RETURN TO MAIN MENU

Wave Designer™

IM649

May, 1999

Safety Depends on You

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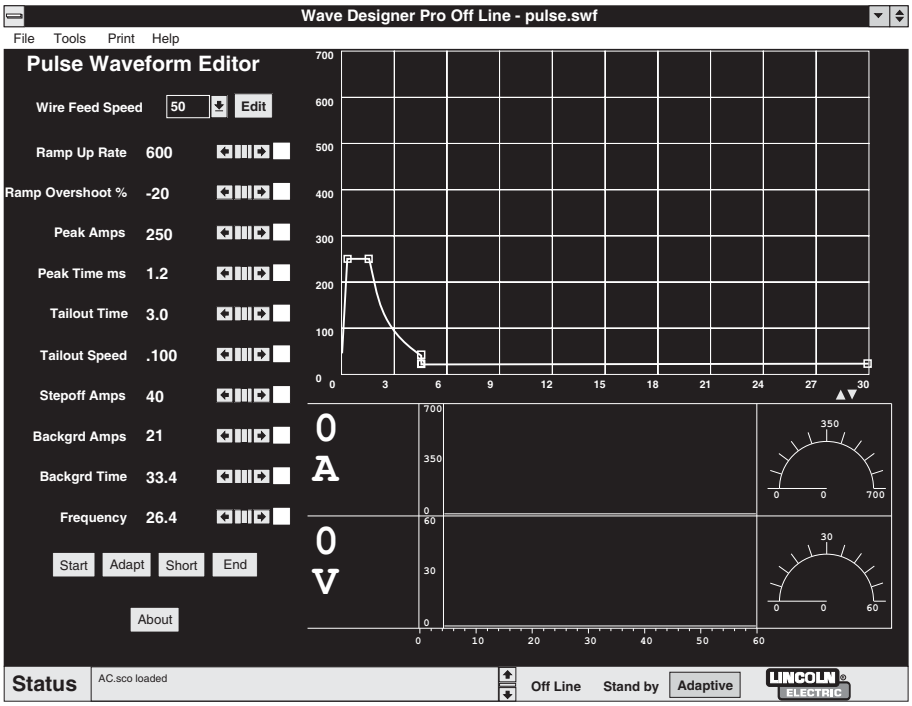

SOFTWARE OPERATOR'S MANUAL

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TABLE OF CONTENTS

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KEY TOPICS

This symbol indicates the location of key concepts throughout this manual.

1.1 PRODUCT OVERVIEW

Wave Designer is a visual, interactive software application used to modify wave shapes for use with programmable waveform-controlled welding machines such as the Power Wave 455. The ***Wave Designer*** software package includes a standard set of waveforms commonly used in commercial and industrial welding applications.

The ***Wave Designer*** software package is intended for use by a weld application engineer in concert with a skilled welding technician properly trained in welding applications.

This Instruction Manual guides you through the installation and operation of ***Wave Designer*** to modify selected standard wave shapes and produce pulsed waveforms tailored to your specific welding applications. The resulting custom waveforms automatically adjust your welding machine to produce consistent weld transfers throughout a range of wire feed speeds and arc lengths.

1.2 USER RESPONSIBILITY

Because design, fabrication, erection, and welding variables affect the results obtained in applying this type of information, the serviceability of a product or structure is the responsibility of the user. Variations such as plate chemistry, plate surface condition (oil, scale), plate thickness, preheat, quench, joint fit-up, gas type, gas flow rate, and equipment may produce results different than those expected. Some adjustments to procedures may be necessary to compensate for unique individual conditions. When possible, test all procedures, duplicating actual field conditions.

1.3 COMPUTER SYSTEM REQUIREMENTS

Wave Designer software is intended for use on Windows 95, Windows 98, or Windows NT 4.0. It will not work with Windows NT 3.51, Windows 3.1, or Windows for Workgroups. The core of this product is architecture-neutral (operating system independent). If you would like to have ***Wave Designer*** on Solaris SPARC, Solaris x86, MAC OS, AIX, OS/2, or Linux, please notify us at wavedesigner@lincolnelectric.com. With Java Internationalization, ***Wave Designer*** can support numerous European and Asian languages. Send your foreign language request to wavedesigner@lincolnelectric.com.

We recommend a Pentium processor, 32 MB of RAM, and 6 MB of hard drive disk space for efficient program operation. When running, ***Wave Designer*** occupies at least 10 MB of RAM. If your computer is low in memory, we suggest you close other programs that consume large memory. If you have less than 32 MB RAM, you may be able to run ***Wave Designer*** with “virtual memory”. Set up virtual memory with one of the following command sequences.

In Windows 95 or 98 Start | Settings | Control Panel | System | Performance
Virtual Memory | Let me specify my own virtual memory settings
Minimum 100 | OK | Are you sure you want to continue? Yes | Close
Do you want to restart your computer now? Yes

In Windows NT 4.0 log on as Administrator
Start | Settings | Control Panel | System | Performance
Virtual Memory Change... | Initial Size (MB): 100 | Set | OK
Do you want to restart your computer now? Yes

An RS-232 serial communication cable is required to use ***Wave Designer*** software with Power Wave power sources. The Power Wave requires an RS-232 DB25 male connector. Most computers feature an RS-232 DB-9 female connector as the COM serial port. (e.g. Radio Shack cat no. 26-269 serial cable connects to this combination). Verify the set up on your computer as it may differ.

We recommend using an 800 x 600 pixel or larger display monitor. A 640 x 480 display will not show all the features of the ***Wave Designer*** Editor Screens.

1.4 SOFTWARE RELEASE DATA

Wave Designer is a product of The Lincoln Electric Company. Please send your comments, questions, suggestions, and problem reports to wavedesigner@lincolnelectric.com.

Refer to the ***Wave Designer*** Welcome screen for the applicable release version of the ***Wave Designer*** software package. ***Wave Designer*** is a JAVA (TM) application (applet) and it comes bundled with Java Runtime Environment (JRE Version 1.1.6) from SUN Microsystems. You may directly download JRE from http://java.sun.com/products/jdk/1.1/jre/index.html. More information about JAVA technology can be found at the http://java.sun.com web site.

1.5 WELDING EQUIPMENT REQUIREMENTS

Wave Designer works only with the Power Wave 455 or similar Lincoln Electric Company Programmable Waveform Controlled welding systems. The following welding equipment is required to interface with ***Wave Designer*** and to produce sample welds.

- power source (Power Wave 455 or similar)
- wire feeder and associated gears and drive rolls (Power Feed 10 or similar)
- welding gun
- regulated supply of shielding gas
- continuous-feed electrode
- interconnecting hoses and cables
- sample weld materials
- oscilloscope (optional)

2.1 FILE STORAGE LOCATIONS

The ***Wave Designer*** default home directory is C:\Program Files\WaveDesigner. Subdirectories included with ***Wave Designer*** are as follows:

- arcScope - user data file for ArcScope traces (***Wave Designer Pro*** option only)
- bin - system executables and support files, do not tamper with these files
- export - user waveform data table in ASCII text and html format
- firmware - bundled system firmware for PW455 machines
- jre - bundled Java Runtime Environment 1.1.6 from Sun Microsystems
- map - waveform editor template map files, do not tamper with them
- pictures - image files for GMAW droplet transfer movies
- systemWeldFile - user custom waveform files
- weldModeFile - copies of the weld mode directory (weld files for the welding machine)

2.2 SOFTWARE INSTALLATION PROCEDURE

Standard installation (CD ROM version): Start | Run | Browse; Run D:\setup.exe

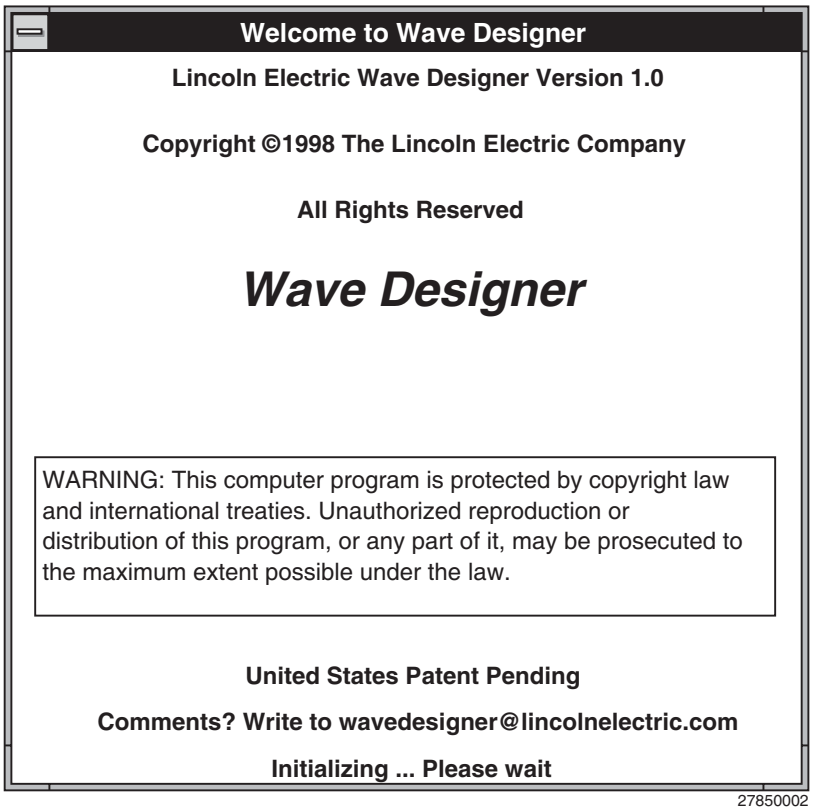
Install the ***Wave Designer*** program as you would any Windows application. Select the ***Wave Designer*** program icon from your START window to start up the program. Refer to Table 2-1 for alternate installation procedures. On startup, the ***Wave Designer*** screens in Figure 2-1 will be displayed.

NOTE: If upgrading a previous software release, save your data files (waveforms, scope traces, etc.) and uninstall the previous software release before installing the new version.

TABLE 2-1. ALTERNATE INSTALLATION PROCEDURES.

Operation	Application/ Drive	Command Sequence
Install Floppy Disk Version	A	Start | Run | Browse; Run setup.exe
Install Java Runtime Executable Version	All	Create shortcut: <dir>\jrew.exe -ms12000000 -cp .*.jar Pwgui Start Program: <dir>\Program Files\WaveDesigner\bin
Install ***Wave Designer*** Icon	Windows NT 4.0	Create Start Menu Shortcut; set icon for “All Users”
Start ***Wave Designer*** in a DOS Window	C	Open C:\Program Files\WaveDesigner\bin Type: jre -ms12000000 -cp .*.jar Pwgui or:..\jre\bin\jre -ms12000000 -cp .*.jar Pwgui
Uninstall Program	All	Start | Settings | Control Panel | Add/Remove Programs Select ***Wave Designer*** in scroll window and click on Add/Remove button. Use Windows Explorer or File Manager to remove ***Wave Designer*** folder.

FIGURE 2-1. *WAVE DESIGNER* STARTUP SCREEN.



2.3 EQUIPMENT INTERFACE CONNECTIONS

Wave Designer communicates welding parameter changes to the welding machine controller in real time (on-the-fly). To enable communication with ***Wave Designer***, reconfigure the welding machine settings as follows:

1. Disconnect the electrical power to the welding machine.

2. Remove the control box LED display panel, Figure 2-2. Be careful not to pull hard on the panel wiring harness.

3. Locate the bottom DIP switch block (SW2) on the user interface control board. Move the last DIP switch (position #8) up and reinstall the LED display panel.

4. Toggle the control box SELECT switch up and down until the Weld Mode indicator lights up. Toggle the SET switch to get an OFF readout on the LED display.

5. An RS-232 serial communication cable is required to use ***Wave Designer*** software with Power Wave power sources. The Power Wave requires an RS-232 DB25 male connector. Most computers feature an RS-232 DB-9 female connector as the COM serial port. (e.g. Radio Shack cat no. 26-269 serial cable connects to this combination). Verify the set up on your computer as it may differ.

6. Connect the RS-232 cable between the COM1 port of your computer and the mating connector behind the front center panel of the power source, Figure 2-3.

PLEASE NOTE: Some IBM ThinkPads® by default have the serial port disabled and instead the port is used for infrared. The following information describes the procedure to disable the infrared feature and enable the serial port. Follow the instructions below to use COM1 to communicate with the PowerWave. More instructions at the end discuss how to use other ports, if necessary.

The following information can also be found at the IBM website at *http://www.pc.ibm.com/qtechinfo/DSHY-3P5QW4.html*

How to enable the external serial port on your ThinkPad

SYMPTOM:
The ThinkPad is not communicating with the PowerWave serial device.

CONFIGURATION:
Any ThinkPad trying to utilize the external serial port using any applicable operating systems.

RESOLUTION:
By default, currently available ThinkPads come with the external serial port disabled and Infrared enabled on COM 1. To use the serial port on COM 1 you must either disable infrared or change infrared so that it uses alternate resources. If you are not using infrared for printing or file sharing it is recommended that it be disabled.

To disable infrared and enable the serial port on COM 1 do the following:

1. Double-click your ThinkPad Features or ThinkPad Configuration icon located in the ThinkPad folder on your desktop.
2. Locate the Infrared button located on the left-hand side of this configuration screen and click it once.
   (Note: If you hold your mouse pointer over any of the icons in this configuration screen the button will be identified at the bottom in the status window.)
3. Change Infrared from "Enable" to "Disable" and click "OK".
4. Locate the serial port icon and click it once.
5. Select serial port "enable" and insure that the COM PORT setting is "COM 1" and click "OK".
6. Shut down and restart the computer.

More Information:
There are many different combinations of port settings that are possible. The following table indicates the standard settings for the four available COM Ports:

COM 1 03F8 4	COM 2 02F8 3
COM 3 03E8 4	COM 4 02E8 3

Please note that COM 1 and 3 share IRQ 4 and COM 2 and 4 share IRQ 3. You can not configure multiple devices to the same IRQ.

If not successful, try to use COM3. Follow the instructions above while substituting COM1 with COM3. Configure Wave Designer by changing the properties of the Wave Designer icon (right click mouse when pointing to the icon), add "-port com3" to the command line.

FIGURE 2-2. CONTROL BOARD DIP SWITCH SETTING.

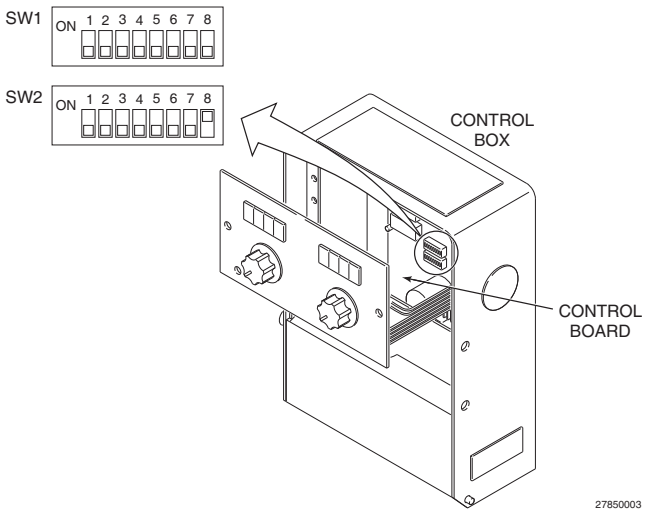
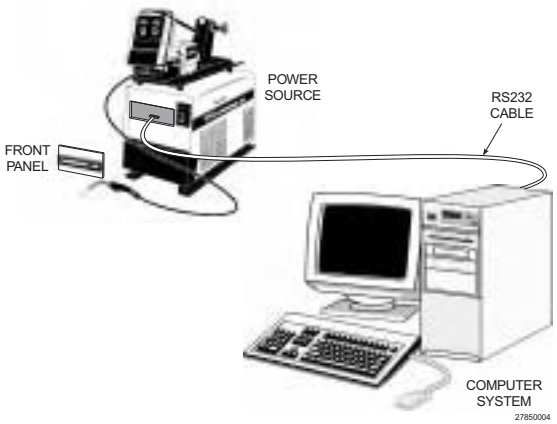
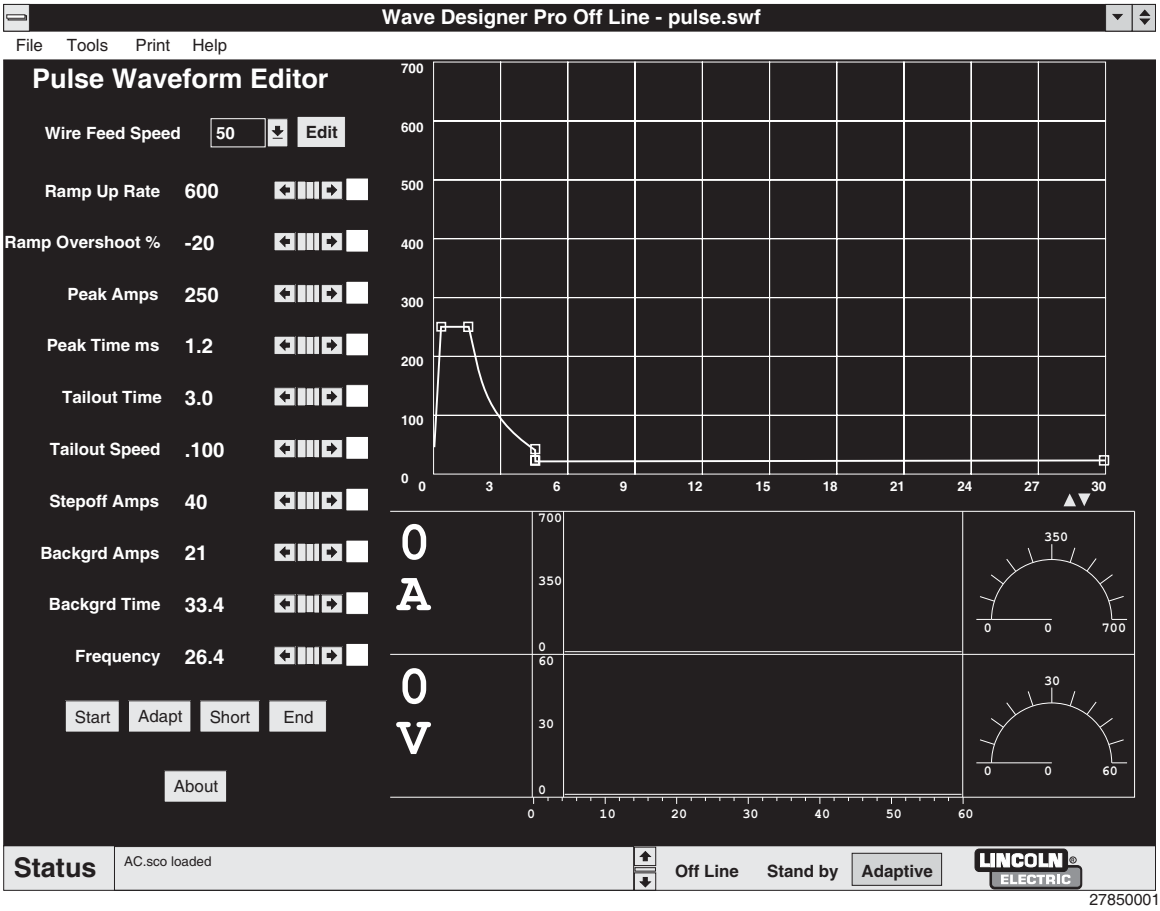


FIGURE2-3. INTERFACE CONNECTION.



2.4 EQUIPMENT/SOFTWARE STARTUP

When the ***Wave Designer*** software installation is complete, ***Wave Designer*** is listed among the programs you can start up from the Windows startup screen. Click on START, point to the programs option, then click on the ***Wave Designer*** option. The ***Wave Designer*** Welcome screen is displayed followed by the Pulse Waveform Editor screen. When the Pulse Waveform Editor screen is displayed, the software is ready for use.



2.5 UPGRADE FIRMWARE

An ArcScope application is provided with ***Wave Designer Pro***. In order to run the ArcScope application, it may be necessary to upgrade the welding machine firmware. If the old firmware does not support ArcScope, the ArcScope application will display garbled data rather than waveforms. ***Wave Designer*** will automatically detect the firmware version and prompt you to upgrade the firmware if required.

3.1 SYNERGIC WELDING AND WORKPOINTS

Prior to using ***Wave Designer*** it is important to have a good understanding of the concepts of synergic welding and workpoints. Synergic welding is basically “one knob control” of a welding process; all other variables of the process are adjusted by the power source based on the single controlling variable. This single controlling variable is known as a workpoint. For example, in synergic pulse welding (GMAW-P), the operator can adjust the wire feed speed (WFS). The WFS is the workpoint. The synergic power source will then set all other GMAW-P variables based on the WFS by “looking up” the other variables from a pre-programmed weld table. See Figure 3-1.

Wave Designer is a program that lets you develop a customized weld procedure by letting you program each variable for multiple workpoints into a weld “look up” table.

Power Wave power sources go even a step further than simply “looking up” pre-programmed variables from a weld table. If a selected WFS is between two pre-programmed workpoints, the Power Wave will interpolate values for each of the welding variables. The result is a precise and continuous range of welding control.

Refering to Figure 3-1, lets examine how this interpolation works by looking at one welding variable — background amps. The operator selects a wire feed speed of 175 in/min. This value is between the pre-programmed workpoints of 150 and 200 in/min. The Power Wave interpolates between the pre-programmed background amp values of 80 and 60 and adjusts the background amps to 70.

FIGURE 3-1. WFS ENCODER AND WELD DATA TABLE.

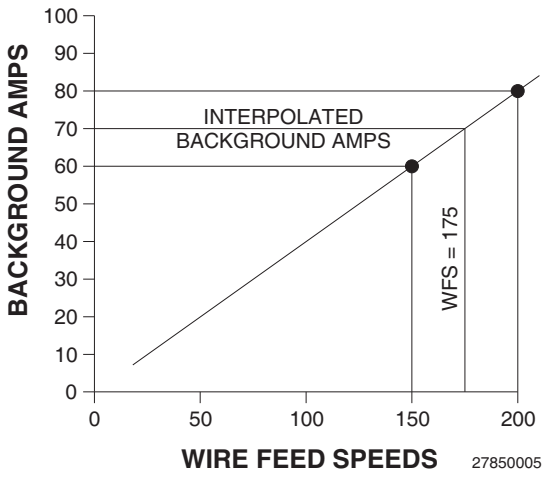
WFS/AMPS ENCODER

NOTE: WFS ENCODER SETTING DETERMINES WELDING PROCESS VARIABLES PER RELATED WELD TABLE.

PRE-PROGRAMMED WELDING PROCESS VARIABLES

WORK-POINTS (WFS)	PEAK CURRENT	PULSE WIDTH	BACKGROUND AMPS	FREQUENCY
80	280	1.2	20	50
100	280	1.2	40	60
150	280	1.2	60	80
200	280	1.2	80	90
250	280	1.2	100	100

INTERPOLATED PARAMETER VALUE

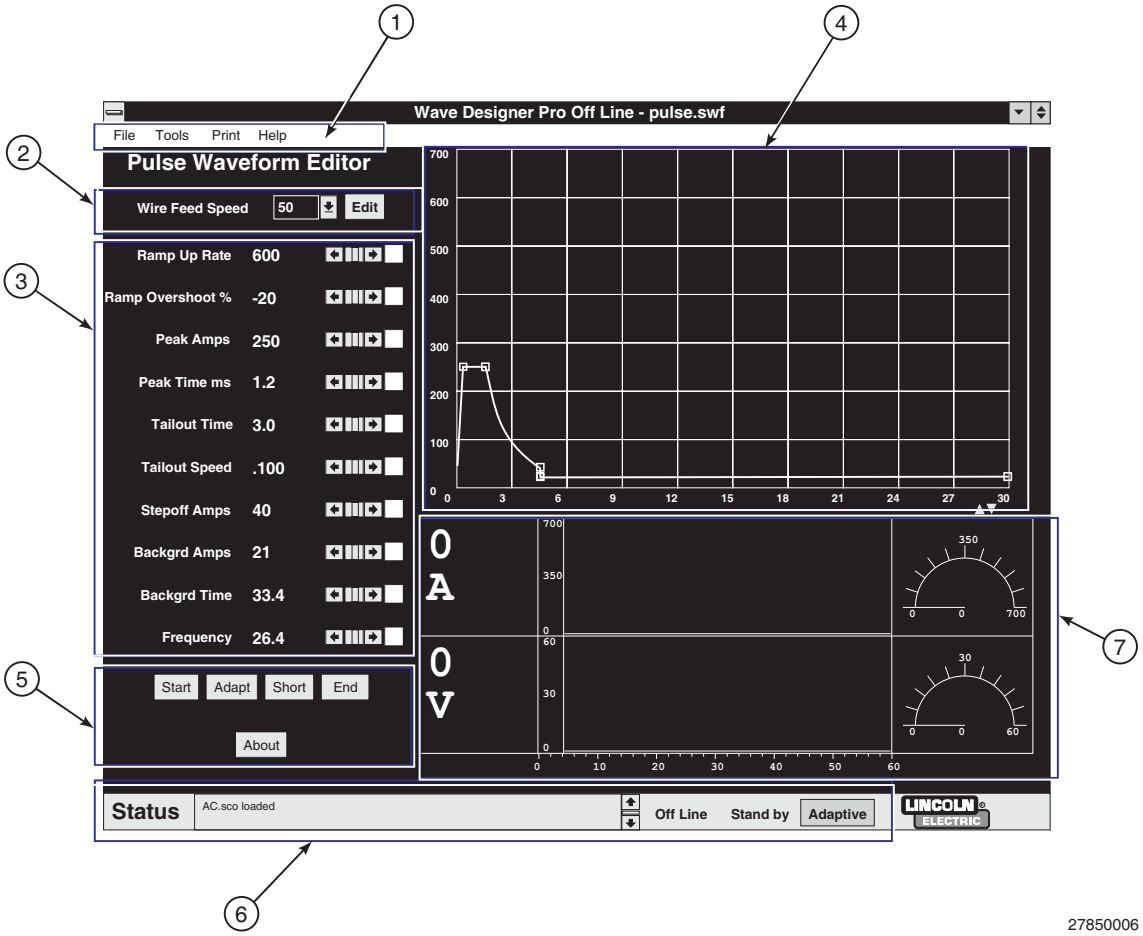


3.2 WORKING IN *WAVE DESIGNER*

3.2.1 WAVEFORM EDITOR WINDOW

Refer to the Waveform Editor window in Figure 3-2 and the related usage instructions.

FIGURE 3-2. WAVEFORM EDITOR WINDOW.



1. **Tool Bar** Tool bar menus access alternate windows, open and save files, etc. Detailed instructions are provided in paragraph 3.2.2.

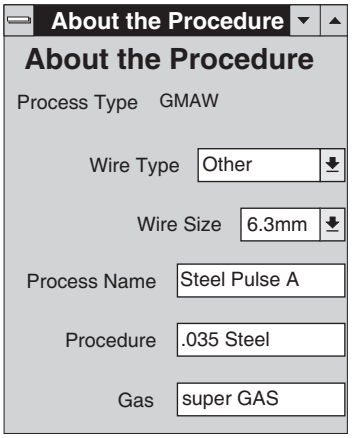
2. **Workpoint Selector/Editor** The workpoint selector includes a pulldown window for selecting a workpoint and an edit window for changing the listing of workpoint values. For the Pulse Waveform Editor, the workpoints are wire feed speeds. The workpoint parameter (peak voltage, current, etc.) varies with the welding mode (pulse, STT, etc.). Refer to paragraph 3.2.3 for more detail on selecting and editing workpoints.

3. **Variable Parameters** The listing of variable parameters display the active parameter values for the selected WFS. The parameter values are changed (edited) with the related arrows and slide bars or by moving parameter nodes in the waveform graphic editor. See paragraph 3.2.4 for more details on editing variable parameters and the wave shape.

4. **Graphic Editor** The graphic editor displays the active wave shape. The wave shape changes when the parameter values are changed. The displayed wave parameter nodes (boxes) can be selected with your mouse to edit the variable parameters. Pressing the <F1> key will also toggle from one selected node to another. See paragraph 3.2.4 for more details on editing variable parameters and the wave shape.

5. **Optional Windows** The optional window buttons open additional windows used during wave shaping. Optional windows in the pulse Waveform Editor include Start, Adapt, Short, End, and About. Details about the use of most optional windows is covered in the applicable appendix (i.e. Appendix A for Pulse Wave Shaping). We use the About window shown in Figure 3-3 to record descriptive weld application data for custom wave shape files. This information is stored with the program in the computer and in the Power Wave.

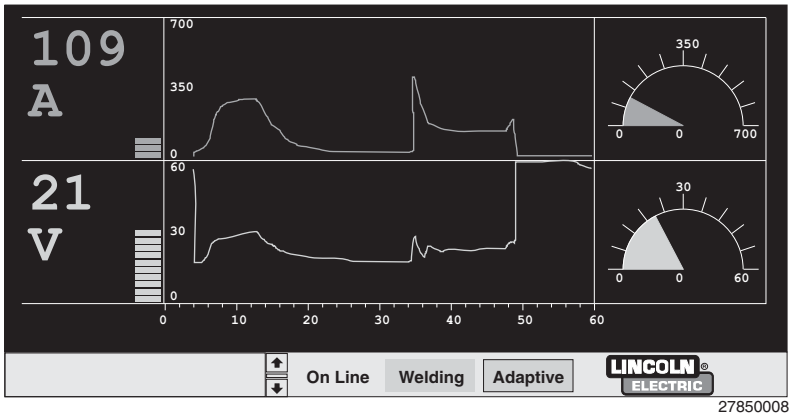
FIGURE 3-3. THE "ABOUT" EDIT WINDOW.



6. **Wave Designer Status Bar** This status bar provides a scrolled listing of recent program events, error conditions, etc. Use the arrow keys ∂ƒ to scroll through the listings. The status bar includes three system status indicators: on line/off line, standby/welding, and adaptive/non-adapt. The adaptive indicator is also a button that toggles between the adaptive and non-adaptive mode.

7. **Volts/Amps Display** The Volts/Amps display, Figure 3-4, provides real time, oscilloscope type displays of the voltage and amperage outputs from the connected power source. Smaller display monitors (640 x 480 pixels or less) will not show the volts/amps display.

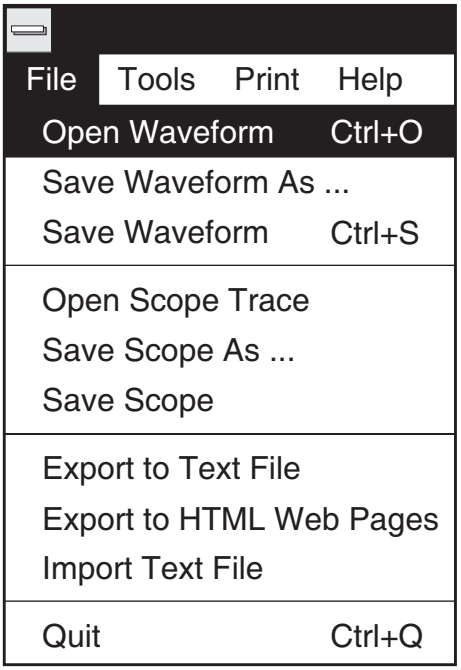
FIGURE 3-4. TYPICAL VOLTS/AMPS DISPLAY.



3.2.2 WAVEFORM EDITOR TOOL BAR

There are four menu selections available on the pulse waveform editor tool bar. The following describes how to use the File, Tools, and Print menus. The Help menu is self explanatory.

3.2.2.1 FILE MENU



The File menu provides options for accessing and managing waveform data files. The File menu options include the following:

Open Waveform Ctrl+O
Use the Open Waveform option to open a ***Wave Designer*** waveform or an in-house custom waveform you created and saved earlier.

Save Waveform As ...
Use the Save Waveform As ... option to save an open waveform under a different filename.

Save Waveform Ctrl+S
The Save Waveform option saves all recent changes to an open waveform file.

Open Scope Trace (***Wave Designer Pro*** option only)
Use the Open Scope Trace option to open a graphical display of oscilloscope type waveforms (volts, ohms, amps, etc.) for any stored waveform (.swf) file.

Save Scope As ... (***Wave Designer Pro*** option only)
Use this option to save an open Scope Trace file under a different filename.

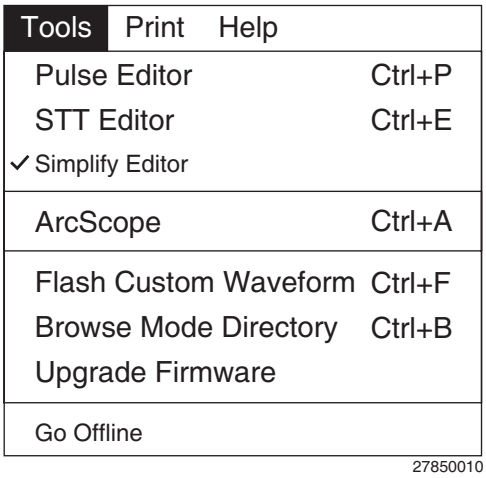
Save Scope (***Wave Designer Pro*** option only)
The Save Scope option saves changes to the parameters in a .sco file caused by recent changes to an open waveform file. Failure to actively open and save the Scope Trace file may result in an inaccurate parameter record for a waveform undergoing design changes.

Export to Text File
Use the Export to Text File option to save a tabular record of the waveform variables data at each of its design (Wire Feed Speed) workpoints.

Export to HTML Web Pages
Use the Export to Web Pages option to copy a custom waveform to a web page for transmission of the waveform to Lincoln Electric for review.

Quit Ctrl+Q
Use the Quit option to exit the ***Wave Designer*** program.

3.2.2.2 TOOLS MENU



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The Tools menu includes waveform display options and other tools required to operate ***Wave Designer***. The Tools menu options include the following:

Pulse Editor Ctrl+P
Display the Pulse Waveform Editor screen.

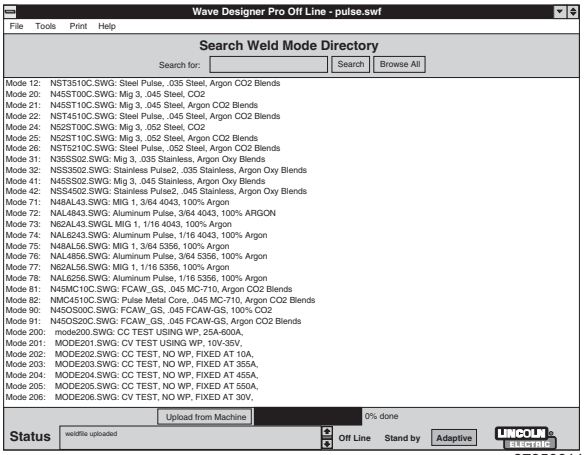
STT Editor Ctrl+E
Display the STT Waveform Editor screen.

Simplify Editor
Display the primary wave shaping parameters only. (See page A-1.)

ArcScope Ctrl+A
(***Wave Designer Pro*** option only)
Display the Scope Trace screen for the currently displayed waveform.

Flash Custom Waveform Ctrl+F
Transmit selected waveforms to the welding machine. This option requires that the equipment interconnections are made and that the welding machine is on-line (communicating).

Browse Mode Directory Ctrl+B
Display the Weld Mode Directory screen. The Weld Mode Directory lists the waveforms that are presently downloaded into the welding machine controller memory. You can download up to ten custom waveforms to the weld mode directory, memory slots (Modes) 155 through 164.



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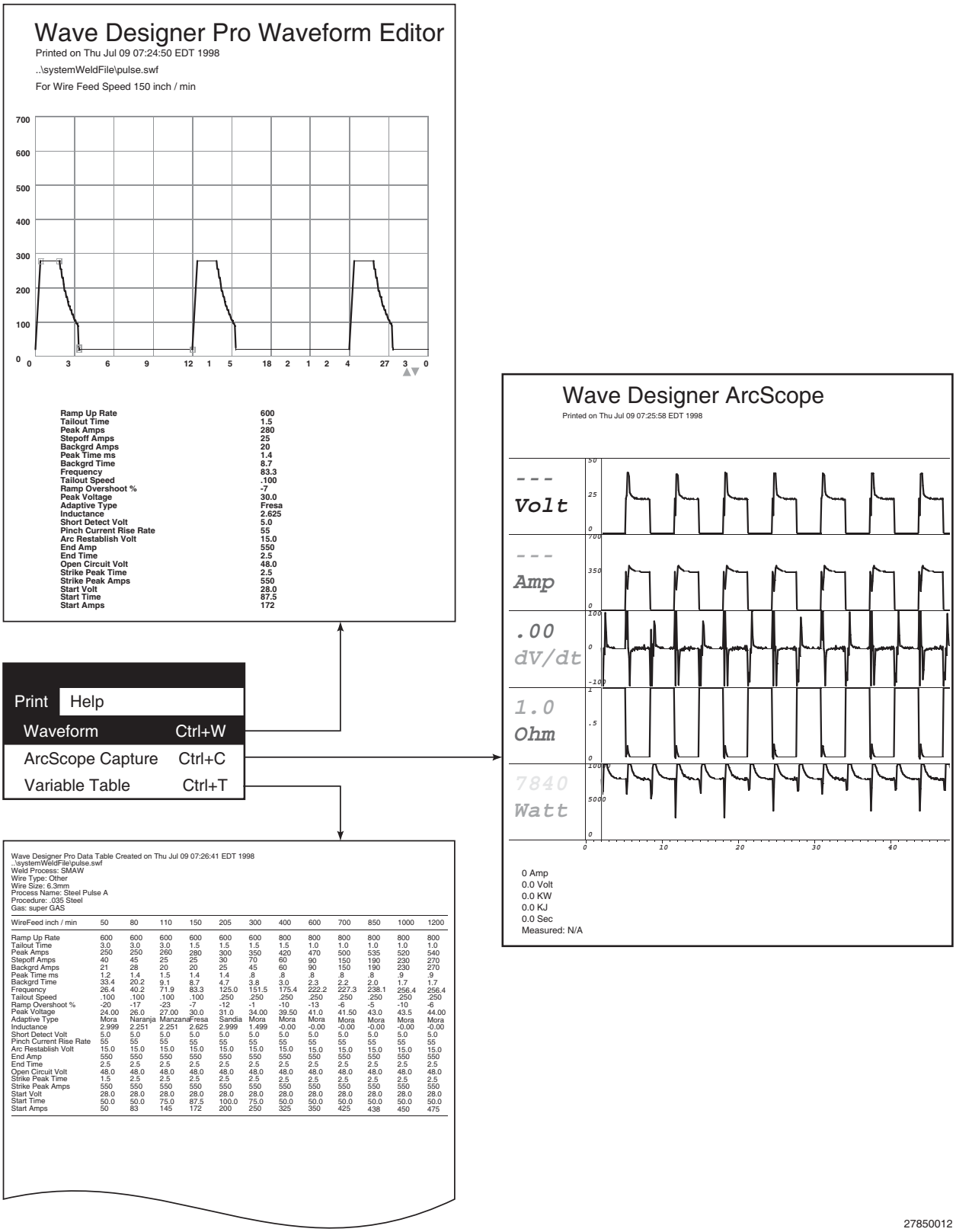
Upgrade Firmware
Use this option when installing new firmware on your welding machine. The new firmware is required to run this ***Wave Designer*** software release. When later software releases are issued, they may or may not include firmware upgrades. If firmware upgrades are included, you will use the Upgrade Firmware option to install the upgrades.

Go Offline
Use the Go Offline option to temporarily interrupt and re-establish communications between the welding machine / wire feeder and ***Wave Designer***.

3.2.2.3 PRINT MENU

Print menu options enable you to print out a waveform display, ArcScope screen, or tabular waveform data listing as shown below. The Print menu options include the following:



WireFeed inch / min	50	80	110	150	205	300	400	600	700	850	1000	1200
Ramp Up Rate	600	600	600	600	600	600	800	800	800	800	800	800
Tailout Time	3.0	3.0	3.0	1.5	1.5	1.5	1.5	1.0	1.0	1.0	1.0	1.0
Peak Amps	250	250	260	280	300	350	420	470	500	535	520	540
Stepoff Amps	40	45	25	25	30	70	60	90	150	190	230	270
Backgrd Amps	21	28	20	20	25	45	60	90	150	190	230	270
Peak Time ms	1.2	1.4	1.5	1.4	1.4	.8	.8	.8	.8	.8	.9	.9
Backgrd Time	33.4	20.2	9.1	8.7	4.7	3.8	3.0	2.3	2.2	2.0	1.7	1.7
Frequency	26.4	40.2	71.9	83.3	125.0	151.5	175.4	222.2	227.3	238.1	256.4	256.4
Tailout Speed	.100	.100	.100	.100	.250	.250	.250	.250	.250	.250	.250	.250
Ramp Overshoot %	-20	-17	-23	-7	-12	-1	-10	-13	-6	-5	-10	-6
Peak Voltage	24.00	26.0	27.00	30.0	31.0	34.00	39.50	41.0	41.50	43.0	43.5	44.00
Adaptive Type	Mora	Naranja	Manzana	Fresa	Sandia	Mora	Mora	Mora	Mora	Mora	Mora	Mora
Inductance	2.999	2.251	2.251	2.625	2.999	1.499	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
Short Detect Volt	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Pinch Current Rise Rate	55	55	55	55	55	55	55	55	55	55	55	55
Arc Restablish Volt	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
End Amp	550	550	550	550	550	550	550	550	550	550	550	550
End Time	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Open Circuit Volt	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Strike Peak Time	1.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Strike Peak Amps	550	550	550	550	550	550	550	550	550	550	550	550
Start Volt	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0	28.0
Start Time	50.0	50.0	75.0	87.5	100.0	75.0	50.0	50.0	50.0	50.0	50.0	50.0
Start Amps	50	83	145	172	200	250	325	350	425	438	450	475

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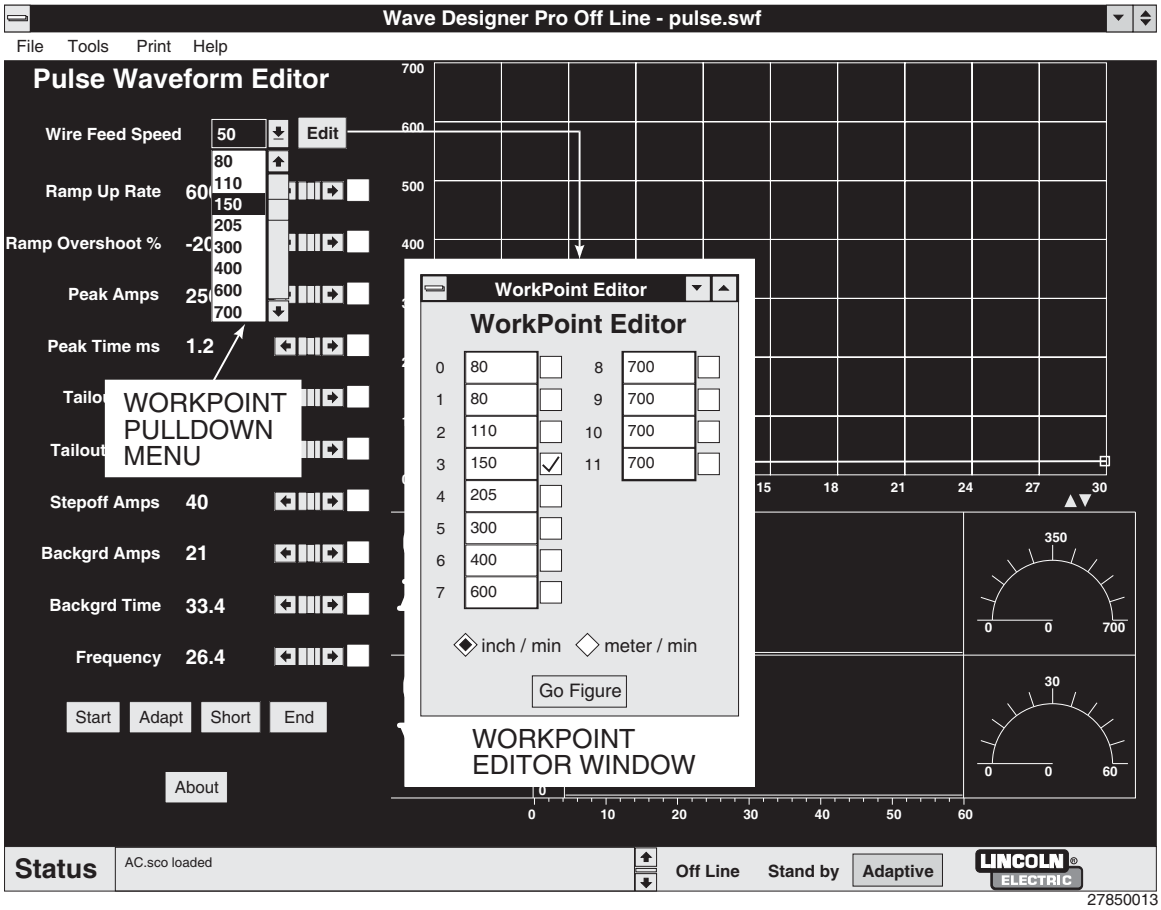
3.2.3 EDITING AND SELECTING WORKPOINTS

For each custom welding application, unique wave shapes are developed for specific workpoints within the range of workpoints defined for the application. In ***Wave Designer*** the range of workpoints and the specific workpoint values are defined in a Workpoint Editor window. After the workpoints are defined, we use a workpoint pulldown menu to select a specific workpoint for wave shaping. The following describes how workpoints are defined (edited) and selected for a Pulse (GMAW) mode welding application.



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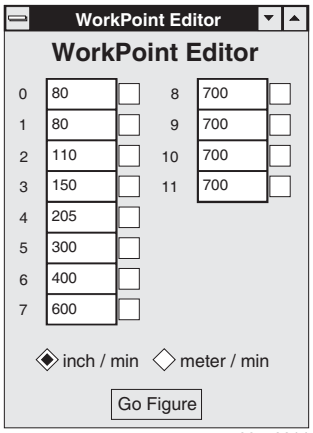
3.2.3.1 EDITING WORKPOINTS

Clicking on the Edit button in the waveform Editor window opens a Workpoint Editor window. The Workpoint Editor window displays a listing of workpoints for the selected standard waveform. Use the Workpoint Editor window according to the following descriptions and guidelines:

- Each workpoint value must be equal to or greater than the preceding workpoint value.
- The workpoints range is from the lowest defined workpoint to the highest.
- Successive workpoint boxes can share the same value. Equivalent workpoints will share the same wave shape. ***Wave Designer*** selects the last workpoint of equal value as the controlling workpoint.
- You can click on the related check box to lock (fix) the wave shape variables for a developed workpoint.
- You can click on the Go Figure button to extrapolate/interpolate fixed workpoint parameter values for all non-checked workpoints.
- When only one workpoint is fixed (checked), Go Figure copies the workpoint (sets the wave shape parameters for all other defined workpoints equal to those of the fixed workpoint). This function should be used just after the wave shape for the first workpoint is fully developed.
- When two or more workpoints are developed and fixed, selecting Go Figure performs a linear interpolation of the wave shape parameters between checked workpoints and extrapolation to unchecked workpoints outside the checked ones.



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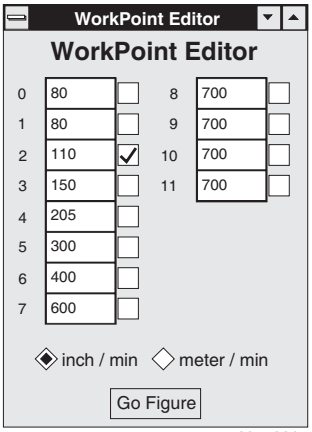

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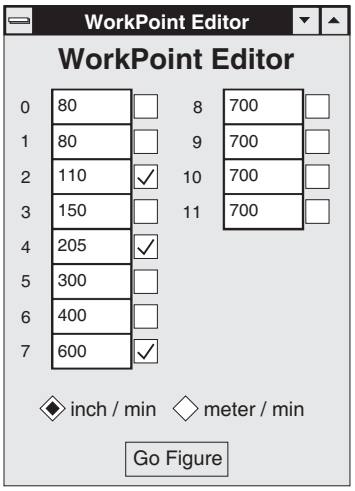

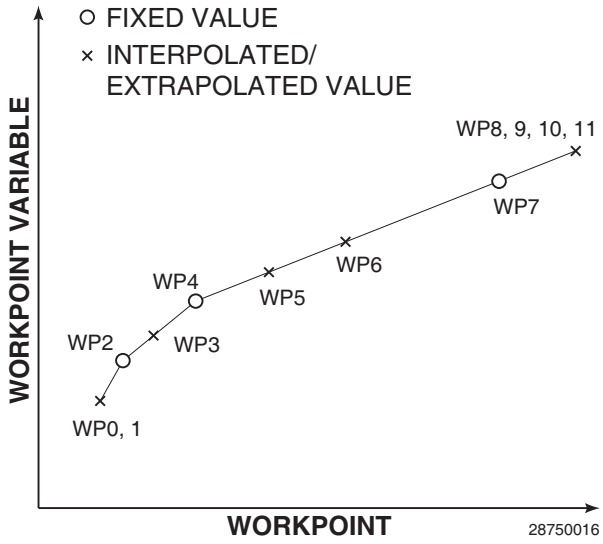

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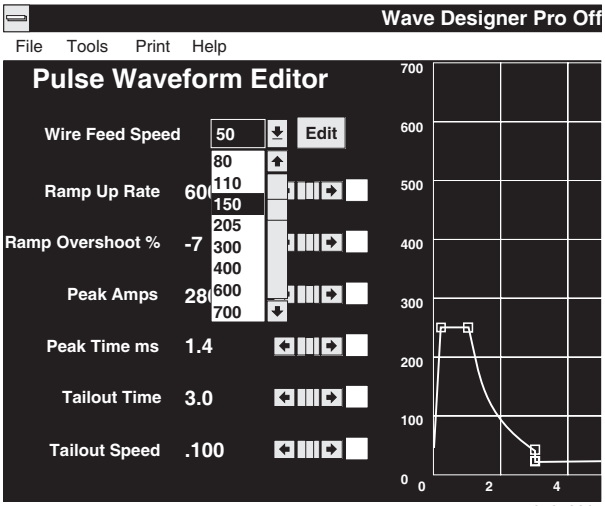
3.2.3.2 SELECTING WORKPOINTS

Clicking on the workpoint display box in the waveform Editor window opens a Workpoint pulldown menu. The pulldown menu displays the listing of workpoints defined for the active waveform. Use the pulldown menu according to the following descriptions and guidelines:

- Click on any one of the listed workpoints to access the related waveform.

- The related welding machine control must be set to the selected parameter value. **If the welding machine setting is not equal to the selected workpoint value, changes to the wave shape will be applied to the workpoint value nearest the welding machine setting.**

- The welding machine Trim encoder must be set to 1.00; the Arc control to “OFF”, and the Mode control to “OFF”. **Failure to verify these welding machine settings will defeat all wave shaping efforts.**



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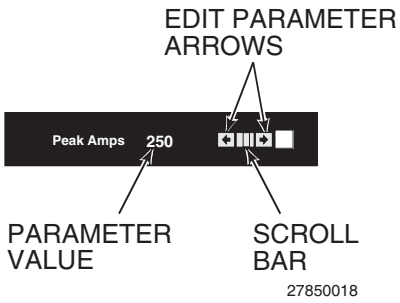
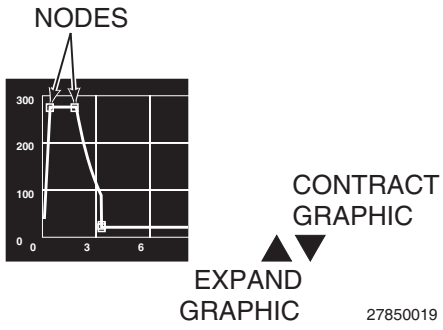
3.2.4 EDITING VARIABLE PARAMETERS

The following is a summary of the different methods available for changing (editing) parameter values on the Waveform Editor screen and other display screens accessible through ***Wave Designer***. Read the following information carefully before making parameter changes on the Waveform Editor screen.

- The variable editor and wave shape graphic functions are interrelated.
- Click once on an edit parameter arrow to increase or decrease the parameter value by one unit; click and hold the arrow to ramp the value up or down.
- Click on and drag the parameter display scroll bar to scroll through the value range.
- Select (highlight) the parameter value. Select and use the up/down keys ∂ƒ to change the value. Hold down the Ctrl key while using the up/down keys to change the value 10 times faster. You may directly type in the desired value.
- Click on a node (hot spot) on the waveform graphic and use the parameter arrows or drag the node with your mouse as needed to achieve the desired parameter value readout. Use the keyboard arrow keys ∂ƒß© to move the hot spot. Press Ctrl and an arrow key to move the hot spot 10 times faster. Use the F1 key to jump to the next hot spot.





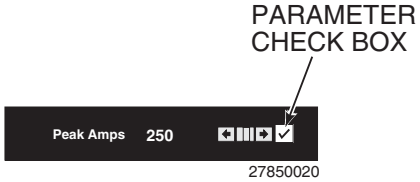
⚠ CAUTION

Uncontrolled drag with the mouse can result in large changes to the welding machine output. Large changes can result in unexpected and undesired results. We recommend using the edit arrows or keyboard entry to change parameter values on-line.

- The expand and contract graphic arrows change the time scale on the X-axis to expand or contract the wave shape.

To select a Waveform Editor parameter for edit, click on the parameter check boxes as needed to erase the checkmarks for all other parameters.

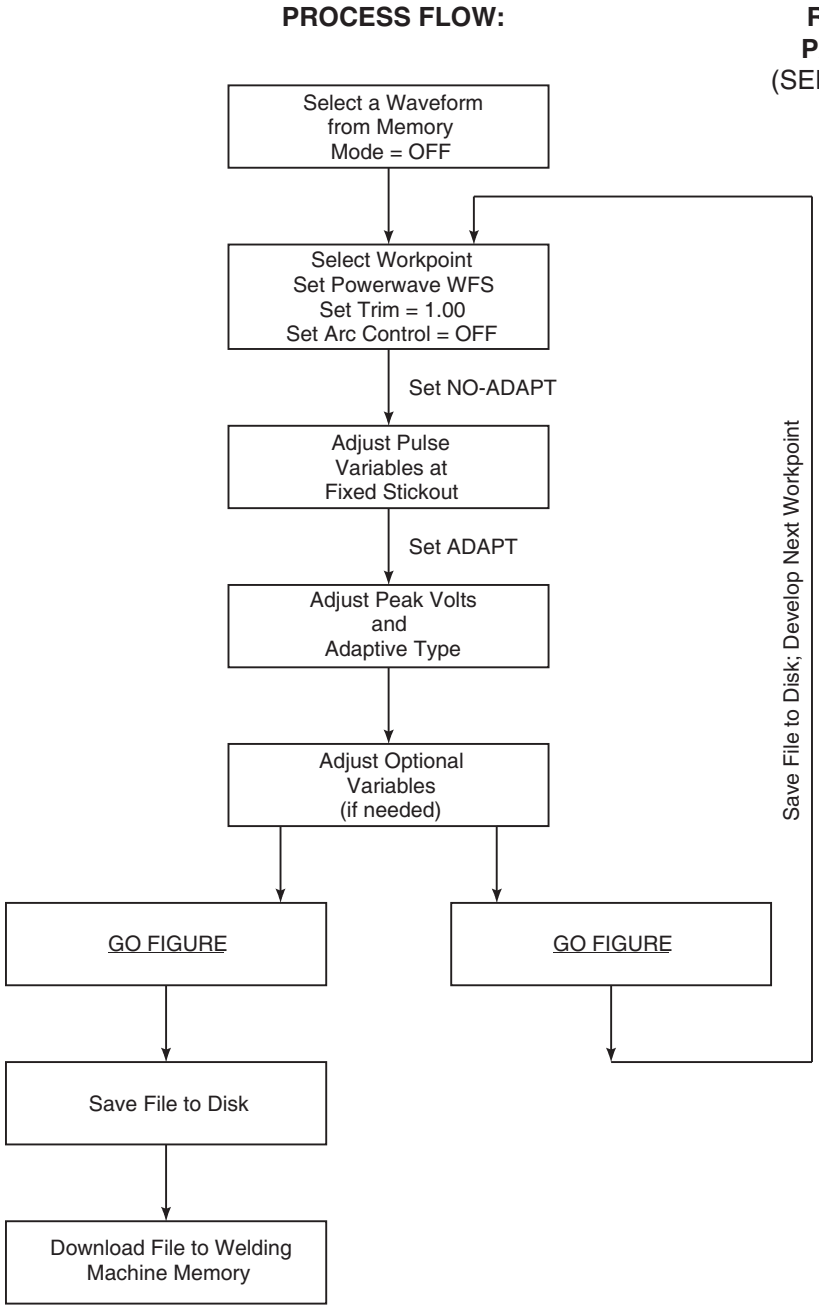
If a parameter has a visible checkmark, the related parameter value will remain fixed; you cannot change it.



When a parameter is known to be set properly, you may wish to leave it fixed while adjusting other parameters. However, the variables are interrelated; changing parameters while one or more is fixed may unpredictably effect other variables.

3.3 WAVE DESIGN PROCESS

The wave design process is a series of operations that allows you to quickly modify a standard waveform to fit your specific welding application. The following process flowchart applies to a pulse waveform, but is similar to the process used to modify STT and other waveforms. Examples of each process step can be found in the listed reference paragraphs.



3.4 DOWNLOADING WAVE SHAPES

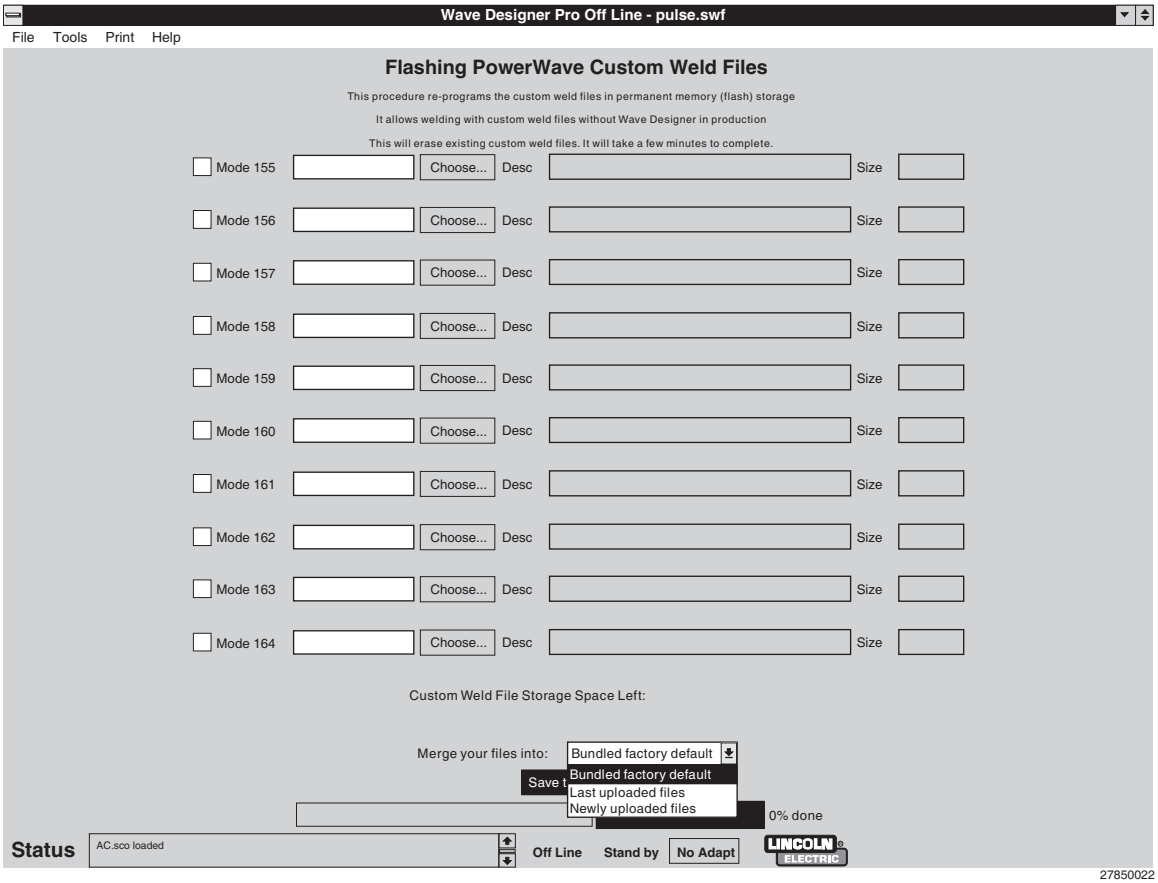
The Power Wave stores wave shapes in the welding machine controller memory. The memory structure does not allow an upload or download of individual wave shapes. When downloading wave shapes to the welding machine, the entire welding machine memory must be overwritten. Each wave shape must be re-selected for download to the flash memory. Two methods are available to access desired weld files; use the “Upload From Machine” option in the Weld Mode Directory window or (if the weld files are all factory default files) select the “Bundled Factory Default” option from the Flash Custom Waveform window. Any custom wave shapes not specifically selected for download will not be re-written to the welding machine’s flash memory.

When downloading files to a new Power Wave welding machine, be aware that the bundled factory default files in the ***Wave Designer*** software may be out of date, but needed for use with older welding machines. Save the old factory default files in a new, “old weld files” directory and access the latest factory default files from the Lincoln Electric web site for use on the newer Power Wave machine(s).

Weld files can be corrupted during upload from a welding machine. If a weld file is corrupted, you will not be able to upload the machine’s weld mode directory.

You can download up to ten custom waveforms to the weld mode directory. The assigned memory slots are Modes 155 through 164. When all ten slots are in use, the only way to install another custom waveform is to overwrite one of the ten allocated memory slots. Use the following procedure to download acceptable wave shapes to the allocated welding machine memory.

1. Select the Flash Custom Waveform option from the Tools menu to display the Flashing PowerWave Custom Weld Files screen.



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2. Select a blank Mode or a defined Mode for overwrite by clicking on a box to the left of the Modes listing. When the Mode is selected, a checkmark appears in the Mode box.

3. Enter the file name of the desired waveform in the box to the right of the selected Mode number. Click on the Choose button to find the exact name of the weld file(s) you wish to download. Click on the weld file name to select the file for download.

4. Use steps 2 and 3 to assign up to ten new file names to the weld Modes list. If a good weld file was already stored in the welding machine's memory, you must re-enter the name of the stored weld file to download it to the welding machine.

5. Click on one of the three "Merge your files into:" options. Select the desired option per the following descriptions.

   a. Bundled factory default — Merges selected files with factory default files for download.

   b. Last uploaded files — Merges selected files with weld mode directory last uploaded from a welding machine. Overwrites modes 155 through 164 if like mode I.D. number(s) are assigned to selected file(s).

   c. Newly uploaded files — Merges selected files with directory of connected welding machine. Overwrites modes 155 through 164 if like I.D. number(s) are assigned to selected file(s).

6. Click on the 

button at the bottom of the screen to download the selected files to the welding machine's Weld Mode Directory.

3.5 AUTOSAVE

When working in ***Wave Designer***, the autosave function will automatically back up the waveform in a file called 'backup.swf' every 5 minutes. In case of a program or computer glitch, exit and restart the program, open the 'backup.swf' file, and use the Save As ... file menu option to save the backup file under a different file name. When you modify a waveform, but fail to manually save it, the waveform title will change to 'Wave Designer Pro – xxx.swf [modified]', thereby indicating that the waveform has not been manually saved.

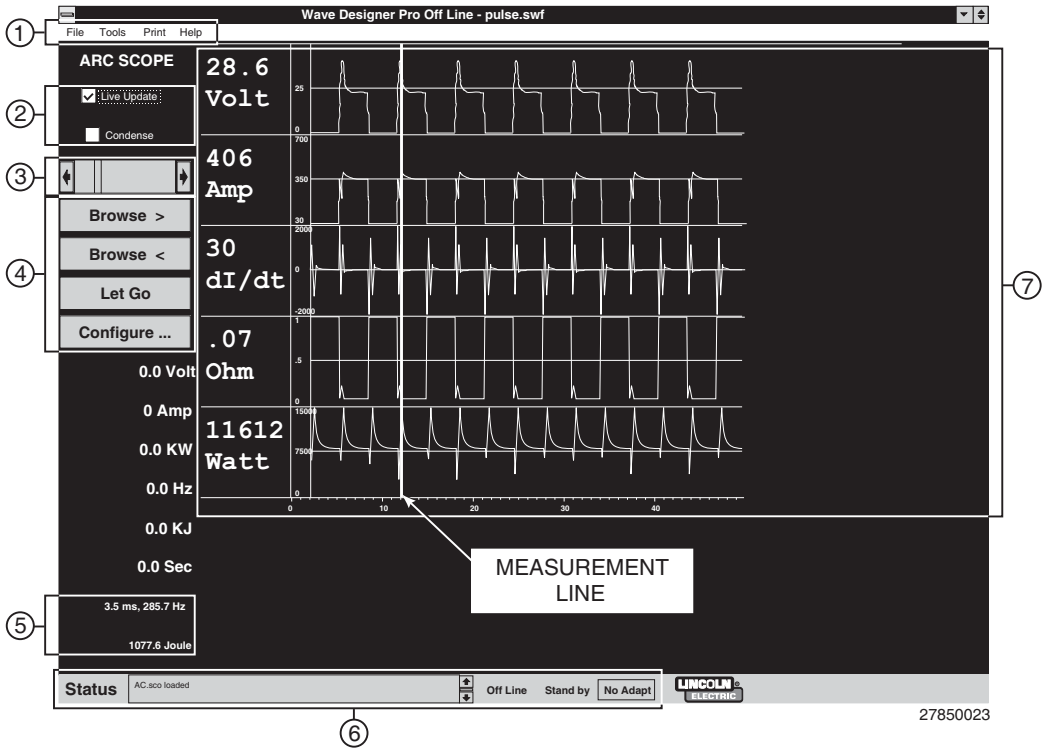
4.1 INTRODUCTION

The following describes the ArcScope application included with ***Wave Designer Pro***. The ArcScope application provides oscilloscope type displays of power source output waveforms on your computer monitor.

4.1.1 USING THE ARC SCOPE WINDOW

Refer to the ArcScope window in Figure 4-1 and the related window usage instructions.

FIGURE 4-1. ARC SCOPE WINDOW.



1. **Tool Bar** The tool bar is the same tool bar displayed in the waveform editor window. The Tools and Print menus provide ArcScope capture and print options for storage and printout of the active ArcScope graphics.

2. **Toggle Options** *Live Update* and *Condense* are toggled on and off with the mouse. Additional information about the *Live Update* and *Condense* options is provided in paragraph 4.1.2.

3. **Measurement Scroll Bar** Use the measurement scroll bar to move the vertical blue measurement line left and right in the waveform display area. The measurement line indicates where the data values are being taken among the various waveforms. Use the scroll bar arrows to move the line incrementally. You can also click and drag the scroll bar or measurement line.

4. **Optional Windows** The optional window buttons select ArcScope windows and options to tailor the ArcScope data sample and display. Refer to paragraph 4.1.2 for additional information about the optional windows.

5. **Sample Statistics** With the blue measurement line at the zero reference point, you can click on any point to the right of the line to get a sample readout of the time period (ms), pulse frequency (Hz), and weld system heat input (kJ) between the reference line and the selected points measured: N/A is shown when no measurement has been taken.

6. **Status Bar** The status bar provides a scrolled listing of recent ***Wave Designer*** program operations, error conditions, etc., and three operational status indicators. The adaptive indicator is also a button that toggles between the Adaptive and Non-Adaptive mode.

7. **Graphical Display Area** The graphical display provides refreshed displays of the selected waveforms from the output of the connected power source. The power source sampling rate is 10kHz, unless the Condense option is selected.

4.1.2 OTHER ARC SCOPE OPTIONS

Live Update: The Live Update option is normally on (checked) to display changing output data during the weld application. To maintain an existing display for study while welding, turn the Live Update option off.

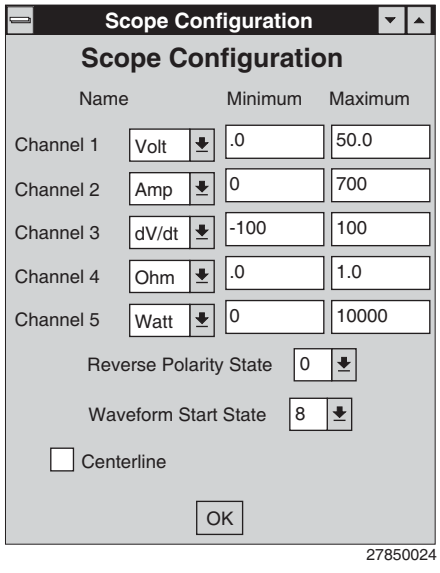
Condense: The Condense option is normally off (not checked). When turned on, the Condense option forces the welding machine to sample data only during weld state transitions. This extends the length (time) of the sample stored in the welding machine buffer and records only what happens during weld state transitions.

Browse: The Browse left/right options allow you to display the contents of the welding machine storage buffer following a weld application. The buffer stores the last 300 milliseconds of sampling data when the Condense option is off. (Longer samples are stored when the Condense option is on.)

Pause/Let Go: The Pause option allows you to freeze an ArcScope display while the welding application is running. The Let Go option disables the Pause function.

Configure: Use the Scope Configuration window to select the power source measurements for the graphical display area.

Centerline: Select the Centerline option to place a gray centerline in each of the displays.



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Available measurement/display options include:

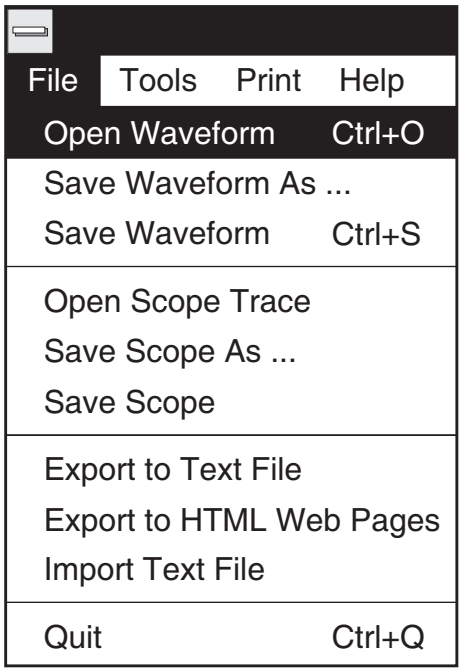
Volt:	average power source output voltage
Amp:	average arc current
GSF:	(Global Scale Factor) correction factor forcing the weld application to the desired arc length
State:	the state progression of the welding application (ramp-up, peak, tailout, etc.)
Watt:	instantaneous power output
dv/dt:	rate of voltage change per unit time calculated at a 10 kHz sampling rate
dI/dt:	rate of amperage change per unit time @ 10 kHz
dp/dt:	rate of power change per unit time @ 10 kHz
ohm:	arc impedance
dr/dt:	rate of resistance change per unit time @ 10 kHz

Reverse Polarity State: For machines with an AC welding option, Reverse Polarity State selects the State (0 to 19) for electrode negative.

Waveform Start State: Specifies which Power Wave state (0 to 19) is used to calculate the actual frequency displayed on the bottom left side of the ArcScope window. ***Wave Designer*** counts the elapsed time between the start of this state to calculate the frequency. The Waveform Start State is set to 8 by default. Call Lincoln Electric for more details.

File | Save Scope: Use the Save Scope option to save the scope trace data in ASCII text format for use in a word editor or spreadsheet data processing application.

File | Open Scope Trace: Use the Open Scope Trace option to open a saved scope trace data file.



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5.1 OVERVIEW

Wave Designer troubleshooting is limited to the software application. If the welding machine does not respond, recheck the interface connection and communication setup requirements in section 2 of this manual. Refer to the welding machine service manuals for troubleshooting suspected equipment malfunctions.

5.2 *WAVE DESIGNER* TROUBLESHOOTING PROCEDURE

If you believe the ***Wave Designer*** software program is malfunctioning, use the following procedure to launch the ***Wave Designer*** program with a DOS console window for diagnostic messages in the background.

a. From your Windows™ Start screen, move the mouse over the ***Wave Designer*** icon.

b. Right click the mouse, and select Properties.

c. Select Shortcut and change ‘jrew.exe’ to read ‘jre.exe’, then select OK.

d. Start up the program from the ***Wave Designer*** icon. The opening screen should display a DOS window titled ‘jre’. Copy down any abnormal message displayed in the ‘jre’ window, especially messages with the word ‘Exception’ in them.

e. Send the message(s) via E-mail on the world wide web to:
wavedesigner@lincolnelectric.com.
We will respond to your problem as quickly as possible.

A.1 APPENDIX OVERVIEW

This appendix provides a series of discussions on pulse wave shaping principles and the development of custom GMAW pulse waveforms. The contents of this appendix are arranged as follows:

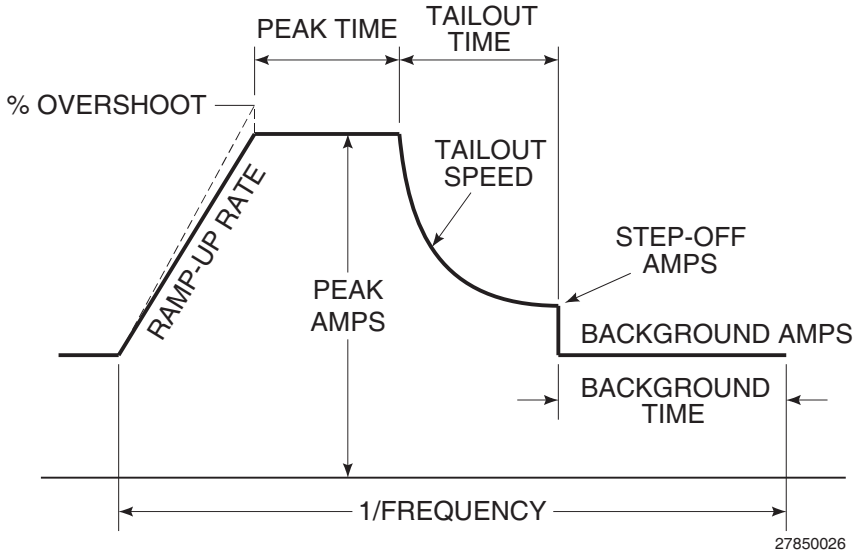
Paragraph No./Title		Contents Description
A.2	GMAW Pulse Overview	How the pulse waveform transfers weld droplets to the weld surface
A.3	Adaptive and Non-Adaptive Mode	How WFS and primary wave shape parameters effect welding
A.4	Pulse Wave Design Process	Flowchart and step by step descriptions of the pulse wave design process
A.5	Primary Pulse Waveform Components	How peak current, peak time, frequency, and background current effect weld droplet transfer
A.6	Secondary Pulse Waveform Components	How ramp up rate, % ramp overshoot, tailout speed, tailout time, stepoff amperage, and background time effect weld droplet transfer
A.7	Application Exercise	Sample development of a power wave welding program using Wave Designer

A.2 GMAW PULSE OVERVIEW

Figure A-1 illustrates the variables of the GMAW-P welding process. Each of these variables can be programmed into a weld table using the ***Wave Designer*** software. Figure A-2 shows how the pulse waveform and the primary variables shape, detach and propel a weld droplet across the arc.

For more details on each of these variables, refer to ***Primary Pulse Waveform Components*** and ***Secondary Pulse Waveform Components*** in paragraphs A.5 and A.6 of this appendix.

FIGURE A-1. PULSE WAVEFORM PARAMETERS.



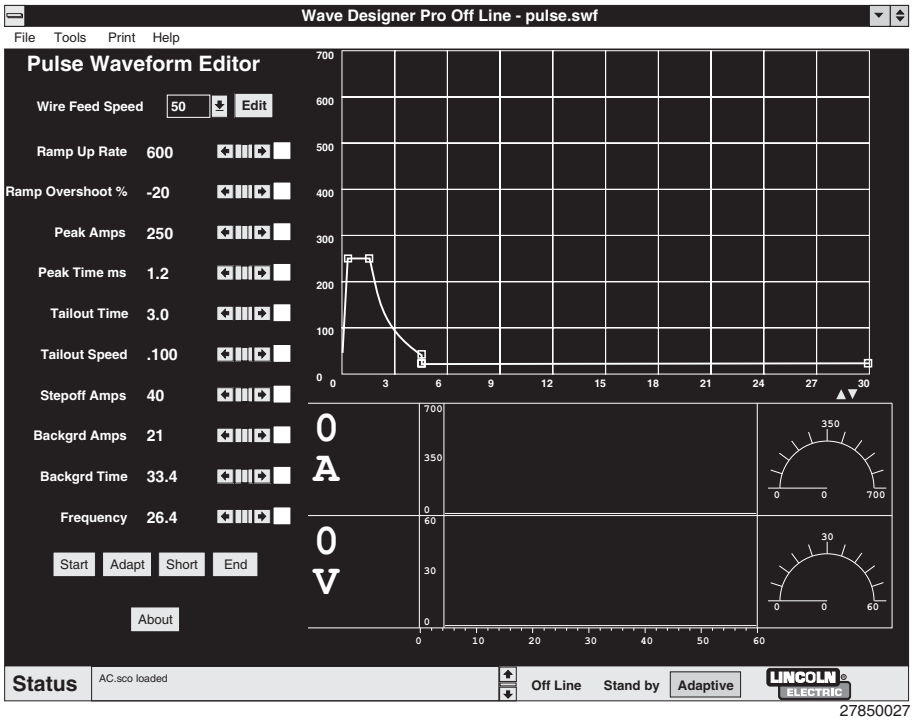
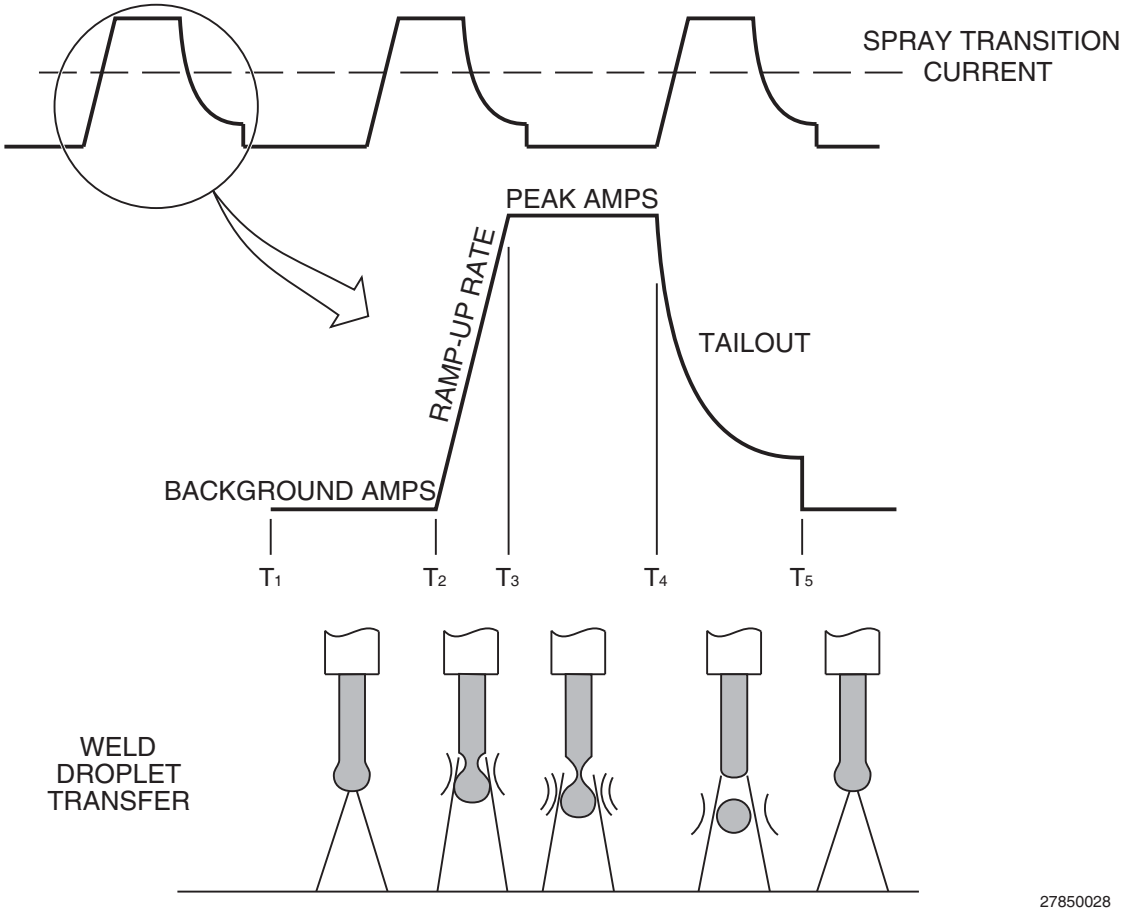
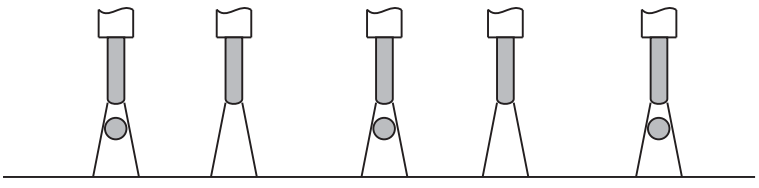


FIGURE A-2. WELD DROPLET TRANSFER.



- From time T1 to T2: Background current maintains an arc, and a weld bead starts to form.
- From time T2 to T3: Ramp-up current forms the weld droplet at the tip of the electrode.
- From time T3 to T4: Peak current and peak time separate the droplet and propel it toward the weld surface. The arc width and transfer force are controlled by peak current and peak time.
- From time T4 to T5: Tailout current controls the heat input to and agitation of the weld puddle. Shorter tailout contributes less heat to the weld. (The level of background current also affects the weld heat.)
- After time T5: The waveform repeats to start the weld droplet transfer process over again.



EACH PULSE DELIVERS ONE DROPLET OF WELD MATERIAL 27850029

A.3 ADAPTIVE AND NON-ADAPTIVE MODE

To proficiently develop welding procedures using ***Wave Designer***, the key concept of Adaptive versus Non-Adaptive welding must be understood. ***Wave Designer*** allows the user to set the machine into either adaptive or non-adaptive mode. During the wave design process both modes will be used depending upon the step.

A.3.1 ADAPTIVE MODE

In normal synergic welding the Power Wave welds in the adaptive mode. As the stickout changes due to variations in the workpiece or operator hand motion, the Power Wave "adapts" or changes the pulse variables to maintain a constant arc length. This is illustrated in Figure A-3.

Since adaptive mode attempts to maintain a fixed arc length, this is the mode that you will use when adjusting an optimal arc length. Refer to steps 3 and 4 "Adjust the Peak Volts" in the flow chart of paragraph A.4. Note: This step must be performed with the Trim set equal to 1.0 on the Power Wave machine.

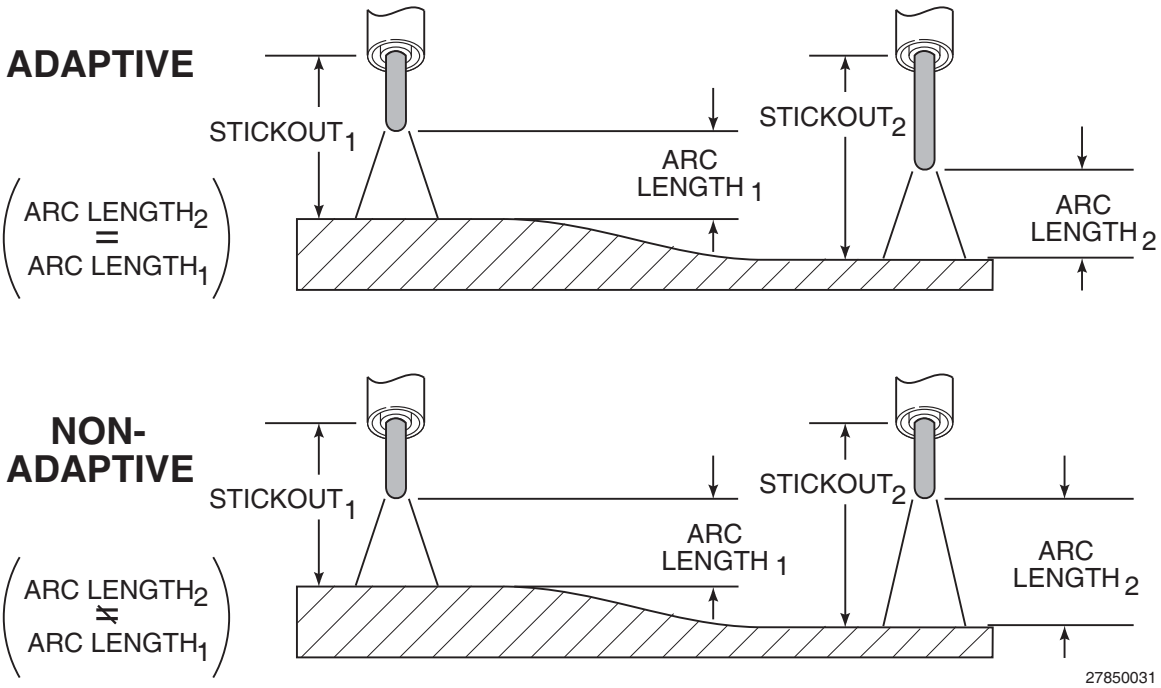
A.3.2 NON-ADAPTIVE MODE

In non-adaptive mode, the Power Wave does not adapt the pulse variables to maintain a constant arc length as the stickout varies. This is illustrated in Figure A-3.

Therefore, the non-adaptive mode is the mode that you use to develop the proper waveform variables. If this is attempted in the adaptive mode, you will get erroneous results since the machine will be attempting to change (adapt) these variables. Refer to step 2 "Adjust Pulse Variables at Fixed Stickout" in the process flow chart, Figure A-4.

NOTE: During this step of the wave design process, it is important to manually hold a constant stickout.

FIGURE A-3. FIXED STICKOUT (NON-ADAPTIVE) VS. OPTIMAL ARC LENGTH (ADAPTIVE).

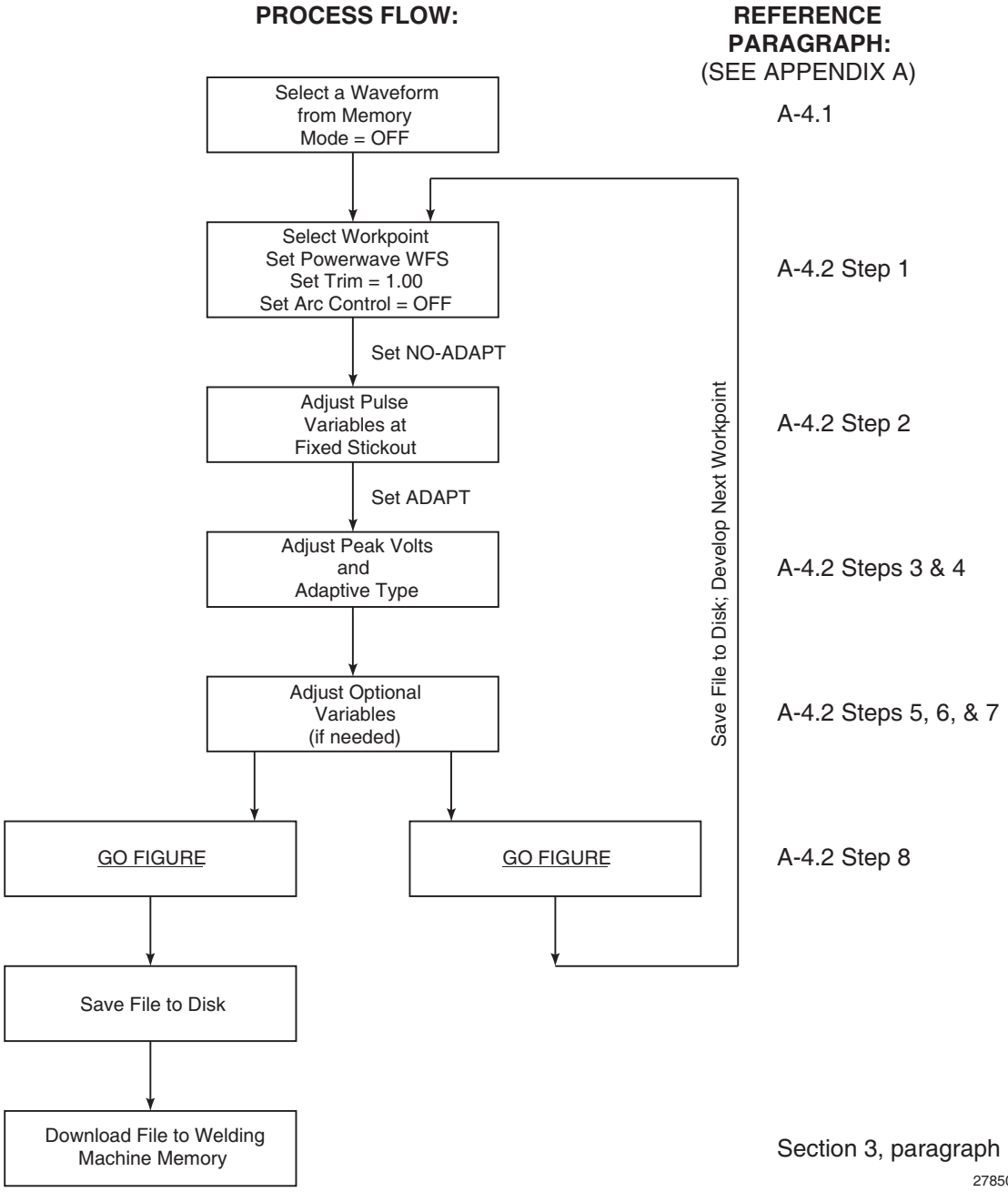


A.4 PULSE WAVE DESIGN PROCESS

The ***Wave Designer*** software interfaces with the welding machine controller to permit real time communication of pulse wave design changes. Refer to paragraph 2.3 for equipment interface connections.

Use the following wave design process to customize a standard wave shape. The process is summarized in the following flowchart. The flowchart is followed by a detailed process description. To ensure that the design process creates a wave shape suitable for your weld application, we recommend that you perform all editing functions in the order presented. Where an editing function is described as optional and you choose not to perform the edit function, proceed to the next edit function in the design process.

FIGURE A-4. PROCESS FLOWCHART.



A.4.1 SELECTING A STARTING WAVE SHAPE

When customizing a waveform for a specific welding application, we recommend that you use a waveform in an existing weld file. An existing weld file can be selected from the systemWeldFiles folder in the ***Wave Designer*** directory as follows:

a. Click on a standard wave shape from the systemWeldFiles folder. Use the load file option in the File menu to download the selected file to the Pulse Waveform Editor.

NOTE: The welding machine's controller memory is allocated 10 weld mode slots (modes 155 to 164) for the storage of custom weld designs. No more than ten custom weld modes can be downloaded to the welding machine. You cannot upload a custom weld from the welding machine, but you can overwrite any or all of your allotted weld file memory locations.

b. In Waveform Editor, select the Save Waveform As ... option from the File menu.

⚠ CAUTION

Failure to use the Save Waveform As... option to copy the standard wave shape will result in changes to the standard wave shape. Make sure you assign a unique file name to a copy of the standard wave shape before making any waveform changes. Make backup copies of all original wave shape files as well as the custom wave shapes you create.

c. When prompted, type in a unique filename for the new waveform. Select OK to assign the new file name to the waveform.

A.4.2 CUSTOMIZING THE WAVE SHAPE

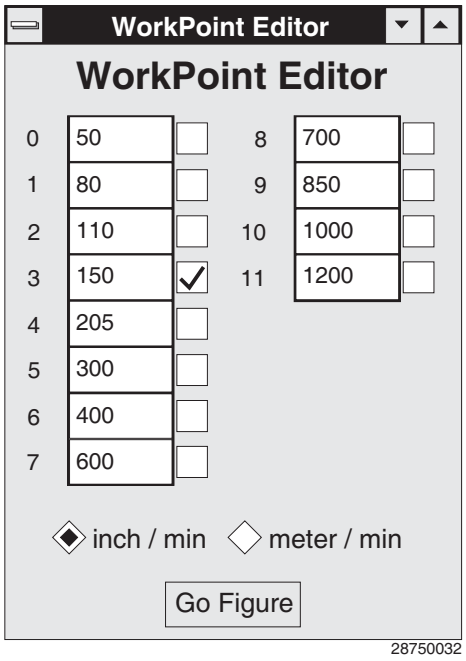
If customizing your first wave shape, perform the wave shaping exercises provided at the back of this section to get thoroughly acquainted with wave shaping. Thereafter, refer to the following wave shaping procedure.

1. Select a Workpoint

a. Select a workpoint from the Wire Feed Speed pulldown menu. The first workpoint selected should be in the midrange of the expected Wire Feed Speeds to be used for the weld application. If you are uncertain of the WFS range, we recommend selecting 150 or 200 in./min. as a first workpoint.

NOTE: You can edit one or more workpoints to values other than the defaults. However, the listing of wire feed speeds displayed must be the same or increasing from top to bottom. All twelve wire feed speeds must be assigned values, but multiple workpoints can share the same value.

The reason you would edit multiple workpoints to the same value would be to limit the range of WFS or to develop fewer than twelve workpoints.



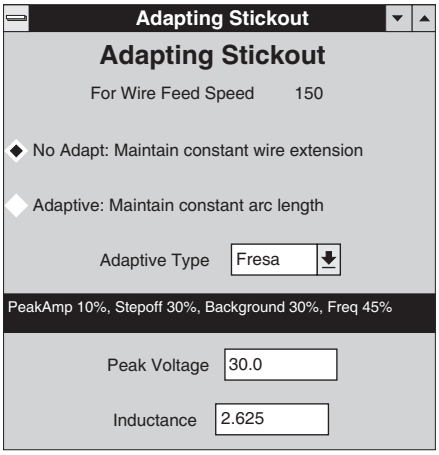
b. Set the welding machine's wire feed speed equal to the selected workpoint setting.

c. Verify that the power source control box Weld Mode is set for an OFF readout at the LED display and that the arc control is OFF.

2. Open the Adaptive Loop / Find the Optimal Arc Characteristics

Use the following weld trials and adjustment sequence to tune the selected waveform for your weld application at the designated workpoint (wire feed speed). Weld trials and adjustments are more easily performed with one person welding while you adjust the waveform parameters at the computer terminal.

a. Click on the Adapt button to open the Adapting Stickout screen. Select the No Adapt option to open the adaptive loop of the welding machine. The adaptive indicator on the editor screen will change to No Adapt, indicating that the welding machine is in an open-loop, non-adaptive, condition.



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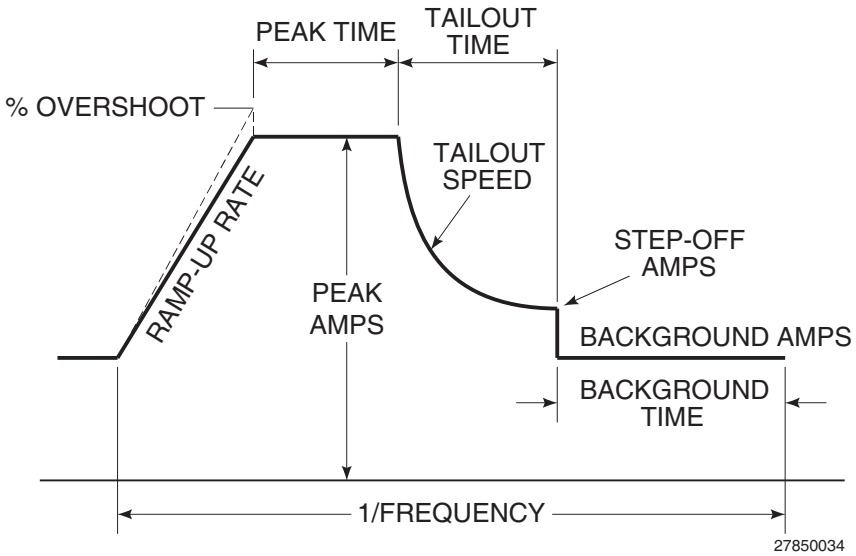
NOTE: The adaptive loop must be open to prevent the welding machine from making adaptive responses to the wave shape changes. If the adaptive loop is closed, observations of how the welding machine responds to the wave shape changes will be false. Failure to open the adaptive loop of the welding machine will inhibit the development of a successful waveform for your welding application.

b. Set the PowerFeed Trim control for a readout of 1.00. This will ensure that the wave shape is designed at the midrange of the trim adjustment capability. The welding machine's trim control allows the welder to adjust the arc length between 0.5 to 1.5 (50% to 150%) times the established arc length adjustment factor.

c. Maintain a constant stickout. The stickout should be equal to the expected average of the welding application. We recommend about 5/8 in. to 3/4 in. (16 mm to 19 mm) electrical stickout.

d. While welding a trial weld bead, adjust the pulse variables (peak current, peak time, background current, frequency, etc.) to achieve a desired droplet transfer with a fixed 5/8 in. to 3/4 in. (16 mm to 19 mm) stickout at the selected wire feed speed. Refer to paragraph A.5.

e. With the stickout at a fixed setting, make trail welds during each adjustment so you can directly observe the effect of the adjustments in the arc and resulting weld. Adjust the variables as needed to achieve the desired weld transfer at the fixed stickout.



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3. Close the Adaptive Loop / Adjust the Peak Voltage

a. If the adaptive stickout window is not open, click on the Adapt button to open the window. Select the adaptive option to close the adaptive loop. Verify that the adaptive button lights up.

NOTE: When on-line with the adaptive loop closed, the wave shape parameters will be adapted (change) to maintain constant arc length. Adjusting one parameter in ***Wave Designer*** often forces the adaptive feature to modify other wave shape parameters. The adaptive nature of the program may be noticed when editing the parameters; changing one parameter value causes other parameter values to change in response. We recommend not changing pulse variables in the adaptive mode.

b. While the adaptive loop is closed, the peak voltage value displayed in the adaptive stickout window is adjustable. While welding a trial bead, adjust the peak voltage for an optimal arc length.

c. If desired, adjust the inductance value to achieve the desired weld pinch. If the inductance value is set too high, it will limit the rate of current change and may limit the ramp-up rate and tailout speed.

4. Select an Adaptive Type (Optional)

a. Click on the Adapt button on the Waveform Editor screen to view the Adapting Stickout screen. Click on the arrow in the adaptive type box to display the adaptive types listing.

b. Select each adaptive type in-turn and perform a trial weld. After performing a trial weld for each adaptive type, select the adaptive type best suited to the wire feed speed. A brief summary of the adaptive type characteristics is presented in Table A-1.

TABLE A-1. ADAPTIVE TYPE CHARACTERISTICS.

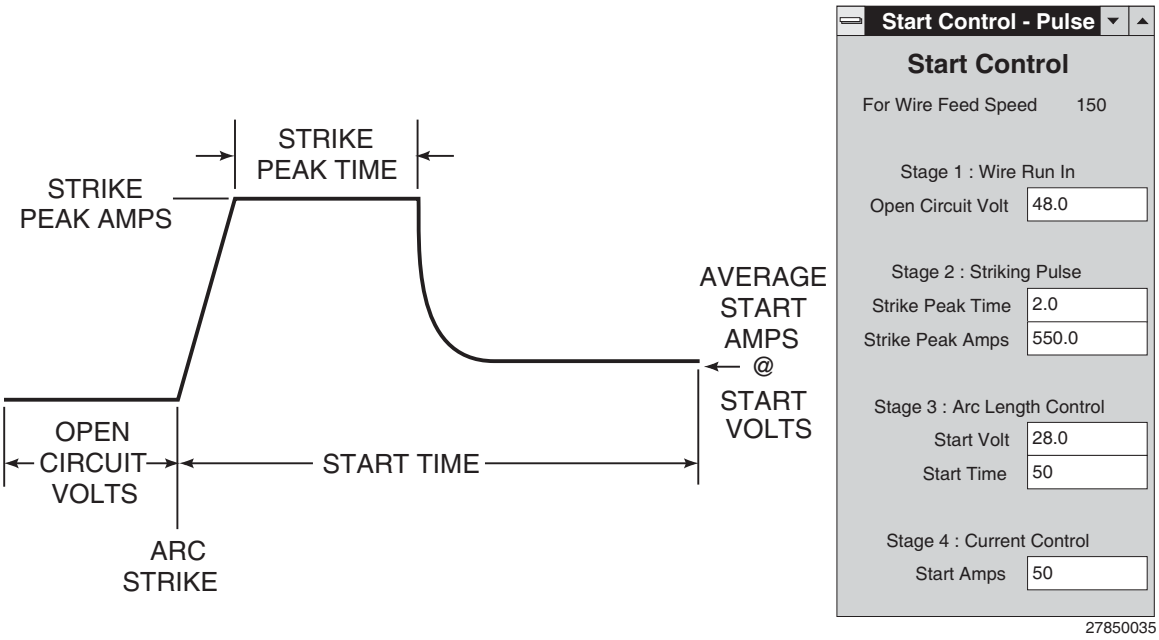
Adaptive Type	*Characteristics	Application
Sandia	Stepoff and background 30%, frequency 45%	lower wire feed speeds and where consistent pulse values for droplet detachment are required
Fresa	Peak current 10%, stepoff and background 30%, frequency 45%	intermediate wire feed speeds
Manzana	Peak current 20%, stepoff and background 10%, frequency 30%	high wire feed speeds; peak current is the controlling variable
Naranja	Peak current and time 10%, stepoff and background 10%, frequency 30%	where highest range of peak adaptive control is required
Mora	Frequency 60%	typical for most pulse GMAW welding machines

*Each adaptive type specifies which parameters are being adapted and the sensitivity of adaptiveness for each parameter. For example, Mora type adapts only one parameter — frequency — at a sensitivity level of 60%. In developing waveforms, try each adaptive type to determine the most desired result.

5. Adjust the Start Control Parameters (Optional)

The start control parameters can be adjusted to define how the welding machine will respond when the arc is struck.

To view the start control window, click on the Start button on the Waveform Editor screen. Adjust the start control parameters to accommodate your welding application and per the following parameter descriptions.



Open circuit voltage: Sets the power source output voltage for the torch idle condition (the welding machine is on, but not welding).

Strike peak amps: Adjust this parameter to set the peak level for the arc-strike current spike.

Strike peak time: Adjust this parameter to set the duration of peak current for the arc-strike current spike.

Starting volts: Adjust this parameter to set the gun voltage to be maintained during the arc starting routine.

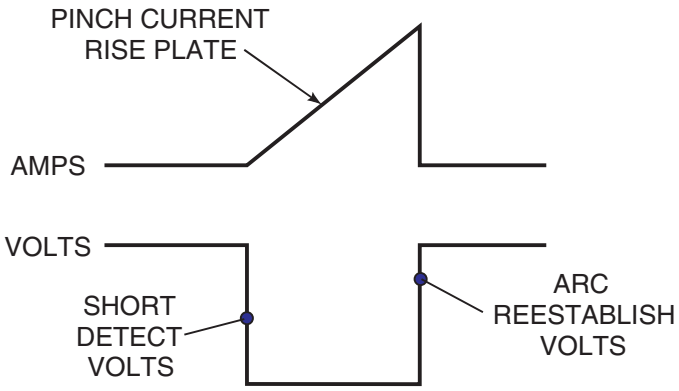
Starting time: Adjust this parameter to set the duration of the arc starting routine.

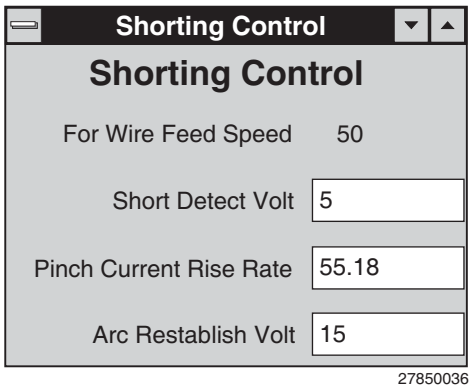
Starting amps: Adjust this parameter to set the average current level during starting.

6. Adjust the Shorting Control Parameters (Optional)

The shorting control parameters can be adjusted to define how the welding machine will respond when the arc shorts to the weld puddle.

To view the shorting control window, click on the Short button on the Waveform Editor screen. Adjust the shorting control parameters to accommodate your welding application and per the following parameter descriptions.





Short detect voltage: Adjust this parameter to set the detect voltage level that will start the shorting response.

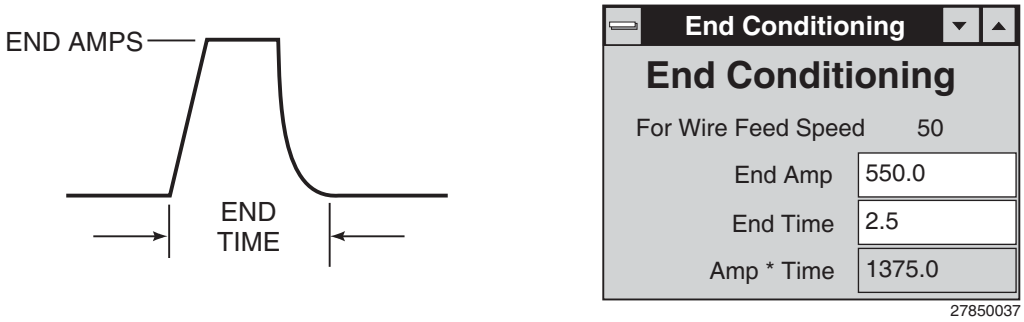
Pinch current rise rate (shorting response): Adjust this parameter to set the current rise rate that will be used to clear a short.

Arc reestablish volts: Adjust this parameter to set the detect voltage level that will end the shorting response.

7. Adjust the End Condition Parameters (Optional)

The end condition parameters can be adjusted to define how the welding machine will respond at the end of a weld application.

To view the end condition window, click on the End button on the Waveform Editor screen. Adjust the end condition parameters to accommodate your welding application and per the following parameter descriptions.



End amps: Adjust this parameter to establish the peak amperage of the wire conditioning pulse. The wire conditioning pulse knocks the last weld droplet from the electrode at the end of a weld.

End time: Adjust this parameter to set the duration of the ending pulse.

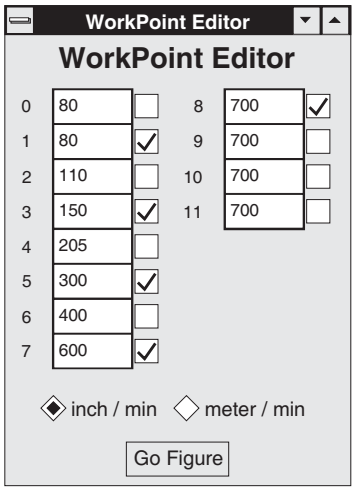
Amp • Time: This parameter indicates the power of the ending pulse.

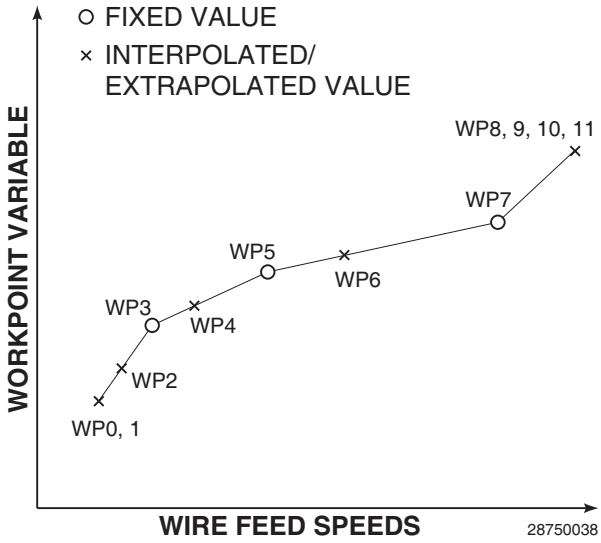
8. "Go Figure" / Make the Waveform Synergic

Weld synergy is established by shaping the 2nd and all subsequent workpoints. Being synergic, the waveform parameters automatically adjust to programmed data table values. The data table values are unique for selected wire feed speeds. Thereby, the output of the power source changes in response to changes in the wire feed speed, as controlled by the PowerWave's WFS encoder setting. The process of making the waveform synergic involves two procedures; developing the 2nd workpoint and workpoints interpolation.

Developing the 2nd Workpoint

Develop the second workpoint in the same manner as the first.





NOTE: In the workpoint window where workpoints 9 through 11 are not selected, they are assigned the value of workpoint 8. This sets 700 as the upper limit on the operative wire feed speeds.

Workpoints Interpolation

After shaping the second waveform, open the workpoint editor and click on the Go Figure button. ***Wave Designer*** interpolates the waveform parameters for each unchecked (not selected) wire feed speed. These steps can be repeated multiple times to fine tune all the workpoints. The set (fixed) wire feed speeds are those indicated (checked) in the workpoints listing. Go Figure will interpolate/extrapolate between/from set workpoints.

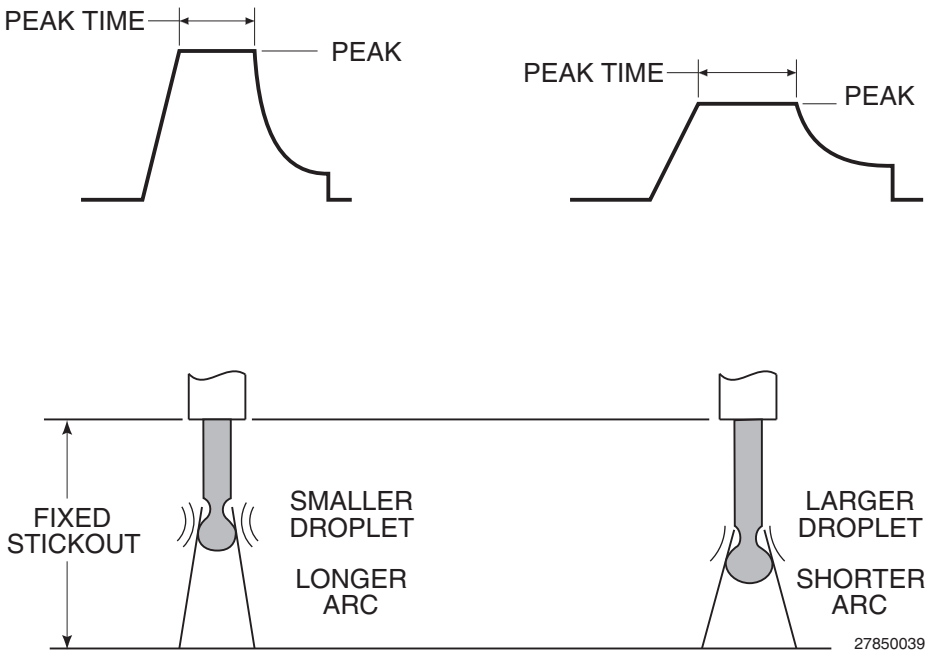
A.5 PRIMARY PULSE WAVEFORM COMPONENTS

The following paragraphs describe how peak current, peak time, frequency, and background current effect weld droplet transfer.

A.5.1 PEAK CURRENT AND PEAK TIME

A combination of peak current and peak time, Figure A-6, applies a force to detach the weld droplet from the electrode and propel it across the arc. Transition current is the current level required to achieve weld droplet formation. In order to achieve weld droplet transfer, the peak current must always be above the spray transition current.

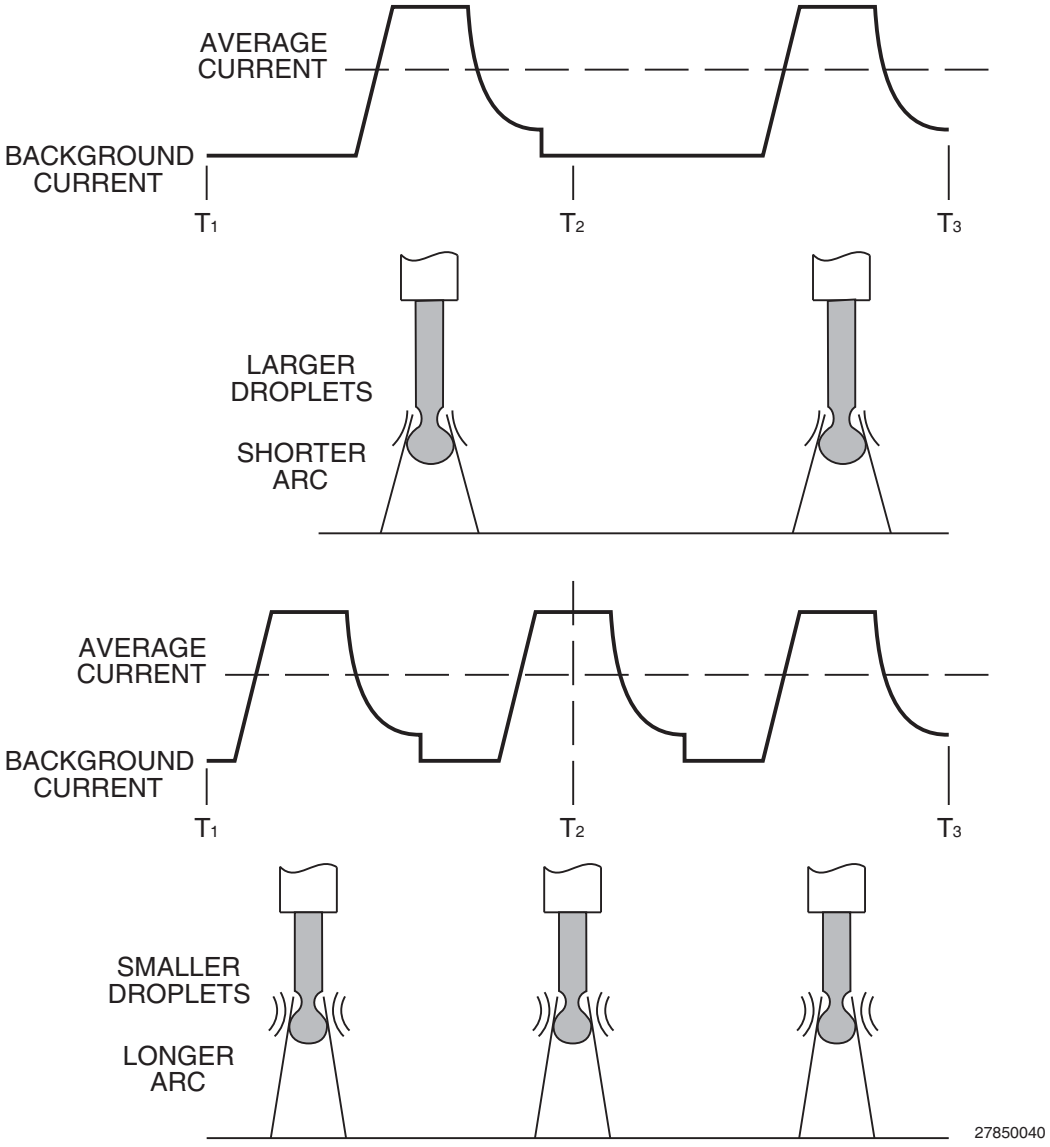
FIGURE A-6. PEAK CURRENT AND PEAK TIME.



A.5.2 FREQUENCY

Frequency, Figure A-7, is the number of pulses per second or, in theory, the number of weld droplets per second. Since increasing the frequency generates more pulses in a given time period, higher frequencies generate higher average current levels.

FIGURE A-7. FREQUENCY.



A.5.3 BACKGROUND CURRENT

The background current, Figure A-7, is set to maintain a desired plasma arc between weld droplet transfers and to control the heat input to the weld system.

A.6 SECONDARY WAVEFORM PARAMETERS

A.6.1 RAMP-UP RATE

The ramp-up rate is the speed of current climb from the background current level to the peak current level. Faster ramp-up rates tend to produce a plasma plume that quickly surrounds the end of the next droplet.

A.6.2 RAMP OVERSHOOT %

The ramp overshoot % can be set from -100% to +100% of the peak amps value. Positive % overshoot is commonly used to harden the arc. Negative % overshoot (undershoot) is used to soften the arc for welding. Ramp overshoot can also be used to compensate for variations in the length of the ground lead which alters the output inductance of the power source.

A.6.3 TAILOUT SPEED

The tailout speed is the rate of amperage decrease from the peak current level to the step-off current level. Tailout speed decreases exponentially. Tailout speed affects the amount of heat put into the system just after droplet transfer. Slow tailout speeds (near 0) apply more heat to the weld system. Rapid tailouts are more likely to short circuit the electrode to the work.

A.6.4 TAILOUT TIME

The tailout time is the duration of tailout. Longer tailout times maintain the system heat longer. Shorter tailout times can force the output to reach the background current level. Note that the adaptive loop can not force the wave period (1/pulse frequency) into the tailout region. We recommend setting the background time long enough to allow the adaptive loop to work.

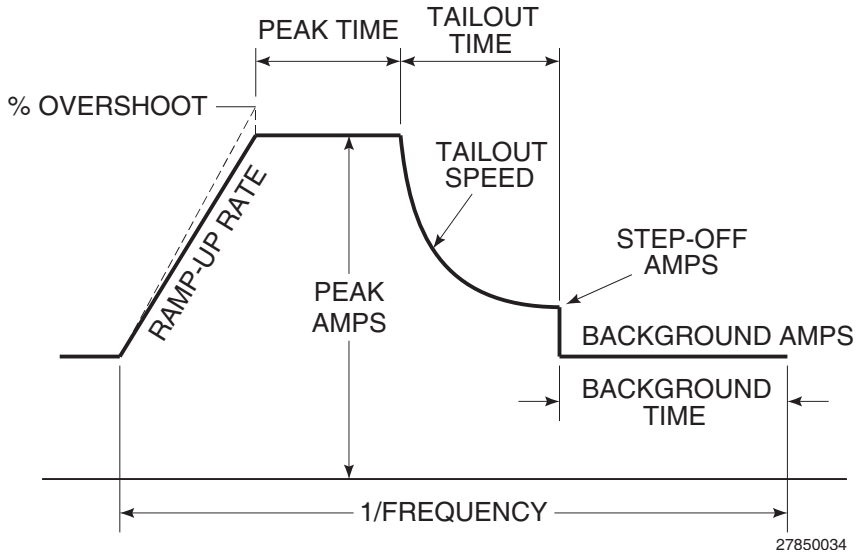
A.6.5 STEP-OFF AMPERAGE

Step-off amperage is the target current level reached during tailout. The step-off amperage must be higher than the background current.

A.6.6 BACKGROUND TIME

Background time is the duration of background current. Background time is equal to the waveform period minus the duration of ramp up, peak time, and tailout. Increasing the background time decreases the pulse frequency. We recommend setting the background time long enough to allow the adaptive loop to work.

FIGURE A-8. PULSE WAVEFORM PARAMETERS.



WAVE DESIGNER

LINCOLN® ELECTRIC

A.7 APPLICATION EXERCISE

This application exercise steps the user through the development of a basic PowerWave welding program using ***Wave Designer***. Your application most likely will vary from this example but the concepts outlined are recommended for all development work.

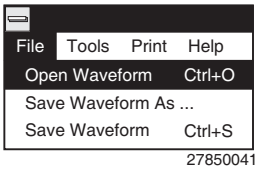
If you would like to follow along with this example, use the following set up:

Machine: PowerWave 455, PowerFeed 10, Magnum 400 gun and cable, miscellaneous other parts to complete welding cell
Wire: 0.035 L-56
Gas: 90% Argon 10% CO_2
Computer: See Section 2 of this manual for minimum requirements and connection diagrams. Click on the ***Wave Designer*** icon to start the program.

For this example, we developed a program to run wire feed speeds between 150 in/min. and 300 in/min. The user may want to develop more workpoints for practice.

Before starting the waveshape development process, confirm that the consumables are working properly with the welder. We recommend using a standard waveshape such as mode 5 to confirm that the welding system performs under normal conditions before attempting to develop waveshapes.

1. ***Select a wave shape.*** (From the tool bar, select 'File', 'Open Waveform'.) For this exercise, select the "pulse.swf" wave shape. This wave shape is automatically loaded when the ***Wave Designer*** program is first used. Generally, the user should choose a waveshape file that has the closest welding performance to the intended application.



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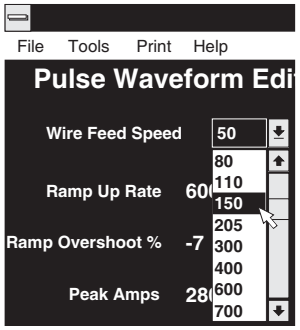
2. ***Pick a wire feed speed*** from the Wire Feed Speed pulldown menu. We started with the 150 in/min. WFS. Also, be sure to set the PowerFeed's wire feed speed to the same WFS as the selected workpoint and set the trim to 1.00. (In this exercise, the WFS is 150 in/min.)



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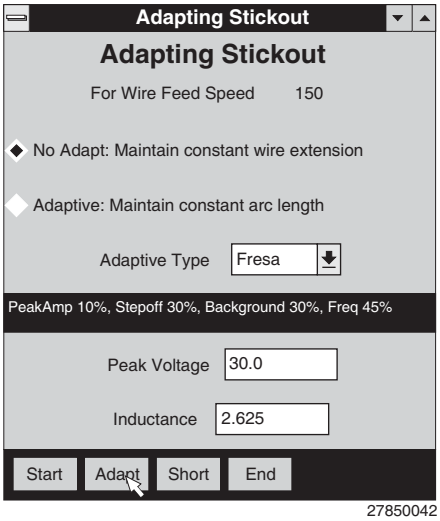
3. Using the adaptive stickout window or the green adaptive button on the status bar, ***select 'No Adapt'***. The status bar at the bottom of the screen should read: On Line | Stand By | No Adapt . Close the "adapt" window (if opened).

4. While welding, ***adjust the pulse variables to improve welding performance***. Maintain a constant 5/8 in. stickout (torch tip to work distance.)

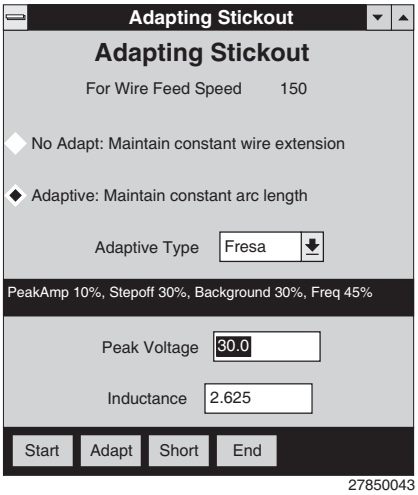


Our Experiment: We found multiple droplet detachment with an arc length that was too long at these waveform settings. To attain the proper droplet detachment, we reduced the peak current value to 250 amps and found improved weld droplet transfer. But reducing the peak current also caused the arc to be shorter.

Then we needed to lengthen the arc. We reduced the background time to 8.5 milliseconds, thereby increasing the frequency. The result was a good arc length set at the fixed stickout of 5/8 in. The droplet transfer was now acceptable and the arc length correct for this stick out. With the pulse variables set, we could now proceed to make the PowerWave adaptive (maintain a set arc length over a range of stickouts).

This was a simple application. It shows that the variables interact with each other. The right solution for a given application may not be the right solution for another. ***Wave Designer*** features great flexibility to manipulate the waveshape to suit specific applications.

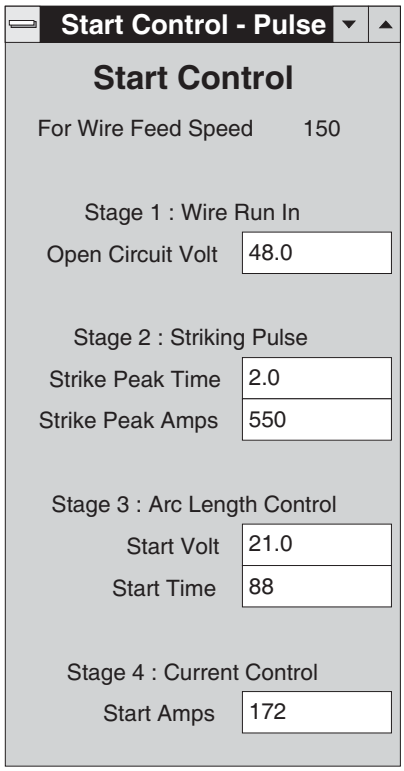
5. Click on the Adapt button and select the ***'Adaptive' mode***. (The status bar now reads: On Line | Stand By | Adaptive .) While making weld, ***set the 'Peak Voltage'*** to obtain the desired arc length at the 1.00 trim setting.



Our Experiment: We found that a peak voltage of 27.0 volts resulted in a useable arc length. (In the "No Adapt" mode, welding with a fixed 5/8 in. stickout, the actual voltage on the PowerWave's voltmeter read about 19 volts. When setting the peak voltage, the average volts was also about 19 volts. Note that the actual voltage readouts at the welding machine will not be the same as the peak voltage.)

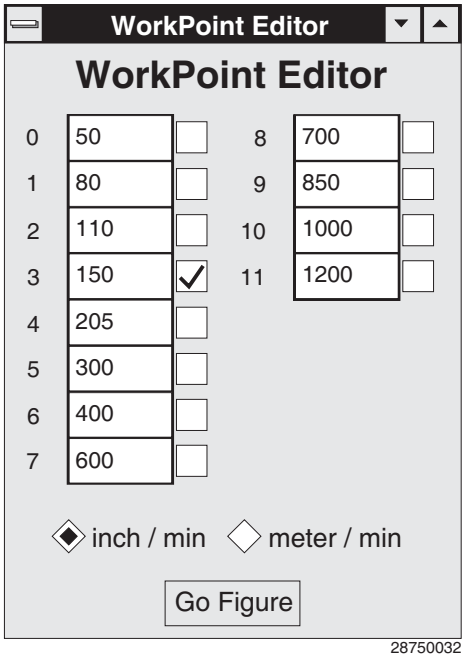
6. The “Start”, “Short”, and “End” windows can be adjusted at this time to optimize the starting, shorting, and ending routines.

Our Experiment: We needed to adjust the starting variables. With the feeder’s run-in WFS set at 65 in/min, we set the starting variables to control the starting routine. With the assistance of ArcScope, we found good settings with these values: start volt 21.0, start time 35 milliseconds, and start current 180 amps. The OCV strike peak time and amps were acceptable as set.



7. Click on the Edit button to display the WorkPoint Editor window. Check only those wire feed speed points that have been developed (only 150 in/min. at this point). The WorkPoint Editor can also be used to change the wire feed speed value of a workpoint. Workpoints can have the same value but must be in numerical order.

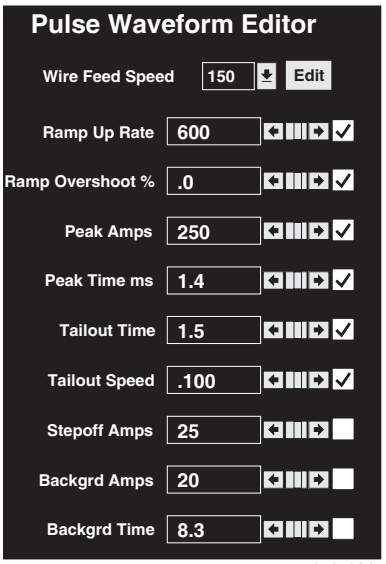
   Select the Go Figure button to set the wave shape parameters for all workpoints equal to the wave shape parameters of the 150 in/min. workpoint. Close the WorkPoint Editor window.



8. For a ***second workpoint*** we went to 300 in/min. Select the 300 in/min. wire feed speed from the pulldown menu in Waveform Editor window. Reset the PowerFeed for 300 in/min. with a 1.00 trim.

9. Open the adapting stickout window and select the 'No Adapt' mode; close the window.

10. At lower wire feed speed settings, some users like to fix the values of the peak variables. To do this, check the boxes next to the peak variables (ramp up rate, ramp overshoot %, peak amps, peak time, and tailout). Perform weld trials and adjust the pulse wave shape variables.



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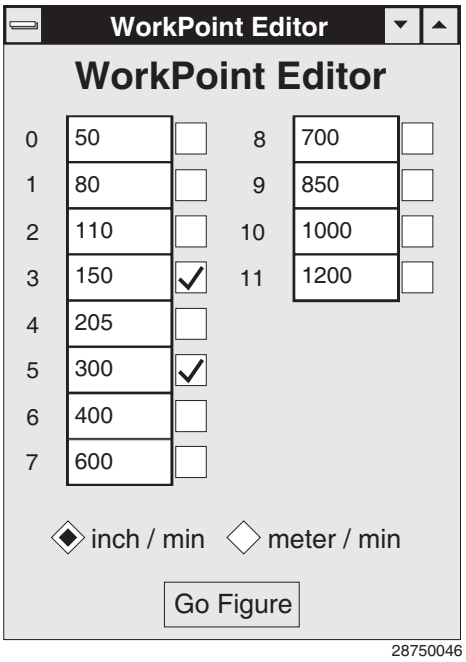
Our Experiment: At the higher wire feed speed, we needed more heat to melt the added wire. We took the background up to 75 amps and the background time down to 3.8 milliseconds. (The frequency also changed due to the change to the background time.) Welding trials indicated that the droplets were transferring properly and that the arc length was correct for the 5/8 in. (16 mm) stickout.

11. Set the mode to 'Adaptive'. Make a trial weld to check the peak voltage setting.

Our Experiment: While welding we found that 27 volts was about right for the peak voltage. Since the peak variables did not change, the peak voltage will remain about the same as well. We also noticed that the average voltage increased from the value observed at 150 in/min. This increase is due to the higher frequency required for the higher wire feed speeds.

12. Open the “Edit” screen and select only those workpoints that have been developed (150 and 300 in/min.). Select the Go Figure button to interpolate the remaining workpoints. The Go Figure function gives a estimation of the values needed for the other wire feed speeds. Each useable workpoint should be developed separately.



Our Experiment: We tested the 205 in/min. workpoint to confirm that its operation was good. We checked the pulse variables in the no adapt mode and the peak voltage in the adaptive mode. The 205 in/min. workpoint was acceptable without modifications. The other workpoints in the program can be developed in a similar fashion. After we completed developing the program, we checked its performance across the range of wire feed speeds.

13. The specific wire feed speed points of the program are now developed in the range of 150 in/min to 300 in/min. Check the full range of the program to confirm its synergic operation.

Our Experiment: We started at 150 in/min. and while welding, ran the wire feed speed up to 300 in/min. The arc looked consistent across the range.

14. If desired, our new custom waveform could be ‘Saved As’ another file name and downloaded into the PowerWave’s weld mode directory.

The new program is complete. To summarize, we performed the following sequence of tasks:

1. Set up the equipment.
2. Selected a program close to our application needs.
3. Selected a wire feed speed.
4. Make program “No Adapt” and set pulse variables.
5. Make program “Adapt” and set arc length.
6. Adjust the starting, shorting, ending routines as needed.
7. Use Go Figure to interpolate and extrapolate values for the other wire feed speeds.
8. Choose the next wire feed speed to develop and go back to step 4.
9. Weld with the range of the program to confirm operation performance.

B.1 APPENDIX OVERVIEW

This appendix provides a series of discussions on STT wave shaping principles and the development of custom STT waveforms. The contents of this appendix are arranged as follows:

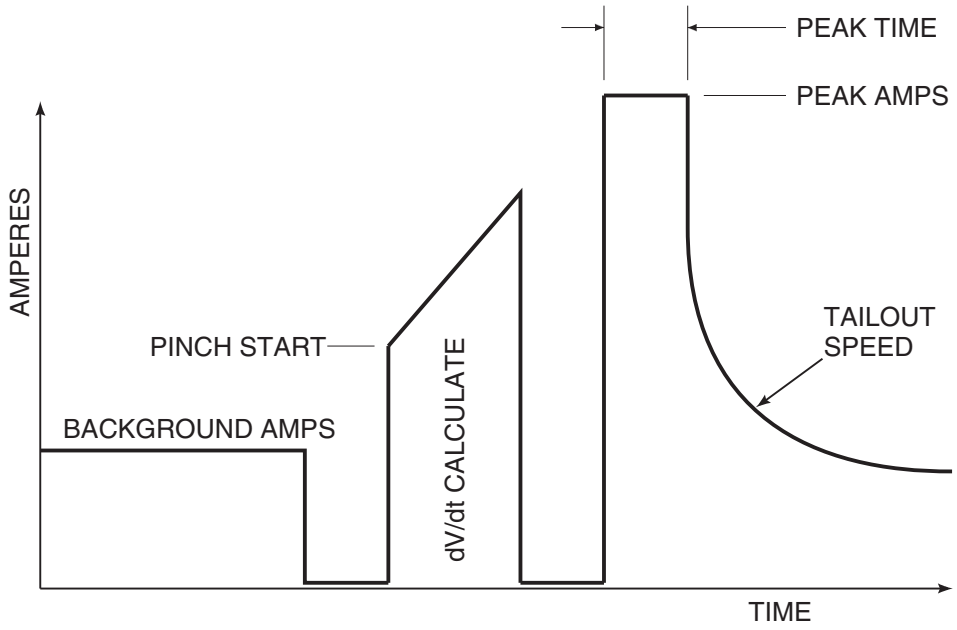
Paragraph No./Title		Contents Description
B.2	STT Overview	How the STT waveform transfers weld droplets to the weld surface
B.3	STT (Surface Tension Transfer)	How WFS and wave shape parameters effect welding
B.4	STT Wave Design Process	Flowchart and step by step descriptions of the STT wave design process
B.5	Primary STT Waveform Components	How peak current, background current, and tailout speed effect weld droplet transfer
B.6	Secondary STT Waveform Components	How pinch start, pinch/peak, peak time, and dV/dt detect effect weld droplet transfer
B.7	Application Exercise	Sample development of an STT welding program using ***Wave Designer***.

B.2 STT OVERVIEW

Figure B-1 illustrates the variables of the STT welding process. Each of these variables can be programmed into a weld table using the ***Wave Designer*** software. Figure B-2 shows how the STT waveform and the primary variables produce a weld.

For more details on each of these variables, refer to ***Primary STT Waveform Components*** and ***Secondary STT Waveform Components*** in paragraphs B.5 and B.6 of this appendix.

FIGURE B-1. STT WAVEFORM PARAMETERS.



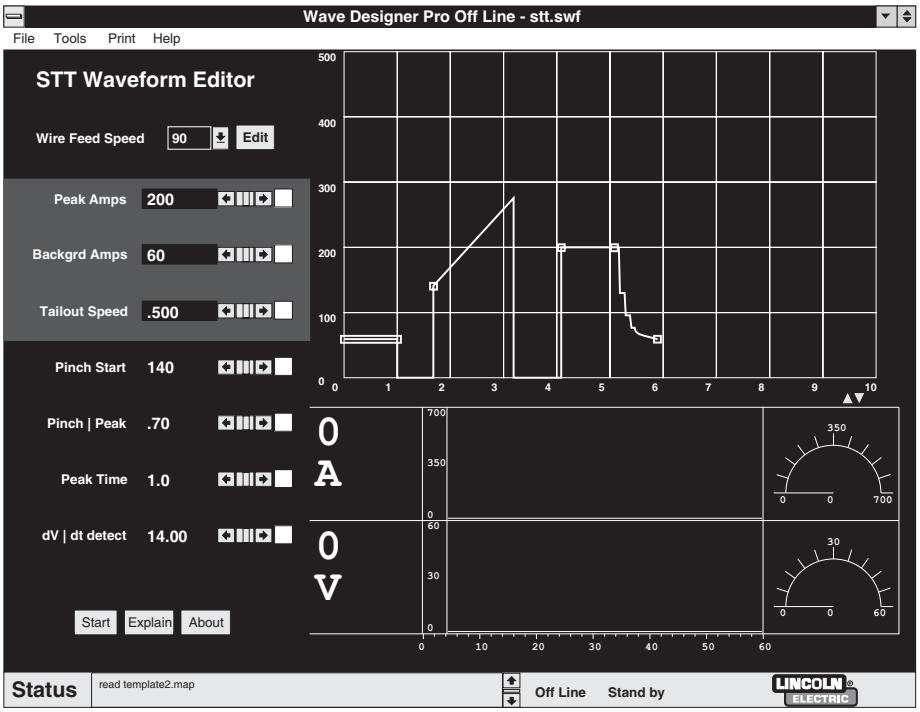


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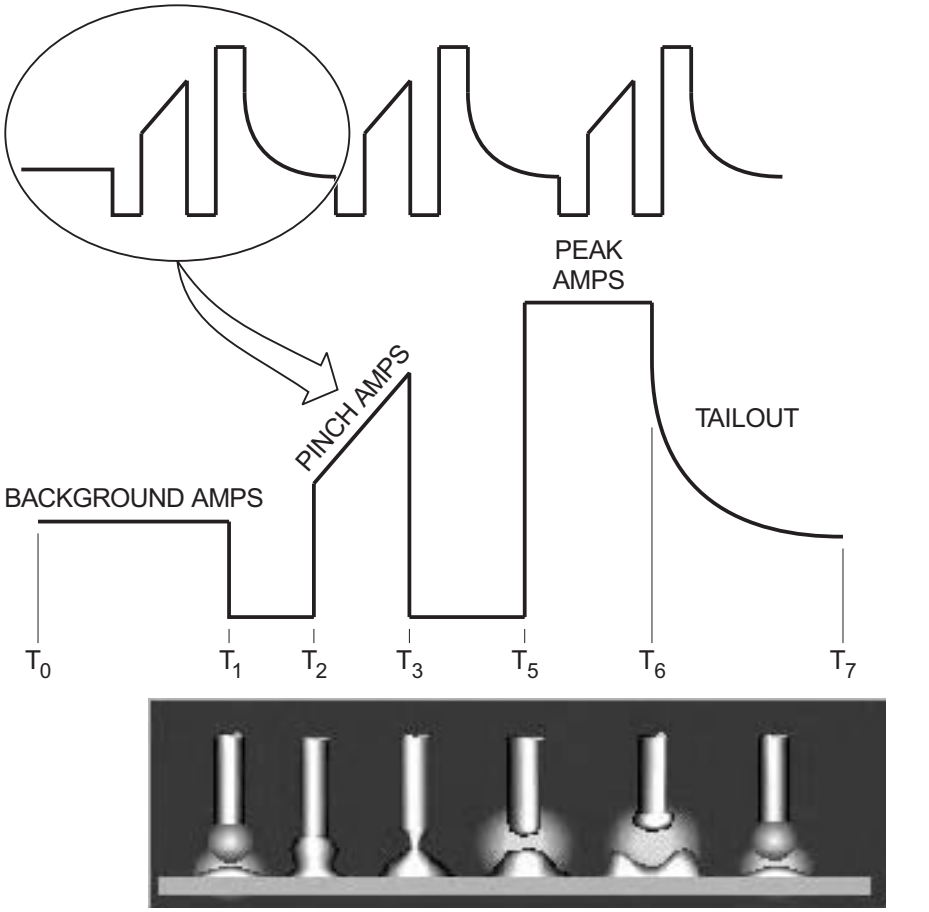
FIGURE B-2. WELD DROPLET TRANSFER.

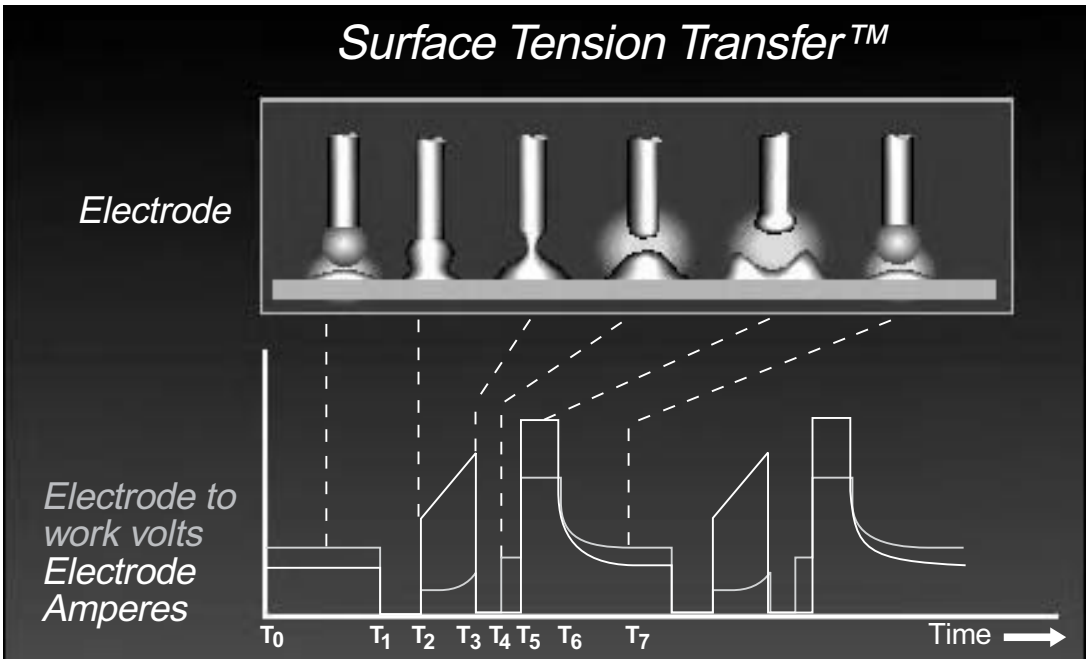


- From time T_0 to T_1: (Background Current) Background current is a steady-state current level, between 50 and 100 Amps that maintains an arc to form a weld bead.
- From time T_1 to T_2: (Ball Time) An arc voltage detector indicates that the arc is shorted; background current is reduced for approximately 0.75 milliseconds.
- From time T_2 to T_3: (Pinch) High current is applied to speed the transfer of molten metal to the weld puddle. A dV/dt calculation indicates when fuse separation is about to occur; current is reduced to 50 Amps.
- Time T_4: (Fuse Separation) Fuse separation occurs at low current. Time T_4 is a function of voltage, and not indicated on the amperage waveform.
- From time T_5 to T_6: (Plasma Boost) A period of high arc current that melts the electrode back.
- From time T_6 to T_7: (Plasma) Arc current is reduced from Peak Amps to the Background current level.

B.3 STT (SURFACE TENSION TRANSFER)

The Invertec STT power source is a high-frequency, current-controlled machine that delivers power to the arc based on immediate arc requirements. The Invertec STT produces large electrode current changes within microseconds. It operates in the short-circuiting welding mode. The electrode current supplied by the power source is guided by the arc voltage state. An ordered sequence of events controls the current throughout the droplet transfer process. The electrode current and voltage waveforms for a typical welding cycle are shown in Figure B-3. Following Figure B-3 are detailed descriptions of the STT welding cycle events.

FIGURE B-3. ELECTRODE CURRENT AND VOLTAGE WAVEFORMS FOR A TYPICAL STT WELDING CYCLE.



$T_0 – T_1$ A **background current** between 50 and 100 Amps is delivered to the arc prior to shorting of the electrode to the weld puddle. Background current is a steady-state current level that serves two purposes. First, the background current supplies power to the arc to maintain the fluidity of the molten drop at the end of the electrode. (Failure to supply the minimum required current causes the upper portion of the molten ball to freeze. As more of the ball solidifies, arc instability and finally stubbing occurs.) Secondly, the background current level greatly effects plate heating.

$T_1 – T_2$ **Ball time** occurs when the electrode initially shorts at the background current level. When the Invertec's arc voltage detector circuit signals that the "arc" is shorting out, the background current is immediately reduced for approximately 0.75 milliseconds. The rapid current drop promotes good electrical contact and "wetting" of the ball to the weld puddle. Wetting prevents an "incipient short", wherein the ball is violently repelled from the weld puddle, breaking apart and causing spatter.

$T_2 – T_3$ The **pinch mode** applies an increasing, dual-slope ramp of current to the shorted electrode. The dual slope ramp of current accelerates the transfer of molten metal by the electric pinch forces. The pinch force is directly proportional to the square of the pinch current.

$T_3 – T_5$ **dV/dt** is the rate of shorted-electrode voltage change per unit time. On-going dV/dt calculations are performed electronically during the pinch mode. Due to the high resistance of molten iron, the electrode-to-work voltage never reaches zero. Near fuse separation at T_4 raises the dV/dt value to a designated maximum. The power source immediately reduces the arc current to 50 Amps. The current drop occurs before the shorted electrode separates. The T_4 event indicates that fuse separation has occurred, but at a very low current.

$T_5 – T_6$ Immediately following separation of the electrode from the weld puddle, **peak current** occurs. Peak current is a period of high arc current. The electrode is quickly saturated by this current and melts back. The jet forces acting upon the weld puddle (cathode) depress the molten surface, increasing the arc length and thereby minimizing the possibility of the electrode shorting prematurely. Peak current is maintained for approximately 1 to 2 milliseconds. Excessive power would melt too much electrode and cause weld spatter. Even at low power, the shape of the melted electrode at this point is very irregular.

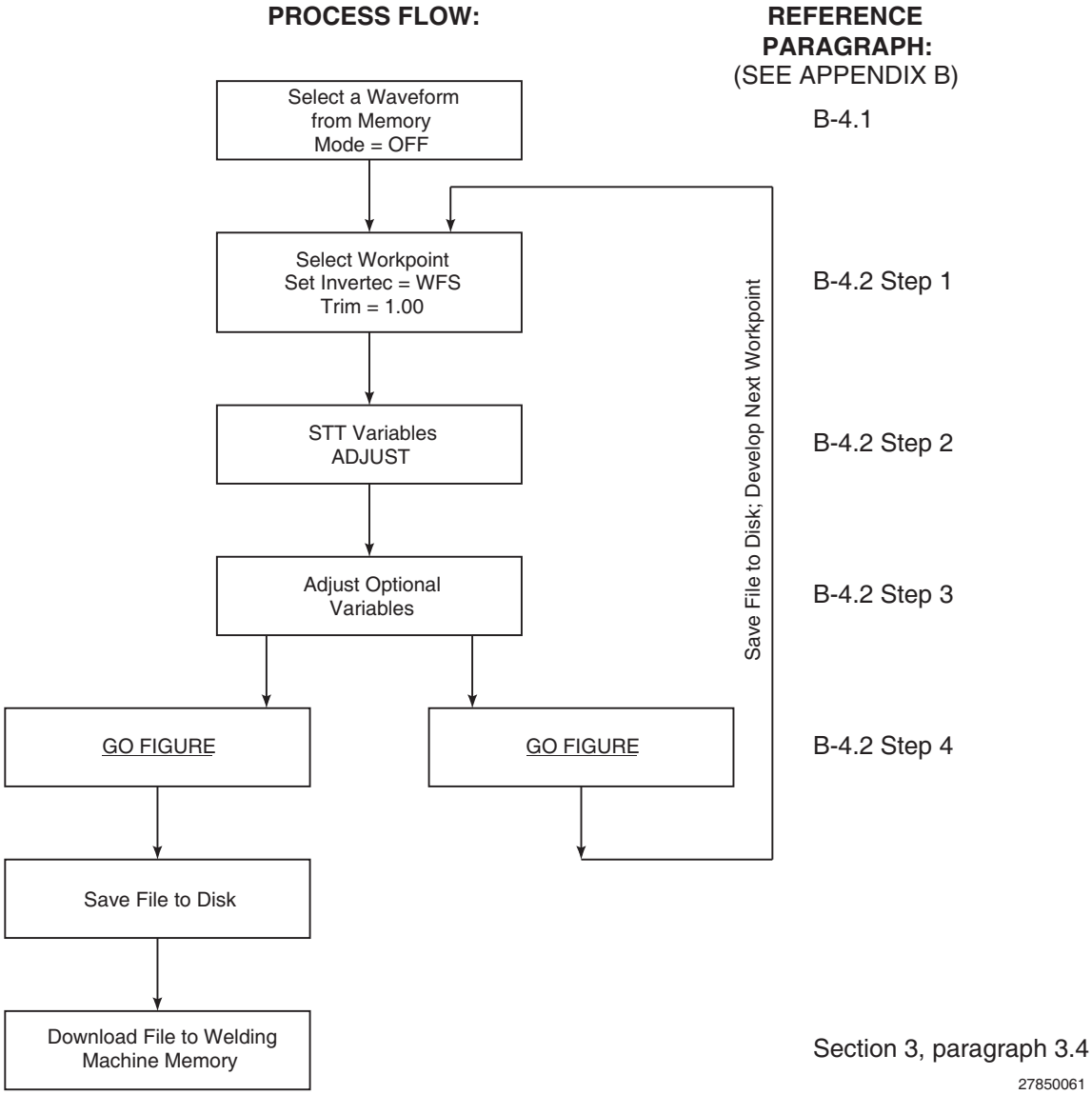
$T_6 – T_7$ **Plasma** is the final period when the arc current is reduced exponentially from the peak current level to the background level. The exponential current drop mechanically dampens the weld pool agitation produced during peak current.

B.4 STT WAVE DESIGN PROCESS

The ***Wave Designer*** software interfaces with the welding machine controller to permit real time communication of STT wave design changes. Refer to paragraph 2.3 for equipment interface connections.

Use the wave design process to customize a standard wave shape. The process is summarized in Figure B-4. The flowchart is followed by a detailed process description. To ensure that the process creates a wave shape suitable for your weld application, we recommend that you perform all editing functions in the order presented. Where an editing function is described as optional and you choose not to perform the edit function, proceed to the next edit function in the design process.

FIGURE B-4. PROCESS FLOWCHART.



B.4.1 SELECTING A STARTING WAVE SHAPE

When customizing a waveform for a specific welding application, we recommend that you use a waveform in an existing weld file. An existing weld file can be selected from the systemWeldFiles folder in the ***Wave Designer*** directory as follows:

a. Click on a standard wave shape from the systemWeldFiles folder. Use the load file option in the File menu to download the selected file to the STT Waveform Editor.

NOTE: The welding machine's controller memory is allocated 10 weld mode slots (modes 155 to 164) for the storage of custom weld designs. No more than ten custom weld modes can be downloaded to the welding machine. You cannot upload a custom weld from the welding machine, but you can overwrite any or all of your allotted weld file memory locations.

b. In Waveform Editor, select the Save Waveform As ... option from the File menu.

⚠ CAUTION

Failure to use the Save Waveform As... option to copy the standard wave shape will result in changes to the standard wave shape. Make sure you assign a unique file name to a copy of the standard wave shape before making any waveform changes. Make backup copies of all original wave shape files as well as the custom wave shapes you create.

c. When prompted, type in a unique filename for the new waveform. Select OK to assign the new file name to the waveform.

B.4.2 CUSTOMIZING THE WAVE SHAPE

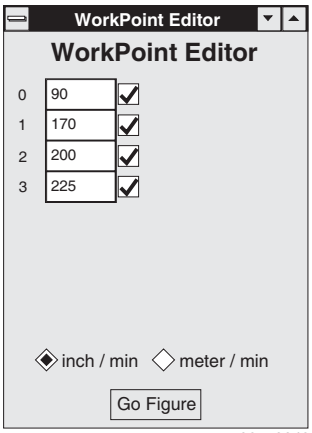
If customizing your first wave shape, perform the wave shaping exercises provided at the back of this section to get thoroughly acquainted with wave shaping. Thereafter, refer the following wave shaping procedure.

1. Select a Workpoint

a. Select a workpoint from the Wire Feed Speed pulldown menu. The first workpoint selected should be in the midrange of the expected Wire Feed Speeds to be used for the weld application. If you are uncertain of the WFS range, we recommend selecting 150 or 200 in/min. as a first workpoint.

NOTE: You can edit one or more workpoints to values other than the defaults. However, the listing of wire feed speeds displayed must be the same or increasing from top to bottom. All four wire feed speeds must be assigned values, but multiple workpoints can share the same value.

The reason you would edit multiple workpoints to the same value would be to limit the range of WFS or to develop fewer than four workpoints.



b. Set the welding machine's wire feed speed equal to the selected workpoint setting.

c. Verify that the control box Weld Mode is set for an OFF readout at the LED display and that the arc control is OFF.

2. Find the Optimal Arc Characteristics

Use the following weld trials and adjustment sequence to tune the selected waveform for your weld application at the designated workpoint (wire feed speed). Weld trials and adjustments are more easily performed with one person welding while you adjust the waveform parameters at the computer terminal.

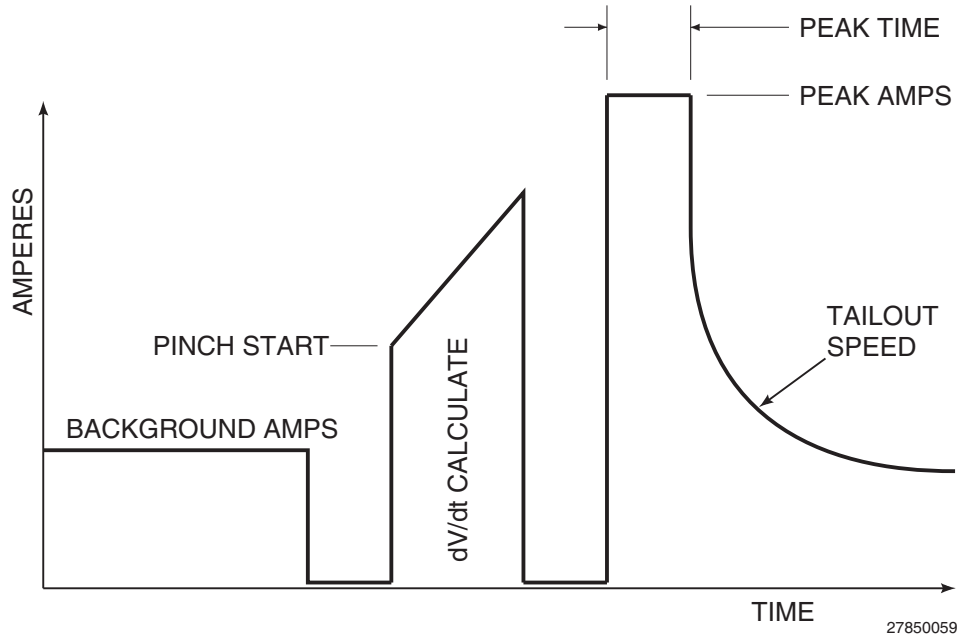
a. Set the Invertec Trim control for a readout of 1.00. This will ensure that the wave shape is designed at the midrange of the trim adjustment capability. The welding machine's trim control allows the welder to adjust the arc length between 0.5 to 1.5 (50% to 150%) times the established arc length adjustment factor.

b. Maintain a constant stickout. The stickout should be equal to the expected average of the welding application. We recommend about 5/8 in. to 3/4 in. (16 mm to 19 mm) electrical stickout.

c. While welding a trial weld bead, adjust the waveform variables (peak current, background current, tailout, etc.) to achieve a desired droplet transfer with a fixed 5/8 in. to 3/4 in. (16 mm to 19 mm) stickout at the selected wire feed speed. Refer to paragraph B.5.

d. With the stickout at a fixed setting, make trail welds during each adjustment so you can directly observe the effect of the adjustments in the arc and resulting weld. Adjust the variables as needed to achieve the desired weld transfer at the fixed stickout.

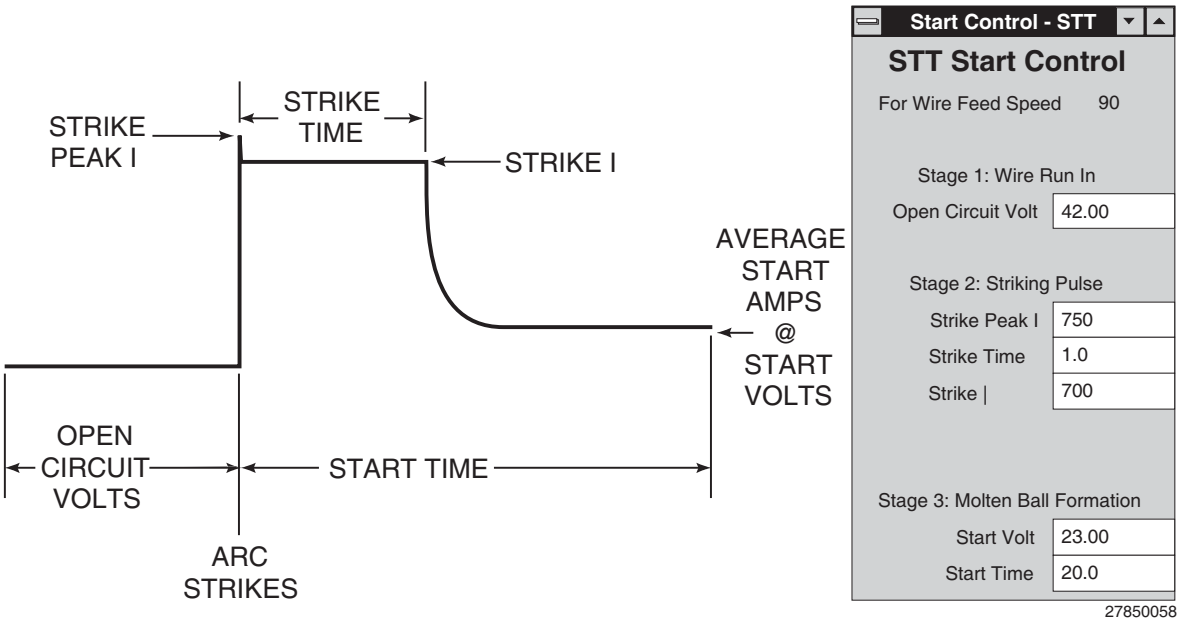
NOTE: Wire feed speed controls the deposition rate. Peak current controls the arc length. Background current controls the bead contour, and tailout adjusts power (heat) in the arc. For optimum spatter control, the arc should be focused on the weld puddle.



3. Adjust the Start Control Parameters (Optional)

The start control parameters can be adjusted to define how the welding machine will respond when the arc is struck.

To view the start control window, click on the Start button on the Waveform Editor screen. Adjust the start control parameters to accommodate your welding application and per the following parameter descriptions.



Open circuit voltage: Sets the power source output voltage for the torch idle condition (the welding machine is on, but not welding).

Strike time: Adjust this parameter to set the duration of peak current for the arc-strike current spike.

Strike Peak I & Strike I: Adjust these parameters to set the peak current level for the arc-strike current spike.

The Strike Peak I is set to some level (e.g. 50 amps) higher than the Strike I to improve current step responsiveness. In other words, the actual current has a tendency of lagging behind in rapid stepping of commanded current. A higher initial Strike Peak I is designed to overcome this problem.

Starting volts: Adjust this parameter to set the gun voltage to be maintained during the arc starting routine.

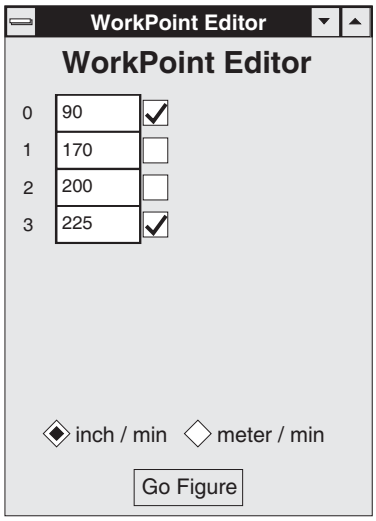
Starting time: Adjust this parameter to set the duration of the arc starting routine.

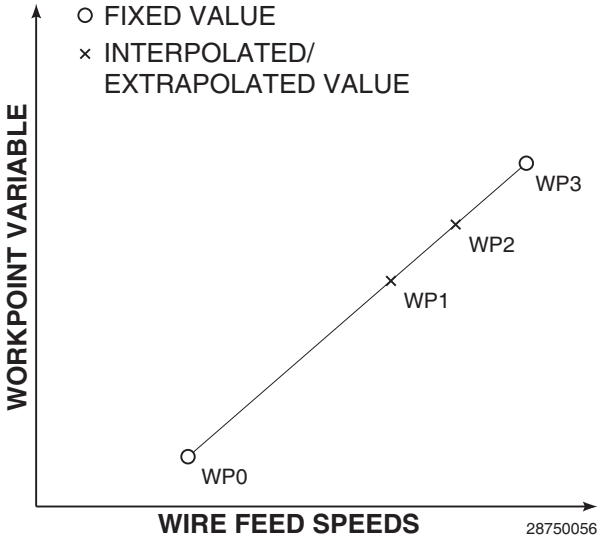
4. "Go Figure" / Make the Waveform Synergic

Weld synergy is established by shaping the 2nd and all subsequent workpoints. Being synergic, the waveform parameters automatically adjust to programmed data table values. The data table values are unique for selected wire feed speeds. Thereby, the output of the power source changes in response to changes in the wire feed speed, as controlled by the Invertec's WFS encoder setting. The process of making the waveform synergic involves two procedures; developing the 2nd workpoint and workpoints interpolation.

Developing the 2nd Workpoint

Develop the second workpoint in the same manner as the first.





Workpoints Interpolation

After shaping the second waveform, open the workpoint editor and click on the Go Figure button. ***Wave Designer*** interpolates the waveform parameters for each selected wire feed speed between the first and second developed workpoints. These steps can be repeated multiple times to fine tune all the workpoints. The set (fixed) wire feed speeds are those indicated (checked) in the workpoints listing. Go Figure will interpolate/extrapolate between/from set workpoints.

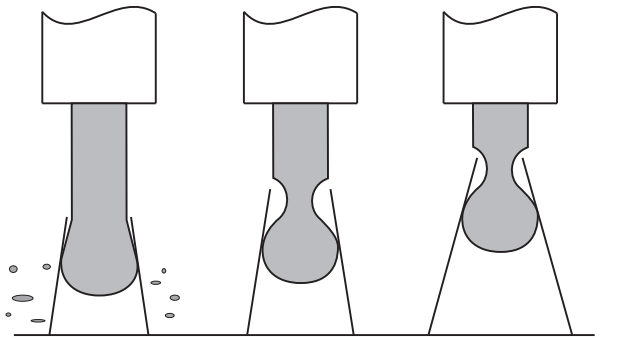
B.5 PRIMARY STT WAVEFORM COMPONENTS

The following paragraphs describe how peak current, background current, and tailout effect weld droplet transfer.

B.5.1 PEAK CURRENT

The peak current control acts similar to an “arc pinch” control. Peak current serves to establish the arc length and promote good fusion. Higher peak current levels will cause the arc to broaden momentarily while increasing the arc length. If set too high, long arc lengths will inhibit travel speed. Setting this level too low will cause instability and wire stubbing. In practice, this current level should be adjusted for minimum spatter and puddle agitation.

ADJUST ARC LENGTH WITH PEAK CURRENT

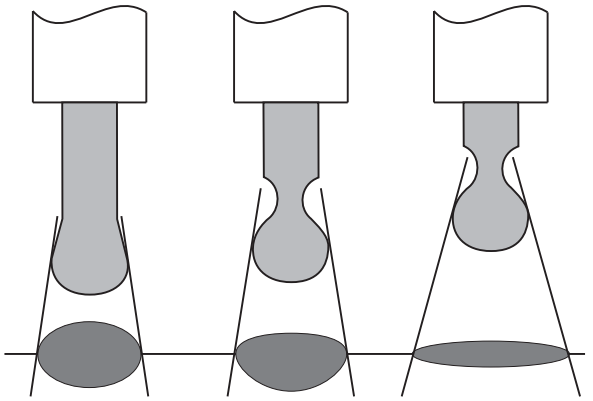


NOTE: In 100% CO_2 shielding gas applications, the peak current level should be set greater than in a similar application using a high percentage Argon blend. Longer initial arc lengths with 100% CO_2 are required to reduce spatter.

B.5.2 BACKGROUND CURRENT

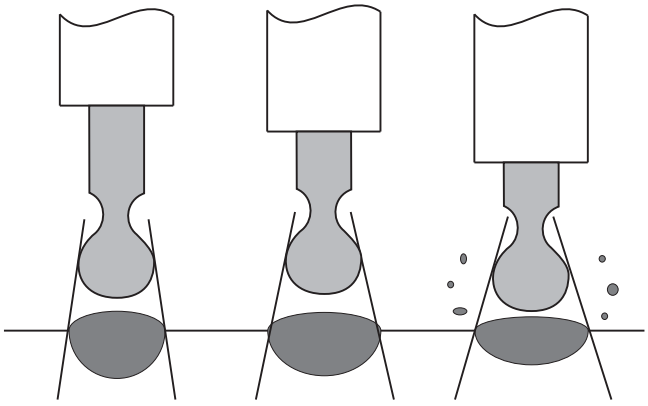
The Background current controls the overall heat input to the weld. Adjusting this level too high will form a large droplet resulting in globular type transfer and increased spatter. Adjusting this level too low will cause wire stubbing and poor wetting of the weld metal.

ADJUST BEAD SHAPE USING BACKGROUND CURRENT



NOTE: Applications using 100% CO_2 require less background current than similar procedures using high Argon blends. This is due to greater heat generated in the 100% CO_2 arc.

CONTACT TIP TO WORK DISTANCE



B.5.3 TAILOUT

The tailout provides additional heat without the molten droplet becoming too large. Increase tailout as needed to add heat to the arc without increasing arc length. (This will allow for faster travel speeds and improved wetting). As tailout is increased, the peal and/or background current is usually reduced.

B.6 SECONDARY STT WAVEFORM COMPONENTS

NOTE: The Invertec STT power source circuitry automatically establishes proper values for most primary and secondary waveform components. The values can be adjusted, but should not be set far from their automatically set values.

B.6.1 PINCH START

The pinch start is the amperage setting that begins the ramp up to the maximum pinch current. Pinch start current must exceed background current.

B.6.2 PINCH/PEAK

Pinch/Peak is the ratio of maximum pinch current to peak current. This parameter is used to establish the desired maximum pinch current value.

B.6.3 PEAK TIME

Peak time is the duration of the plasma boost period (peak amps) in milliseconds. The duration of peak time is typically set from 1 to 2 milliseconds. Longer peak times may cause weld spatter.

B.6.4 dV/dt DETECT

The dV/dt detect setting determines at what point in the necking down process pinch current will be discontinued.

B.7 APPLICATION EXERCISE

This application exercise steps the user through the development of a basic PowerWave/STT welding program using ***Wave Designer***. Your application most likely will vary from this example but the concepts outlined are recommended for all development work.

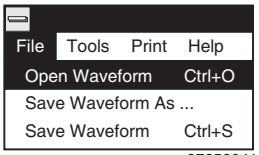
If you would like to follow along with this example, use the following set up:

Machine: PowerWave/STT, PowerFeed 10, Magnum 400 gun and cable, miscellaneous other parts to complete welding cell (The standard PowerWave does not have an STT capability. Be sure to use the STT output stud on the STT power source.)
Wire: 0.045 L-56
Gas: CO_2
Computer: See Section 2 of this manual for minimum requirements and connection diagrams. Click on the ***Wave Designer*** icon to start the program.

For this example, we developed a program to weld 16 gauge fillets and lap welds at 130 in/min wire feed speed. The user may want to develop more workpoints for practice.

Before starting the waveshape development process, confirm that the consumables are working properly with the welder. We recommend using a standard waveshape such as mode 5 to confirm that the welding system performs under normal conditions before attempting to develop waveshapes.

1. ***Select a wave shape.*** (From the tool bar, select 'File', 'Open Waveform'.) For this exercise, select the "AST452CF STT Fillet Steel 045 CO2 mode.swf" (***Wave Designer*** with Windows 95/NT supports long file names.) The STT Waveform Editor window is automatically displayed. Generally, the user should choose a waveshape file that has the closest welding performance to the intended application.



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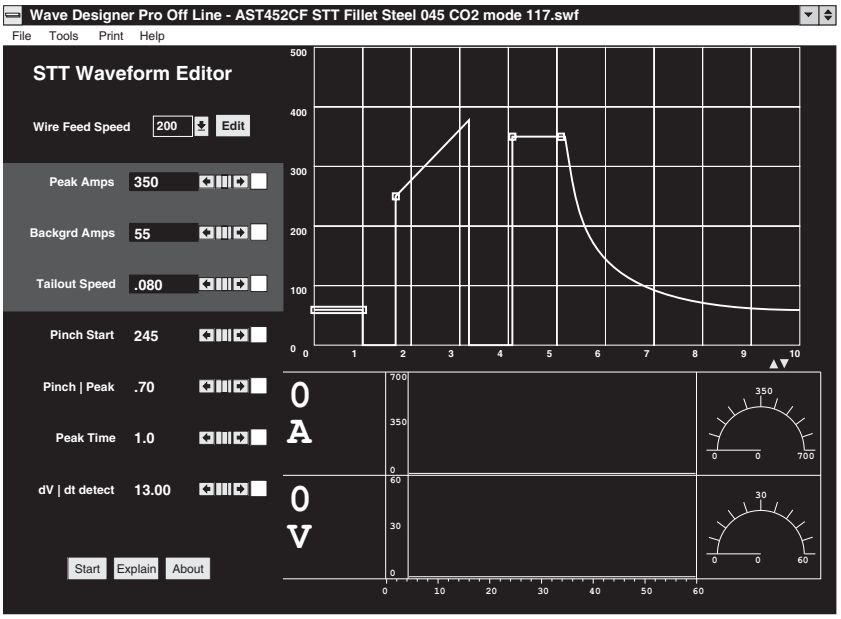

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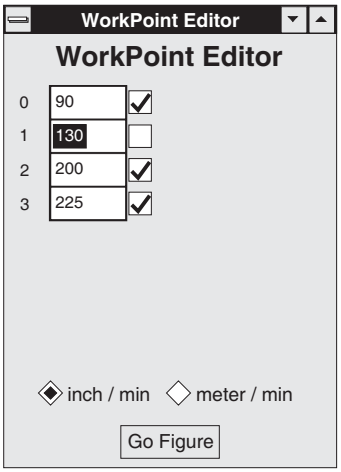
2. ***Pick a wire feed speed*** from the Wire Feed Speed pulldown menu. We wanted to start with a 130 in/min. WFS. But 130 is not a workpoint in the selected wave shape application. Use the Workpoint Editor window to change the second workpoint (170 in/min.) to 130.



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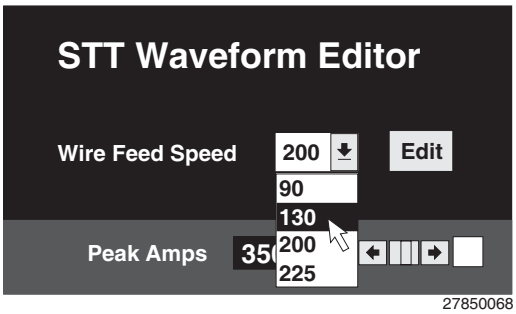
3. ***Select 130*** from the Wire Feed Speed pulldown menu. Also, be sure to set the PowerFeed's wire feed speed to the same WFS as the selected workpoint and set the trim to 1.00. (In this exercise, the WFS is 130 in/min.) Set the PowerWave mode and Arc Control settings to 'OFF'.



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4. If you are using the expanded STT Editor window, check the box next to the pinch/peak variable. This will fix the ratio of pinch start to peak amps. Selecting the Simplify Editor option (see the tools menu) automatically fixes this ratio.

NOTE: The STT process reacts to changes in the arc. When a short occurs, the STT routine responds to the short in a controlled fashion. The STT process does not use an adaptive loop. The process adapts to changes in stickout only by changes in the number of times shorts occur.

5. While welding, ***adjust the STT variables to improve welding performance.*** Maintain a constant 5/8 in. stickout (torch tip to work distance.)

Our Experiment: The weld produced by this setting is too hot. We burned through the 16 gauge fillet. The arc is too long and is producing too much spatter.

First, we reduced the peak current to 250 amps. Welding again shows that the arc length is now correct, but there is still too much heat in the arc.

Second, we reduced tailout from .100 to .140 (increasing tailout reduces the heat input). We welded again and found there was still too much heat in the arc.

Next, we reduced the background to 35 amps. This resulted in very good fillet welds on 16 gauge steel.

The starting screen can be adjusted at this time if needed. The STT waveform incorporates a soft start feature. The initial pulse to start the arc can be adjusted as necessary to achieve excellent results on a wide variation of applications.

Our goal was to optimize the welding at only one workpoint. The 130 in/min. workpoint is fully developed. If desired, you can save the new application, select the next workpoint and optimize the welding at that wire feed speed in a similar fashion as the first. The Go Figure function can assist in interpolating/extrapolating the variables at the next workpoint.

INDEX

A

B

C

D

E

F

G

I

INDEX

M

O

P

R

S

T

U

V

W

INDEX