where quick connects are not permitted. This type of system uses an external 12 V (dc) secondary solenoid valve instead of using the solenoid valve located inside the power supply. If necessary, the secondary solenoid valve may be the high purity type.

A secondary solenoid bypass plug is inserted in the EXT GAS CONTROL connector on the rear panel to disable the solenoid inside the power supply and provide +12V to control the secondary solenoid.

For the gas delivery system using a secondary shielding gas solenoid valve, locate the:

- Secondary solenoid bypass plug
- Secondary shielding gas solenoid valve
- 1/4-turn internal purge gas shut-off valve.

Referring to Figure 8, install the optional gas delivery system. Be sure to adhere to the following precautions:

- Ensure that the gas storage container(s) are secured before using them.
- Ensure all connections are tight and do not leak.
- Observe correct polarity on the secondary solenoid bypass plug.
- Adjust the low pressure regulator gage to reduce the gas storage container source pressure to 25 to 50 psig (1,9 to 3,5 bar).



### Caution!

**Do not insert the secondary solenoid bypass plug into the connector unless you are using a secondary solenoid. Inserting the plug disables the power supply solenoid.**

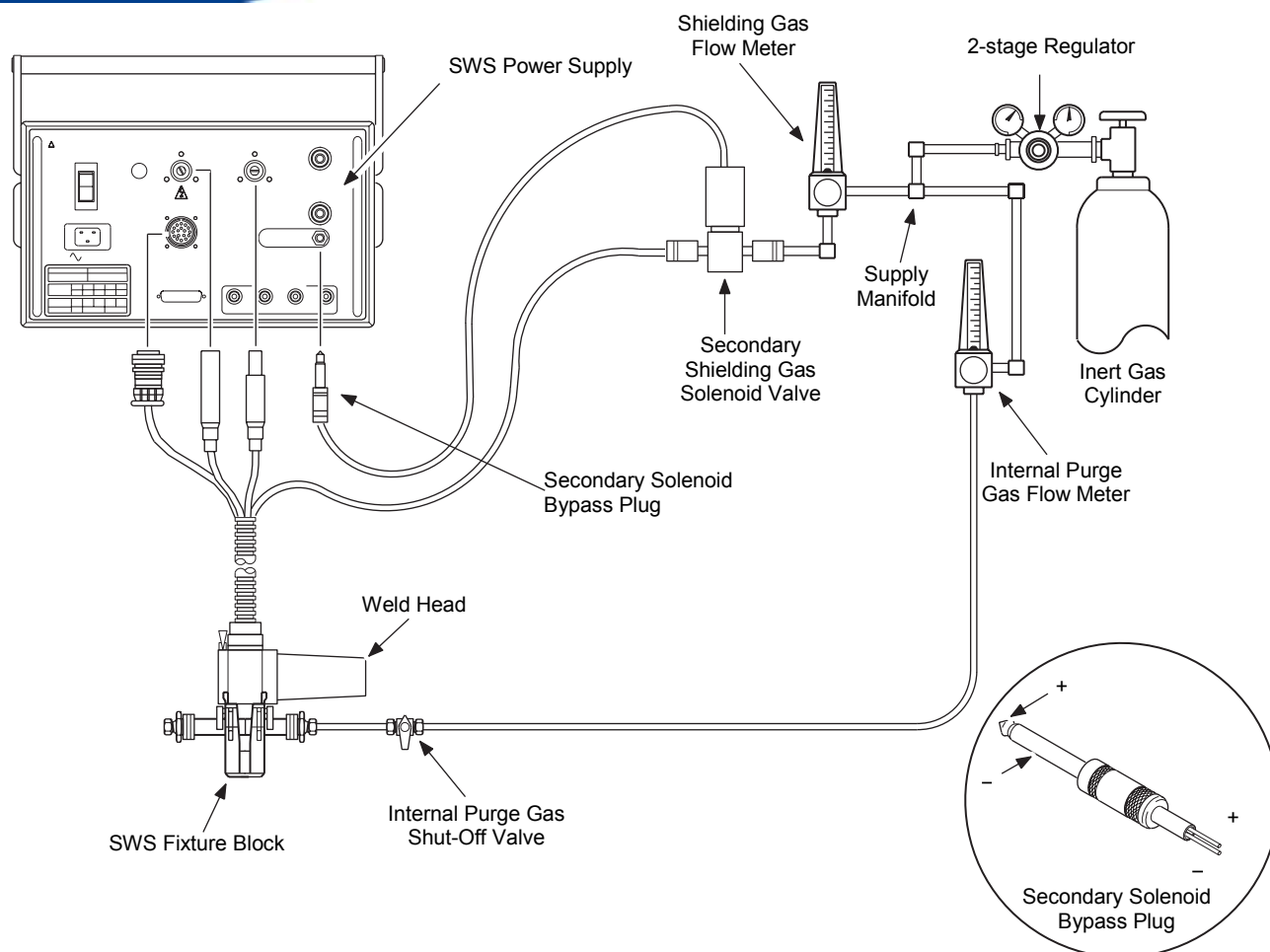


Figure 8 Optional Gas Delivery System

## Preliminary Check

Before placing the SWS into operation, you should make some preliminary checks to verify the power supply is operating correctly.

To check the system, follow these steps:

1. Connect the power supply power cord to an appropriate electrical outlet.
2. Turn on the power supply circuit breaker.
3. At this point, an owner password, which can be up to 11 characters in length, is requested. You must enter a password to continue.
  - The programmer or the welding user does not need the owner password. Discrete passwords are available for these users.
  - The owner of the welding system should consider the owner password a “master key” and protect it as such.
4. Position the weld head so that the rotor can be easily seen. See Figure 10. Do not have the fixture block attached to the weld head.

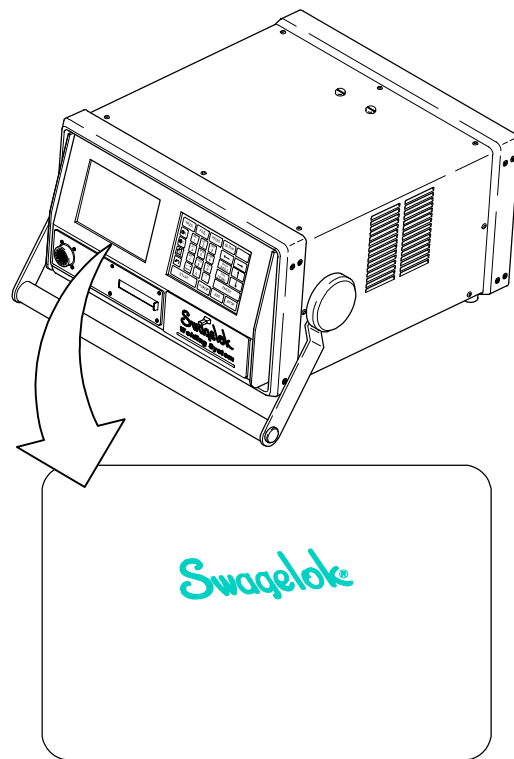


Figure 9 Password Requested

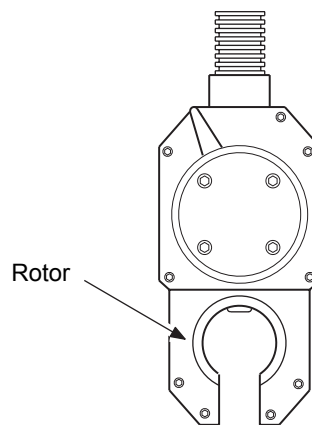


Figure 10 Positioning the Weld Head to View the Rotor Rotation

5. Press **WELD**, then **JOG** on the operator keypad to return the rotor to its home position.
6. Turn off the power supply.
7. If problems occur, refer to the Troubleshooting manual for a list of possible causes and corrective actions.

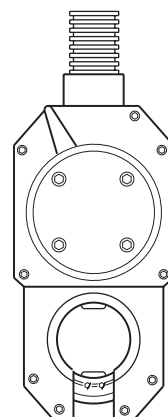


Figure 11 Checking the Rotor Rotation

## Operation

This section describes the basic operation of the Swagelok Welding System (SWS). This section covers:

- Front panel controls
- M100 modes of operation and functions
- Entering the weld parameters
- Setting the shield gas flow
- Starting and completing the weld
- Using the data recording printer
- Using the PC memory card

The welding process described in this section uses a weld procedure guideline for tubing with a 1/2 in. OD and 0.049 in. wall thickness. A weld procedure guideline is a list of weld parameter settings for a particular job. Keep in mind that the weld parameters listed in this section are for demonstration purposes and may not produce an optimum weld. Weld Parameter Development describes how to optimize welding parameters.

## Front Panel Controls

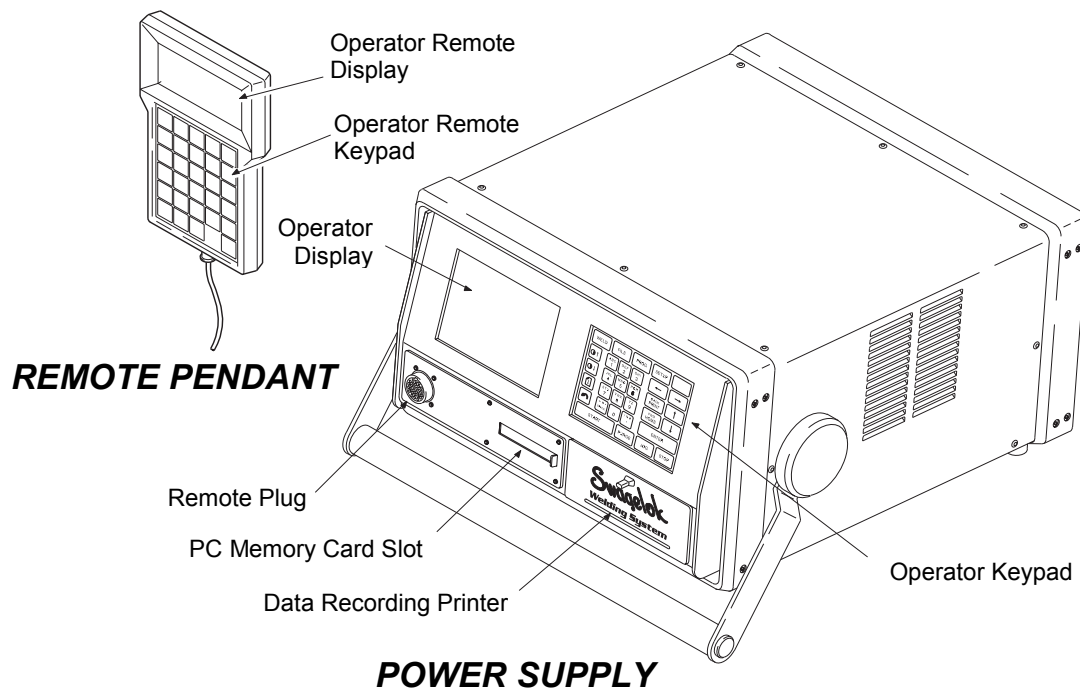


Figure 12 Front Panel Controls

The operator interface on the front panel of the power supply includes a keypad and the operator display. The keypad provides a means of entering information needed to operate the M100. The operator display allows you to monitor the welding process and to perform programming and file operations.

A remote pendant can also be used to operate the unit. It has a keypad and a display.



A Swagelok PC memory card is a flash memory device designed for use with the M100. No other memory card may be used in its place.

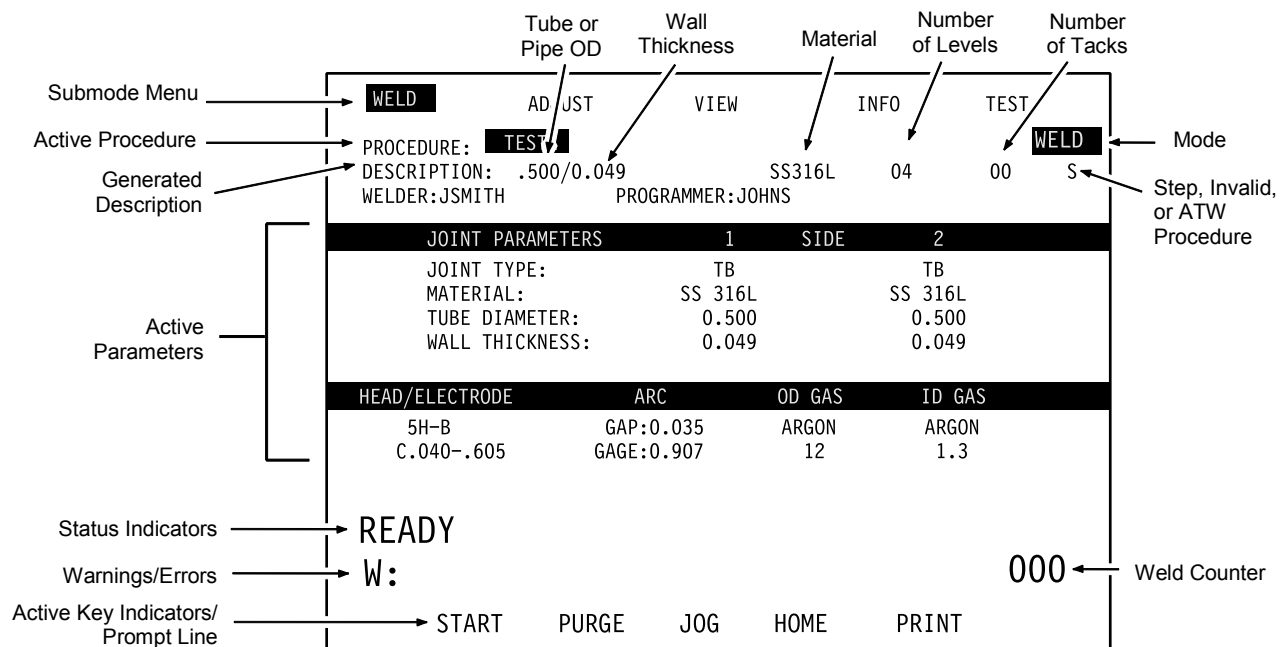
The PC memory card has a Write Protect Switch. When the switch is on, the card will read only. The M100 will prompt you if the switch is on and you attempt to write or delete.

The PC memory card has three (3) basic functions:

1. Weld procedures may be stored outside the internal memory of the unit on the PC memory card. The procedures may be re-installed into the internal memory of any M100 or used directly from the card.
2. Weld data logs may be stored on the PC memory card as they are made or downloaded from the internal memory to the card for transfer to a PC.
3. Front Panel application software may be loaded into the M100 using the PC memory card.

## Operator Display

### POWER SUPPLY



### REMOTE PENDANT

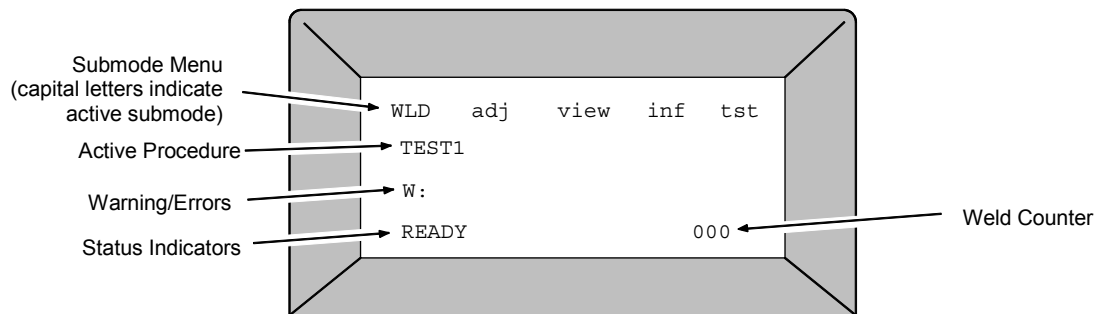


Figure 13 Operator Display



The operator display shows information about the current mode of operation. It also displays indicators, warnings, pop-up menus, and prompts when appropriate. The remote pendant displays a limited range of information.

In each mode, a series of submodes are displayed across the top of the screen. When a submode that has several functions is selected, those functions are listed in a pop-up menu below the heading.

In the WELD and PROG modes, the second line on the display shows the name of the active procedure and the current mode of operation. Below the name of the active procedure is a brief description of the procedure. On the next line, the welders and programmers names are listed. The first page of parameters for the active procedure is also displayed.

In all modes, the M100 will display brief directions on how to make selections or continue a function in the bottom line of the display (Prompt Line).

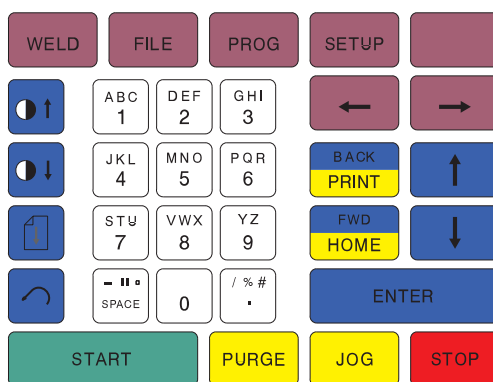


## Operator Keypad

The operator keypad has four types of keys:

- Mode keys
- Navigation and selection keys
- Weld function keys
- Alphanumeric keys

POWER SUPPLY



REMOTE PENDANT

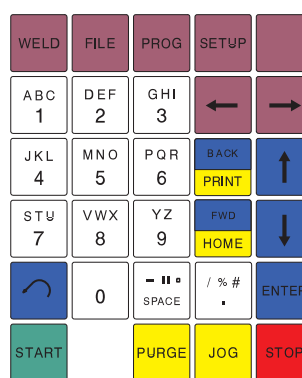


Figure 14 Operator Keypad

## MODE KEYS

The four mode keys are located in the top row of the keypad. These keys are “hot,” meaning you can press them at any time, except when a weld is being executed, to change the operation mode.

Whenever a mode key is pressed, the available series of submodes are displayed with the left most submode and the first active parameter of the submode highlighted (selected).

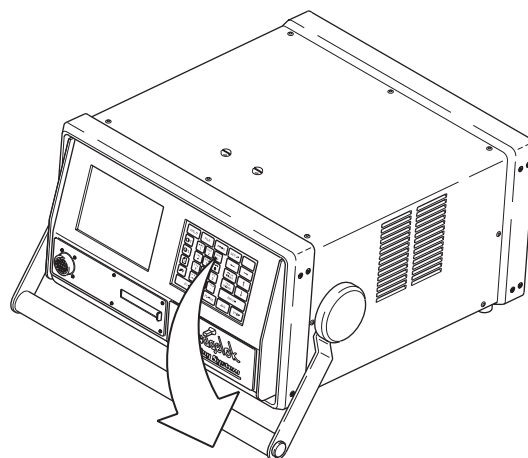


Figure 15 Mode Keys

**WELD**

Accesses the WELD mode.

In the WELD mode, you can execute a weld using the active procedure, make minor adjustments (ADJUST) to the procedure, or review the parameters of the procedure using the VIEW submode. In the WELD mode, the weld function keys are active. Pressing **START**, for example, would start a weld using the active weld procedure.

Though minor modifications to the active procedure are possible, most parameters must be set in the PROG (programming) mode.

INFO Submode – Additional information may be added to data output by operator.

TEST Submode – Test of the active procedure is accomplished here.

**POWER SUPPLY**

WELD	ADJUST	VIEW	INFO	TEST																				
PROCEDURE: <b>TEST1</b> DESCRIPTION: .500/0.049 WELDER:JSMITH      PROGRAMMER:JOHNS																								
<table border="1"> <thead> <tr> <th>JOINT PARAMETERS</th> <th>1</th> <th>SIDE</th> <th>2</th> </tr> </thead> <tbody> <tr> <td>JOINT TYPE:</td> <td>TB</td> <td></td> <td>TB</td> </tr> <tr> <td>MATERIAL:</td> <td>SS 316L</td> <td></td> <td>SS 316L</td> </tr> <tr> <td>TUBE DIAMETER:</td> <td>0.500</td> <td></td> <td>0.500</td> </tr> <tr> <td>WALL THICKNESS:</td> <td>0.049</td> <td></td> <td>0.049</td> </tr> </tbody> </table>					JOINT PARAMETERS	1	SIDE	2	JOINT TYPE:	TB		TB	MATERIAL:	SS 316L		SS 316L	TUBE DIAMETER:	0.500		0.500	WALL THICKNESS:	0.049		0.049
JOINT PARAMETERS	1	SIDE	2																					
JOINT TYPE:	TB		TB																					
MATERIAL:	SS 316L		SS 316L																					
TUBE DIAMETER:	0.500		0.500																					
WALL THICKNESS:	0.049		0.049																					
<table border="1"> <thead> <tr> <th>HEAD/ELECTRODE</th> <th>ARC</th> <th>OD GAS</th> <th>ID GAS</th> </tr> </thead> <tbody> <tr> <td>5H-B</td> <td>GAP:0.035</td> <td>ARGON</td> <td>ARGON</td> </tr> <tr> <td>C.040-.605</td> <td>GAGE:0.907</td> <td>12</td> <td>1.3</td> </tr> </tbody> </table>					HEAD/ELECTRODE	ARC	OD GAS	ID GAS	5H-B	GAP:0.035	ARGON	ARGON	C.040-.605	GAGE:0.907	12	1.3								
HEAD/ELECTRODE	ARC	OD GAS	ID GAS																					
5H-B	GAP:0.035	ARGON	ARGON																					
C.040-.605	GAGE:0.907	12	1.3																					
<b>READY</b> <b>D:</b>																								
				000																				
START	PURGE	JOG	HOME	PRINT																				

**REMOTE PENDANT**

WLD	adj	view	inf	tst
500/049   SS   316   04 READY            000				

Figure 16 Weld Mode Display

**FILE**

Accesses the FILE mode.

In FILE mode, a saved weld procedure can be selected from memory, the active procedure can be saved, or stored procedures can be deleted or copied. Procedure files can be saved in either the internal memory or the PC memory card. Weld data log records are not accessed in the FILE mode; the weld data log records are located in SETUP/DATALOG.

**POWER SUPPLY**

<b>LOAD</b>	SAVE	DELETE	COPY
<div style="border: 1px dashed black; padding: 5px;">           LOAD PROCEDURE            PRINT PROCEDURE            PRINT DIRECTORY         </div>	<b>FILE</b>		

**REMOTE PENDANT**

LOAD
save
del
copy

print directory  
 >> LOAD PROCEDURE  
 print procedure

Chevrons and Capital Letters  
Indicate Cursor Position

*Figure 17 File Mode Display*



File access can be limited by installing a programmer password.

**FILE Mode – Limited Access:** When a programmer password has been set, the user has limited access to the LOAD PROCEDURE functions. The procedure is read only which means no changes can be made. The user may also access PRINT COUPON and PRINT DIRECTORY. If any other function is requested, the unit will ask for the programmer password. The user cannot save weld changes, delete weld procedures, or transfer data to the PC memory card for weld procedures.

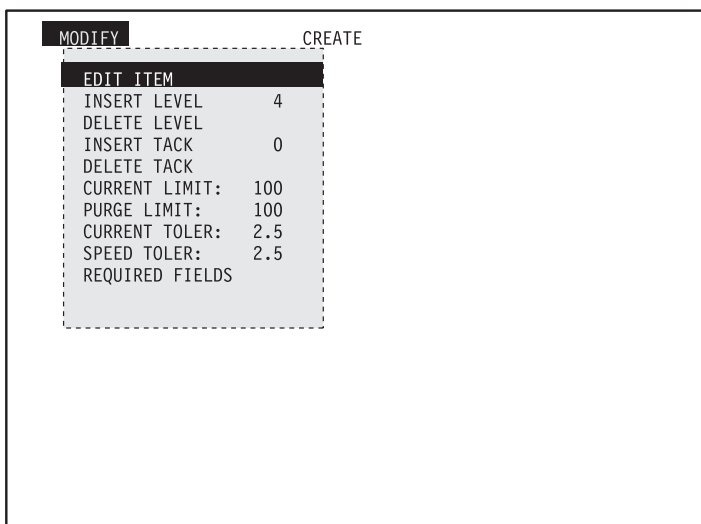
**FILE Mode – Unlimited Access:** When a programmer password has not been set, or it was entered at initial start up, the user has access to all the functions described later in this section under “File Mode.”

**PROG**

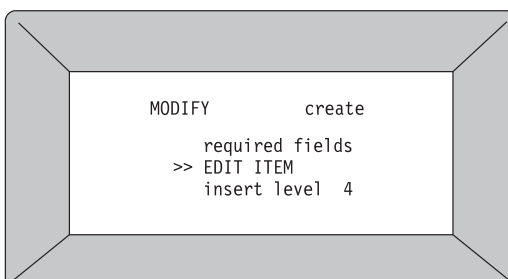
Accesses the PROG (programming) mode.

In the PROG mode, active procedures can be modified and new procedures can be developed. This mode can be password protected. Any information entered in PROG/CREATE or MODIFY is saved with the procedure.

**PROG Mode – Access:** Access to the programming mode is limited to users with programming privileges or higher. Programming privileges are obtained by entering the programmer password (if one has been set) at initial start up.

**POWER SUPPLY**


MODIFY		CREATE
<b>EDIT ITEM</b>		
INSERT LEVEL	4	
DELETE LEVEL		
INSERT TACK	0	
DELETE TACK		
CURRENT LIMIT:	100	
PURGE LIMIT:	100	
CURRENT TOLER:	2.5	
SPEED TOLER:	2.5	
REQUIRED FIELDS		

**REMOTE PENDANT**


```

MODIFY      create
          required fields
          >> EDIT ITEM
          insert level 4
  
```

*Figure 18 Programming Mode Display*

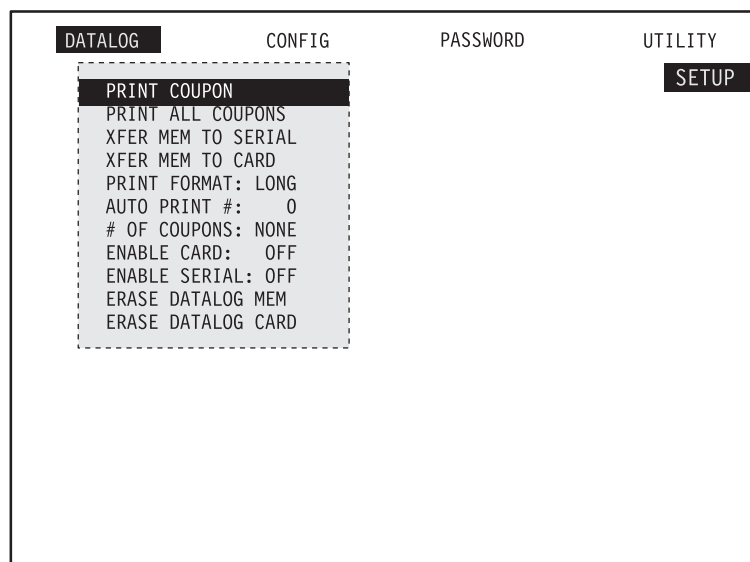
# SETUP

Accesses the SETUP mode.

This is a multi-purpose mode in which user preferences, options for data logging, and other parameters can be set. Any modifications made in SETUP mode are saved on the system and not in a specific procedure.

**SETUP Mode – Access:** Access to the setup mode is limited to users with programming privileges or higher. Programming privileges are obtained by entering the programmer password at initial start up (if one has been set).

## POWER SUPPLY



## REMOTE PENDANT

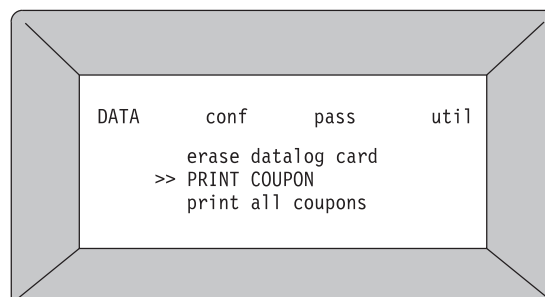


Figure 19 Setup Mode Display

## Navigation and Selection Keys

Two navigation keys are used to move through the menu of submodes in each mode. These keys are also “Hot” and will take you immediately to the next menu selection of the current mode, unless a weld is being executed.



Moves you forward in the submodes



Moves you backward in the submodes

The vertical arrow keys move you up and down through the pop-up lists or are used in the WELD/ADJUST submode to change the values.



The **UP/DOWN** keys can be used to select a function from the pop-up lists that appear below the menu of submodes.



Move up or down to highlight the function you wish to use, and press **ENTER** to select the highlighted option.

Sometimes, when you are modifying or selecting a value, there will be a list of options. The vertical arrow keys can also be used to select from these pick-lists. Highlight the option you want, and press **ENTER** to select it.

Highlighted values can also be changed by entering a number on the alphanumeric keypad.



The **FWD** and **BACK** keys can be used to scroll through screens of information.



In WELD/VIEW mode or in PROGRAM/MODIFY/EDIT ITEM mode, use **FWD** and **BACK** to scroll through the screens of procedure values. Pressing these keys moves the cursor through one group of values. For example, if you have a value in the joint parameters highlighted, pressing **FWD** once will move the cursor to highlight the weld head type, which is the first value in the next group. Pressing **FWD** again will move the cursor to the next screen of data.

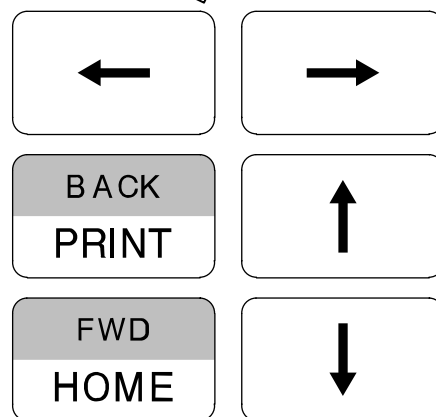
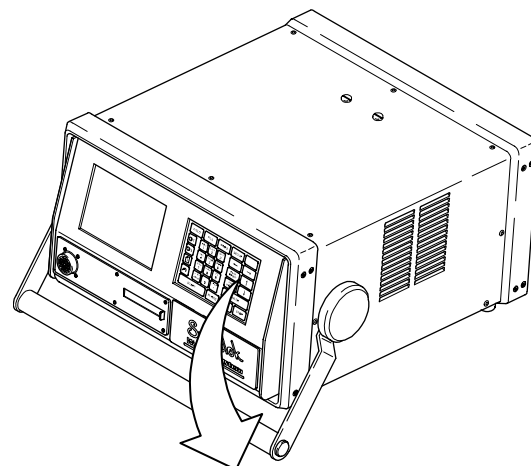


Figure 20 Navigation and Selection Keys

**FWD** and **BACK** can also be used to scroll through pop-up menus and pick-lists that are more than one screen long.

When entering a value using the alphanumeric keys, **BACK** can be used as a “backspace” key and **FWD** will move the cursor forward one space.

**FWD** and **BACK** appear on the same keys as **PRINT** and **HOME**, respectively. The **PRINT** and **HOME** functions are only available when the M100 is in the **WELD/WELD** mode. **FWD** and **BACK** are available in other modes.



## Weld Function Keys

The yellow, green, and red weld operation keys are used to control the welder. The keys are only active in the WELD/WELD mode.

**START**

Pressing this key will start the weld with the active weld procedure.

**PURGE**

Pressing this key will toggle the weld head purge gas on and off. When the purge gas is on the word "PURGE" will flash on the screen and the remote to indicate the continuous purging. When it is not flashing, the active weld procedure controls the flow of purge gas.

**JOG**

Pressing this key will jog the rotor at the speed set in the SETUP/CONFIGURATION submode (see page 64). Press **JOG** and hold for rotor motion. The rotor will stop when **JOG** is released. An indicator in the bottom right corner of the screen gives the location of the rotor in relation to the home position (see Figure 22).

**STOP**

Pressing **STOP** will stop the:

- Weld in progress immediately.
- Rotor homing in process.

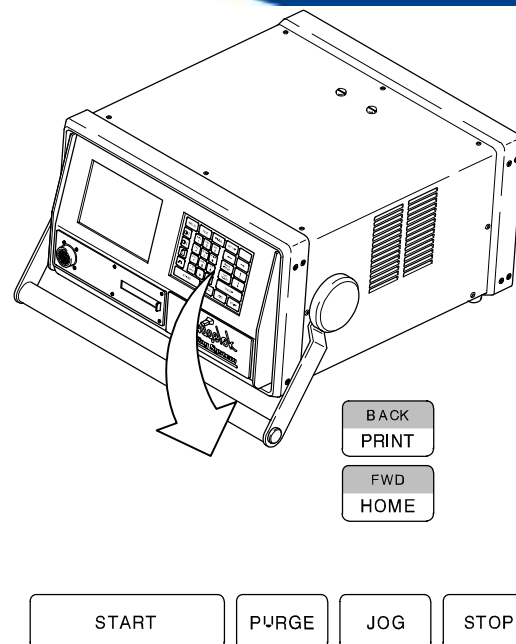


Figure 21 Weld Operation Keys

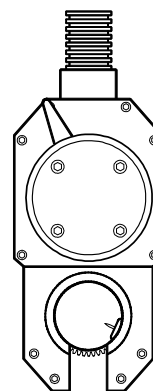
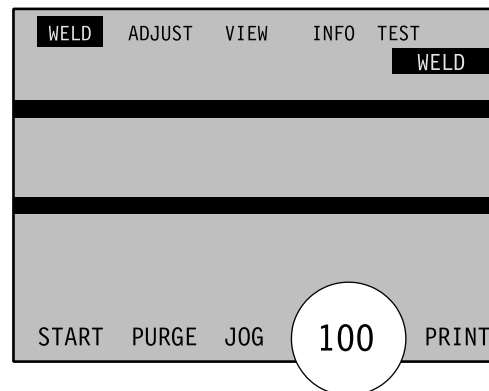


Figure 22 Rotor Position

BACK  
PRINT

Pressing this key will print the information for the most recent weld performed. To obtain a printout of a weld prior to the most recent weld performed; you must go to SETUP/DATALOG (see page 59). The type of printout to be produced can be selected in the SETUP/DATALOG submode.

FWD  
HOME

Pressing this key will move the rotor to the home position. The rotor will always move at full speed when **HOME** is pressed.

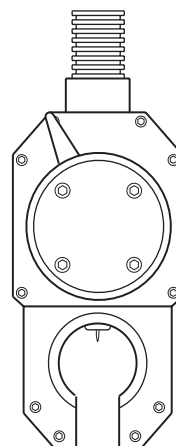


Figure 23 Rotor Home Position

## Alphanumeric Keys

The white alphanumeric keys are used to enter information into a field, where direct field entry is possible.

Each key has up to four characters. To select the desired symbol, do the following:

- Press the key once to select the large bottom symbol, which is a number or a commonly used character such as a space or a period.
- Press the key twice quickly to select the first character on the top line of the key.
- Press the number three or four times quickly to select the second or third character on the top line of the key.
- Press a different key or wait approximately half of a second without pressing a key to enter the selected symbol.
- After the desired string or value has been completed, press **ENTER** to confirm the selection.

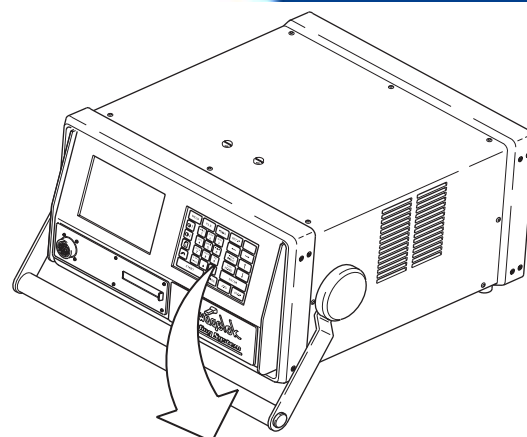


Figure 24 Alphanumeric Keys

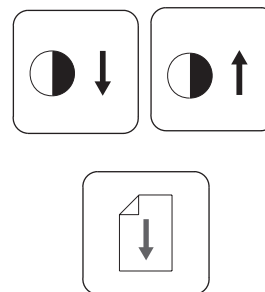
## CANCEL Key



Pressing **CANCEL** will cancel the last entry and revert to the previous submode selected. If you press **CANCEL** while in a direct data entry field, it will revert to the previous value.

## Contrast Keys

Use these keys to adjust the display contrast. To change the screen color from white background with black letters to black background with white letters, press the Contrast Keys several times.



## Data Recording Printer Feed Key

Press this key to advance the paper through the data recording printer.

## M100 Modes of Operation

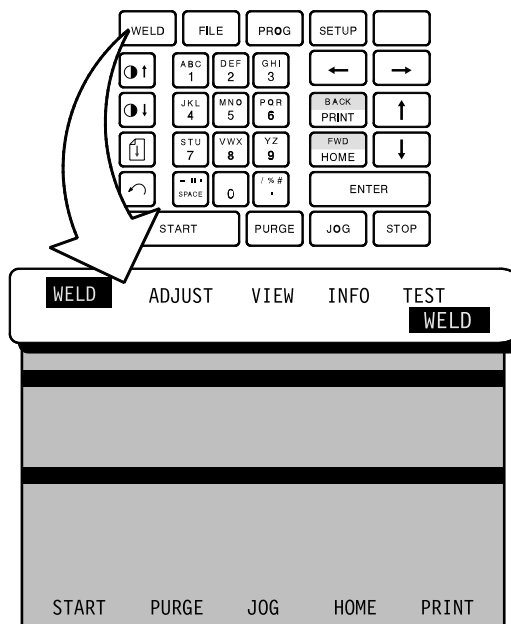
The M100 has four modes to perform different types of functions:

- WELD Page 28
- FILE Page 42
- PROG Page 49
- SETUP Page 58

### WELD Mode

WELD

The WELD mode includes most of the functions needed to execute a weld. Pressing **WELD** in the top left corner of the keypad at any time accesses this mode. Quick adjustments to the current setting can be made in this mode, in addition to performing welding operations.



### Weld Mode Directory

Submode	Activity	Page
WELD	Ready state	30
	Executing a weld	30
	Error indicators	32
ADJUST	Clear adjustments	35
	Average current per level	35
	Prepurge, postpurge	36
VIEW	View settings in active weld procedure	37
INFO	Select welder name	39
	Weld head serial number	39
	Set heat number	40
	Set certification number or Dewar serial number	40
	Open 1 and 2 available for additional information up to 10 characters	40
	Set project name or drawing name	41
TEST	Check or demonstrate weld program	41

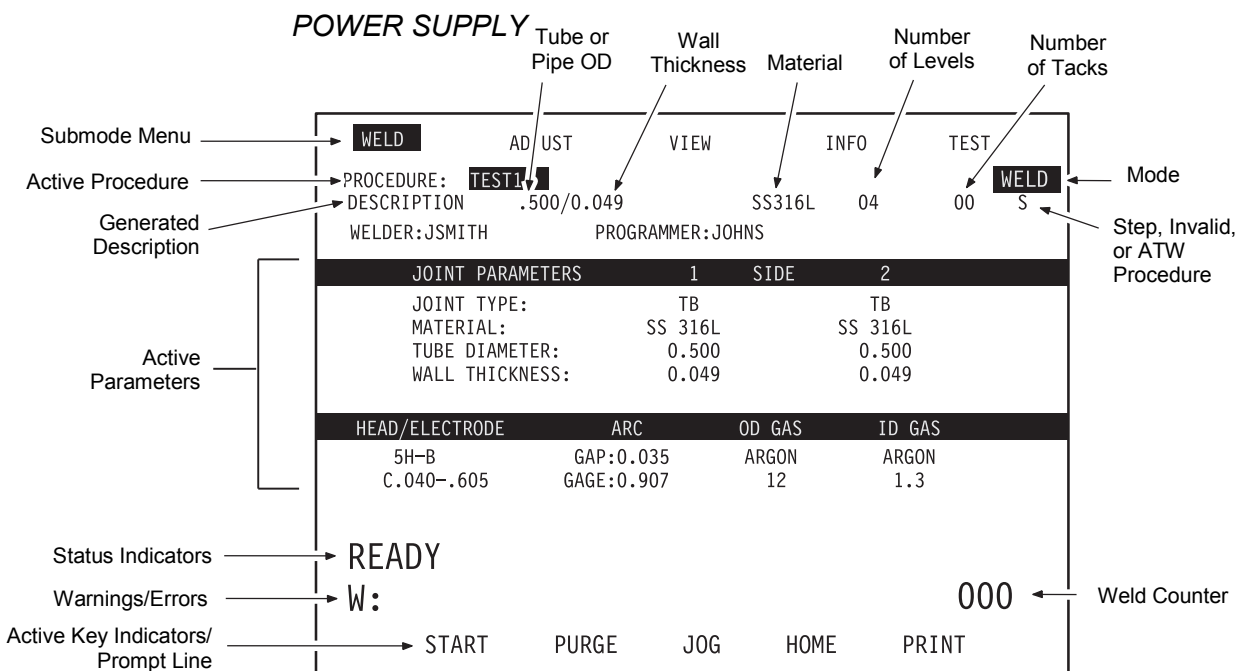
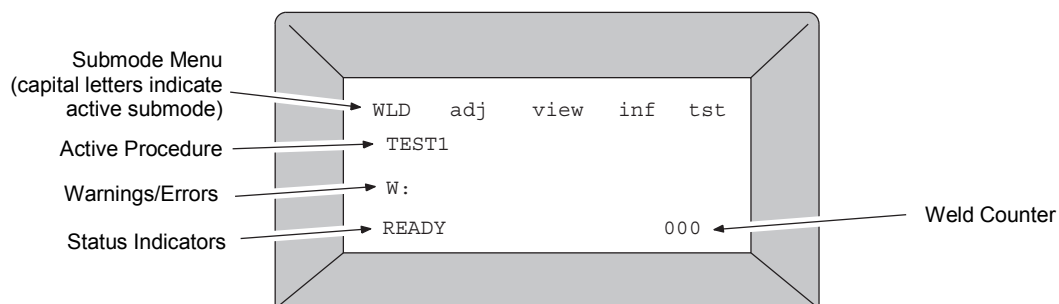
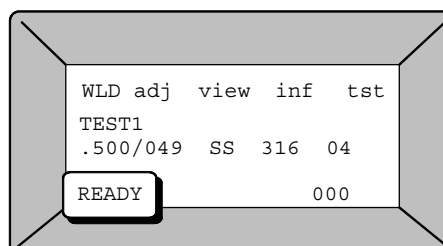
**REMOTE PENDANT**

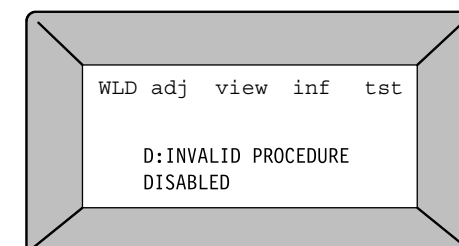
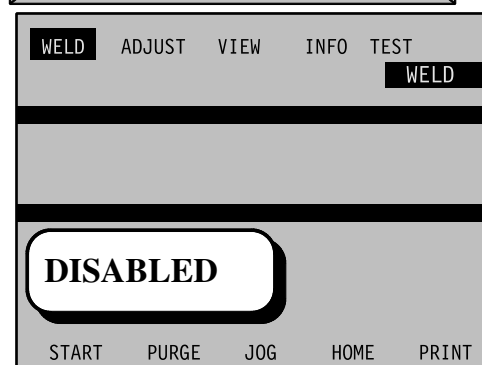
Figure 25 WELD Mode Display

## WELD – Ready State

When the M100 is in the WELD/WELD mode, it indicates that it is ready to weld by “READY” on the screen and “READY” on the remote. This means that if **START** is pressed, the weld cycle will begin as programmed in the active weld procedure. In this submode, **PURGE**, **JOG**, **HOME**, **PRINT** and **STOP** are active.



If the M100 is not ready to weld, the word “DISABLED” will be displayed and an error indicator will call attention to an error in the active procedure. Correct the error, or select a different program file, and the unit will be able to proceed with the weld. See page 32 for more information on error indicators.



## WELD – Executing a Weld

When **START** is pressed, the M100 begins executing a weld according to the active weld procedure.

During the weld, the status line on the display and the remote will indicate the current, voltage, level number being executed and time remaining in each step. If tacks are part of the selected weld procedure they are executed before the level(s). As the tacks and levels are executed the data for each is highlighted.

## POWER SUPPLY

<b>WELD</b>	ADJUST	VIEW	INFO	TEST
PROCEDURE: <b>TEST1</b>				<b>WELD</b>
DESCRIPTION: .500/0.049	SS316L	04	00	S
WELDER:JSMITH	PROGRAMMER:JOHNS			
JOINT PARAMETERS		1	SIDE	2
JOINT TYPE:	TB			TB
MATERIAL:	SS 316L			SS 316L
TUBE DIAMETER:	0.500			0.500
WALL THICKNESS:	0.049			0.049
HEAD/ELECTRODE	ARC	OD GAS	ID GAS	
5H-B	GAP:0.035	ARGON	ARGON	
C.040-.605	GAGE:0.907	12	1.3	
READY		000		
START	PURGE	JOG	HOME	PRINT

## REMOTE PENDANT

WLD adj	view	inf	tst
TEST1			
.500/049	SS	316	04
READY			000

Figure 26 WELD Mode Display

After the weld is completed properly, the unit returns to the “READY” state. If error conditions occurred during the weld, the error will be displayed and **ENTER** will have to be pressed for confirmation. For more information on error indicators see page 32.

## WELD – Disable, Warnings, and Weld Errors

### **Disable**

When the word “DISABLED” is on the status line, a condition exists that must be corrected before a weld can be executed. The line below DISABLED describes the condition. Disabling conditions are preceded by **D:**. Warning conditions are preceded by **W:**. These both may be displayed but only the disabling (**D:**) conditions must be cleared before welding.

### **Warning**

A warning (**W:**) condition should be noted by the operator but welding may proceed with discretion.

### **WELD ERRORS**

The M100 has been programmed to monitor conditions during the weld cycle. If the M100 detects an error, the status line will indicate Weld Completed or Weld Not Completed, the line below will describe the error, and the audio alarm will sound if SETUP/CONFIGURATION/ALARM is on. The condition must be acknowledged by pressing **ENTER** before the next weld may be accomplished. All weld errors are recorded in the weld data.

### **Information Message Box**

The Information Message Box may appear in any mode or submode. The box may require a corrective action by the operator or may contain information only.



### **Caution!**

**Information message boxes may contain actions that should not be taken by the operator.**



Table 3 Status Conditions

Disable	Description
High-Temperature	The power supply is over its rated temperature. This condition will automatically reset when the power supply has cooled to within its limits.
No Weld Head	There is no weld head attached to the power supply.
No Proc. Selected	There is no procedure selected. You must select a program from FILE or create one from PROGRAM/CREATE.
Invalid Procedure	The procedure selected is not executable. The program weld field must be reset within tolerance using PROGRAM/MODIFY/EDIT ITEM.
Update Weld Info	A field that has been designated as requiring data and the information has not been entered in the WELD/INFO mode.
Req. Memory Card	When SETUP/DATALOG/CARD ENABLE/ON is active a PC memory card must be installed to receive data. The card write protect must be off.
Memory Card Full	The PC memory card installed does not have memory space available.
System Memory Full	The number of saved procedures has exceeded the amount of available memory. You must delete unused programs or delete datalog records. You may want to SAVE the procedure to a PC memory card.
High Rotor Speed	The weld head connected to the power supply cannot provide the rotor speed programmed in the active procedure. You must adjust the program rotor speed or change to the correct weld head.
Card Write Protect	When SETUP/DATALOG/CARD ENABLED/ON is active, the PC memory card is inserted but the write protect is on.
Card Uninitialized	When SETUP/DATALOG/CARD ENABLED/ON is active, the PC memory card is inserted, and the write protect is on but the card is not initialized and data cannot be written to the card. To initialize card go to SETUP/UTILITY/INITIALIZE CARD.

Warnings	Description
Wrong Weld Head	The active procedure calls for a different weld head than the weld head connected to the power supply.
Printer Paper Out	The printer is out of paper.
Printer Head Up	The printer head is up for loading.
Printer Overtemp	The printer temperature is over its rated temperature. You will not be able to print until the warning is removed.
Short Prepurge	The prepurge time is set for less than 5 seconds. If the parameters of the weld include continuous purge, this warning will not be displayed.
Test Mode	The M100 is in test mode and will not execute a weld.

Weld Errors	Description
Rotor Jammed	The rotor has stopped turning during the weld program.
Misfire	The arc was not established.
Arc Failed	The arc failed during the weld.
Tack Not Complete	The tack failed to be completed as programmed.
High-Temperature	The power supply has exceeded its rated temperature.
Low Arc Voltage	The electrode has touched the weld puddle.
Stop Pressed	The operator has pressed the Stop Key to abort the weld in progress.
Speed Tolerance	The weld did not perform within the specified speed tolerance. The tolerance is set in PROGRAM/MODIFY/SPEED TOLERANCE.
Current Tolerance	The weld did not perform within the specified tolerance. The tolerance is set in PROGRAM/MODIFY/CURRENT TOLERANCE.

Information Box	Description
System Clean-Up	System Clean-up is an automatic Clean-up function that the M100 will perform when internal memory is nearing capacity. The M100 rearranges files to open up additional internal memory. If the System Clean-up Information box occurs often or takes excessive time to perform, weld data logs may need to be deleted in SETUP/DATALOG/ERASE DATALOG MEMORY OR CARD.

## ADJUST – CLEAR ADJUSTMENTS

When a procedure has been adjusted by one of the displayed selections it is noted by adding “-ADJUSTED” to the procedure name displayed on the screen. Selecting CLEAR ADJUSTMENTS returns to the initial procedure values, and the appended notation is removed. Saving the Adjusted Active Procedure will also clear the appended notation.

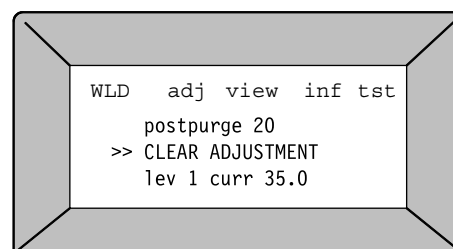
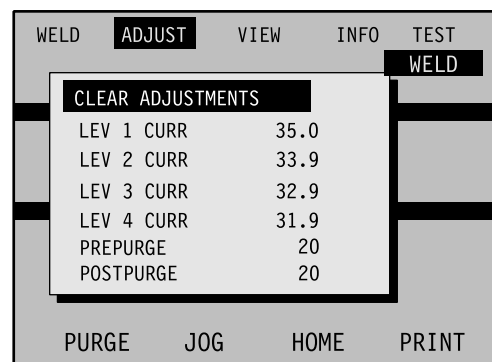


Figure 27 Clear Adjustments

## ADJUST – AVERAGE CURRENT PER LEVEL

This selection allows you to make a quick adjustment to the current for a level. The value that can be adjusted is the average current, which is the average of the impulse, maintenance, and impulse width values for the level. You are allowed an adjustment range within the limits set in PROGRAM/MODIFY/CURRENT LIMIT (see page 53). The limit is usually about 10 % of the initial average for that level. The M100 adjusts the average current by following the appropriate Weld Procedure Guideline.

1. **Select the level** – Use the **UP/DOWN** keys to highlight the level you wish to adjust on the selection list then press **ENTER**. For example, to adjust the current for level 1, select and press **ENTER** on **LEV 1 CURR** line.
2. **Adjust the current setting** – The average current value for the selected level is then highlighted and can be adjusted using the UP/DOWN keys. The adjusted value will be automatically constrained by the current limits.

The M100 can be returned to the Ready state by pressing WELD or highlighting the WELD submode with the menu arrows.

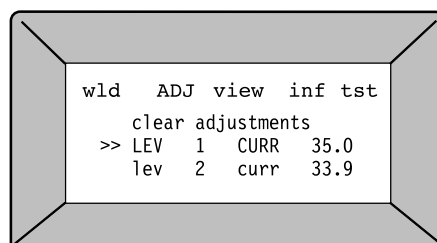
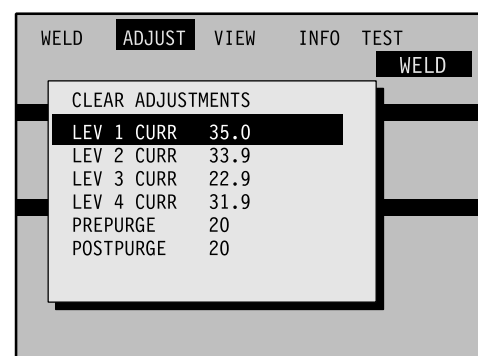


Figure 28 Current Level Adjustment

## ADJUST – Prepurge, Postpurge

The prepurge and postpurge times of the weld procedure selected can be adjusted the same way as the average current settings. Select PREPURGE or POSTPURGE on the selection list and change the time. The range of adjustment can be set in PROGRAM/MODIFY/PURGE LIMIT.

WELD	ADJUST	VIEW	INFO	TEST
				WELD
CLEAR ADJUSTMENTS				
LEV 1	CURR	35.0		
LEV 2	CURR	33.9		
LEV 3	CURR	22.9		
LEV 4	CURR	31.9		
	PREPURGE	20		
	POSTPURGE	20		

wld	ADJ	view	inf	tst
lev	4	curr	31.9	
>>	PREPURGE		20	
	postpurge		20	

Figure 29 Prepurge and Postpurge Adjustment

## VIEW

This submode allows you to review the settings in the active weld procedure. Joint parameters, start parameters, tacks, and levels as well as other settings are displayed. You cannot change any information in the VIEW submode.

### POWER SUPPLY

WELD	ADJUST	VIEW	INFO	TEST
PROCEDURE: TEST1				
DESCRIPTION: .500x0.049 SS316L 04 00 S				
WELDER:JSMITH PROGRAMMER:JOHNS				

LEVEL PA	WELD	ADJUST	VIEW	INFO	TEST
IMPULSE: MAINTENA WELD TIM RAMP: PULSE RA PULSE WI SPEED HI SPEED LO	PROCEDURE: TEST1				
	DESCRIPTION: .500x0.049 SS316L 04 00 S				
	WELDER:JSMITH PROGRAMMER:JOHNS				
	USE ARROWS, FWD/BACK TO POSITION CURSOR				
	USE ARROWS, FWD/BACK TO POSITION CURSOR				

STA	WELD	ADJUST	VIEW	INFO	TEST
START POW START CUR ROTOR DEL	PROCEDURE: TEST1				
	DESCRIPTION: .500x0.049 SS316L 04 00 S				
	WELDER:JSMITH PROGRAMMER:JOHNS				
	USE ARROWS, FWD/BACK TO POSITION CURSOR				
	USE ARROWS, FWD/BACK TO POSITION CURSOR				

TACKS	JOINT PARAMETERS		1	SIDE	2
POSITION:	JOINT TYPE:		TB		TB
CURRENT:	MATERIAL:		SS 316L		SS 316
TACK TIME	TUBE DIAMETER:		0.500		0.500
	WALL THICKNESS:		0.049		0.049

HEAD/ELECTRODE	ARC	OD GAS	ID GAS
5H-B	GAP:0.035	ARGON	ARGON
C.040-.605	GAGE:0.907	12	1.3

USE ARROWS, FWD/BACK TO POSITION CURSOR

### REMOTE PENDANT

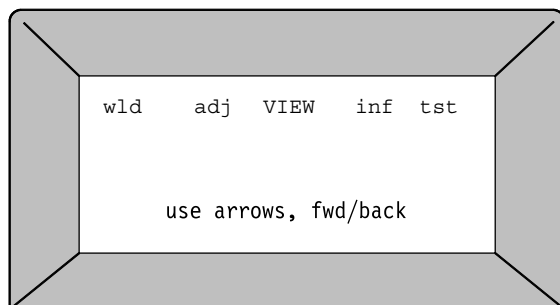


Figure 30 Review Active Weld Settings

## INFO

This submode allows the equipment operator to enter data to the DATALOG record output. Data must be entered in a field displaying an asterisk (\*required field) prefix. Information entered here will be displayed on the printout and in the Weld Datalog Record.

### POWER SUPPLY

WELD	ADJUST	VIEW	INFO	TEST
<div> <div>WELDER:</div> <div>HEAD SN:</div> <div>HEAT 1:</div> <div>HEAT 2:</div> <div>OD GAS#:</div> <div>ID GAS#:</div> <div>OPEN 1:</div> <div>OPEN 2:</div> <div>PROJECT:</div> <div>DRAWING:</div> </div>				

### REMOTE PENDANT

wld	adj	view	INF	tst
drawing:				
>> WELDER:				
head sm:				

Figure 31

## INFO

The selection is cleared when the unit is powered down.

## INFO – Welder Name

The welder name or ID may be entered here by using the alphanumeric keypad. This entry field is cleared on unit power down.

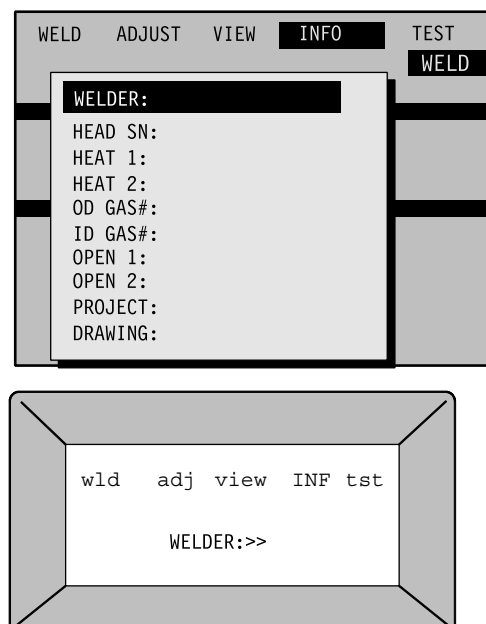


Figure 32 Welder Name Selection

## INFO – Weld Head Serial Number

The serial number of the weld head being used may be entered here. The model number of the weld head is entered during creating of the procedure. This entry field is cleared on unit power down.

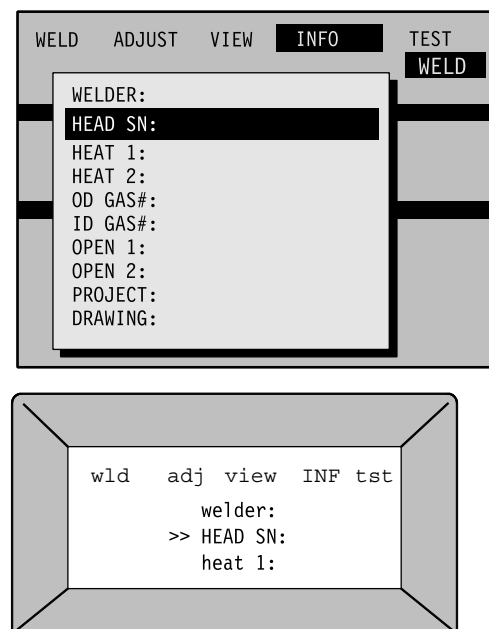


Figure 33 Weld Head Serial Number

## INFO – Heat Number

The heat number or lot number of the materials being welded may be entered in these locations. The entry field will clear on unit power down.

WELD	ADJUST	VIEW	INFO	TEST
WELDER:				
HEAD SN:				
HEAT 1:				
HEAT 2:				
OD GAS#:				
ID GAS#:				
OPEN 1:				
OPEN 2:				
PROJECT:				
DRAWING:				

```

wld  adj  view  INF  tst
      head sn:
      >> HEAT1:
      heat 2:
  
```

Figure 34 Heat of Lot Number

## INFO – Shield Gas and Purge Gas Certification Numbers

The certification number of Dewar serial number may be entered in these locations. These entry fields will clear on unit power down.

WELD	ADJUST	VIEW	INFO	TEST
WELDER:				
HEAD SN:				
HEAT 1:				
HEAT 2:				
OD GAS#:				
ID GAS#:				
OPEN 1:				
OPEN 2:				
PROJECT:				
DRAWING:				

```

wld  adj  view  INF  tst
      heat 1:
      >> OD GAS#:
      id gas#:
  
```

Figure 35 Shield Gas and Purge Gas Certification Numbers

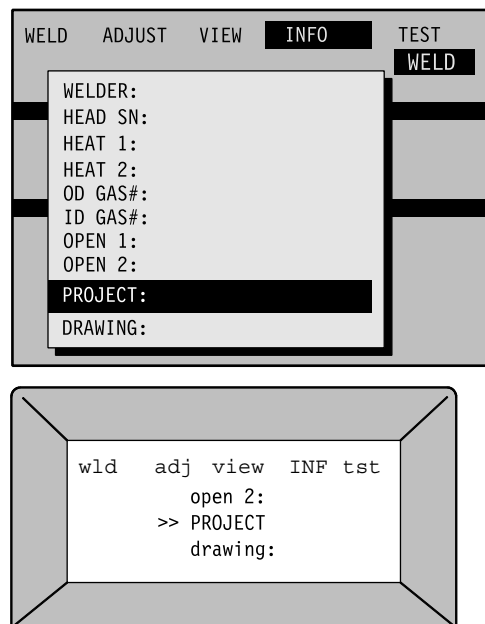
## INFO – Open 1 and Open 2

These two lines are available for any additional information up to 10 characters. These entry fields will clear on unit power down.



## INFO – Project Name/Drawing Name Entry

The project name and the drawing name or number may be entered in these locations. These entry fields will clear on unit power down.



WELD ADJUST VIEW **INFO** TEST

WELDER:  
HEAD SN:  
HEAT 1:  
HEAT 2:  
OD GAS#:  
ID GAS#:  
OPEN 1:  
OPEN 2:  
**PROJECT:**  
DRAWING:

wld adj view INF tst  
open 2:  
>> PROJECT  
drawing:

Figure 36 Project Name/Drawing Name Entry Fields

## TEST PROCEDURE

The TEST submode of the WELD mode is used to check or demonstrate a weld procedure. WELD/TEST is similar to WELD/WELD except that no current is applied to the electrode and the weld head does not have to be installed into the fixture block. The weld count will not advance in the TEST submode. To use the TEST submode: Select and install a weld procedure; press **START**. The M100 will ask you to check that the rotor is clear to rotate; press **ENTER** to begin the TEST.



## FILE MODE

FILE mode is used to access and edit weld procedure files in memory and on the PC memory card.

### File Mode Directory

Submode	Activity	Page
LOAD	Load procedure	43
	Print procedure	44
	Print directory	45
SAVE	Store to memory	46
	Store to card	46
DELETE	Delete procedure	47
	Erase memory	47
	Erase card	47
COPY	One procedure from card to memory	48
	One procedure from memory to card	48
	All procedures from card to memory	48
	All procedures from memory to card	48

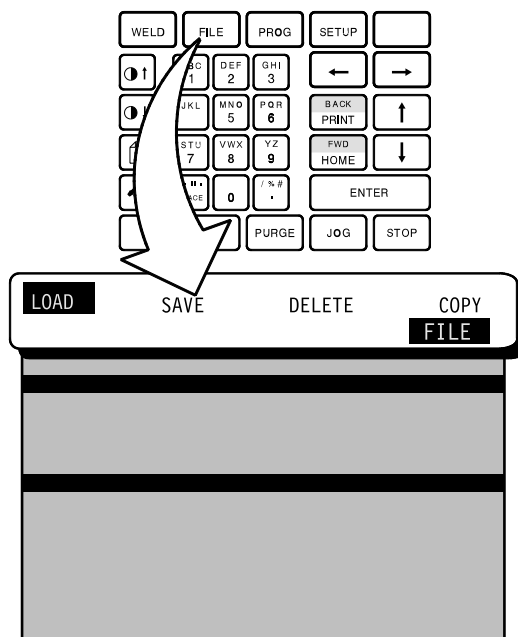
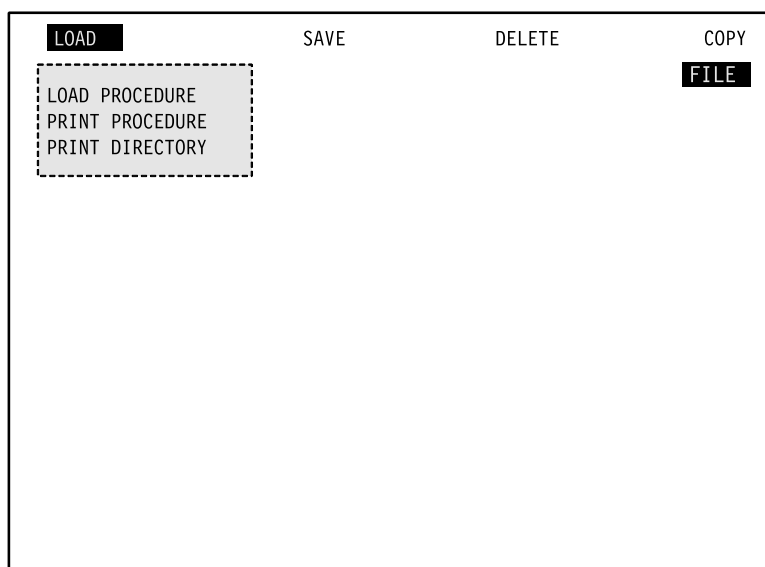


Figure 37 File Mode

### POWER SUPPLY



### REMOTE PENDANT

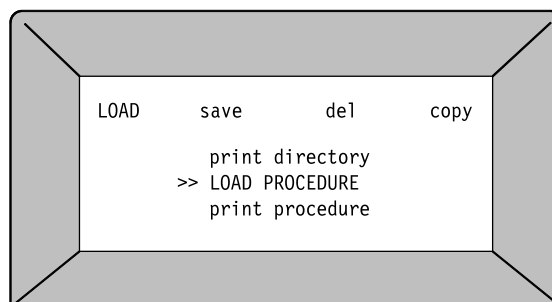


Figure 38 File Mode Display

## LOAD – LOAD PROCEDURE

This function allows you to select a procedure stored in memory or the PC memory card. Select **LOAD PROCEDURE** and press **ENTER** to bring up the list of stored procedures. Scroll through the list to highlight the procedure you would like to load, then press **ENTER**. The selected procedure is copied from memory to the work area as the active procedure and the M100 changes to the Weld mode. If no weld procedure files are stored in memory, a “NO PROCEDURES FOUND” message is displayed.

Load Procedure also allows you to load procedures from the PC memory card. Install a PC memory card with weld procedures. The weld procedures from the memory card will be displayed first, with the letter C preceding the file name. Weld procedures from internal memory will have the letter S preceding the name.

### Arrows

The arrows indicate more procedures above or below in the display. The procedures may be reached by scrolling with the **UP/DOWN** or **FWD/BACK** keys.

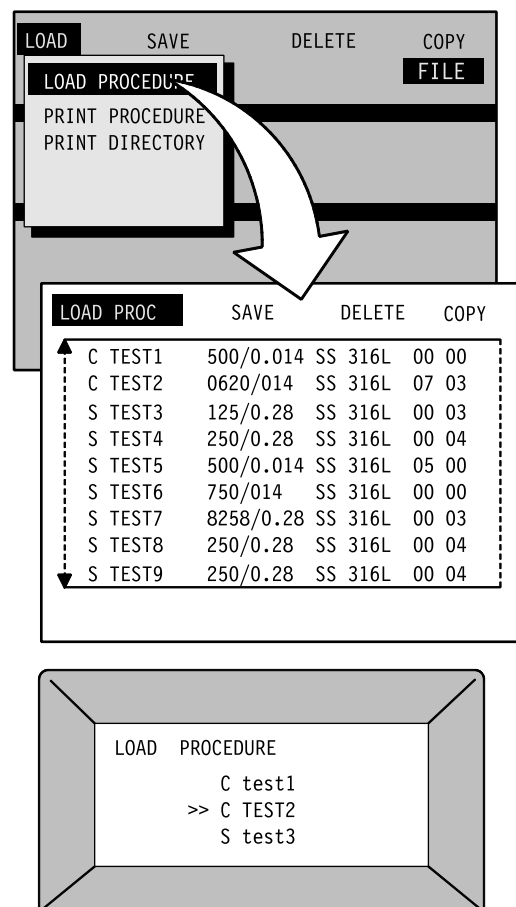


Figure 39 Load a Procedure Display

## LOAD – PRINT PROCEDURE

This function allows you to print a weld procedure. No datalog information is available here. To print procedure:

1. Select Print Procedure, then press **ENTER**.
2. Highlight the desired weld procedure using the **UP/DOWN** keys. The **FWD/BACK** keys move the highlighted area 1/2 page at a time making scrolling easier. Press **ENTER**.

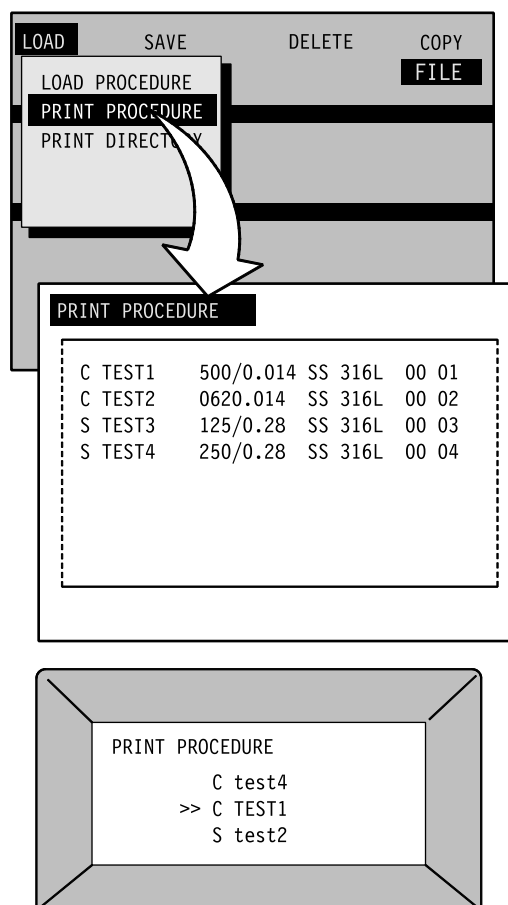


Figure 40 Print a Procedure Display

### Note:

Card files will be listed first preceded by the letter C. System memory files will be preceded by the letter S.

## LOAD – PRINT DIRECTORY

To print a directory of the weld procedures select PRINT DIRECTORY, then press **ENTER**.

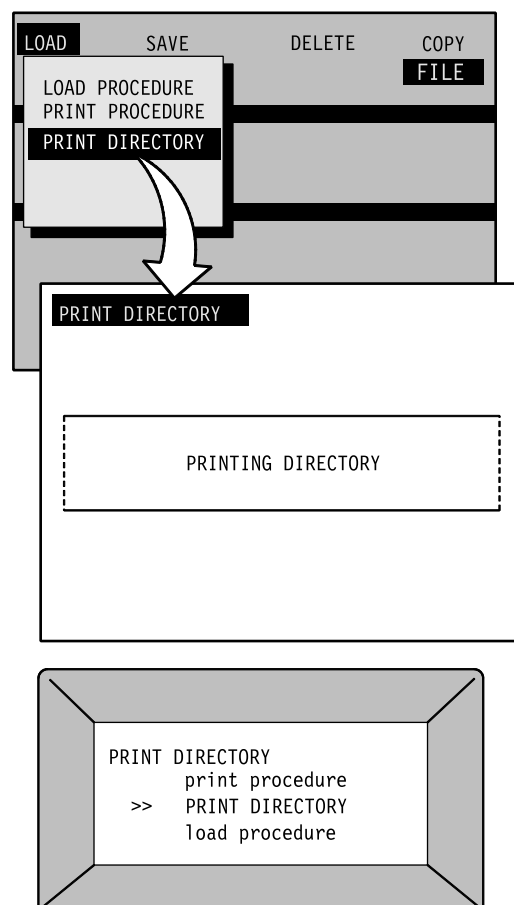


Figure 41 Print the Directory Display

**Note:**

Card files will be listed first preceded by the letter C. System memory files will be preceded by the letter S.

## SAVE – STORE TO MEMORY

This function stores the active procedure in memory. If a procedure has been edited or adjusted, you may overwrite the procedure or create a new procedure with a new name.

## SAVE – STORE TO CARD

This function stores the active procedure on the PC memory card.

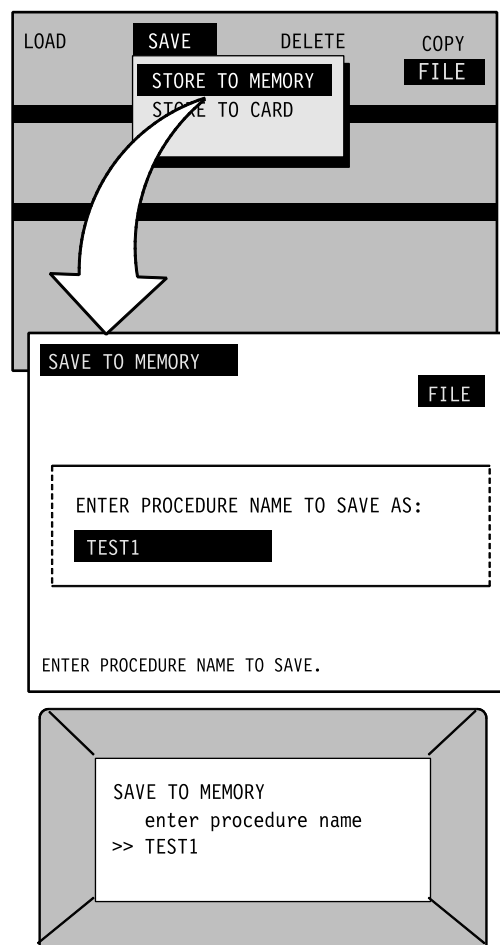


Figure 42 Store Procedure to Memory Display

## DELETE – DELETE PROCEDURE

This function allows you to delete an unwanted weld procedure file from memory or card. Select the procedure from the list presented and press **ENTER**.

## DELETE – ERASE MEMORY

The erase memory selection will erase all procedures from memory but will not delete the datalog records.

## DELETE – ERASE CARD

The erase card selection will erase all procedures from the PC memory card but will not delete the datalog records. The M100 will ask for confirmation that you want to erase the card. Using the **UP/DOWN** keys to highlight your selection, **ENTER** “yes” to proceed or “no” to cancel.

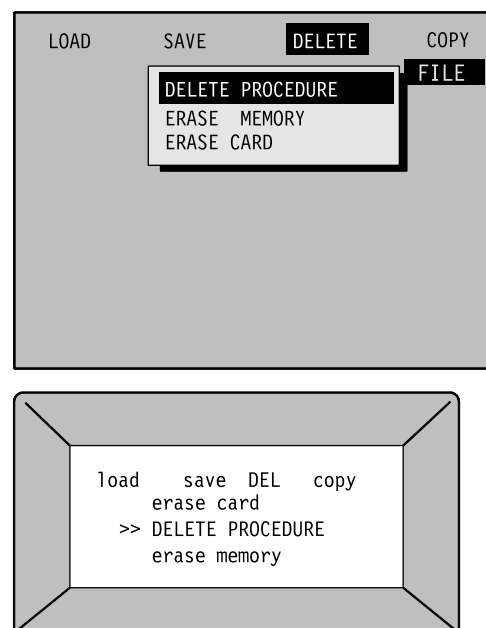


Figure 43 Delete Procedure from Memory Display

## COPY – Copy Procedure Files

### 1 Memory to Card All Memory to Card

These functions allow you to download one file or all files in memory to a PC memory card for storage or subsequent upload to another M100. The unit will ask if you want to overwrite PC memory card files with memory files of the same name. Select “yes” or “no” using the **UP/DOWN** keys. The default answer is “no.” When storing is done, press a mode key to continue.

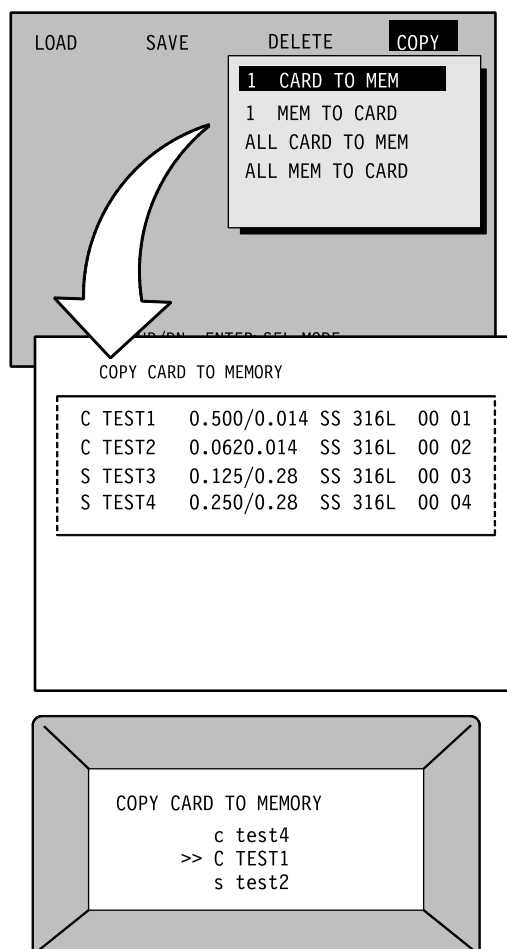


Figure 44 Copy Procedure Display

### 1 Card to Memory All Card to Memory

These functions allow you to download one file or all files from a PC memory card to memory. The M100 will ask you if you wish to overwrite files with the same name in memory. Select “yes” or “no” using the **UP/DOWN** keys. The default answer is “no.” When storing is done, press a mode key to continue.



## PROG MODE

The PROG mode allows a programmer to modify and create weld procedures. To ensure that only authorized programmers create procedures, a password can be required to enter this mode.

### Program Mode Directory

Submode	Activity	Page
MODIFY Procedure	Edit item	50
	Insert level	52
	Delete level	52
	Insert tack	52
	Delete tack	53
	Change current limits	53
	Purge time limits	53
	Current performance tolerance	53
	Rotor speed performance tolerance	53
	Designate required fields	54
CREATE Procedure	Auto entry	54
	Manual entry	57
	Load and edit	57

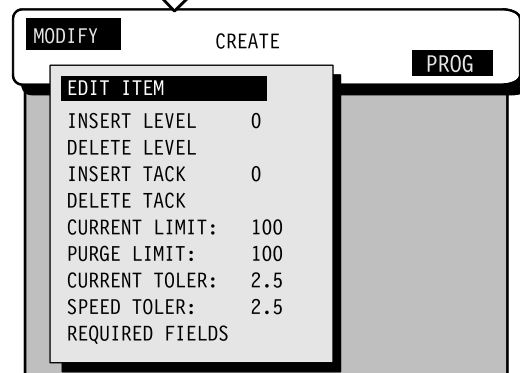
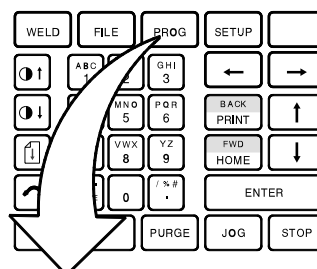
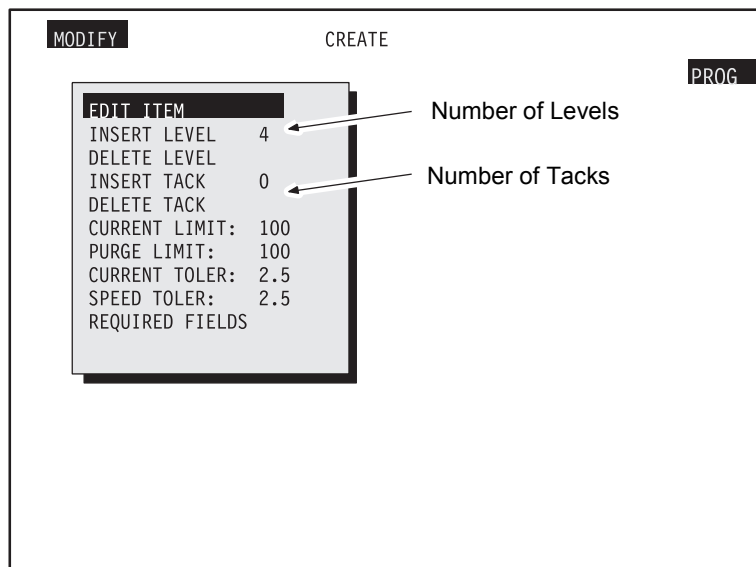


Figure 45 Program Mode

### POWER SUPPLY



### REMOTE PENDANT



Figure 46 Program Mode Display

## MODIFY PROCEDURE – EDIT ITEM

This function allows you to edit the active weld procedure. Use the **FWD/BACK** keys to move between fields of information and the **UP/DOWN** keys to highlight information to be changed.

**Page one:** This page is primarily composed of textual information, which is important for identifying the procedure, and is displayed in the WELD/WELD mode. All fields of a procedure are directly modifiable in the EDIT mode except for three: Procedure Name, Welder Name, and Description.

**Procedure name:** This can only be modified in the FILE mode.

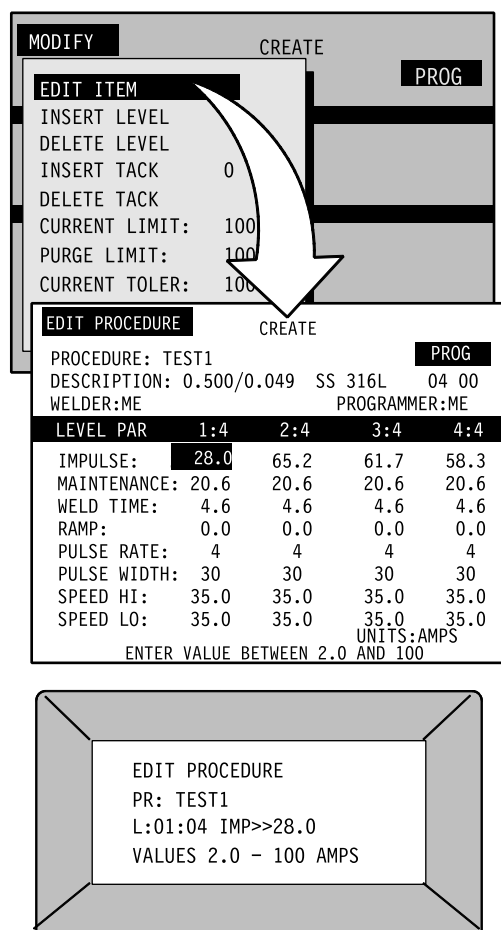
**Welder Name:** This can only be changed in WELD/INFO mode.

**Description:** Is automatically generated and updated by the M100. It cannot be directly modified. It is composed of 6 individual fields that help identify the procedure. These fields are:

DDDDD/WW MMMMM LL TTC

- D: 5 characters for Side 1 Tube Outside diameter.
- W: 3 characters for Side 1 Tube Wall thickness.
- M: First 6 characters of Side 1 Material.
- L: Number of Levels in procedure.
- T: Number of Tacks in procedure.
- C: Is blank for most procedures. An “S” indicates a step procedure; an “I” indicates an invalid procedure, and an “A” indicates an ATW procedure.

**Page two:** This page contains the Start Parameters and Tacks sections. The Start Parameters are values that are executed once in the procedure (as opposed to level type information which is repeated for every level). The tacks section can display 4 tacks at a time. The M100 allows up to 10 tacks/procedure. If more than 4 tacks are present, they can be displayed by using the **FWD/BACK** keys that will scroll a tack at a time.



LEVEL	PAR	1:4	2:4	3:4	4:4
IMPULSE:		28.0	65.2	61.7	58.3
MAINTENANCE:		20.6	20.6	20.6	20.6
WELD TIME:		4.6	4.6	4.6	4.6
RAMP:		0.0	0.0	0.0	0.0
PULSE RATE:		4	4	4	4
PULSE WIDTH:		30	30	30	30
SPEED HI:		35.0	35.0	35.0	35.0
SPEED LO:		35.0	35.0	35.0	35.0

UNITS:AMPS  
ENTER VALUE BETWEEN 2.0 AND 100

Figure 47 Adjusting the Floating-point Numbers

**Page Three:** This page contains the Level sections. The M100 allows from 1 – 99 levels but only 4 levels may be displayed at one time. If a procedure has more than 4 levels, the remaining levels can be displayed by using the **FWD/BACK** keys that will scroll a level at a time.

To use EDIT ITEM:

1. Select MODIFY/EDIT ITEM, press **ENTER**.
2. Using the alphanumeric keys, make the desired changes on all three pages of the weld procedure. If the value entered is outside the limits allowed for that parameter, a warning will appear. If you elect to leave an invalid entry, the program will not run.
3. Press any mode key to exit. If any of the procedure fields are invalid, you will be prompted with the number of errors and ask to save or correct errors.

**Correct Errors** – If Correct Errors is chosen, the cursor will be located on the first error.

**Save** – If Save with Errors is chosen the procedure will be invalid.

4. You will be asked if you wish to rename the procedure. If you don't rename the M100 will default to the original file name. If you then enter **ENTER** with the original file name it will be overwritten without a warning message. If you enter a new name, both files will be saved. To delete one of the files, go to FILE/DELETE.

## MODIFY PROCEDURE – INSERT LEVEL

The number of levels in a procedure is displayed next to the INSERT LEVEL function on the menu list. The programmer can create up to 99 levels in a weld procedure. When INSERT LEVEL is selected, the levels are displayed and you can use **FWD/BACK** to select the point of insertion in the procedure. The new level will be added immediately before the selected level. The new level will make a copy of the selected level. You must then go to EDIT ITEM to modify the values.

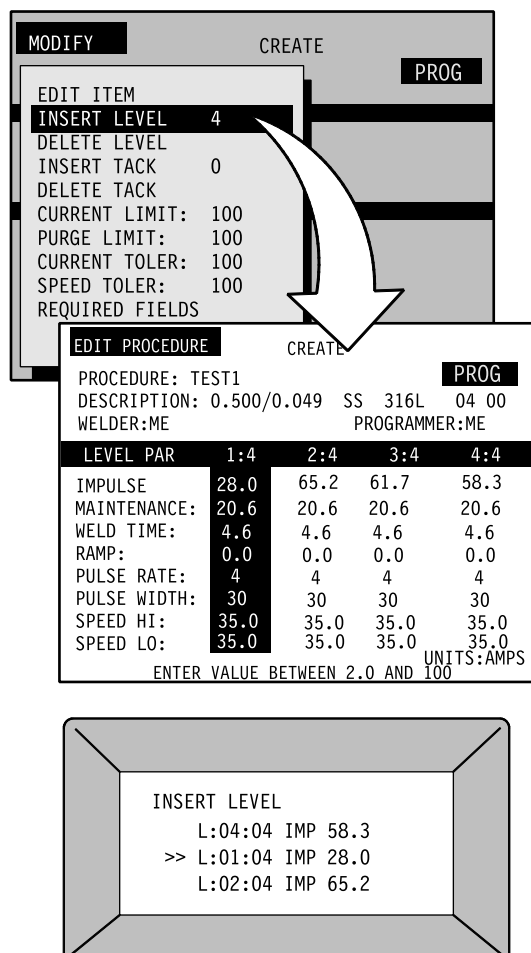


Figure 48 Inserting a Level

## MODIFY PROCEDURE – DELETE LEVEL

The DELETE LEVEL function is used to remove a level from the procedure. Highlight the level to be deleted, and then press **ENTER**. The M100 will ask for confirmation before deleting a level.

## MODIFY PROCEDURE – INSERT TACK

The number of tacks in a procedure is displayed next to the INSERT TACK function on the menu list. The maximum number of tacks that can be used in a procedure is 10. When INSERT TACK is selected, the tacks are displayed and you can use **FWD/BACK** to select the point of insertion in the procedure. The new tack will be added immediately before the selected tack. The new tack will be a copy of the selected tack. You must go to EDIT ITEM to modify the values.

## MODIFY PROCEDURE – DELETE TACK

The DELETE TACK function is used to remove a tack from the procedure. Highlight the tack to be deleted and then press **ENTER**. The M100 will ask for confirmation before deleting the tack.

## MODIFY PROCEDURE – CURRENT LIMITS

If you wish to limit the amount of average current adjustment allowed in the Adjust/Average Current Per Level function on page 35, this setting allows such modification. The value is expressed as a percentage and can be set to any value between +/- 0 and 100%. The default value is 100%. You must have programmer privilege to access this function.

## MODIFY PROCEDURE – PURGE LIMITS

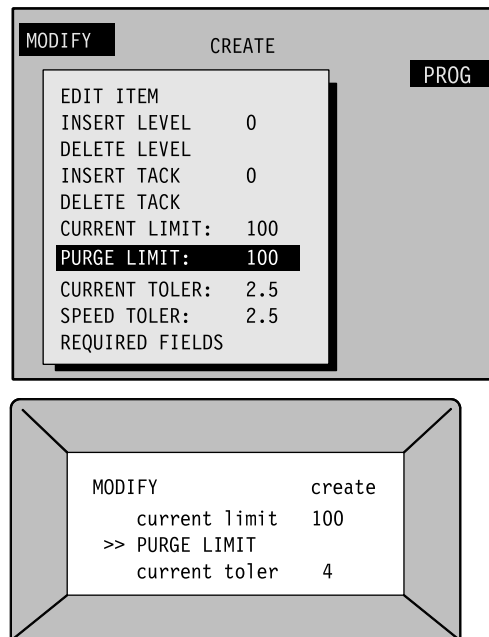
If you wish to limit the amount of purge time adjustment allowed in the ADJUST/PREPURGE, POSTPURGE function on page 35, this setting allows such modification. The value is expressed as a percentage and can be set to any value between +/- 0 and 100%. The default value is 100%. You must have programmer privilege to access this function.

## MODIFY PROCEDURE – CURRENT TOLERANCE

If you wish to adjust the tolerance for the acceptable performance or check calculations for average current, this setting allows selection of a new tolerance. It can be set to any value between +/- 0.0 and 9.9%. The default value is +/- 2.5 %.

## MODIFY PROCEDURE – SPEED TOLERANCE

If you wish to adjust the tolerance for the acceptable rotor speed performance, this setting allows selection of a new tolerance. It can be set to any value between 0.0 and 9.9%. The default value is +/- 2.5%.



The image shows two screenshots of the M100 control interface. The top screenshot is the 'MODIFY' menu, which lists various settings. The 'PURGE LIMIT' is highlighted with a value of 100. The bottom screenshot shows the 'MODIFY' menu with the 'current limit' set to 100 and the 'PURGE LIMIT' set to 4.

MODIFY	CREATE	PROG
EDIT ITEM		
INSERT LEVEL	0	
DELETE LEVEL		
INSERT TACK	0	
DELETE TACK		
CURRENT LIMIT:	100	
<b>PURGE LIMIT:</b>	<b>100</b>	
CURRENT TOLER:	2.5	
SPEED TOLER:	2.5	
REQUIRED FIELDS		

MODIFY	create
current limit	100
>> PURGE LIMIT	
current toler	4

Figure 49 Adjust Limits

## MODIFY PROCEDURE – REQUIRED FIELDS

If you wish to require some or all the fields in WELD/INFO to be filled in by the welder before welding, this setting is available. Three configurations are available.

- NO (the field is not required)
- REQ (the field must be entered before welding begins and will be cleared with power off)
- CHG (the field must be entered before welding begins and must be re-entered for every weld).

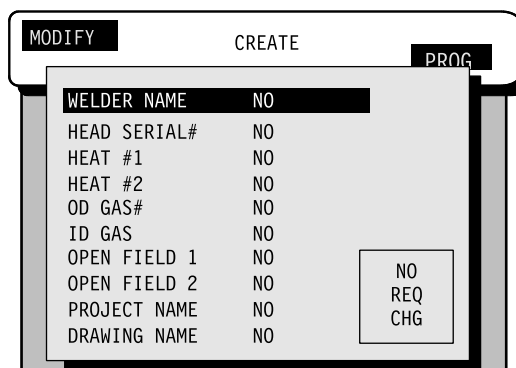
An asterisk (\*) will appear before each field requiring data in the WELD/INFO mode.

## CREATE PROCEDURE – AUTO ENTRY

The AUTO ENTRY is a quick and easy way to create a weld procedure. You are prompted to select the weld parameters from a series of pick-lists and the M100 calculates the initial values for tacks, levels, and other data. You must complete all the steps listed below, or your work will not be saved.

1. **Select Programmer** – Enter your name or ID with the alphanumeric keypad.
2. **Select joint type** – Select the joint type. The list presented gives the type of tube for each side of the joint. Some of the options include:
  - TB-TB (side 1 Tube Butt Weld to side 2 Tube Butt Weld)
  - TB-ATW (side 1 Tube Butt Weld to side 2 Auto Tube Weld)

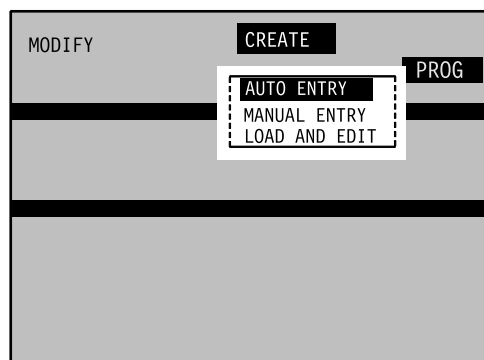
The side 2 ATW defaults to a normal cuff thickness. However, if desired, you may adjust thickness setting.



FIELD	STATUS
WELDER NAME	NO
HEAD SERIAL#	NO
HEAT #1	NO
HEAT #2	NO
OD GAS#	NO
ID GAS	NO
OPEN FIELD 1	NO
OPEN FIELD 2	NO
PROJECT NAME	NO
DRAWING NAME	NO

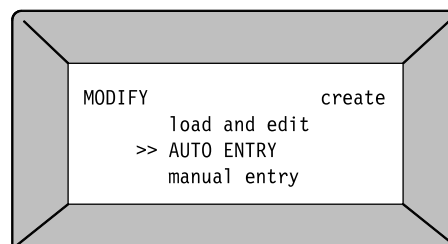
NO REQ CHG

Figure 50 Designating the Required Fields



MODIFY CREATE PROG

AUTO ENTRY  
MANUAL ENTRY  
LOAD AND EDIT



MODIFY create

load and edit  
>> AUTO ENTRY  
manual entry

Figure 51 Creating an Auto Entry Procedure

3. **Select side 1 material** – Select the material for side 1 from the pick-list. The M100 assumes that both sides of the weld are the same material and duplicates side 1 information in side 2. If necessary, changes can be made in MODIFY/EDIT ITEM.
4. **Select units** – Select the dimensional units desired for the weld procedure. Options include inches, millimeters, and OD in inches/wall thickness in mm.
5. **Select side 1 diameter** – Select the OD for the tube for side 1. The M100 assumes that both sides of the weld are the same material and duplicates side 1 information in side 2. If necessary, changes can be made in MODIFY/EDIT ITEM.
6. **Select wall thickness** – Select the wall thickness for side 1. The M100 assumes that both sides of the weld are the same material and duplicates side 1 information in side 2. If necessary, changes can be made in MODIFY/EDIT ITEM.
7. **Select weld head** – Select the weld head to be used. Since each weld head series is compatible with specific ranges of OD, only the compatible weld heads are presented for selection.
8. **Select number of passes** – If the tube diameter is 1/4 in. or less, the M100 prompts you to select whether a single-level multiple-pass procedure or multiple-level single-pass procedure is to be calculated.
9. **Select tacks, levels, or both** – After the weld head and number of passes are selected, the M100 presents a list for you to select tacks, levels, or both for the unit to calculate.
10. **Select tacks** – M100 prompts for the number of tacks desired.

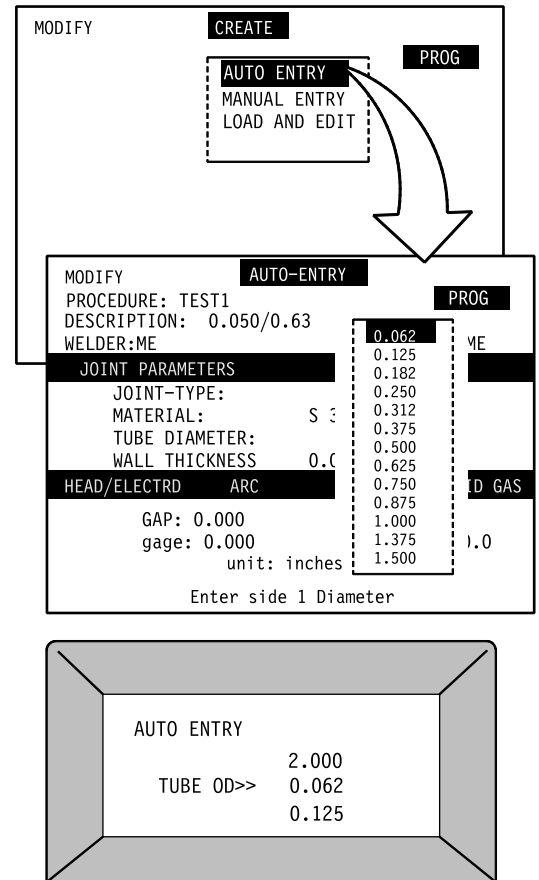


Figure 52 OD Pick List

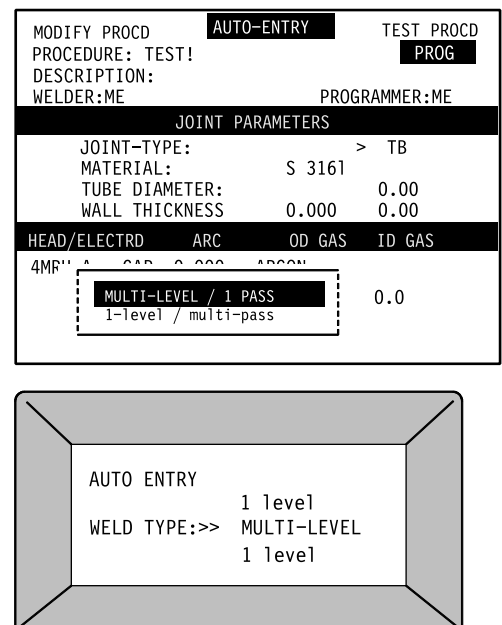


Figure 53 Number of Passes List



**11. Select levels** – M100 prompts for the number of levels desired.

At this point, the M100 calculates the remainder of the data for the weld procedure.

- The electrode is selected based on the weld head and tube diameter entered.
- The arc gap is selected based on the weld head wall thickness and OD.
- The start power is selected based on wall thickness.
- The tube purge pressure is selected based on the diameter.
- The shield purge rate is selected based on the weld head type.
- The prepurge and postpurge times are selected based on the weld head.
- The level data is calculated based on a set of factors (“A,” “B,” “C,” “thickness speed,” and “OD speed”) taken from the latest table developed for Weld Guideline Preparation.
- If tacks were selected, the tack current is calculated from the first level data. All tacks are evenly spaced starting at 10 degrees.
- The start current is calculated from first level data.
- The downslope time is calculated as a percentage of the total weld time.
- The arc gap gage setting is calculated based on weld head, diameter, and arc gap value.
- After all work specifications are entered, the M100 will create the description. If tacks or levels are added or deleted, the description will be updated.

**12. Store/Save** – You have the option of saving the newly created procedure to memory or to the PC memory card. The other option is Active (No Save), which allows the weld procedure to be the active procedure, but it is not saved.

**13. Name Procedure** – If you chose to save, you will be prompted to enter the procedure name.

**14. Screen Revert to PROGRAM/CREATE** – The M100 defaults back to the auto entry screen ready to program another weld procedure.



## CREATE PROCEDURE – MANUAL ENTRY

This submode is used when the programmer wishes to enter all values. The M100 will only check if the values are valid not if they are appropriate for the weld procedure desired.

To use manual entry:

1. Select **MANUAL ENTRY**, then press **ENTER**.
2. Enter the number of tacks desired (0 – 10) and press **ENTER**.
3. Enter the number of levels desired (0 – 99) and press **ENTER**.
4. A zero or a minimum value is placed by the M100 in all fields and places you in **PROGRAM/EDIT ITEM**.
5. Enter appropriate values in all available fields.  
The M100 will generate the description from the entered information.
6. To exit, press any Mode key.
7. M100 will recognize any invalid fields. See Step 3 on page 51.
8. Save to one of the following:
  - Save to memory
  - Save to PC memory card
  - Active (no save)
9. Press **ENTER**.
10. Enter a procedure name and press **ENTER**. The procedure is complete.

## CREATE PROCEDURE – LOAD AND EDIT

This submode is used to copy a weld procedure that is similar to the one you want to create and it places you directly into **EDIT ITEM** so you can make changes. The default name will be untitled to remind you a new name is needed. You cannot overwrite an existing procedure from this function.

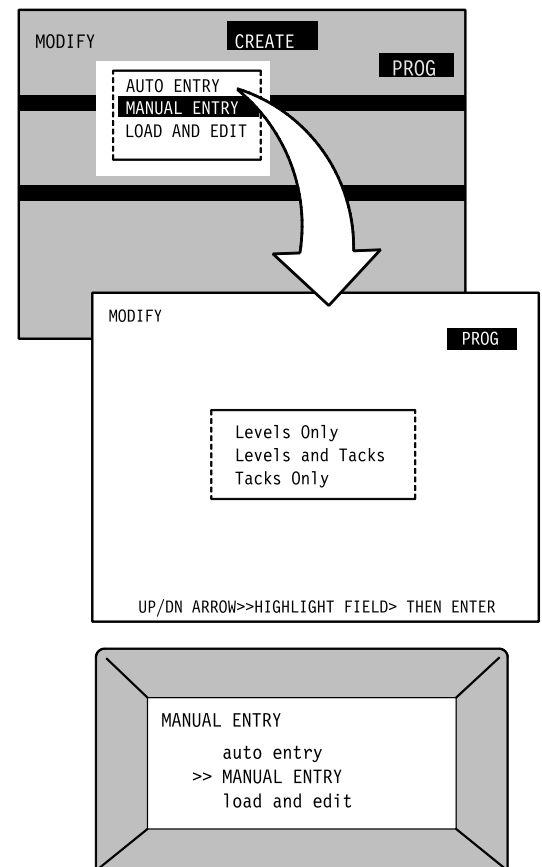


Figure 54 Manual Create Input

## SETUP MODE

The SETUP Mode handles a number of auxiliary functions of the M100. User preferences can also be changed in this mode (See page 22).

### Setup Mode Directory

Submode	Activity	Page
DATALOG	Print coupons	59
	Transfer memory	59
	Modify print format	59
	Auto print option	63
	Number of coupons	63
	Enable card or serial port	63
	Erase datalog memory or card	63
CONFIGURE	Jog speed	64
	Dimensional units	64
	Purge rate units	65
	Set date format	65
	Remote backlight	65
	Remote keyclick	65
	Panel light	65
	Panel keyclick	65
	Monitor polarity	65
	Alarm	65
	Modify minimum volts	65
	Count Misfires	66
PASSWORD	Change owner password	66
	Change programmer password	66
	Change security	66
UTILITY	Reset weld counter	68
	Set date and time	68
	Initialize card	68
	Clear application	69
	Executor Version	69
	F. Panel Version	69
	Loader Lo Version Loader Hi Version	69

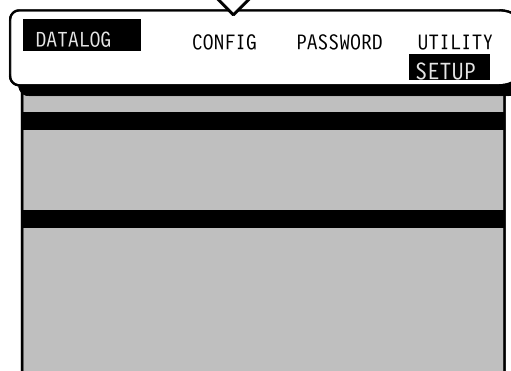
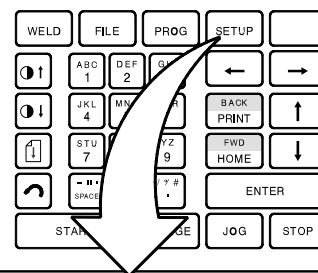


Figure 55 Setup Mode

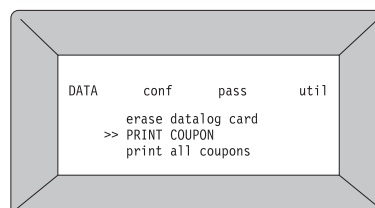
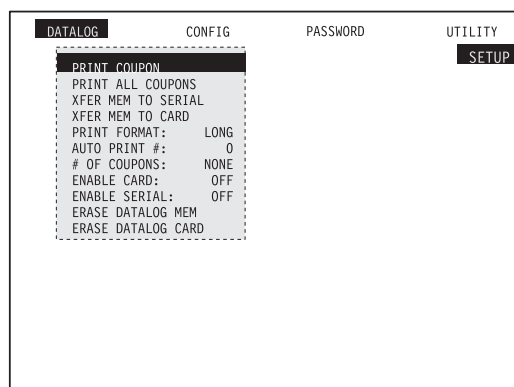


Figure 56 Setup Mode Display

## DATALOG – PRINT COUPON

When this function is selected: the M100 lists all Data records from memory or an installed PC memory card. Select the desired file using the **UP/DOWN** and **FWD/BACK** keys. The highlighted record will be printed when **ENTER** is pressed.

## DATALOG – PRINT ALL COUPONS

When this submode is selected and the **ENTER** key is pressed, the M100 will print all the data records in memory.

## DATALOG – XFER MEM TO SERIAL

This submode allows you to transfer all the system datalog records to the serial port. This function does not transfer weld procedures. The port is active in this function even if the DATALOG/ENABLE SERIAL is in the OFF position.

## DATALOG – XFER MEM TO CARD

This submode allows you to transfer the system datalog records to the PC memory card. This function does not transfer weld procedures. The port is active in this function even if the DATALOG/ENABLE CARD is in the OFF position.

## DATALOG – PRINT FORMAT

This function allows you to specify a preferred format for printed output from three choices. The choices are: long, short, and medium and each provides more or less information. See Figure 58 through Figure 60.

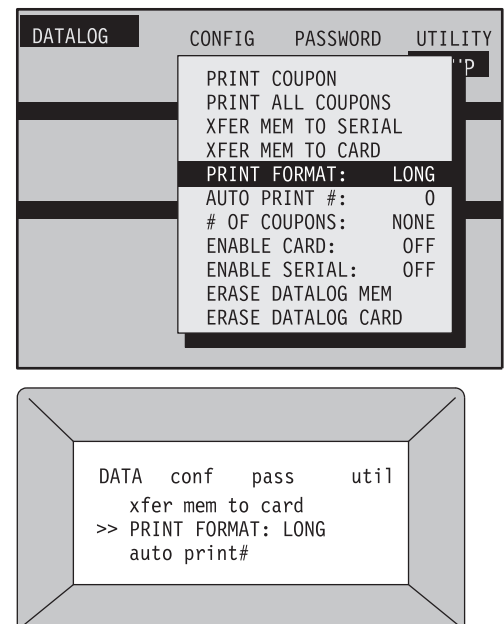


Figure 57 Print Format

## Weld Data Record Examples

The **Short** printout shown in Figure 58 contains only the header information, description, outputs, and performance confirmation.

SWAGelok WELDING SYSTEM DATA RECORD SHORT						
MODEL	M100-1	VER:	1.01	5.05		
SERIAL#	1050					
DATE	JUL 13, 1999	TIME	03:42p			
WELD#	12					
DESCRIPTION						
PROCEDURE:	WPS TEST 1A					
DESCRIPTION:	0.500/049 SS 316 04 03					
PROGRAMMER:	XXXXXXXXXX					
WELDER:	XXXXXXXXXX					
OUTPUTS						
AVERAGE						
LVL	AMPS	VOLT	RPM	TIME	KJ	
1	34.9	6.7	35.51	4.6	1.0	
2	33.8	6.6	35.51	4.6	1.0	
3	32.8	6.6	35.51	4.6	0.9	
4	31.8	6.6	35.51	4.6	0.9	
D/S	15.5	6.6	35.51	3.6	0.3	
PERFORMANCE CONFIRMATION						
WELD COMPLETE						
PERFORMANCE ACCEPTABLE						
QA/QC:						
NOTES:						

Figure 58 Short Printout

The **Medium** printout shown in Figure 59 contains the output information most commonly requested. This printout gives header information, description, inputs, outputs, and performance confirmation.

SWAGelok WELDING SYSTEM DATA RECORD MEDIUM					
MODEL	M100-1	VER:	1.01	5.05	
SERIAL#	1050				
DATE	JUL 13, 1999	TIME	03:42p		
WELD#	12				
DESCRIPTION					
PROCEDURE:	WPS TEST 1A				
DESCRIPTION:	0.500/049 SS 316 04 03				
PROGRAMMER:	XXXXXXXXXX				
WELDER:	XXXXXXXXXX				
LAST CAL:	JUN 15, 1999				
MIN VOLTS:	4.0				
CUR TOL:	2.5%				
SPEED TOL:	2.5%				
CUR LIMIT:	100%				
PURGE LIMIT:	100%				
INPUTS					
LVL	AMPS		RPM	TIME	
1	35.0		35.50	4.6	
2	33.9		35.50	4.6	
3	32.9		35.50	4.6	
4	31.9		35.50	4.60	
OUTPUTS					
AVERAGE					
LVL	AMPS	VOLT	RPM	TIME	KJ
1	34.9	6.7	35.51	4.6	1.0
2	33.8	6.6	35.51	4.6	1.0
3	32.8	6.6	35.51	4.6	0.9
4	31.8	6.6	35.51	4.6	0.9
D/S	15.5	6.6	35.51	3.6	0.3
PERFORMANCE CONFIRMATION					
WELD COMPLETE					
PERFORMANCE ACCEPTABLE					
QA/QC:					
NOTES:					

Figure 59 Medium Printout

The **Long** printout shown in Figure 60 contains all information on inputs and outputs. This printout lists the entire weld procedure as well as the results.

SWAGelok WELDING SYSTEM DATA RECORD LONG					
MODEL	M100-1	VER:	1.01	5.05	
SERIAL#	1050				
DATE	JUL 13, 1999	TIME	03:42p		
WELD#	12				
DESCRIPTION					
PROCEDURE:	WPS TEST 1A				
DESCRIPTION:	0.500/049 SS 316 04 03				
PROGRAMMER:	XXXXXXXXXX				
WELDER:	XXXXXXXXXX				
JOINT TYPE:	TUBE	TUBE			
MATERIAL:	SS 316L	SS316L			
HEAT #:	A123456789	A123456789			
DIAMETER:	0.500 IN	0.500 IN			
WALL THICK:	0.049 IN	0.049 IN			
PROJECT:	MANUAL 123				
DRAWING:	AIR 12-456				
WELD HEAD:	5H	60801			
ELECTRODE:	C.040-.555				
ARC GAP/SET:	0.035 IN	0.907 IN			
OD GAS:	ARGON	AA98765432			
OD FLOW:	12 CFH				
ID GAS:	ARGON	BB98765432			
ID PRESSURE:	1.3 IWC				
OPEN 1:	1 2 3 4 5				
OPEN 2:	6 7 8 9 0				
LAST CAL:	JUN 15, 1999				
MIN VOLTS:	4.0				
CUR TOL:	2.5%				
SPEED TOL:	2.5%				
CUR LIMIT:	100%				
PURGE LIMIT:	100%				
INPUTS					
START POWER:	NORM				
START CUR:	35.0	AMPS			
ROTOR DELAY:	1.1	SECONDS			
DOWNSLOPE:	3.6	SECONDS			
PREPURGE:	20	SECONDS			
POSTPURGE:	20	SECONDS			
TACKS:	DEGREES	AMP	SECONDS		
1	0	35.0	1.0		
2	120	35.0	1.0		
3	240	35.0	0.9		
LEV	IMPULSE	MAINT	-IMPULSE- RATE	WIDTH	AVG CURR.
1	68.6	20.6	4	30	35.0
2	65.2	20.6	4	30	33.9
3	61.7	20.6	4	30	32.9
4	58.3	20.6	4	30	31.9
LEV	TIME	RAMP	HI	LOW	AVG RPM
1	4.6	0.0	3.50	3.50	35.0
2	4.6	0.0	3.50	3.50	35.0
3	4.6	0.0	3.50	3.50	35.0
4	4.6	0.0	3.50	3.50	35.0
OUTPUTS					
AVERAGE					
LVL	AMPS	VOLT	RPM	TIME	KJ
1	34.9	6.7	35.51	4.6	1.0
2	33.8	6.6	35.51	4.6	1.0
3	32.8	6.6	35.51	4.6	0.9
4	31.8	6.6	35.51	4.6	0.9
D/S	15.5	6.6	35.51	3.6	0.3
PERFORMANCE CONFIRMATION					
WELD COMPLETE					
PERFORMANCE ACCEPTABLE					
QA/QC:					
NOTES:					

Figure 60 Long Printout

## DATALOG – AUTO PRINT #

This function allows you to specify whether the print is to be output only when requested or automatically every “nth” weld.

## DATALOG – # OF COUPONS

This function allows you to specify how many weld data logs the unit will store in internal memory. Selection of (NONE) will command the unit to store no weld data logs. Selection of a number will command the unit to store that number of logs then roll off the oldest log as new logs are added. Selection of (ALL) will command the unit to store all logs until the files are erased or the memory is full.

## DATALOG – ENABLE CARD

When this function is turned ON, the unit will transmit the weld data, as welds are made, to the data card port. The Weld Mode Error function MEMORY CARD FULL or REQ. MEMORY CARD will be active.

## DATALOG – ENABLE SERIAL

When this function is turned ON, the unit will transmit the datalog records as welds are made to the serial port in comma delimited format.

## DATALOG – ERASE DATALOG MEM

Erases all datalog records from memory.

## DATALOG – ERASE DATALOG CARD

Erases all datalog records from PC memory card.

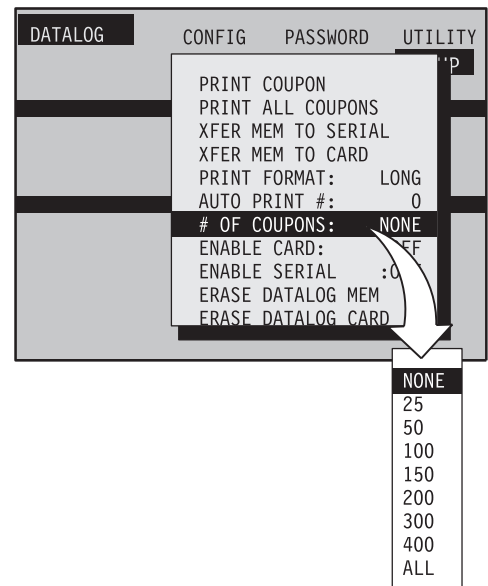


Figure 61 # of Coupons

## CONFIG – JOG SPEED

This function allows you to specify manual jog speed as a percentage of the maximum rotor RPM.

DATALOG	CONFIG	PASSWORD	UTILITY
JOG SPEED	50%		SETUP
DIM UNITS:	INCHES		
PURGE UNITS:	CFH		
DATE FMT:	MM/DD/YY		
REMOTE LIGHT:	ON		
REMOTE KEYCLICK:	ON		
PANEL LIGHT:	ON		
PANEL KEYCLICK:	ON		
MON POLARITY:	HIGH		
ALARM:	ON		
MINIMUM VOLT:	4.0		
COUNT MISFIRES:			

```

data  CONF  pass  util
data fmt: mm/dd/yy
>> JOG SPEED: 6.0
dim units: inches
  
```

Figure 62 Jog Speed

## CONFIG – DIM UNITS

This function allows you to change the linear measurement units between Metric and English measurement systems. Select inches, millimeters, or inches for OD and inches or millimeters for wall thickness.

The dimensional units displayed are defaulted from the last auto-generated program.

DATALOG	CONFIG	PASSWORD	UTILITY
JOG SPEED :	50%		SETUP
DIM UNITS:	INCHES		
PURGE UNITS:	CFH		
DATE FMT:	MM/DD/YY		
REMOTE LIGHT:	ON		
REMOTE KEYCLICK:	ON		
PANEL LIGHT:	ON		
PANEL KEYCLICK:	ON		

DIM UNITS	DATALOG	ADJ-LIMITS	TEST OTHER
INCHES			SETUP
MILLIMETERS			
IN-OD/MM-TH			

UNITS?> IN-OD/MM-TH  
INCHES  
MILLIMETERS

UP/DN ARROW>>HIGHLIGHT FIELD> THEN ENTER

```

data  CONF  pass  util
      inches/mm
DIM UNIT >INCHES
      millimeters
  
```

Figure 63 Dimensional Units



## CONFIG – PURGE UNITS

This preference allows you to either measure purge gas flows in std ft<sup>3</sup>/hr or std L/min.

## CONFIG – DATE FMT

This submode allows you to set the date format to:

- Month/Day/Year
- Day/Month/Year
- Year/Month/Day

## CONFIG – REMOTE LIGHT

Allows you to turn ON/OFF the remote pendant backlight. Backlighting makes the remote pendant display readable in low ambient lighting.

## CONFIG – REMOTE KEYCLICK

Allows you to turn ON/OFF the remote pendant key panel audible tone.

## CONFIG – PANEL LIGHT

Allows you to turn ON/OFF the main screen backlight. This is desirable when the ambient temperature is at or above 40°C (104°F) (normal operating range of the screen). The main screen backlight should be on except when operating above 40°C.

## CONFIG – PANEL KEYCLICK

Allows you to turn ON/OFF the main key panel audible tone when pressing keys.

## CONFIG – MON POLARITY

Allows you to change the output polarity of the recorded output enable port (located on the rear panel) + on to - on.

## CONFIG – ALARM

If this function is on and a weld error occurs the audio alarm is activated. The status line displays the error. Reset by pressing **ENTER**.

## CONFIG – MINIMUM VOLT

Allows you to change the voltage that the M100 senses for low arc voltage error. The voltage will default to 4 volts. The value may have to be adjusted up when using a weld head extension cable. Refer to *Weld Errors* on page 32.

## CONFIG – COUNT MISFIRES

Allows you to specify whether misfires will be counted on the reset table weld counter.

## PASSWORD – CHANGE SECURITY, PROGRAMMER, OWNER

Allows an authorized user to change or set passwords for a particular privilege level. If the password field for that privilege level is left blank, no password is required to access those functions.

There are three password privilege levels available with the M100 welding system. In descending order of privilege:

- Owner Password**  
A privileged password is one that only the person responsible for the welder should know. This level accesses all privileges and can override the programmer and security level passwords if necessary. Think of this password as a master key and protect it as such.
- Programmer Password**  
Programmer privilege allows you to change the programmer password and is required for full use of the equipment. This privilege level has full WELD mode and FILE mode privileges. If a Programmer password has been set, users without it will only have WELD mode and limited FILE mode privileges. Owner password can override.
- Security Password**  
The security password is used to secure the M100 during periods that it is unattended. If a Security password is entered, it must be entered to access any function of the equipment. Owner password and Programmer password can override.

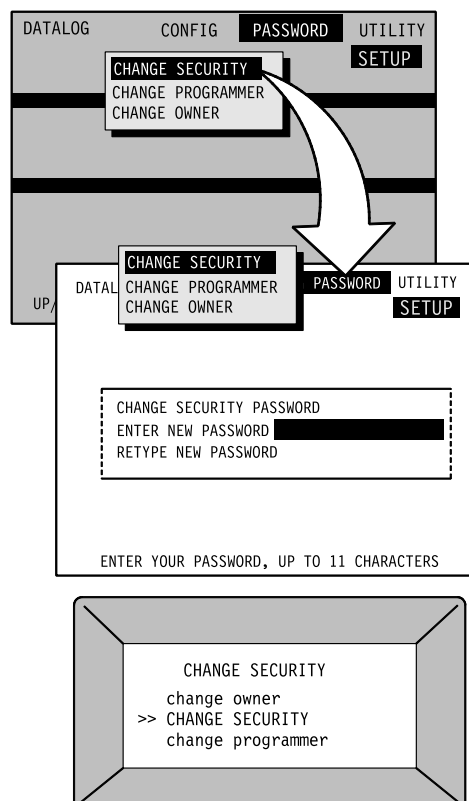


Figure 64 Change Password

### Note:

If the owner password does not work, contact your Swagelok representative for instructions.

### Note:

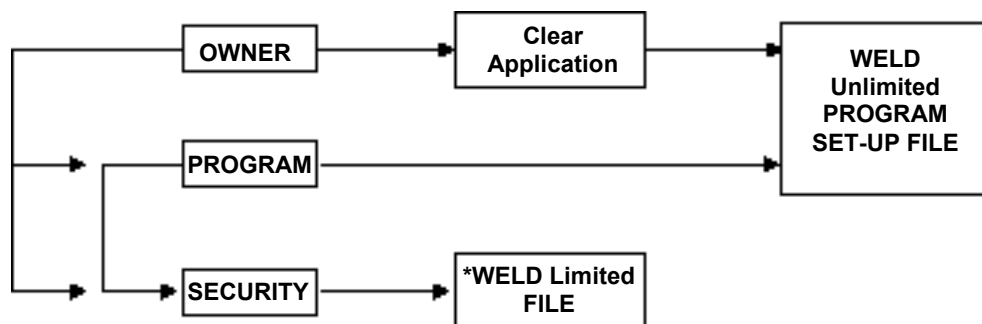
If no programmer password is used, all users will have programmer privileges with full File mode activities.

### Note:

The M100 must be turned off to activate security.

## To change a Password

1. **Select the function** – Select the password level you want to change (Owner, Programmer, Security).
  - a. **Owner** – The existing owner password must be entered. Enter the new password, and verify the new password by retyping it in the confirmation field.
  - b. **Programmer** – The old programmer password or the owner password must be entered. Enter the new programmer password, and verify the new password by retyping it in the confirmation field.
  - c. **Security** – The programmer password or the owner password must be entered. Enter the new security password, and verify the new password by retyping it in the confirmation field.



\* If a Program password is not entered the security will allow the user to access all Programmer functions

Figure 65 Password



## UTILITY – RESET WELD COUNTER

The Weld Counter that appears on the main or remote screen and in datalog, can be reset or changed. Key in the new counter number and press **ENTER**.

### Note:

*The M100 advances the Weld Count each time a new weld is started.*

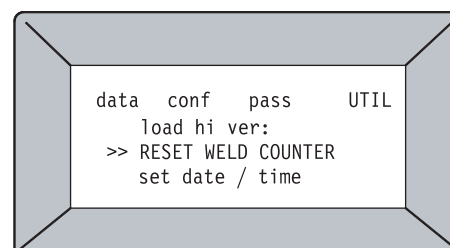
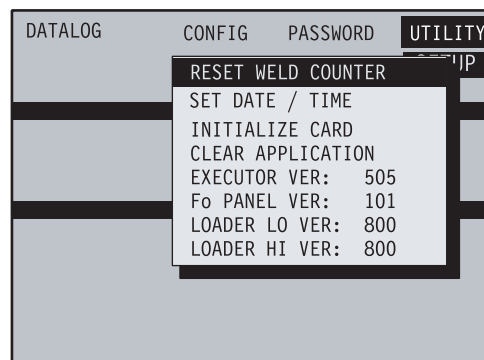


Figure 66 Reset Weld Counter

## UTILITY – SET DATE\TIME

If the date or time displayed is incorrect, you can enter a new date and time. SAVE TIME NOW option must be pressed after changes are made.

## UTILITY – INITIALIZE CARD

If the PC memory card data or formatting becomes corrupt, the card can be cleared and initialized.



### Caution!

**All data will be cleared from the PC memory card when the PC memory card is initialized.**

## UTILITY – CLEAR APPLICATION

This is an owner-password-protected function used when updating the application software installed in the unit. The new application software on a PC memory card should be on hand before the current software is cleared.

### SEE EXTREME CAUTION!

Procedure to clear and load update software:

1. Select CLEAR APPLICATION and press **ENTER**.
2. Key in Owner Password and select **ENTER**.
3. Verify/Confirmation to Continue (YES/NO).
4. **SEE EXTREME CAUTION!**
5. Press **ENTER**.
6. Turn Power OFF upon prompt.
7. Insert the PC memory card with the new software into the card port.
8. Turn power ON.
9. Remove the PC memory card upon prompt.
10. Turn power OFF upon prompt.
11. Turn power ON and the installation is complete.

## UTILITY – EXECUTOR VER: XXX

The Executor Software interfaces the Application or Front Panel Software with the welding section of the power supply.

## UTILITY – F. PANEL VER: XXX

F. Panel software, often called the application software, controls the user's communication with the M100 Power Supply.

## UTILITY – LOADER LO VER: XXX

## UTILITY – LOADER HI VER: XXX

Loader software controls the loading of F. Panel software.



### Extreme Caution!

**If the unit software is cleared without the new software update the unit will be DISABLED.**

### Note:

*The only software version that is updateable in the field is the F. Panel Version*

## Effect of Weld Parameters

The following text briefly discusses how the weld parameters relate to the current waveform and the effects of any parameter changes.

### Weld Parameters Affect the Output Waveform

The shape and duration of the output current waveform created during the weld cycle is determined by the weld parameter settings entered on the M100 front panel. The values from the weld procedure guideline in Section 5 create a current waveform as shown in Figure 67 and Figure 68.

During a typical weld, the power supply pulses between high amp current (Impulse) and low amp current (Maintenance). In Figure 68, the current control settings are:

<b>IMPULSE</b>	56.4 A	Level 1
	53.6 A	Level 2
	50.9 A	Level 3
	48.4 A	Level 4
<b>MAINTENANCE</b>	15.8 A	
<b>IMPULSE RATE</b>	3 pulses per second	
<b>IMPULSE WIDTH</b>	30 %	

In this case, the current pulses between the high and the low levels 3 times per second. The current is at the high level 30 % of the time and at the low level 70 % of the time.

### Effects of Weld Parameter Changes

Impulse current and rotor speed affect the depth of penetration of the weld.

Impulse width also affects weld penetration. The control allows fine-tuning of the weld penetration level.

Pulse rate is typically set so that each weld spot overlaps the previous one by at least 70 %.

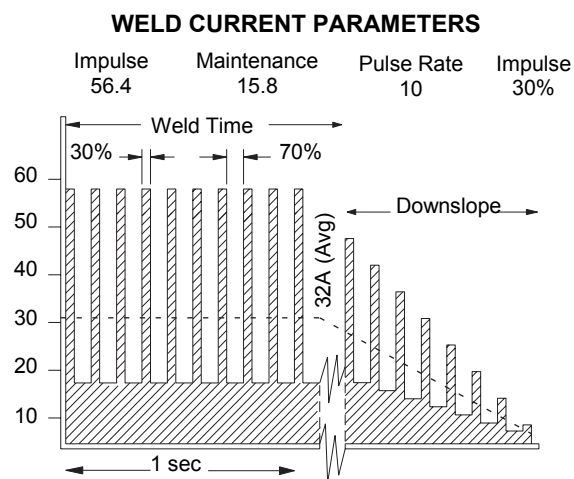


Figure 67 Single Level Weld Current Waveform

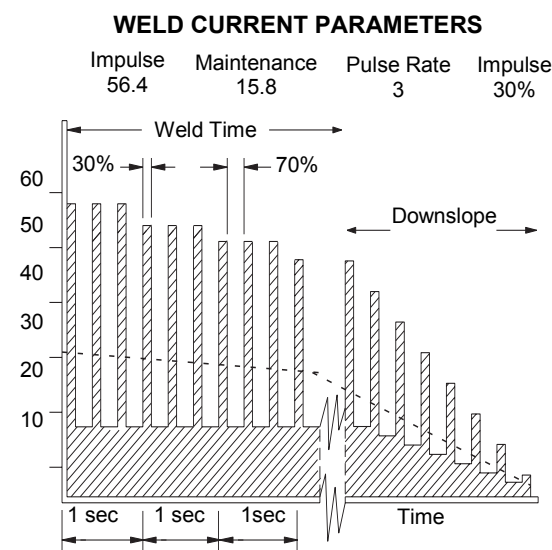


Figure 68 Multiple Level Weld Current Waveform

## Setting the Shield Gas Flow

1. Verify the shielding and purge gas connections to the work pieces.
2. Set the shielding gas flow meter to the proper setting. Refer to Table 4.



### Caution!

Excessive or insufficient flow rates may affect arc start and arc stability.

*Table 4 Shield Gas Flow Rates (Argon)*

Weld Head Series	std ft <sup>3</sup> /h	L/min
5H	10 to 15	4.7 to 7.1
10H	10 to 20 <sup>①</sup>	4.7 to 9.4
20H-A	10 to 20 <sup>①</sup>	4.7 to 9.4
20H-B/C	20 to 40 <sup>①</sup>	9.4 to 18.8
40H	25 to 50 <sup>①</sup>	12 to 24
4MH	8 to 10	4 to 4.7
8MH	15 to 20	7.1 to 9.4

<sup>①</sup> Set the flow to the higher rates when welding at high current levels.

3. Press PURGE to operate the shielding gas solenoid valve and to start the shielding gas flow. Allow the system to purge for several minutes on initial setup to clear the shielding gas system of oxygen. Refer to Table 5.
4. Press **PURGE** again to close the shield gas solenoid valve.

Table 5 Purge Rate and Pressure Tables

Tube Size	Wall Thickness	Minimum ID Purge Rate	Pressure <sup>①②</sup>	Swagelok Weld Head Purge Rates <sup>③④</sup>	Restrictor Size <sup>⑤</sup>
1/16 in. n/a	0.015 in. n/a	.2 std ft <sup>3</sup> /hr .1 L/min	13 to 16.8 torr 7 to 9 iwc 175 to 230 mmwc 17.4 to 22.4 mb	10 to 20 std ft <sup>3</sup> /hr 5 to 10 std L/min	n/a
1/8 in. 3 mm	0.028 in. 0.8 mm	1 std ft <sup>3</sup> /hr .5 L/min	9.3 to 16.8 torr 5 to 9 iwc 130 to 230 mmwc 12.4 to 22.4 mb	10 to 20 std ft <sup>3</sup> /hr 5 to 10 std L/min	1/16 in.
1/4 in. 6 mm	0.035 in. 1 mm	6 std ft <sup>3</sup> /hr 3 std L/min	5.2 to 6.3 torr 2.8 to 3.4 iwc 71 to 86 mmwc 7.0 to 8.5 mb	10 to 20 std ft <sup>3</sup> /hr 5 to 10 std L/min	1/8 in. 3 mm
3/8 in. 10 mm	0.035 in. 1 mm	10 std ft <sup>3</sup> /hr 5 L/min	2.8 to 4.7 torr 1.5 to 2.5 iwc 38 to 64 mmwc 3.7 to 6.2 mb	10 to 20 std ft <sup>3</sup> /hr 5 to 10 std L/min	1/8 in. 3 mm
1/2 in. 12 mm	0.049 in. 1 mm	15 std ft <sup>3</sup> /hr 7 std L/min	1.9 to 2.8 torr 1.0 to 1.5 iwc 25 to 38 mmwc 2.5 to 3.7 mb	10 to 40 std ft <sup>3</sup> /hr 5 to 12 std L/min	1/4 in. 6 mm
3/4 in. 20 mm	0.065 in. 1.5 mm	20 std ft <sup>3</sup> /hr 10 std L/min	1 to 2 torr 0.5 to 1.1 iwc 13 to 28 mmwc 1.2 to 2.7 mb	15 to 40 std ft <sup>3</sup> /hr 7 to 14 std L/min	1/4 in. 6 mm
1 in. 25 mm	0.065 in. 1.5 mm	40 std ft <sup>3</sup> /hr 20 std L/min	1 to 1.3 torr 0.5 to 0.7 iwc 13 to 18 mmwc 1.2 to 2.5 mb	15 to 40 std ft <sup>3</sup> /hr 7 to 14 std L/min	1/4 in. 6 mm
1 1/2 in. 38 mm	0.065 in. 1.5 mm	90 std ft <sup>3</sup> /hr 43 L/min	1 to 1.3 torr 0.5 to 0.7 iwc 13 to 18 mmwc 1.2 to 1.7 mb	15 to 50 std ft <sup>3</sup> /hr 7 to 12 std L/min	1/4 in. 6 mm
2 in. 50 mm	0.065 in. 1.5 mm	170 std ft <sup>3</sup> /hr 80 L/min	0.7 to 1.3 torr 0.4 to 0.7 iwc 13 to 18 mmwc 1.0 to 1.7 mb	15 to 50 std ft <sup>3</sup> /hr 7 to 12 std L/min	3/8 in. 10 mm
3 in. 75 mm	0.065 in. 1.5 mm	400 std ft <sup>3</sup> /hr 190 L/min	0.4 to 0.9 torr 0.2 to 0.5 iwc 5 to 13 mmwc 0.5 to 1.2 mb	30 to 50 std ft <sup>3</sup> /hr	1/2 in. 12 mm
4 in. 100 mm	0.083 in. 2 mm	720 std ft <sup>3</sup> /hr 340 L/min	0.4 to 0.7 torr 0.2 to 0.4 iwc 5 to 13 mmwc 0.5 to 1.0 mb	30 to 50 std ft <sup>3</sup> /hr	3/4 in. 20 mm
6 in. 150 mm	0.083 in. 2 mm	1670 std ft <sup>3</sup> /hr 790 L/min	0.4 to 0.9 torr 0.2 to 0.5 iwc 5 to 13 mmwc 0.5 to 1.2 mb		1 in. 25 mm

**Note:**

These weld tables are for use on butt welds only. If Weld Head Purge Rates exceed Swagelok recommendations, be cautious of arc wander. For best results, use constant weld head purge between welding cycles.

① ATW welds and Weld Ring welds typically will require approximately 15% more purge pressure.

② Pressures must be adjusted for ID encroachment of 0 to +10% of wall thickness at the bottom of the weld.

③ Indicated purge rates are for minimum color line.

④ ID purge rates shall be adjusted to the desired ID color line.

⑤ Restrictor sizes are approximate; purge rate and pressure are critical parameters.



## Starting and Completing the Weld

1. Check the following before starting the weld
  - All rear panel connections are complete.
  - Shielding and purge gas lines are properly connected.
  - The inert gas source is on.
  - Correct gas flow rates are set.
  - Weld pieces are properly aligned and clamped in the fixture block.
  - The proper arc gap is set.
  - The weld head is connected to the fixture block.
  - The proper weld procedure program has been selected and entered.
  - WELD mode display shows **READY**.
  - The internal purge gas is flowing.
2. Press **START**.  
Total time for the process is the sum of the following times:
  - Prepurge
  - Rotor delay
  - Weld time (all levels)
  - Downslope
  - Postpurge

**Note:**

*Although the power supply welds in any orientation, it is recommended that it be placed in the upright position before welding.*

**WARNING!**

**DO NOT TOUCH THE CABLE CONNECTORS DURING ARC START. IF THE CABLES HAVE BEEN DAMAGED, THE POTENTIAL FOR AN ELECTRICAL SHOCK EXISTS.**

## Display Indications During Welding

During welding, the status messages are displayed on the screen in the following sequence:

- **Loading**
- **Prepurge**
- **Arc Start**
- **Tacks**
- **Rotor DLY (delay)**
- **Ramp**
- **Levels (time remaining)**
- **Downslope (time remaining)**
- **Postpurge.**

**Note:**

*If the arc fails to start, the power supply status becomes **MISFIRE**. See the Troubleshooting section for possible causes and corrective actions.*

## After the Weld is Complete

1. Wait for the M100 to return to “Ready” state. If a weld error occurs refer to page 32.
2. Check if the fixture block has cooled enough to be safely handled. Allow additional cooling time if necessary before handling. If necessary, increase postpurge time to aid cooling.
3. Release the locking lever on the weld head housing.
4. Remove the weld head from the fixture block. If it is difficult to remove the weld head, release one of the side plate levers.
5. Remove the internal purge gas lines from the welded assembly.
6. Release the levers on the fixture block.
7. Open the side plates of the fixture block.
8. Remove the welded assembly.



### WARNING!

**USE GLOVES OR OTHER PROTECTIVE DEVICES IF YOU MUST HANDLE PARTS IMMEDIATELY AFTER WELDING. THE PARTS CAN BE EXTREMELY HOT AND MAY CAUSE BURNS.**



### Caution!

**Do not immerse the hot fixture block in water after welding. If using only one fixture block, allow it to cool before performing the next weld. More than one fixture block can be used for repetitive welding.**

### Note:

*Inspect the electrode after each weld. Look for oxidation, wear, or weld material on the tip*

## Operation Summary

1. Install the electrode.
2. Set the arc gap using the arc gap gage.
3. Prepare the work pieces.
4. Select the correct fixture block and collets.
5. Install the collets in the fixture block.
6. Align the work pieces in the fixture block.
7. Connect the internal purge gas line to the work piece to be welded, and set the flow meter.
8. Press **PURGE**, and set the shield gas flow.
9. Press **PURGE** to stop the shielding gas flow prior to starting the weld.
10. Connect the weld head to the fixture block.
11. Program the welder.
12. Press **START** and complete the weld.
13. Remove the weld head from the tube fixture block.

## Data Recording Printer

The SWS Data Recording Printer is a small size thermal printer housed inside the M100 case. See Figure 69.

The data recording printer is covered under the same warranty as the power supply.

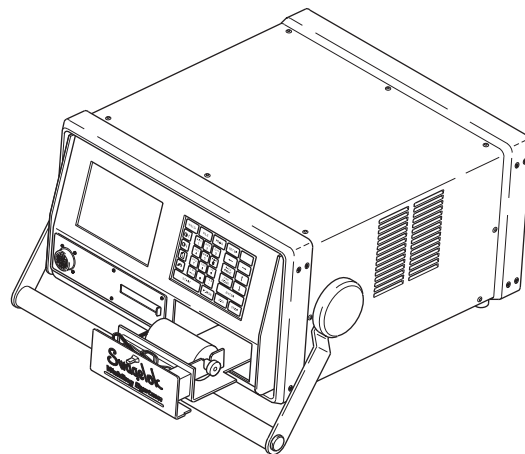


Figure 69 Data Recording Printer

### Load the Paper

1. Turn the latch counter-clockwise to release the printer body from the case. Remove the printer body from the case by pulling it forward. See Figure 70.

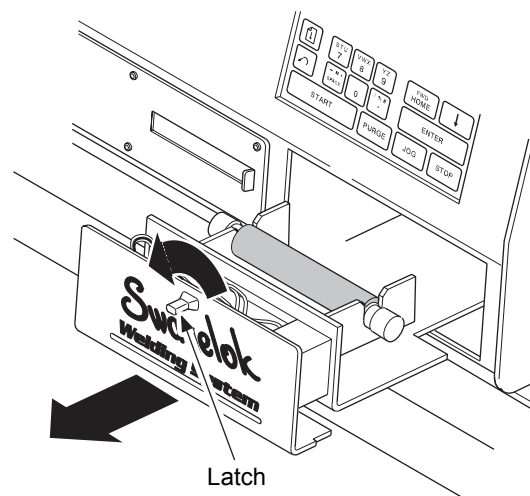


Figure 70 Opening the Data Recording Printer Drawer

2. Lift the printer head fully by raising the lift arm located with the manual paper feed wheel next to the printer cover panel.

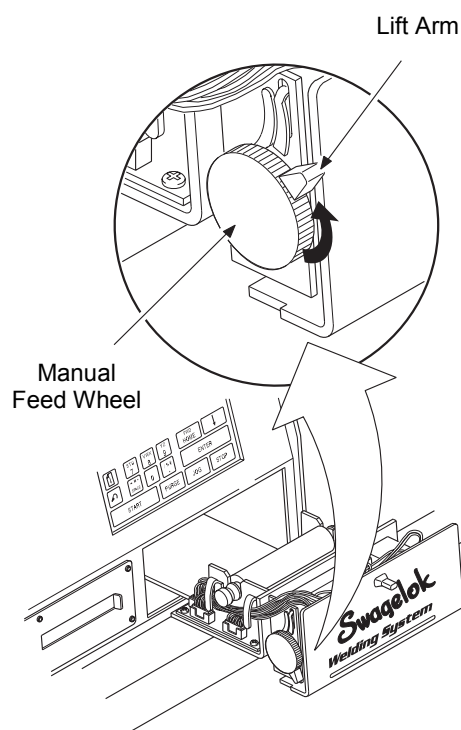


Figure 71 Lift the Printer Head

3. Press the ends of the spindle and lift to remove the paper roll spindle pin and used paper spindle.

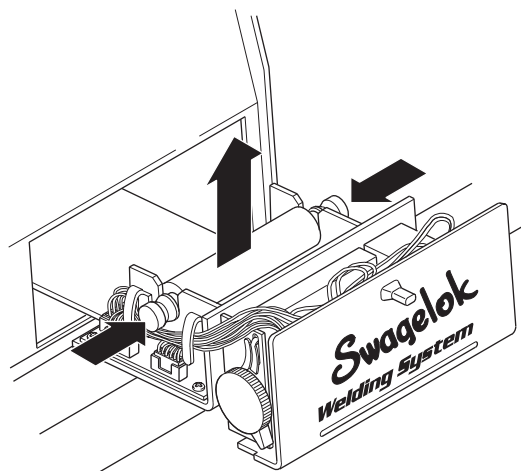


Figure 72 Press the Ends of the Spindle and Lift

4. Install the new roll of thermal paper and load the paper into the feed mechanism. See Figure 73.
  - a. Lift the printer head fully by raising the lift arm located with the manual paper feed wheel next to the printer cover panel. The lift arm has three positions. Full down for printing and full up to load the paper. The center position is not used.
  - b. Before you place the paper into the support bracket, feed the paper through the printer. The paper enters the printer between the support brackets above the white plastic bar. Feed the paper completely through the printer until it comes out the front panel slot. The paper feeds from the top of the roll.
  - c. Insert the spindle through the paper roll. Press both ends of the spindle and insert into the slots. Release ends and check spindle seating.

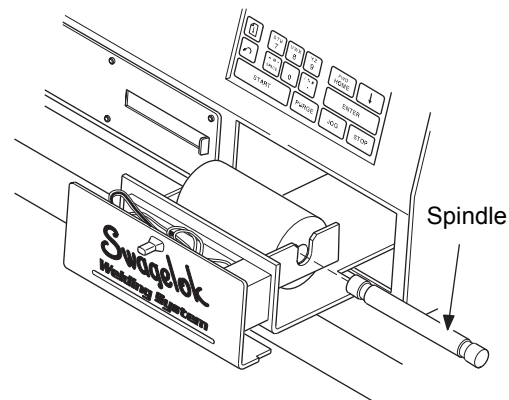


Figure 73 Install Paper

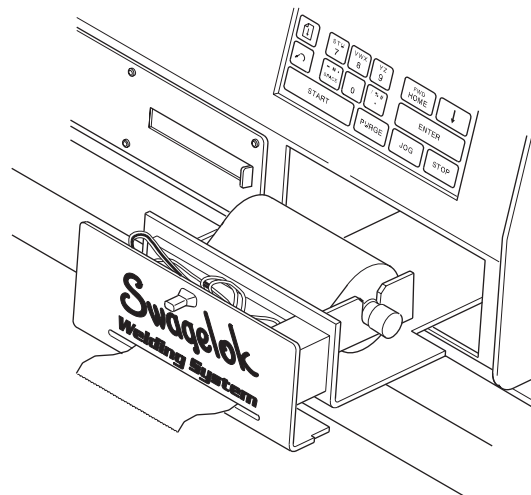


Figure 74 Advancing the Paper

- d. Lower the printer head fully by lowering the lift arm.

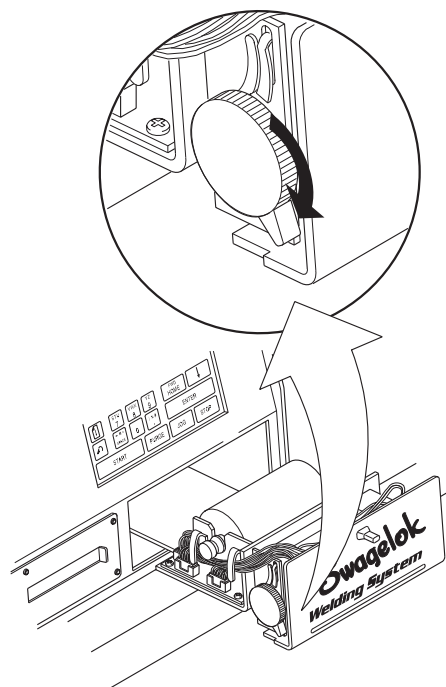


Figure 75 Lower the Printer Head

5. Slide the data recording printer back into the unit case.
6. Turn the latch clockwise to secure the data recording printer to the case.



**Caution!**

**Once the paper enters the feed mechanism, do not pull it back in the direction of the paper roll. Feed the paper with the Advance Paper Button.**

## Operating the Data Recording Printer

The controls used to operate the data recording printer have been kept to a minimum.

### Using the Data Recording Printer

Activate the data recording printer from the power supply by one of the following methods.

- Press **PRINT** on the power supply front panel.
- Establish an automatic print cycle by setting the automatic print counter from the SETUP/DATALOG function.

- Press  to advance the paper.

The data recording printer will always print the last valid weld data record. If no valid data exists, no data record will be printed.

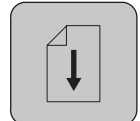
### Data Recording Printer Options

- Select FILE/LOAD/PRINT PROCEDURE. This function is printed on the data recording printer. (See FILE/LOAD/PRINT PROCEDURE on page 44.)
- Select FILE/LOAD/PRINT DIRECTORY. This function is printed on the data recording printer. (See FILE/LOAD/PRINT DIRECTORY on page 45.)
- Select the Print Format (short, medium or long) from the SETUP/DATALOG/PRINT FORMAT. (See SETUP/DATALOG/PRINT FORMAT on page 59.)
- Select SETUP/DATALOG/PRINT COUPON. This function is printed on the data recording printer. (See SETUP/DATALOG/PRINT COUPON on page 59.)
- Select SETUP/DATALOG/PRINT ALL COUPONS. This function is printed on the data recording printer. (See SETUP/DATALOG/PRINT ALL COUPONS on page 59.)



#### Caution!

Do not operate the data recording printer without paper. (Refer to section on paper loading.)



## Maintenance

The SWS data recording printer is designed to require a minimum of maintenance and service. Contact your Swagelok representative for any electrical or mechanical repairs that must be performed.

### Clearing Paper Jams

In the event of a paper jam do not force paper into the unit or try to pry the paper out of the unit. This may damage the thermal print mechanism. Instead:

1. Turn off the power supply.
2. Turn the latch counter-clockwise to release the data recording printer body from the case. Extend the data recording printer body from the power supply by pulling it forward. See Figure 76.
3. Lift the printer head fully by raising the lift arm located with the manual paper feed wheel next to the printer cover panel. See Figure 77.

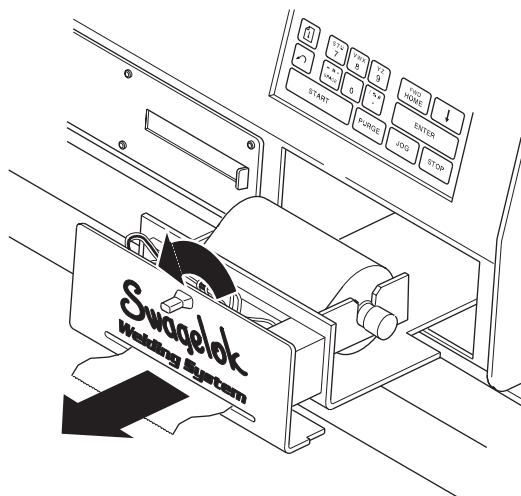


Figure 76 Opening the Data Recording Printer Drawer



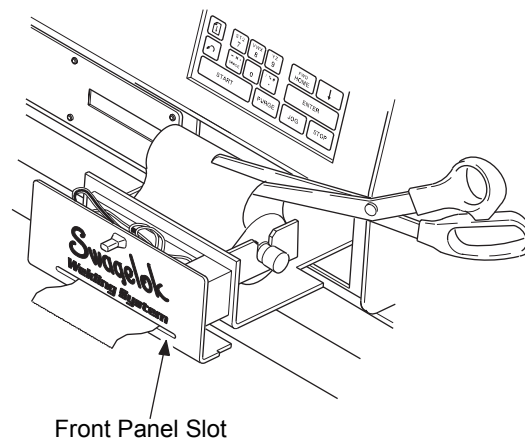
Figure 77 Lift the Printer Head



4. Cut the paper off at the roll. Carefully remove the paper in the data recording printer mechanism by advancing the Manual Feed Wheel or using tweezers or small needle nose pliers. Remove the paper through the front panel. See Figure 78.
5. If the paper cannot be cleared, the front panel cover may be removed by removing two screws located on the underside of the front panel cover. Clear the paper jam and replace the front panel cover.
6. Reload the paper after the jam has been cleared.
7. Slide the data recording printer back into the power supply and tighten the latch.

**Caution!**

**Do not pull the paper backwards toward the paper roll. This can damage the print head mechanism.**



*Figure 78 Clearing a Paper Jam*

## Optional Equipment

The optional equipment available for your Swagelok Welding System (SWS) is listed below. Contact your Swagelok representative for additional information on any listed option.

Optional Equipment Includes:

- SWS Remote Pendant
- remote pendant extension cables
- weld head extension cables
- data logging/monitoring
- PC Interface Cable.

### SWS Remote Pendant

See Figure 79. The remote pendant allows you to access all the controls and functions of the M100 power supply. The screen on the remote pendant is not as large as on the main screen. Therefore only data highlighted on the main screen will be displayed on the remote screen.

The unit is attached to the power supply via a cable and the connector labeled Remote on the front panel.

See Figure 80.

### Remote Pendant Extension Cable

The remote pendant extension cable is 35 feet long. This allows the remote pendant to reach the weld head when the weld head extension cable is used.

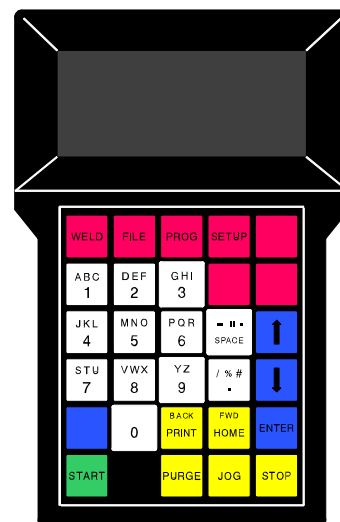


Figure 79 Remote Pendant

#### Note:

The SWS remote pendant for the D-Series welding machine will not work on the M-Series welding machine.

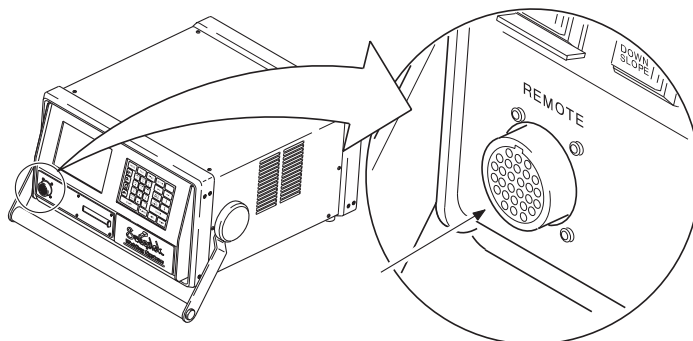


Figure 80 Remote Pendant Connector

## Weld Head Extension Cables

The weld head extension cables allow the user to position the weld head up to 50 feet away from the power supply. The extension cable is placed between the power supply and weld head.

Install the extension cable as follows:

1. Turn off the power supply circuit breaker.
2. Disconnect the weld head from the power supply. Plug the appropriate weld head connectors into the end of the extension cable.
3. Insert the connectors at the other end of the extension cable into the appropriate sockets on the power supply rear panel.
4. Turn on the power supply.
5. Locate the **HOME** and **PURGE** pushbuttons on the front panel. See Figure 81.
6. Press **HOME** and check for rotor rotation. Press **HOME** again if the rotor is not at the home position.
7. Press **PURGE** and check for gas flow through the weld head. Allow the shielding gas to flow for at least 60 seconds to clear the gas lines of oxygen. Press **PURGE** again to stop the gas flow.

**Note:**

*When using an extension cable, increase the prepurge time by 1 second for each foot of extension cable.*

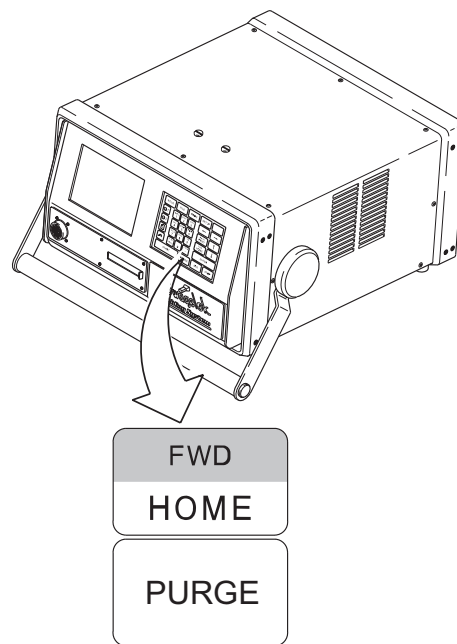


Figure 81 Pushbutton Locations



## Analog Data Logging/Monitoring

The power supply has four Bayonetted-N Style connectors (BNC) on the lower portion of the rear panel to provide analog data outputs. The data outputs have a signal range from 0 V (dc) to 4 V (dc). See Table 6.

Connect a chart recorder or other recording device to these outputs to monitor the SWS during welding. The data outputs include:

- current
- voltage
- rotor travel speed
- enable.

The current, voltage, and rotor speed outputs are used to monitor the performance of the SWS.

*Table 6 Data Output References*

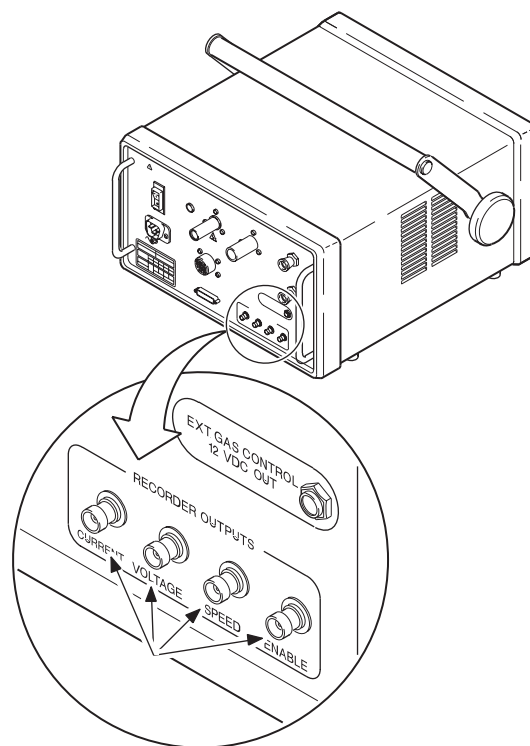
Output Function	0 V Reference	4 V Reference
Current	0 A	100 A
Voltage	0 V	20 V
Travel Speed	0% of max RPM	100% of max RPM

Enable is a control signal for the external recorder. Equipment with the capability to start and stop data recording can use this signal as the trigger to control the recording function.

The polarity of the enable signal is selectable. Refer to SETUP/CONF/MON POLARITY on page 65.

The data from these outputs does not indicate whether the weld is acceptable, but instead provides a record of the equipment performance during the welding process. The data can be compared to the weld procedure guideline as a method of quality control.

Visual, mechanical, and other testing must also be done to verify the weld integrity. As with any connection, proper leak testing should be performed once the weld is completed.



*Figure 82 Data Logging Outputs*

**Note:**

The data recorder must have high impedance inputs (greater than 1 MΩ).

**Note:**

Variables such as material chemistry, weld end preparation, electrode condition, and shielding gas may also affect the weld quality. The user must decide how to use the information provided by this feature.

Swagelok neither sells nor recommends a specific type or brand of recording equipment. However, when selecting data recording equipment remember that the frequency response (sampling rate) of the equipment will determine how accurately a data printout will reflect the actual welding process.

A data-collecting device should have a sampling rate at least ten times faster than the maximum weld impulse rate (99 pulses per second). Thus a sampling rate of 1000 samples per second will help ensure accurate recording of the data. The equipment should also be capable of gathering data over the longest programmed weld time.

When an analog strip chart recorder is used, the 0 V (dc) to 4 V (dc) signals drive the strip chart pens. This type of recorder generally has limited memory and does not store data for future retrieval.

When the data must be captured and stored for future reference, digital recording equipment is used. This equipment converts the analog signals to data patterns that are stored to some device, such as a memory unit or a hard disk. The data can be recalled as needed and can be used for later analysis of the welding process.

Remember that data recording is just a method used to monitor the welding process and does not guarantee the quality of the weld.

## PC Memory Card

A Swagelok PC memory card is a flash memory device designed for use with the M100. No other memory card may be used in its place.

The PC memory card has a Write Protect Switch. When the switch is on, the card will read only. The M100 will prompt you if the switch is on and you attempt to write or delete.

The PC memory card has three (3) basic functions:

1. Weld procedures may be stored outside the internal memory of the unit on the PC memory card. The procedures may be re-installed into the internal memory of any M100 or used directly from the card.
  - File/SAVE – STORE TO CARD (page 46)
  - File/ COPY – Copy Procedures Files (page 48)
2. Weld data logs may be stored on the PC memory card as they are made or downloaded from the internal memory to the card for transfer to a PC.
  - Setup Mode/DATALOG – ENABLE CARD (page 63)
  - Setup Mode/DATALOG – XFER MEM TO CARD (page 59)
3. Front Panel application software may be loaded into the M100 using the PC memory card.
  - Setup Mode/ UTILITY – CLEAR APPLICATION (Page 69)

## PC Interface Cable

The M100 may be connected directly to your personal computer. The data sent to the computer is in comma delimited format.

The computer needs communications software included with Windows 3.1 or above, but not normally with DOS operating systems. DOS systems must have communications software installed such as Telex or Procom. Please check with your computer supplier. The communication set up is:

- baud 9600
- parity none
- 1 stop bit
- 8 bit.

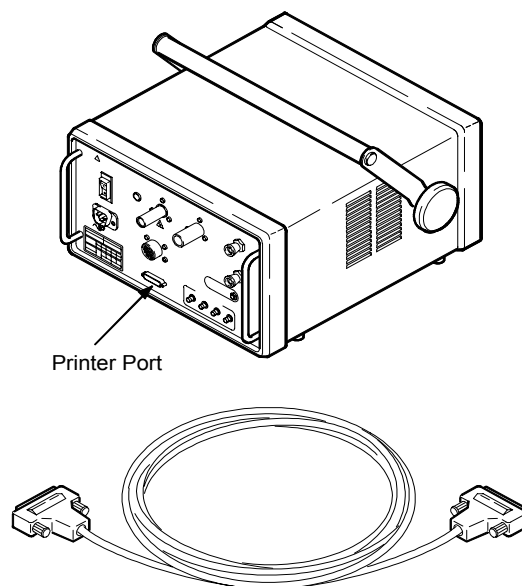
The storage requirements will be approximately 1.5 K per each data log file (weld file). Please check that you have adequate memory space available. This is a very small usage of memory and should not be a problem.

Your application requirements for handling the information after your computer receives the data should be considered when purchasing a software program. Therefore, consult your software supplier before purchasing a program.

A PC Interface Cable (SWS-PC-CABLE) is shipped with each M100. One end of the cable is connected to the printer port on the back of the power supply. See Figure 83.

*Table 7 M100 Printer Port Pin Outputs*

Pin No.	Signal Name from SWS M100
2	Transmit
3	Receive
5	Clear to Send (CTS)
7	Signal Ground
9	+15 V (dc)
20	Data Transmit Ready (DTR)
24	Ground



*Figure 83 PC Interface Cable*



## Weld Parameter Development

This section describes the procedures necessary for developing weld parameters to create welds that meet required specifications. This section includes

- developing a weld procedure guideline
- evaluating the weld
- adjusting software settings for weld quality.

### Developing a Weld Procedure Guideline

In order to create a weld that meets the required specifications, you may need to adjust the welding parameters. You start with the Example Weld Procedure Guideline Worksheet on page 104. Each of the following steps on pages 89 through 103 correspond to the steps on the example worksheet. After completing each step, verify the recorded value on the example worksheet.

The “Worksheet entry” values in the procedure correspond to the steps in the Example Weld Procedure Guideline Worksheet found. The example is based on 1/2 in. OD, 0.049 in. wall thickness 316L stainless steel tubing using the Series 5 Weld Head. However, the procedure applies for all weld heads.

A blank worksheet is included on page 106 for you to use when creating your own weld procedure guidelines. The steps in the worksheet show you how to develop the speed, current, and timing for the SWS.

**Note:**

*This procedure assumes you are fusion butt welding austenitic stainless steel tubing.*

**Note:**

*This procedure is only a guideline. The final weld quality depends on the operator's welding experience and on the proper use of welding techniques.*



## Determining the Work Specifications

- Record the programmer's name.
- Record the joint type.

TB – TB	Tube Butt Weld to Tube Butt Weld
TB – ATW	Tube Butt Weld to Auto Tube Weld

Worksheet entry: **TB – TB**

- Record the material being welded for each side.

316L	316 SS Low Carbon
316LV	316 SS Low Carbon Controlled Sulfur
304L	304 SS Low Carbon

Worksheet entry: **316LV-316LV**

- Record the tube or pipe outside diameter.

Worksheet Entry: **0.5 in.**

- Record the wall thickness.

Worksheet Entry: **0.049 in.**

- Record the weld head model. See weld head manuals for selection.

Worksheet Entry: **CWS-5H-B**

- Record the proper electrode. Refer to the Electrode Selection Table in the appropriate weld head manual.

Worksheet Entry: **C.040-.605**

- Record the arc gap for the weld head being used. Refer to the Arc Gap Gage Setting Table in the appropriate weld head manual.

Worksheet Entry: **0.035 in.**

- Record the ID purge gas flow rate and the type of purge gas. Refer to Table 4 *Shield Gas Flow Rates (Argon)* on Page 71.

Worksheet Entry: **15 SCFH Argon**

- Record the shield gas flow rate and the type of shielding purge gas. Refer to Table 4 *Shield Gas Flow Rates (Argon)* on Page 71.

Worksheet Entry: **13 SCFH Argon**

- Record the purge gas pressure from the ID purge pressure. Refer to Table 5 *Purge Rate and Pressure Tables* on Page 72.

Worksheet Entry: **1.2 iwc**

## Setting Single or Multi-Level Program Parameters

1. Calculate the Travel Speed:
  - a. Determine the travel speeds by locating the wall thickness (.049) and the OD size (1/2 in.) in the appropriate table (Table 8 or Table 9) then reading the corresponding travel speeds.

*Table 8 Travel Speed Setting Chart – Fractional*

Wall Thickness (in.)	OD Size (in.)		Travel Speed (in. per min)
	Tube	Pipe	
0.010 to 0.020	1/16		10
0.021 to 0.034	1/8		8
0.035 to 0.046	1/4		7
0.047 to 0.055	3/8	1/8	6
0.056 to 0.065	1/2	1/4	5
0.066 to 0.070	5/8	3/8	4.5
0.071 to 0.075	3/4		4
0.076 to 0.080	7/8	1/2	3.6
0.081 to 0.085	1	3/4	3.3
0.086 to 0.090	1 1/4	1	3
0.091 to 0.095	1 1/2	1 1/4	2.6
0.096 to 0.109	1 3/4	1 1/2	2.3
0.110 to 0.154	2 - 4		2

*Table 9 Travel Speed Setting Chart – Metric*

Wall Thickness (mm)	OD Size		Travel Speed (mm per min)
	Japan (in.)	Europe (mm)	
0,20 to 0,50	1/16	2	4,2
0,51 to 0,86	1/8	3	3,4
0,87 to 1,17	1/4	6	3,0
1,18 to 1,40	3/8	10	2,5
1,41 to 1,65	1/2	12	2,1
1,66 to 1,78	5/8	16	1,9
1,79 to 1,90	3/4	20	1,7
1,91 to 2,03	7/8	22	1,5
2,04 to 2,16	1	25	1,4
2,17 to 2,29	1 1/4	32	1,3
2,30 to 2,41	1 1/2	38	1,1
2,42 to 2,77	1 3/4	46	1,0
2,78 to 4,0	2 - 4	50	0,8

- b. Calculate and record the corrected travel speed using the following formula:

Average Travel Speeds:

$$[(\text{OD Speed} + \text{Wall Thickness Speed}) \div 2] = \text{Corrected Travel Speed}$$

For example: for a 1/2 in. x .049 in. wall thickness  
 $(6 + 5) \div 2 = 11 \div 2 = \underline{5.5}$

Worksheet Entry: **5.5**

**Note:**

A travel speed of 3 in./min to 15 in./min is a general range for GTAW welding.

2. Calculate the Rotor Speed in rpm:

- a. Calculate the circumference using the formula:

$$\text{Tube OD} \times \pi = \text{Circumference}$$

For example:

$$0.5 \times 3.1416 = \underline{1.5708} \text{ inches circumference}$$

- b. Use the travel speed from step 1.b. and the circumference from step 2.a. to calculate and record the rpm:

$$(\text{Travel Speed} \div \text{Circumference}) = \text{rpm}$$

For example:

$$\underline{5.5} \div 1.5708 = 3.5014 = \underline{3.5} \text{ rpm}$$

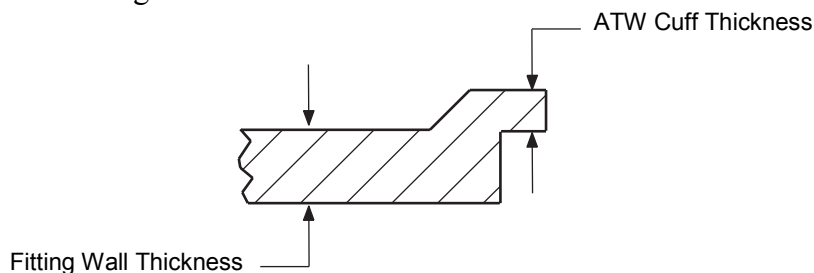
Worksheet Entry: **3.5**

3. Calculate the Impulse Level 1:

- a. Determine the wall thickness (0.049 in.)

**ATW Fitting**

To determine the wall thickness used for an ATW fitting, add 40 % of the ATW cuff thickness to the fitting wall thickness.



*Figure 84 ATW Fitting wall Thickness*

The new ATW wall is then used in Table 10 for the "A" factor.



- b. Locate the wall thickness (0.049 in.) and then read the corresponding “A” factor in Table 10.

*Table 10 Wall Thickness and “A” Factor*

Wall Thickness Range		“A” Factor
In.	mm	
0.020	0,5	0.75
0.021 to 0.034	0,51 to 0,86	1.1
0.035 to 0.046	0,87 to 1,17	1.4
0.047 to 0.055	1,18 to 1,40	1.4
0.056 to 0.065	1,41 to 1,65	1.4
0.066 to 0.070	1.66 to 1,78	1.41
0.071 to 0.075	1.79 to 1.90	1.33
0.076 to 0.080	1,91 to 2,03	1.25
0.081 to 0.085	2,04 to 2,16	1.17
0.086 to 0.090	2,17 to 2,28	1.11
0.091 to 0.095	2,29 to 2,41	1.05
0.096 to 0.109	2,42 to 2,77	0.90
0.110 to 0.118	2,78 to 3,0	0.84
0.119 to 0.154	3,1 to 4,0	0.65

- c. Calculate and record the Impulse Level 1 using the following formula:

$$\text{“A”} \times \text{Wall Thickness} \times 1000 = \text{Impulse Value Level 1}$$

For example, for a wall thickness of 0.049 in.:

$$1.4 \times 0.049 \text{ in.} \times 1000 = 68.6 \text{ A}$$

Worksheet entry: **68.6**

**Note:**

*Because the IMPULSE setting accepts values to only one decimal place, you may need to round off the number.*

4. Calculate the Maintenance Amps:

- a. Locate the wall thickness (0.049 in.) and then read the corresponding “B” factor in Table 11.

*Table 11 Wall Thickness and “B” Factor*

Wall Thickness Range		“B” Factor
In.	mm	
0.010 to 0.020	0,2 to 0,5	0.15
0.021 to 0.034	0,51 to 0,86	0.20
0.035 to 0.046	0,87 to 1,17	0.30
0.047 to 0.055	1,18 to 1,40	0.30
0.056 to 0.065	1,41 to 1,65	0.30
0.066 to 0.070	1.66 to 1,78	0.31
0.071 to 0.075	1.79 to 1.90	0.32
0.076 to 0.080	1,91 to 2,03	0.33
0.081 to 0.085	2,04 to 2,16	0.36
0.086 to 0.090	2,17 to 2,29	0.39
0.091 to 0.095	2,30 to 2,41	0.40
0.096 to 0.109	2,42 to 2,77	0.43
0.110 to 0.154	2,78 to 4,0	0.45

- b. Calculate and record the Maintenance Amps using the following formula:

Impulse Current level 1 x "B" = Maintenance Value all levels

For example, for a wall thickness of 0.049 in.:

$$68.6 \text{ A} \times 0.30 = 20.58 = 20.6 \text{ A}$$

Worksheet entry: **20.6**

5. Determine and record the Start Power (U-Low/Low/Norm) for the weld head and wall thickness being used. Refer to the appropriate weld head manual.

Worksheet entry: **norm**

6. Calculate and record the Start Current using the following formula:

$(\text{Impulse} \times \% \text{ Impulse Width}) + [\text{Maint} \times (1 - \% \text{ Impulse Width})] = \text{Arc Start}$

For example:

$$(68.6 \times 0.30) + [20.6 \times (1 - 0.30)] = 35.00 = 35 \text{ A}$$

Worksheet Entry: **35**

7. Calculate the Total Weld Time Single Pass in seconds using the following formulas:

- a. First, calculate the Seconds per Revolution

$$60 \div \text{rpm} = \text{Seconds per Revolution}$$

For example:

$$60 \div 3.5 = 17.1429 \text{ seconds} = \underline{17.1 \text{ seconds}}$$

- b. Next, calculate the weld overlap time using the following formula:

$$(\text{Wall Thickness} \times 2) \div \text{Travel Speed In seconds} = \text{Weld Overlap Time}$$

For example:

$$(0.049 \times 2) \div (5.5 \div 60) = .098 \div .0917 = \underline{1.1 \text{ seconds}}$$

**Note:**

Because the **MAINTENANCE** setting accepts values to only one decimal place, you may need to round off the number. For example, 16.92 is rounded off to 16.9.

**Note:**

**Impulse Width** is determined and recorded in step 13 on page 95 and entered as percentage in the formula.

- c. Next, calculate and record the Total Weld Time Single Pass using the following formula:

Seconds per Revolution + Weld Overlap = Total Weld Time Single Pass

For example:

17.1 + 1.1 = Total Weld Time Single Pass

18.2 = Total Weld Time Single Pass

Worksheet entry: **18.2**

- d. Determine the total WELD TIME setting. The total Weld Time setting depends on the number of passes needed to complete the weld diameter. If the outside diameter is:

- less than 1/4 in. (multiple pass technique)\*, multiply the total weld time for a single pass by two and set WELD TIME according to that result.
- 1/4 in. or greater (single pass technique) use the total weld time for a single pass.

For example, since the tubing in this example has an outside diameter of 1/2 in., the Weld Time is 18.2 sec.

8. Determine and record the Rotor Delay by calculating the weld overlap time in 7.b on page 93.

Worksheet entry: **1.1**

9. Record a Prepurge Time of 20 seconds.  
Use a continuous purge when using the micro weld head by pressing the PURGE pushbutton.

Worksheet entry: **20**

**\*Note:**

*Experience suggests that tubing with an outside diameter of less than or equal to 1/2 in. typically requires two revolutions (two passes). Tubing with a larger outside diameter requires one revolution (one pass).*



**Caution!**

**When welding 1/2 in. or 12 mm outside diameter with the 8 MRH Weld Head, use a single pass (one revolution) weld procedure only.**

**Note:**

*The suggested minimum Prepurge time is 10 seconds for all weld heads. Higher Prepurge times may be necessary for certain applications.*

10. Record a Postpurge Time of 20 seconds.

Worksheet entry: **20**

11. Calculate and record the Downslope using the following formula:

$$\text{Weld Time} \times 0.2 = \text{Downslope setting}$$

For example, using the Weld Time of 18.2 seconds from step 7.d.:

$$18.2 \times 0.2 = 3.64$$

Worksheet entry: **3.6**

12. Calculate and record the Pulse Rate for 80% overlap using the following formula:

$$\text{Travel speed} \div (30 \times \text{wall thickness}) = \text{Pulse Rate}$$

For example, for a wall thickness of 0.049 in.:

$$5.5 \div (30 \times .049) = 5.5 \div 1.47 = 3.74 = 4$$

Worksheet entry: **4**

13. Determine and record the Impulse Width by locating the wall thickness and then reading the corresponding “C” factor in Table 12.

*Table 12 Wall Thickness and “C” Factor*

Wall Thickness Range		“C” Factor
in.	mm	
0.010 to 0.020	0,20 to 0,50	15
0.021 to 0.034	0,51 to 0,86	15
0.035 to 0.046	0,87 to 1,17	25
0.047 to 0.055	1,18 to 1,40	30
0.056 to 0.065	1,41 to 1,65	33
0.066 to 0.070	1,66 to 1,78	35
0.071 to 0.075	1,79 to 1,90	36
0.076 to 0.080	1,91 to 2,03	37
0.081 to 0.085	2,04 to 2,16	38
0.086 to 0.090	2,17 to 2,29	40
0.091 to 0.095	2,30 to 2,41	45
0.096 to 0.109	2,42 to 2,77	50
0.110 to 0.154	2,78 to 4,0	50

For example, a wall thickness of 0.049 in. has a “C” factor of 30.

Worksheet entry: **30**

**Note:**

*The suggested minimum Postpurge Time is 20 seconds. This time allows for sufficient cooling of the electrode and weld zone.*

**Note:**

*Additional Postpurge time may be necessary for a weld made with a high average current setting.*



14. When developing a multi-level program, the level times are calculated using the following formulas:

- a. Calculate and record the Weld Time for Each Level by choosing the number of levels desired and using the following formula:

Total Weld Time ÷ Number of Levels = Weld Time for Each Level

For example:

$$18.2 \div 4 = 4.55 = \underline{4.6 \text{ Seconds per Level}}$$

Worksheet entry: **4.6**

- b. Calculate and record the Level Factor using the following formula:

$(\text{Impulse Amps Level 1} \times .15) \div (\text{Number of Levels} - 1) =$   
Level Factor

For example:

$$(68.6 \times .15) \div (4-1) = 10.29 \div 3 = 3.43 = 3.4 \text{ Amps}$$

Worksheet entry: **3.4**

- c. Calculate and record the Impulse Amps for all levels after level one using the following formula:

Impulse Amps for the Previous Level – Level Factor = Impulse  
Amps for this Level

For example:

For level 2:  $68.6 - 3.4 = 65.2 \text{ Amps}$

Worksheet entry: **65.2**

For level 3:  $65.2 - 3.4 = 61.8 \text{ Amps}$

Worksheet entry: **61.8**

For level 4:  $61.8 - 3.4 = 58.4 \text{ Amps}$

Worksheet entry: **58.4**

**Note:**

*Always round the weld time for each level up to the next tenth of a second.*

**Note:**

*The Level Factor is used to calculate the Impulse Amps for all three levels after level one.*



## Step Programs Multi-Level

A Step Program should be used when the rotor speed differs between the Impulse (high) pulse period and the Maintenance (low) pulse period. The rotor speed may vary from zero to maximum rotor rpm of the weld head being used. Decreasing rotor rpm will increase heat input and increasing rotor rpm will decrease heat input.

1. Calculate the average seconds per revolution before the weld overlap and total weld time.

$(\text{Impulse rpm} \times \text{Impulse Width}) + [\text{Maintenance rpm} \times (1 - \text{Impulse Width})] = \text{Average rpm}$

**Example:** We want to stop the rotor (0 rpm) during the impulse period.

$$(0 \times .30) + [3.5 \times (1 - .30)] = 0 + [3.5 \times .70] = 2.45 \text{ average rpm}$$

2. Calculate the seconds per revolution using this rpm.

$$60 \div \text{Average rpm} = \text{Seconds per Revolution}$$

For example:

$$60 \div 2.45 = 24.49 = 24.5 \text{ seconds}$$

3. Calculate the average travel speed to find the weld overlap time.

- a. Calculate the circumference.

$$\text{Tube OD} \times \pi = \text{Circumference}$$

For example:

$$.5 \times 3.1416 = 1.5708$$

- b. Calculate the average travel speed using the average rpm and the circumference.

$$\text{Average rpm} \times \text{Circumference} = \text{Average Travel Speed}$$

For example, using the average rpm from step 2. and the circumference from step 3.3:

$$2.45 \times 1.5708 = 3.84846 = 3.8 \text{ IPM}$$

**Note:**

*The Impulse Rate must be less than or equal to 10 cycles per second for step programs.*

**Note:**

*Do not use the Impulse Width for heat (penetration) adjustments in a step program. Program timing problems may result. Make heat adjustments with the Impulse Amps or the Maintenance Amps.*



**Caution!**

**Step Programs are not used with Series 4 or Series 8 Micro Weld Heads.**

**Note:**

*Step Programs do not produce speed data for the data log record.*

- c. Calculate the weld overlap using the wall thickness and the average travel speed.

$$(\text{Wall Thickness} \times 2) \div (\text{Average IPM} \div 60) = \text{Weld Overlap Time}$$

For example, using .049 wall thickness and the average travel speed from step 3.b:

$$(0.049 \times 2) \div (3.8 \div 60) = .098 \div .063 = 1.555$$

$$= 1.6 \text{ seconds}$$

4. Calculate the total weld time.

$$\text{Weld Time per Revolution} + \text{Weld Overlap Time} = \text{Total Weld Time}$$

For example, using the weld time per revolution from step 2. and the weld overlap time from 3.c.:

$$24.5 + 1.6 = 26.1 \text{ seconds}$$

5. Calculate the weld time per level.

$$\text{Total Weld Time} \div \text{Number of Levels} = \text{Weld Time per Level}$$

For example, using the weld time from step 4 and 4 levels:

$$26.1 \div 4 = 6.525 = 6.5 \text{ seconds per level}$$

## Socket Welds

Because socket welds are not full penetration welds, a modified concept is used to calculate the weld procedure guideline. Refer to the Automatic Socket Weld Procedure Guideline Worksheet located on page 110.

The modification is to the High/Low current value and the % Impulse value. Adjusting the electrode offset will change the profile of the weld. Adjusting the weld level heat will change the profile of individual levels.

All socket welds use a single pass technique. The arc gap will be 0.010 in. (0,25 mm) for all sizes and offset 0.015 in. (0,35 mm) as shown in Figure 85. The welding diameter is based on the socket OD.

**Note:**

*Start all socket welds between 11 and 12 o'clock positions to assist the formation of a weld pool.*

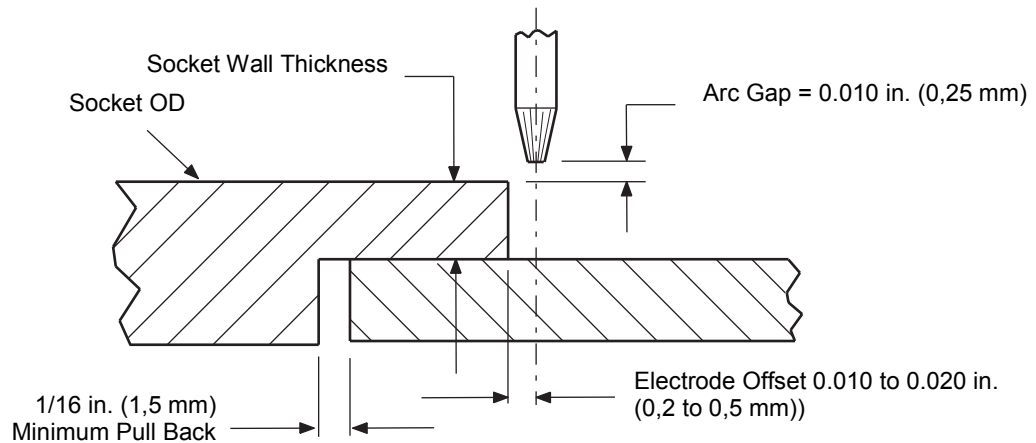


Figure 85 Socket Weld Arc Gap

## Tacks

Tacks are used for various reasons. They are used by themselves and the weld is made at a later time or tacks are used with the weld following immediately. The M100 will automatically generate up to 10 tacks during Programming/Auto Generate or you may add tacks to any program in PROG/MODIFY/INSERT TACK. Choose the location of the tack in degrees, use the Start Current of the program, and start with 80 % of the Rotor Delay time for each tack to be added. If the tacks break during welding, increase the time by 1/2 (0.5) seconds for each tack. If the tacks are not fully consumed by the weld, decrease the time by 1/2 (0.5) seconds for each tack. Several cautions are important when using tacks:

- If the tacks are to be welded at a later time, they must be brushed before they are welded. The oxidation will cause weld meander if it is not removed. This is not necessary if the weld follows immediately.
- All tacks should be consumed completely by the weld. (Decrease tack size or the number of tacks.)
- Tacks should not break during the welding. (Increase tack size or the number of tacks.)



### Caution!

**Tack programs or programs that include tack should not be used with the micro weld heads.**

## Weld Program with Ramp Time

Ramping is used in two applications. The first and most commonly used is ramping between levels. Its main purpose is to spread over a set period of time the change of amperage between levels. The second is to Ramp-up slowly when starting a weld. Its main purpose is to apply heat to the material in a controlled manner, which is necessary with some materials. The ramp time is applied to the beginning of the level it is entered.

Ramping between levels – If you desire to ramp the heat down from level one to level two, you apply the desired ramp time to level two, see Figure 86.

**Note:**

*Ramp Time will affect the collection of Data Logs if the weld time is not at least one second longer than the Ramp Time.*

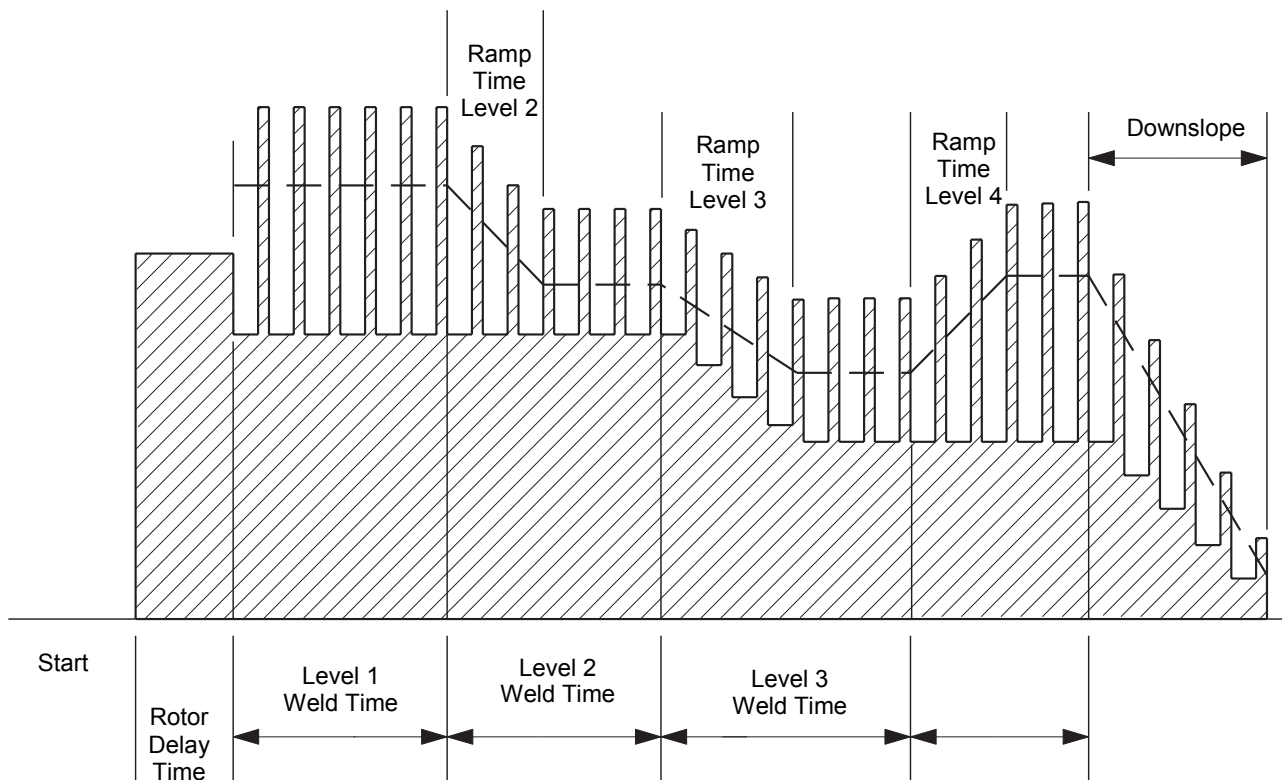


Figure 86 Ramp Between Levels

**Ramping up in level one** – If you desire to ramp the heat up from a minimum value to welding temperature over a set period of time, two procedures may be used:

1. The weld does not penetrate immediately, see Figure 87.  
The following is accomplished in  
PROG/MODIFY/EDIT ITEM:
  - a. Set the Start Current to an acceptable level minimum (5 Amps) or greater.
  - b. Set the Start time to .1 seconds.
  - c. Enter the ramp-up time in level one Ramp (time).
  - d. Add the ramp-up time to level one Weld (time).
  - e. Adjust the procedure weld time to overlap the start of the weld for an even ID bead width.

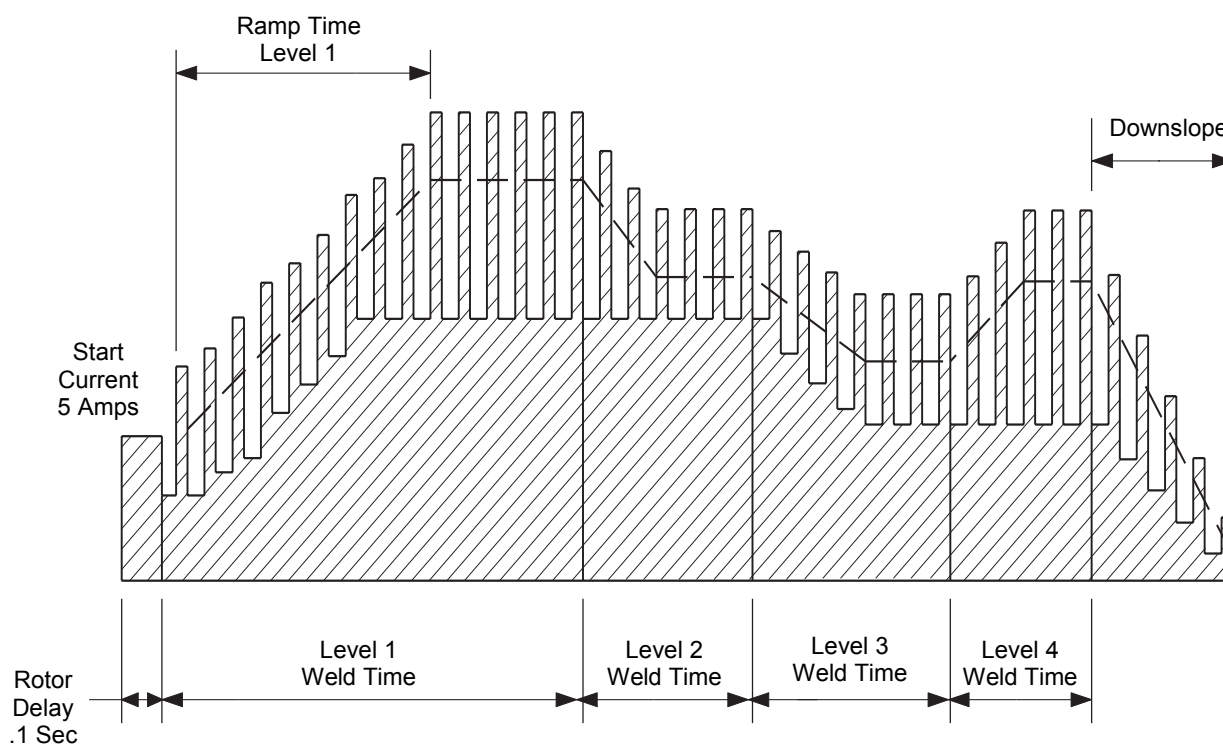


Figure 87

2. The weld must penetrate completely before the rotor begins to move, see Figure 88. After the basic weld program is developed, duplicate level one by using PROG/MODIFY/INSERT LEVEL. The following is accomplished in PROG/MODIFY/EDIT ITEM:
  - a. Set the Start Current to an acceptable level minimum (5 Amps) or greater.
  - b. Set the Start time to .1 seconds.
  - c. Change the Weld (time) of level one to the desired ramp-up time plus any rotor delay time needed for penetration.
  - d. Enter the ramp-up time in level one Ramp (time).
  - e. Change the Speed High RPM and the Speed Low RPM to Zero RPM.
  - f. Increase the start penetration by increasing the weld time of level one or by increasing the weld input amperage.
  - g. Decrease the start penetration by decreasing the weld input amperage.
  - h. Level one is now a Ramp-up time and Rotor Delay Level. The first weld level will be level two. Make heat changes to weld accordingly using either WELD/ADJUST or PROG/MODIFY/EDIT ITEM.

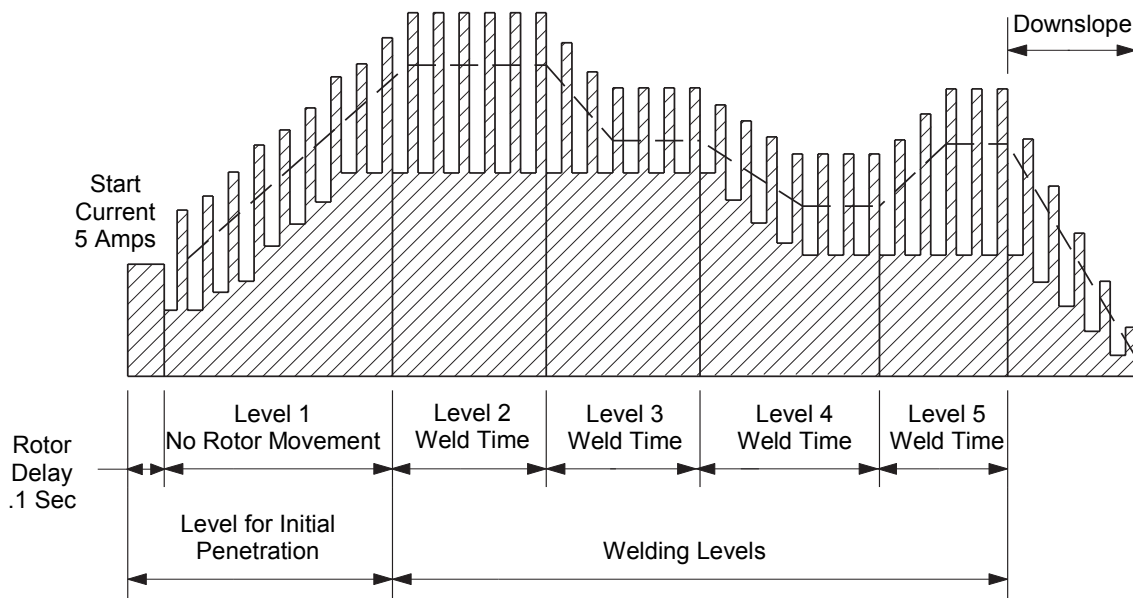


Figure 88



## Example Weld Procedure Guideline Worksheet

### Determine the Work Specifications

Step	Parameter	Setting
1	Programmer's Name	John J Jones
2	Joint Type	TB – TB
3	Material Type (Side1 – Side 2)	316LV - 316LV
4	Weld Diameter in Inches	0.5 Inches
5	Wall Thickness in Inches (Side 1 – Side 2)	0.049 – 0.049
6	Weld Head Model No.	CWS-5H-B
7	Electrode Part No.	C.040 –.605
8	Arc Gap in Inches	0.035 Inches
	Arc Gap Gage Setting	0.907 Inches
9	ID Purge Gas Flow in SCFH Gas Type Ar	15 SCFH
10	Shielding Gas Flow in SCFH Gas Type Ar	13 SCFH
11	ID Purge Gas Pressure in IWC	1.2 IWC

\*For ATW fittings, use the corrected wall thickness. To determine the wall thickness for an ATW fitting, add 40 % of the ATW cuff thickness to the fitting wall thickness. Refer to Figure 84 on page 91.

### Calculating Weld Parameters – Example

Step	Parameter	Setting
1	Travel speed (in. per min.) (Table 8)	5.5 in. per min.
2	Rotor speed in rpm for all levels $\text{Travel Speed} \div \text{Circumference} = \text{rpm}$ $\text{Tube OD} \times \pi = \text{Circumference}$ $.5 \times 3.1416 = 1.5708$ $5.5 \div 1.5708 = 3.5014 = 3.5$	3.5 rpm
3	Impulse amps for level 1 (Table 10) $"A" \times \text{Wall Thickness (in thousands of an inch)} \times 1000 = \text{Impulse Amps}$ $1.4 \times .049 \times 1000 = 68.6$	68.6 Amps
4	Maintenance amps for all levels (Table 11) $"B" \times \text{Impulse Level 1} = \text{Maintenance Amps}$ $0.30 \times 68.6 = 20.58 = 20.6$	20.6 Amps
5	Start power (u-low/low/norm)	Norm
6	Start current $(\text{Imp. Level 1} \times \% \text{ Imp. Width}^{**}) + [\text{Maint.} \times (1 - \% \text{ Imp. Width})]$ = Arc Start $(68.6 \times .30) + [20.6 \times (1 - 0.30)] =$ $20.58 + [20.6 \times 0.70] =$ $20.58 + 14.42 = 35.00$	35 Amps

\*\*Impulse Width is determined in step 13.



## Calculating Weld Parameters – Example Continued

Step	Parameter	Setting
7	Total weld time single pass in seconds <i>Seconds per Revolution + Weld Overlap = Total Time Single Pass</i> $60 \div rpm = \text{Seconds per Revolution}$ $60 \div 3.5 = 17.1429 = 17.1$ <i>(Wall Thickness x 2) ÷ (Travel Speed ÷ 60) = Weld Overlap</i> $(.049 \times 2) \div (5.5 \div 60) = 0.098 \div 0.0917 = 1.1$ <i>Seconds per Revolution + Weld Overlap = Total Time Single Pass</i> $17.1 + 1.1 = 18.2$	18.2 Seconds
8	Rotor delay time use the weld overlap time from step 7.	1.1 Seconds
9	Prepurge time in seconds	20 Seconds
10	Postpurge time in seconds	20 Seconds
11	Downslope <i>Total Weld Time x 0.2 = Downslope</i> $18.2 \times 0.2 = 3.64 = 3.6$	3.6 Seconds
12	Pulse rate <i>Travel Speed ÷ (30 x Wall Thickness) = Impulse Rate</i> $5.5 \div (30 \times 0.049) = 5.5 \div 1.47 = 3.74 = 4$	4 cycles per sec.
13	Impulse width ("C" Table 12)	30 %
14	Weld time for each level <i>Total Weld Time ÷ Number of Levels = Weld Time for each Level</i> $18.2 \div 4 = 4.55 = 4.6$	4.6 Seconds
15	Level factor <i>(Impulse Amps Level 1 x .15) ÷ (Number of Levels – 1) = Level Factor</i> $(68.6 \times 0.15) \div (4-1) = 10.29 \div 3 = 3.43 = 3.4$	3.4 Amps
16	Impulse amps for level 2 <i>Impulse Amps Level 1 – Level Factor = Impulse Amps for Level 2</i> $68.6 - 3.4 = 65.2$	65.2 Amps
17	Impulse amps for level 3 <i>Impulse Amps Level 2 – Level Factor = Impulse Amps for Level 3</i> $65.2 - 3.4 = 61.8$	61.8 Amps
18	Impulse amps for level 4 <i>Impulse Amps Level 3 – Level Factor = Impulse Amps for Level 4</i> $61.8 - 3.4 = 58.4$	58.4 Amps
19	Impulse amps for level 5 <i>Impulse Amps Level 4 – Level Factor = Impulse Amps for Level 5</i> ____ - ____ = ____	
20	Impulse amps for level 6 <i>Impulse Amps Level 5 – Level Factor = Impulse Amps for Level 6</i> ____ - ____ = ____	
21	Impulse amps for level 7 <i>Impulse Amps Level 6 – Level Factor = Impulse Amps for Level 7</i> ____ - ____ = ____	
22	Impulse amps for level 8 <i>Impulse Amps Level 7 – Level Factor = Impulse Amps for Level 8</i> ____ - ____ = ____	

## Weld Procedure Guideline Worksheet US Customary Standard (inches)

### Determine the Work Specifications

Step	Parameter	Setting
1	Programmer's Name	
2	Joint Type	
3	Material Type	
4	Weld Diameter in Inches	
5	Wall Thickness in Inches	
6	Weld Head Model No.	
7	Electrode Part No.	
8	Arc Gap in Inches	
	Arc Gap Gage Setting	
9	ID Purge Gas Flow in SCFH Gas Type	
10	Shielding Gas Flow in SCFH Gas Type	
11	ID Purge Gas Pressure in IWC	

### Calculating Weld Parameters

Step	Parameter	Setting
1	Travel speed (in. per min.) (Table 8)	
2	Rotor speed in rpm for all levels $(\text{Travel Speed} \div \text{Circumference}) \times 60 = \text{rpm}$ $\text{Tube OD} \times \pi = \text{Circumference}$ _____ x 3.1416 = _____	
3	Impulse amps for level 1 (Table 10) "A" x Wall Thickness (in thousands of an inch) x 1000 = Impulse Amps _____ x _____ x 1000 = _____	
4	Maintenance amps for all levels (Table 11) "B" x Impulse Level 1 = Maintenance Amps _____ x _____ = _____	
5	Start power (u-low/low/norm)	
6	Start current $(\text{Imp. Level 1} \times \% \text{ Imp. Width}^{**}) + [\text{Maint.} \times (1 - \% \text{ Imp. Width})]$ = Arc Start $(\text{_____} \times \text{_____}) + [\text{_____} \times (1 - \text{_____})] =$ _____ + [_____ x _____] = _____ + _____ = _____	

\*\* Impulse Width is determined in step 13.

## Calculating Weld Parameters (Inches) Continued

Step	Parameter	Setting
7	Total weld time single pass in seconds <i>Seconds per Revolution + Weld Overlap = Total Time Single Pass</i> $60 \div \text{rpm} = \text{Seconds per Revolution}$ $60 \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$ $(\text{Wall Thickness} \times 2) \div (\text{Travel Speed} \div 60) = \text{Weld Overlap}$ $(\underline{\hspace{1cm}} \times 2) \div (\underline{\hspace{1cm}} \div 60) = \underline{\hspace{1cm}}$ <i>Seconds per Revolution + Weld Overlap = Total Time Single Pass</i> $\underline{\hspace{1cm}} + \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
8	Rotor delay time use the weld overlap time from step 7.	
9	Prepurge time in seconds	
10	Postpurge time in seconds	
11	Downslope $\text{Total Weld Time} \times 0.2 = \text{Downslope}$ $\underline{\hspace{1cm}} \times 0.2 = \underline{\hspace{1cm}}$	
12	Pulse rate x 2.364 $\text{Travel Speed} \div (30 \times \text{Wall Thickness}) = \text{Impulse Rate}$ $\underline{\hspace{1cm}} \div (1.182 \times \underline{\hspace{1cm}}) = \underline{\hspace{1cm}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
13	Impulse width ("C" Table 12)	
14	Weld time for each level $\text{Total Weld Time} \div \text{Number of Levels} = \text{Weld Time for each Level}$ $\underline{\hspace{1cm}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
15	Level factor $(\text{Impulse Amps Level 1} \times .15) \div (\text{Number of Levels} - 1) = \text{Level Factor}$ $(\underline{\hspace{1cm}} \times 0.15) \div (\underline{\hspace{1cm}} - 1) = \underline{\hspace{1cm}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
16	Impulse amps for level 2 $\text{Impulse Amps Level 1} - \text{Level Factor} = \text{Impulse Amps for Level 2}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
17	Impulse amps for level 3 $\text{Impulse Amps Level 2} - \text{Level Factor} = \text{Impulse Amps for Level 3}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
18	Impulse amps for level 4 $\text{Impulse Amps Level 3} - \text{Level Factor} = \text{Impulse Amps for Level 4}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
19	Impulse amps for level 5 $\text{Impulse Amps Level 4} - \text{Level Factor} = \text{Impulse Amps for Level 5}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
20	Impulse amps for level 6 $\text{Impulse Amps Level 5} - \text{Level Factor} = \text{Impulse Amps for Level 6}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
21	Impulse amps for level 7 $\text{Impulse Amps Level 6} - \text{Level Factor} = \text{Impulse Amps for Level 7}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
22	Impulse amps for level 8 $\text{Impulse Amps Level 7} - \text{Level Factor} = \text{Impulse Amps for Level 8}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	

## Weld Procedure Guideline Worksheet – Metric Standard

### Determine the Work Specifications

Step	Parameter	Setting
1	Programmer's Name	
2	Joint Type	
3	Material Type	
4	Weld Diameter in Millimeters	
5	Wall Thickness in Millimeters	
6	Weld Head Model No.	
7	Electrode Part No.	
8	Arc Gap in Millimeters	
	Arc Gap Gage Setting	
9	ID Purge Gas Flow in L/min Gas Type	
10	Shielding Gas Flow in L/min Gas Type	
11	ID Purge Gas Pressure in mm/wc	

### Calculating Weld Parameters

Step	Parameter	Setting
1	Travel speed (mm. per sec.) (Table 8)	
2	Rotor speed in rpm for all levels $(\text{Travel Speed} \div \text{Circumference}) \times 60 = \text{rpm}$ $\text{Tube OD} \times \pi = \text{Circumference}$ $\text{_____} \times 3.1416 = \text{_____}$ $(\text{_____} \div \text{_____}) \times 60 = \text{_____}$	
3	Impulse amps for level 1 (Table 10) $"A" \times \text{Wall Thickness (in mm)} \times 39,4 = \text{Impulse Amps}$ $\text{_____} \times \text{_____} \times 39,4 = \text{_____}$	
4	Maintenance amps for all levels (Table 11) $"B" \times \text{Impulse Level 1} = \text{Maintenance Amps}$ $\text{_____} \times \text{_____} = \text{_____}$	
5	Start power (u-low/low/norm)	
6	Start current $(\text{Imp. Level 1} \times \% \text{ Imp. Width}^{**}) + [\text{Maint.} \times (1 - \% \text{ Imp. Width})] = \text{Arc Start}$ $(\text{_____} \times \text{_____}) + [\text{_____} \times (1 - \text{_____})] = \text{_____}$ $\text{_____} + [\text{_____} \times \text{_____}] = \text{_____}$ $\text{_____} + \text{_____} = \text{_____}$	

\*\* Impulse Width is determined in step 13.

## Calculating Weld Parameters (Metric) Continued

Step	Parameter	Setting
7	Total weld time single pass in seconds <i>Seconds per Revolution + Weld Overlap = Total Time Single Pass</i> $60 \div \text{rpm} = \text{Seconds per Revolution}$ $60 \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$ $(\text{Wall Thickness} \times 2) \div \text{Travel Speed} = \text{Weld Overlap}$ $(\underline{\hspace{1cm}} \times 2) \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$ <i>Seconds per Revolution + Weld Overlap = Total Time Single Pass</i> $\underline{\hspace{1cm}} + \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
8	Rotor delay time use the weld overlap time from step 7.	
9	Prepurge time in seconds	
10	Postpurge time in seconds	
11	Downslope $\text{Total Weld Time} \times 0.2 = \text{Downslope}$ $\underline{\hspace{1cm}} \times 0.2 = \underline{\hspace{1cm}}$	
12	Pulse rate $(\text{Travel Speed} \times 2.364) \div (1.182 \times \text{Wall Thickness}) = \text{Impulse Rate}$ $(\underline{\hspace{1cm}} \times 2.364) \div (1.182 \times \underline{\hspace{1cm}}) = \underline{\hspace{1cm}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
13	Impulse width ("C" Table 12)	
14	Weld time for each level $\text{Total Weld Time} \div \text{Number of Levels} = \text{Weld Time for each Level}$ $\underline{\hspace{1cm}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
15	Level factor $(\text{Impulse Amps Level 1} \times 0.15) \div (\text{Number of Levels} - 1) = \text{Level Factor}$ $(\underline{\hspace{1cm}} \times 0.15) \div (\underline{\hspace{1cm}} - 1) = \underline{\hspace{1cm}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
16	Impulse amps for level 2 $\text{Impulse Amps Level 1} - \text{Level Factor} = \text{Impulse Amps for Level 2}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
17	Impulse amps for level 3 $\text{Impulse Amps Level 2} - \text{Level Factor} = \text{Impulse Amps for Level 3}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
18	Impulse amps for level 4 $\text{Impulse Amps Level 3} - \text{Level Factor} = \text{Impulse Amps for Level 4}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
19	Impulse amps for level 5 $\text{Impulse Amps Level 4} - \text{Level Factor} = \text{Impulse Amps for Level 5}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
20	Impulse amps for level 6 $\text{Impulse Amps Level 5} - \text{Level Factor} = \text{Impulse Amps for Level 6}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
21	Impulse amps for level 7 $\text{Impulse Amps Level 6} - \text{Level Factor} = \text{Impulse Amps for Level 7}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
22	Impulse amps for level 8 $\text{Impulse Amps Level 7} - \text{Level Factor} = \text{Impulse Amps for Level 8}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	

## Automatic Socket Weld Procedure Guideline Worksheet US Customary Standard (Inches)

### Determine the Work Specifications

Step	Parameter	Setting
1	Programmer's Name	
2	Joint Type	
3	Material Type	
4	Weld Diameter in Inches	
5	Wall Thickness in Inches	
6	Weld Head Model No.	
7	Electrode Part No.	
8	Arc Gap in Inches	
	Arc Gap Gage Setting	
9	ID Purge Gas Flow in SCFH	
10	Shielding Gas Flow in SCFH	

### Calculating Weld Parameters

Step	Parameter	Setting
1	Travel speed (in. per min.) Use 5 in. per min.	
2	Rotor speed in rpm for all levels <i>Travel Speed ÷ Circumference = rpm</i> <i>Socket OD x π = Circumference</i> _____ x 3.1416 = _____ <i>Travel Speed ÷ Circumference = rpm</i> _____ ÷ _____ = _____	
3	Impulse amps for level 1 (Table 10) <i>1.2 x Socket Wall Thickness (in thousands of an inch) x 100 = Amps</i> 1.2 x _____ x 1000 = _____	
4	Maintenance amps for all levels (Table 11) <i>.33 x Impulse Amps = Maintenance Amps</i> .33 x _____ = _____	
5	Start power (u-low/low/norm)	Norm
6	Start current <i>(Imp. Level 1 x % Imp. Width**) + [Maint. x (1 - % Imp. Width)] = Arc Start</i> (_____ x _____) + [_____ x (1 - _____)] = _____ _____ + [_____ x _____] = _____ _____ + _____ = _____	

\*\* Impulse Width is determined in step 13.

## Calculating Socket Weld Parameters (Inches) Continued

Step	Parameter	Setting
7	Total weld time single pass in seconds <i>Seconds per Revolution + Weld Overlap = Total Time Single Pass</i> $60 \div rpm = \text{Seconds per Revolution}$ $60 \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$ $(\text{Wall Thickness} \times 2) \div (\text{Travel Speed} \div 60) = \text{Weld Overlap}$ $(\underline{\hspace{1cm}} \times 2) \div (\underline{\hspace{1cm}} \div 60) = \underline{\hspace{1cm}}$ <i>Seconds per Revolution + Weld Overlap = Total Time Single Pass</i> $\underline{\hspace{1cm}} + \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
8	Rotor delay time use the weld overlap time from step 7.	
9	Prepurge time in seconds	
10	Postpurge time in seconds	
11	Downslope $\text{Total Weld Time} \times 0.2 = \text{Downslope}$ $\underline{\hspace{1cm}} \times 0.2 = \underline{\hspace{1cm}}$	
12	Pulse rate $\text{Travel Speed} \div (30 \times \text{Wall Thickness}) = \text{Impulse Rate}$ $\underline{\hspace{1cm}} \div (30 \times \underline{\hspace{1cm}}) = \underline{\hspace{1cm}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
13	Impulse width = 50 %	
14	Weld time for each level $\text{Total Weld Time} \div \text{Number of Levels} = \text{Weld Time for each Level}$ $\underline{\hspace{1cm}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
15	Level factor $(\text{Impulse Amps Level 1} \times 0.15) \div (\text{Number of Levels} - 1) = \text{Level Factor}$ $(\underline{\hspace{1cm}} \times 0.15) \div (\underline{\hspace{1cm}} - 1) = \underline{\hspace{1cm}} \div \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
16	Impulse amps for level 2 $\text{Impulse Amps Level 1} - \text{Level Factor} = \text{Impulse Amps for Level 2}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
17	Impulse amps for level 3 $\text{Impulse Amps Level 2} - \text{Level Factor} = \text{Impulse Amps for Level 3}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	
18	Impulse amps for level 4 $\text{Impulse Amps Level 3} - \text{Level Factor} = \text{Impulse Amps for Level 4}$ $\underline{\hspace{1cm}} - \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$	

## Evaluating the Weld

A completed weld must meet structural and metallurgical requirements. The weld must be uniform, and free of cracks, porosity, and undercuts. It must not have excessive oxidation. And, if it is a butt weld, it must have full penetration from the outside diameter to the inside diameter. See Figure 89.

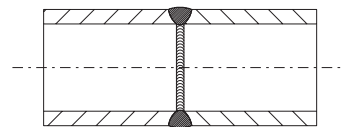


Figure 89 Acceptable Weld

## Identifying Typical Weld Discontinuities

Figure 90 shows typical weld discontinuities.

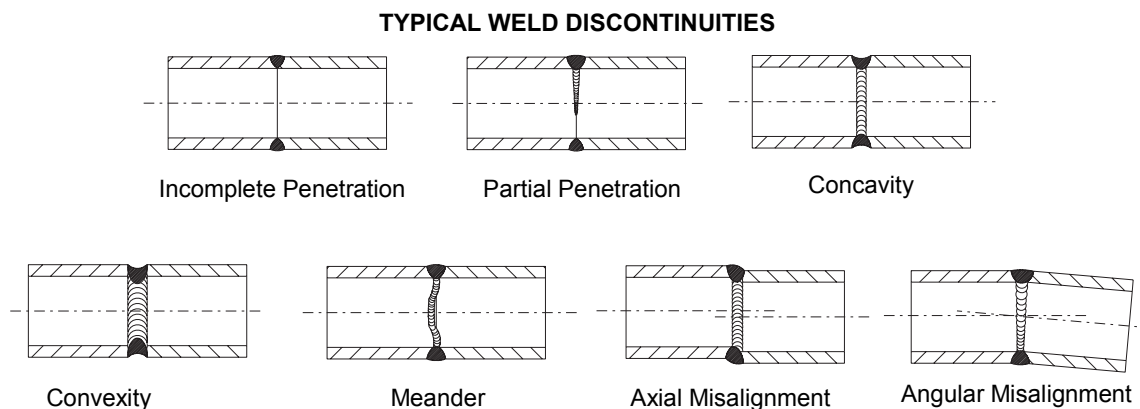


Figure 90 Typical Weld Discontinuities



## Identifying Proper Welds

The cross-sectional welds in Figure 91 through Figure 102 on pages 113 through 118 show how changing various parameters effects the shape of the weld.

To check the weld, follow these steps:

1. Inspect the weld on the outside of the tube. Check for:
  - uniformity
  - cracks
  - undercuts
  - excessive oxide.
2. Inspect the weld on the inside of the tube. Check for:
  - uniformity, cracks, undercuts, and excessive oxidation
  - full penetration
  - excessive weld bead width variations
  - excessive weld-spot overlap.

## Reference Weld

Figure 91 shows a cross-section of a proper weld. The weld shows full penetration from the outside diameter to the inside diameter, a crown on the outside diameter, and minimal weld bead convexity on the inside diameter.

Table 13 lists the parameters used to create the weld. Compare welds with Figure 91.

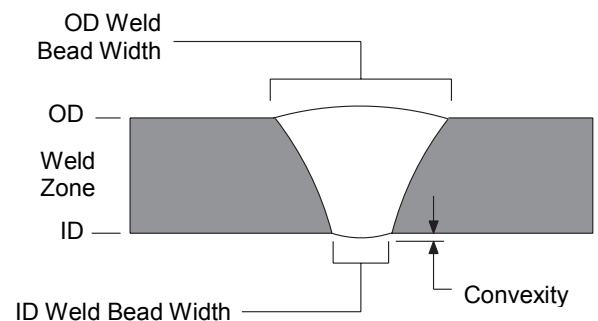
*Table 13 Reference Weld Parameters*

Parameter	Setting
Impulse (Amperes)	58.8
Maintenance (Amperes)	17.6
Impulse Rate	10
Impulse Width	35
Speed (rpm)	3
Arc Gap	0.035 in.
Avg. Current Display (Amperes)	32

The following examples show how changes in various parameters can affect the weld shape.

### Note:

*The welds are made with 316L stainless steel tube with the following dimensions: ½ in. OD, 0.049 in. wall thickness.*



*Figure 91 Reference Weld Illustration*

## Weld Example No. 1

Table 14 lists the parameter change used to create the weld shown in Figure 92.

*Table 14 Weld Example No. 1*

Parameter	Reference Setting	This Setting
Impulse (Amperes)	58.8	49.8
Average Current (Amperes)	32	28.87

Lowering the Impulse current lowers the average current. This decreases the heat input per unit of electrode travel resulting in no inside diameter penetration.



*Figure 92 Improper Weld Example No. 1*

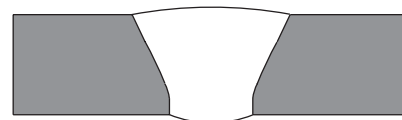
## Weld Example No. 2

Table 15 lists the parameter change used to create the weld shown in Figure 93.

*Table 15 Weld Example No. 2*

Parameter	Reference Setting	This Setting
Impulse (Amperes)	58.8	67.9
Average Current (Amperes)	32	35.2

Raising the Impulse current raises the average current. This increases the heat input per unit of electrode travel resulting in increased inside diameter convexity and weld bead width.



*Figure 93 Improper Weld Example No. 2*



*Reference Illustration of Proper Weld*

### Weld Example No. 3

Table 16 lists the parameter change used to create the weld shown in Figure 94.

*Table 16 Weld Example No. 3*

Parameter	Reference Setting	This Setting
Maintenance (Amperes)	17.8	14.8
Average Current (Amperes)	32	30.2

Lowering the Maintenance current lowers the average current. This decreases the heat input per unit of electrode travel resulting in no inside diameter penetration.



*Figure 94 Improper Weld Example No. 3*

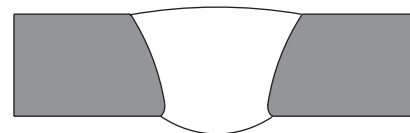
### Weld Example No. 4

Table 17 lists the parameter change used to create the weld shown in Figure 95.

*Table 17 Weld Example No. 4*

Parameter	Reference Setting	This Setting
Maintenance (Amperes)	17.8	20.8
Average Current (Amperes)	32	34.12

Raising the Maintenance current raises the average current. This increases the heat input per unit of electrode travel resulting in increased inside diameter convexity and weld bead width.



*Figure 95 Improper Weld Example No. 4*



*Reference Illustration of Proper Weld*

## Weld Example No. 5

Table 18 lists the parameter change used to create the weld shown in Figure 96.

*Table 18 Weld Example No. 5*

Parameter	Reference Setting	This Setting
Impulse Width	35	30
Average Current (Amperes)	32	30

Shortening the Impulse Width lowers the average current. This decreases the heat input per unit of electrode travel resulting in no inside diameter penetration.

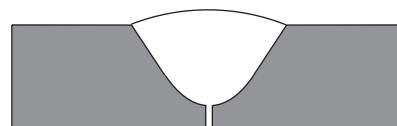
## Weld Example No. 6

Table 19 lists the parameter change used to create the weld shown in Figure 97.

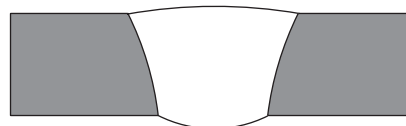
*Table 19 Weld Example No. 6*

Parameter	Reference Setting	This Setting
Impulse Width	35	40
Average Current (Amperes)	32	34

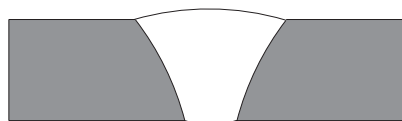
Lengthening the Impulse Width raises the average current. This increases the heat input per unit of electrode travel resulting in increased inside diameter convexity and weld bead width.



*Figure 96 Improper Weld Example No. 5*



*Figure 97 Improper Weld Example No. 6*



*Reference Illustration of Proper Weld*

## Weld Example No. 7

Table 20 lists the parameter change used to create the weld shown in Figure 98.

*Table 20 Weld Example No. 7*

Parameter	Reference Setting	This Setting
Speed (rpm)	3 (19)	4 (15)

Raising the Rotor Speed decreases the heat input per unit of electrode travel resulting in no inside diameter penetration.

## Weld Example No. 8

Table 21 lists the parameter change used to create the weld shown in Figure 99.

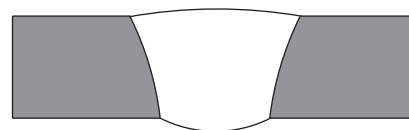
*Table 21 Weld Example No. 8*

Parameter	Reference Setting	This Setting
Speed (rpm)	3 (19)	2 (26)

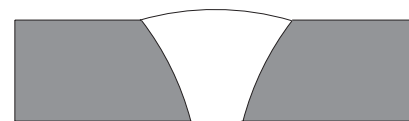
Lowering the Rotor Speed increases the heat input per unit of electrode travel resulting in increased inside diameter convexity and weld bead width.



*Figure 98 Improper Weld Example No. 7*



*Figure 99 Improper Weld Example No. 8*



*Reference Illustration of Proper Weld*

## Pulse Rate Reference Weld

Table 22 lists the parameter used to create the reference weld shown in Figure 100.

*Table 22 Pulse Rate Reference Weld*

Parameter	Reference Setting	This Setting
Pulse Rate	10	10



*Figure 100 Pulse Rate Reference Weld*

## Pulse Rate Weld Example No. 1

Table 23 lists the parameter change used to create the weld shown in Figure 101.

*Table 23 Weld Example No. 1*

Parameter	Reference Setting	This Setting
Pulse Rate	10	5



*Figure 101 Pulse Rate Weld Example No. 1*

Lowering the pulse rate reduces weld-spot overlap.

## Pulse Rate Weld Example No. 2

Table 24 lists the parameter change used to create the weld shown in Figure 102.

*Table 24 Weld Example No. 2*

Parameter	Reference Setting	This Setting
Pulse Rate	10	25



*Figure 102 Pulse Rate Weld Example No. 2*

Raising the pulse rate increases weld-spot overlap.

At times, the welding parameters (as described on page 104) must be adjusted to create an acceptable weld.

## Maintenance

The power supply has no internal serviceable parts and should not be disassembled.

### Fuse Inspection and Replacement

A 20 A (110 V (ac) system) or a 10 A (220 V (ac) system) ceramic fuse is on the rear panel of the power supply. If the power is on but the arc fails to start, you may have a blown fuse.

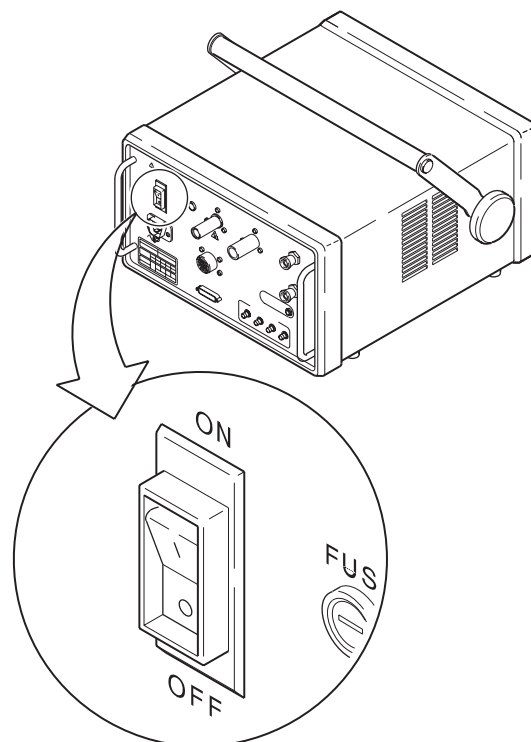
To inspect the fuse:

1. Turn off the power supply. See Figure 103.
2. Unplug the power cord.



**WARNING!**

**THE USER SHOULD NOT  
SERVICE THE  
POWER SUPPLY.**



*Figure 103 Power Supply Circuit  
Breaker in the OFF Position*

3. Inspect the fuse and fuse cap:
  - a. Unscrew the fuse cap using a flat blade screwdriver. See Figure 104.
  - b. Inspect the fuse cap for damage (overheating, burning, etc.). Replace the cap if necessary.
  - c. Using an ohmmeter, check the continuity of the fuse. If it is blown, replace it with a fuse of the same type and rating.
4. Turn on the power supply.

**Note:**

The fuse can be checked with an ohmmeter.


**Caution!**

Use only insulated pliers to remove fuse.

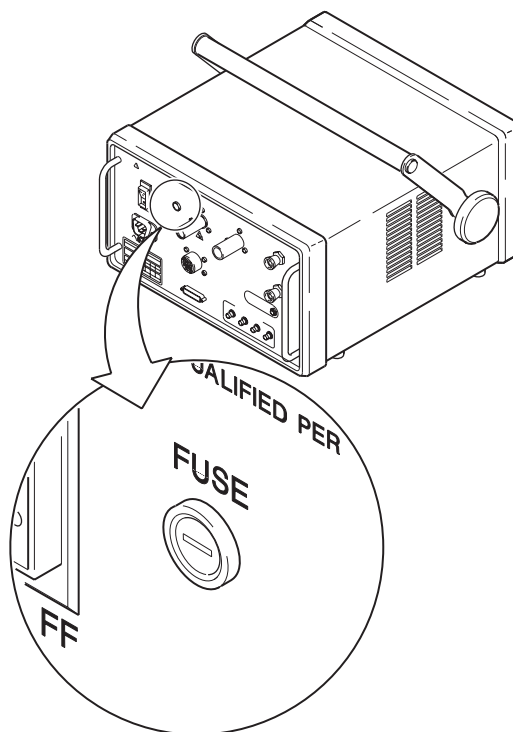


Figure 104 Ceramic Fuse Location

## Specifications

Table 25 Power Supply

Model	Supply Voltage*	Service Amps	Output Current (dc)
SWS-M100-1	115 V (ac)	20 A	2 to 100 A
SWS-M100-1	115 V (ac)	15 A	2 to 70 A
SWS-M100-2	230 V (ac)	15 A	2 to 100 A

\*10% input voltage tolerance, frequency range 50 Hz to 60 Hz

Table 26 Duty Cycle

Model	30%	60%	100%
SWS-M100-1	100 Amps 9 Volts	75 Amps 9 Volts	45 Amps 9 Volts
SWS-M100-2	100 Amps 13 Volts	75 Amps 9 Volts	45 Amps 9 Volts



Welding systems may be operated at different power-output settings, prescribed by the appropriate Duty Cycle Rating (Table 26). The Duty Cycle Rating (expressed as %) refers to the maximum weld time allowed during a given period of time, with the balance of the cycle being required for cooling. The industry uses a 10-minute Duty Cycle as a standard.

Using the 10-minute Duty Cycle, the weld times and idle times for several Duty Cycle Ratings are presented in the following table.

*Table 27 10 Minute Cycle Times*

Duty Cycle Rating	Maximum Weld Time (minutes)	Required Idle Time (minutes)
30%	3	7
60%	6	4
100%	10	0

Continually exceeding the duty cycle may activate an internal thermal protector that will disable the power supply and display a critical error message code on the operator interface screen.

*Table 28 Power Supply Dimensions and Weight*

Model	Dimensions (overall)	Weight
SWS-M100-1	15.5 in. (39 cm) wide 19.4 in. (49 cm) deep 9 in. (23 cm) high (without handle)	42.5 lb (16.8 kg)
SWS-M100-2	15.5 in. (39 cm) wide 19.4 in. (49 cm) deep 9 in. (23 cm) high (without handle)	45.5 lb (20.6 kg)

*Table 29 Extension Cords*

Model	Supply Voltage	Wire gauge 0 to 50 ft (0 to 15 m)	Wire gauge 50 to 100 ft (15 to 30 m)
SWS-M100-1	115 V (ac)	#12 AWG (2,5 mm)	#10 AWG (4,0 mm)
SWS-M100-2	230 V (ac)	#12 AWG (2,5 mm)	#10 AWG (4,0 mm)

Some power loss will occur, depending on the length of the extension cord. See table to determine the **minimum** wire size to use.



**WARNING!**

**DO NOT USE EXTENSION CORDS THAT ARE IN POOR PHYSICAL CONDITION OR HAVE INSUFFICIENT CURRENT CAPACITY. FAILURE TO DO SO CAN POSE FIRE AND SHOCK HAZARDS.**

