

ADMSTAT Plus™

Arc Data Monitor Statistical Analysis Program

Operation / Installation Manual

Manual Part Number: A8M5013
Revised: August 23, 2005



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1.0 SYSTEM OVERVIEW ADMSTAT PLUS™

ADMSTAT Plus™ is a product of Computer Weld Technology, Inc. and is designed to operate in conjunction with our ADM IV™ monitoring system. The program provides a serial communications program, which is used to communicate with the ADM IV and to collect weld data. It provides graphical functions, which permits the user to view and analyze stored welding data. The program provides a full function, user configurable ASCII terminal program, which can be used to configure all of the ADM IV functions. It provides weld data collection routines that allow the user to collect run-time weld data and store this data for future analysis. A statistical function allows the user to generate basic Process Control Limits for a specified weld schedule based on stored weld data files. The ADM IV control limits can be edited and include a Weld Setup specification sheet, which is used to save process specific user information for the current weld schedule. A graphical analysis function is included to provide easy analysis of stored weld data files and to generate graphical reports.

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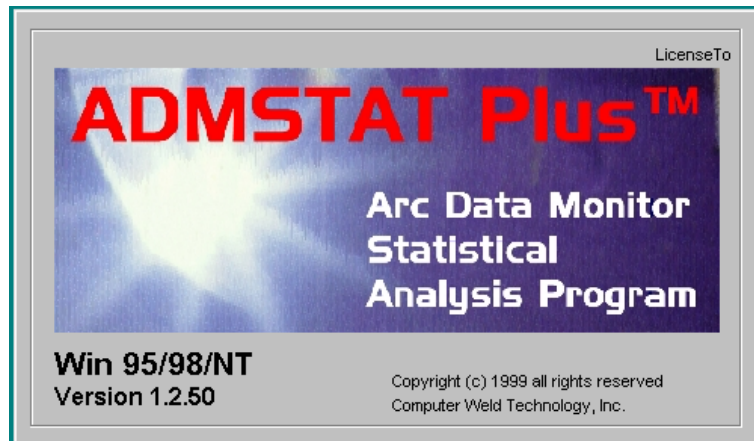
2.0 SYSTEM REQUIREMENTS

Processor:	150mhz Pentium™ or higher microprocessor
Memory:	24 Megs minimum for Windows 98®, 32 Megs for Windows NT®
Hard Drive:	25 Megs of available hard drive space
Graphics:	Minimum SVGA graphics. X VGA recommended
Serial Port:	RS-232 serial port
Type Set:	Regional and Language Option must be set for U.S. English

3.0 OPERATING SYSTEM

The ADMSTAT Plus™ program is designed for use with Windows 98®, Windows® XP or Windows NT® 4.0 or later platforms. The program has been tested with Windows 98®, Windows NT® 4.0 and Windows® XP.

4.0 INSTALLATION OF SOFTWARE



The following steps will guide you through the installation process.

1. Power on your computer and start Windows.
2. Insert Disk 1 of ADMSTAT Plus™ into the computer's floppy drive.
3. From the **START** Button, choose **RUN**.
4. In the **OPEN** field, type **A:Setup.exe** and press **Enter** or click **OK**.
5. Follow the instructions on screen.
6. If the system requires you to restart Windows, remove the floppy diskette and restart the system. Once Windows has restarted repeat the installation procedures for this program starting with **Step 2**.
7. Once installation is complete you may start the **ADMSTAT Plus** Program by clicking the **START** button on the Windows screen then selecting the **PROGRAMS** folder, **ADMSTAT Plus** folder, and then the **ADMSTAT Plus** file.

5.0 FILE PULL - DOWN MENU

The following Menu items are available under the File Pull-down Menu:

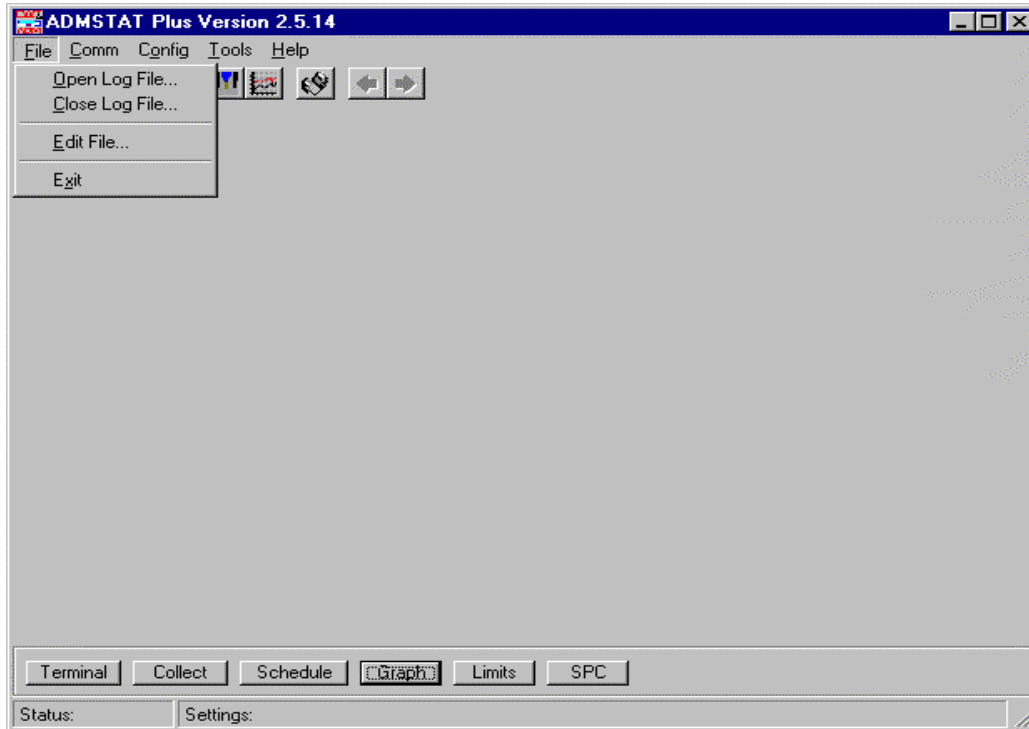


Figure 1 - File Pull-down Menu

- | | |
|------------------------------|--|
| <u>O</u>pen Log File | Opens a Log File when the Terminal mode is active. All commands entered and all data sent by the ADM IV will be saved to a user-specified file. If the Collect Welding Data mode is active weld data collected will be saved to the user-specified file. |
| <u>C</u>lose Log File | Close any opened Log File or Weld Data File. |
| <u>E</u>dit File | Invokes a Text Editor that can be used to View, Edit or Print any Faulted Data File, SPC Data File, Log File, Weld Data File or Limit File. |
| <u>E</u>xit | Terminates the ADMSTAT Plus program. |

6.0 COMM PULL-DOWN MENU

The following Menu items are available under the Comm Port Pull-down Menu:

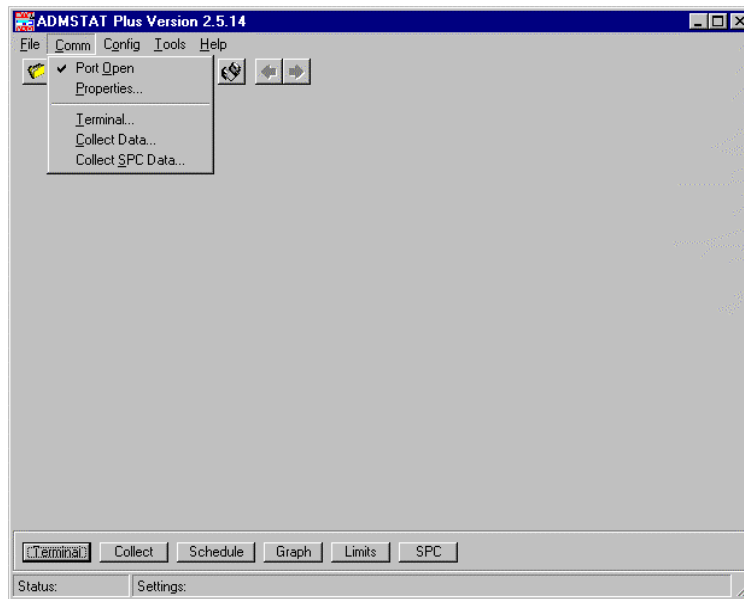


Figure 2 - Comm Port Pull-down Menu

Port Open Indicates the current port status. If checked, the selected port is open. If unchecked the port is closed. Clicking on the item will toggle the state of the port. The port must be open to communicate with the ADM IV.

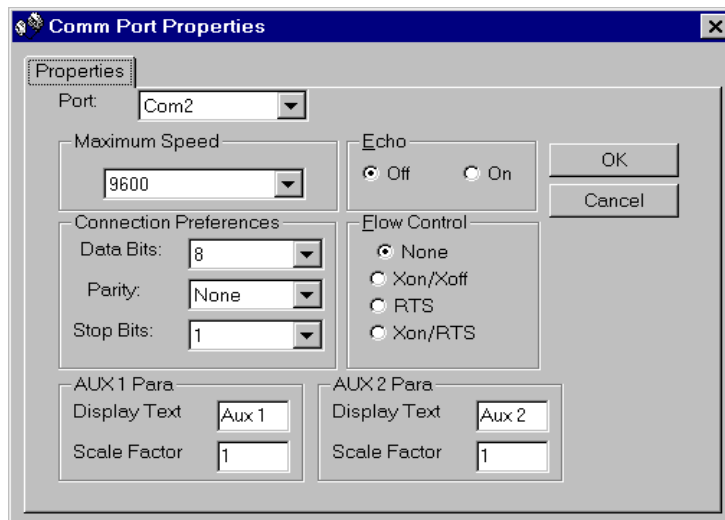


Figure 2.1 - Properties Pull-down Menu

Properties Opens the Comm Port Properties dialog (Fig. 2.1) and allows the user to configure the Comm port and the two AUX Parameters.

PORT – This pull down window allows the user to select the Comm Port for Serial communication with the ADM IV.

Maximum Speed – This pull down window allows the user to select the communication speed (baud rate) between the ASMSTAT program and the ADM IV. The default speed setting for the ADM IV and ADMSTAT is 9600 Baud. The current maximum speed is 19200 Baud. To change the speed to 19200, first go to the Terminal mode and set the ADM IV to the new speed by typing **M32=1 <enter>**. Power cycle the ADM IV by turning the power switch off and then on. From the ADMSTAT, Exit the Terminal Mode. Pull down the COMM Window and select the Properties Dialog. Click on the Maximum Speed Dialog and select the 19200 setting.

NOTE: If you are experiencing communications problems with the ADM IV refer to Section 15.0 Terminal Commands or contact the factory for advice.

Echo – Always set to Off.

Connection Preferences – Data Bits set to 8, Parity set to None, Stop Bits set to 1.

Flow Control – Set to None.

AUX 1 Para - Allows the user to define the Name of the AUX1 input parameter that will be displayed on the ADMSTAT Sweep Charts and Graphs. The Text length is limited to 6 characters. The Scale Factor can be specified to provide the correct scaling for the AUX 1 parameter. The ADM Limits will be multiplied by this number to provide correct decimal point location for the specified sensor input.

AUX 2 Para - Allows the user to define the Name of the AUX 2 input parameter that will be displayed on the ADMSTAT Sweep Charts and Graphs. The Text length is limited to 6 characters. The Scale Factor can be specified to provide the correct scaling for the AUX 2 parameter. The ADM Limits will be multiplied by this number to provide correct decimal point location for the specified sensor input.

- Terminal** Opens the ADMSTAT ASCII terminal screen. The Terminal screen will be displayed. To exit the Terminal program, press the EXIT button on the control bar or the Terminal speed button on the tool bar. Refer to the Terminal Command (Section 16.0) for valid ADM IV commands and additional information.
- Collect Data** Opens the ADMSTAT Plus Sweep Chart window and enables weld data collection. Refer to Sweep Chart Configuration (Section 12.0) for additional information.
- Collect SPC Data** Opens the SPC (Statistical Process Control) down load dialog window and allows the user to download stored ADM summary data and to generate and view the resulting SPC data graph. The SPC data will be appended to the existing SPC monthly data file and the new data will be plotted. See Chapter 19.0 for more information.

7.0 CONFIG PULL-DOWN MENU

The following Menu items are available under the Config Pull-down Menu:

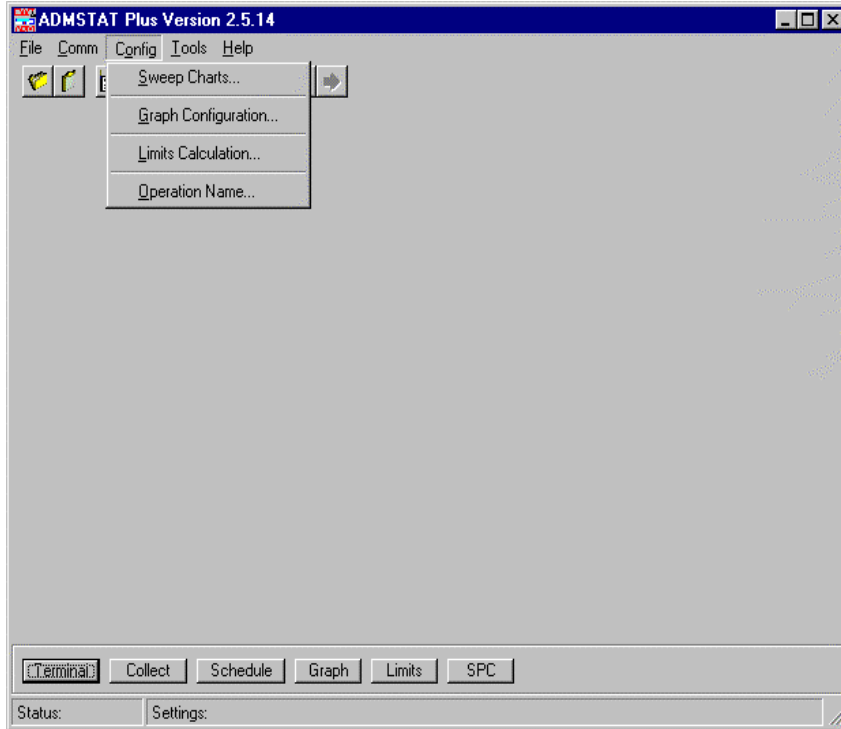


Figure 3 - Config Pull-down Menu

- | | |
|-----------------------------------|---|
| <u>S</u>weep Charts | Opens the Sweep Chart Configuration dialog. See the Sweep Charts (Section 12.0) for additional information. |
| <u>G</u>raph Configuration | Opens the Set Graphical Parameters dialog. See the Set Graphical Parameters (Section 13.0) for additional information. |
| <u>L</u>imits Calculation | Opens the Limit Calculation Parameters dialog. See the Limit Calculation Parameters (Section 14.0) for additional information. |
| <u>O</u>peration Name | Allows the user to edit the ADM IV Change Operations Name. The ADM IV must be connected for this function to be operational. The program will open the Change Operations Name input dialog box and the existing ADM IV Operation Name will be displayed. To edit the name, type in the new name. Press the OK button to save the new name in the ADM IV. Press the Cancel key to exit without saving. |

8.0 TOOLS PULL-DOWN MENU

The following Menu items are available under the Tools Pull-down Menu:

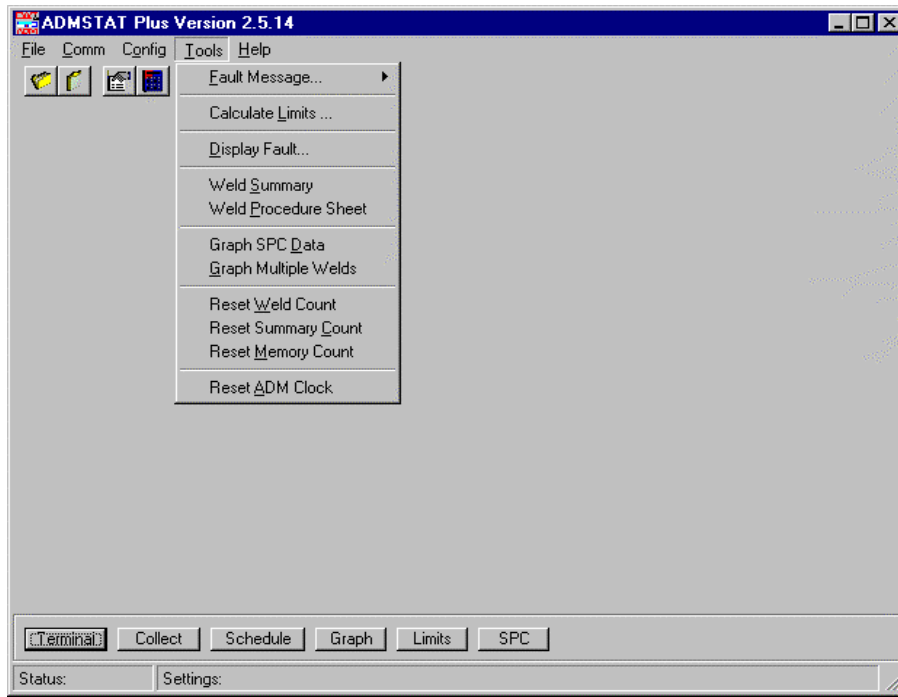


Figure 4 - Tools Pull-down Menu

- | | |
|--|---|
| <u>F</u>ault Message... | Calls the weld parameter sub menu for each parameter's associated Fault Message. Refer to the ADM IV Terminal Command (Section 16.0) for additional information concerning ADM IV Fault Messages. |
| <u>C</u>alculate <u>L</u>imits... | Invokes the Calculate ADM Limits from Weld Data dialog and allows the user to calculate control limits based on collected weld data files. Refer to the Limit Calculation Parameters (Section 14.0) for additional information. |
| <u>D</u>isplay <u>F</u>ault... | Reads the fault data stored in the ADM or from a previously saved fault data file and displays the data. The user can scroll through the data, Print the data and reset the ADM IV Fault counter. See Display Fault data Dialog for additional information. |
| <u>W</u>eld <u>S</u>ummary... | Invokes the Read Weld Data File dialog. Select the weld data file to be summarized and press the Open button. The program will display a Summary of all the weld data in that file in the Weld Summary dialog. |
| <u>W</u>eld <u>P</u>rocedure ...
Sheet | Displays the Edit Weld Process Sheet dialog. This enables the entry and editing of the weld Process Data information, Torch Data information, Weld Data information and the Process Notes entered by the operator for the data collected in that file. |

- Graph SPC Data...** Invokes the Open SPC Data File dialog window and allows the user to select saved SPC Data files, generate and view the resulting SPC data graph. The SPC data is saved in monthly data files by schedule number and ADM IV Station number. See Chapter 19.0 for more information.
- Graph Multiple Weld ..** Invokes the Open Weld Data File dialog. Select the weld data file to be graphed and press the Open button. The program will display the selected data by parameters as defined by the Graph Configuration dialog. Use the Speed buttons to Select the weld data parameter you wish to view. Each parameter selected will be displayed in a 3D Multiple Weld Graph. See Chapter 17.1.0 for additional information.
- Reset Weld Count...** This routine will reset the ADM IV Weld counter to weld 1.
- Reset Summary ...
Count** This routine will reset the Average Weld Data summary counter. Resetting this counter will allow the ADM IV to store new summary Weld data.
- Reset Memory Count..**This routine will reset the run-time data weld memory counter. Resetting this counter will allow the ADM IV to store new run-time Weld data.
- Reset ADM Clock...** Loads the PC Date/Time to the ADM IV real time clock.

9.0 TOOL BAR SPEED BUTTONS



Figure 5 - Tool Bar

The following Menu items are available under the Tool Bar Speed Buttons:

- | | |
|-----------------------------|--|
| Open Log File | Speed Button opens a Log File when the Terminal mode is active. All commands entered and all data sent by the ADM IV will be saved to a user-specified file. If the Collect Welding Data mode is active weld data collected will be saved to the user-specified file. |
| Close Log File | Speed Button closes any opened Log File or Weld Data File. |
| Edit Limits | Speed Button invokes the ADM IV Weld Schedule Edit dialog and allows the user to modify Control Limits and Weld Setup data. The user can Read data from and Write data to the ADM IV. Refer to the Limit Calculation Parameters (Section 14.0) for additional information. |
| Calculate Limits | Speed Button opens the Calculate ADM Limits from Weld Data dialog and allows the user to calculate limits based on stored weld data Files. The function will use multiple weld files and grouped schedules to calculate control limits based on a specified Standard Deviation Value. Refer to the Limit Calculation Parameters (Section 14.0) for additional information. |
| Collect Welding Data | Speed Button invokes the Weld Data Collection Sweep Chart function using the default sweep chart configuration parameters. To exit press the Collect Weld Data speed button or the Exit key on the control bar. |
| Graph Welding Data | Speed Button invokes the Open Weld Data File dialog. Select the weld data file to be graphed and press the Open key. The program will display the selected data as defined by the Graph Configuration dialog. Use the arrow buttons to scroll through the weld data files. Click the right mouse button to open the graph pop-up menu. To zoom an area on the graph hold the left-mouse button and drag a zoom box around the area to be zoomed. Release the button and graph will display the new area. To restore from the zoom mode press the 'Z' key on the keyboard. Press the Graph Welding Data speed button or the Exit button on the control bar to exit. |
| Terminal Program | Speed Button invokes the ASCII terminal program. To exit the terminal program press the Terminal Program speed button or the Exit button on the control bar. See Terminal Protocol (Section 15.0) for additional information and ADM IV commands. |
| Graph Last Weld | Left Arrow Speed Button, when enabled during the Graph Weld routine, will redisplay the last weld graphed. The Left Arrow Speed Button will become enabled only when more than one weld has been displayed. |

Graph Next Weld

Right Arrow Speed Button, when enabled during the Graph Weld routine, will display the next weld stored in the weld data file. When the last weld is displayed the Right Arrow Speed Button will be disabled.

10.0 CONTROL BAR COMMAND BUTTONS

The following Menu items are available under the Control Bar Command Buttons:

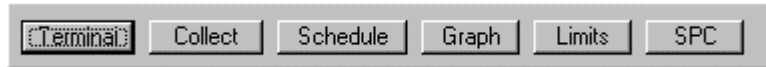


Figure 6 - Control Bar

Terminal

Open/Close the ADMSTAT ASCII Terminal screen. To open the Terminal program press the Terminal Button. The Terminal screen will be displayed showing any previous data sent or received in the terminal mode. The prompt on the Terminal button will be changed to Exit indicating terminal activation. Using the keyboard, type any valid ADM IV command and the data will be displayed in the text window. Once the screen has been filled with commands or data, scroll bars will be enabled. Use the scroll bars to view previous data that has been input or received. To exit the Terminal program, press the EXIT button on the control bar or the Terminal speed button on the tool bar. See Terminal Command Summary (Section 16.0) for valid ADM IV commands and additional information.

Collect

Opens/Closes the weld data Sweep Chart routine. The prompt on the Collect button will be changed to Exit indicating Sweep Chart activation. When invoked, ADMSTAT Plus will enable the ADM IV weld data collection upload routine. If the weld is active when the program is invoked, only the run time data in the Parameter Windows at the bottom of the chart will be displayed. No data will be plotted on the Sweep Chart until the first arc off has been detected. New weld data will be displayed in the Parameter Windows and plotted on the sweep charts based on the user configuration set in the Sweep Chart dialog window. At the end of the weld the program will display the statistical average for all parameters in the Parameter Display Windows. While collecting data it is possible to zoom an area on the chart.

Zooming is the process of using the mouse to select new extents of the chart grid. To Zoom:

1. Press the left mouse button and drag the cursor to select the new extents.
2. Release the mouse button.

To Undo the Zoom press the 'Z' key, or use the pop-up menu to select the Undo Zoom menu item.

If the Save Weld option was enabled in the Sweep Configuration dialog window the selected file name will be displayed on the Program Window header. When the selected number of welds have been collected the file will be closed and the Program Window header will be reset.

To save new data to a file press the Open Log File speed button and the Save Weld Data dialog will be displayed. Enter the weld name and press the Open button. If the weld is active the program will wait for the

arc off signal. Data will be written to the file at the start of the next weld. To end the Save Weld Data functions click the Close Log File speed button. When using this method the user must terminate the data collection at the end of a weld cycle. The weld counter is not active in this mode. To Exit the collection program press the Exit key on the control bar or the Collect Welding Data speed button on the tool bar.

WARNING: *It is recommended that the user only exit the program when the weld is inactive. Depending on the data collection rate and ADM IV options the End upload command issued by the program may not terminate the ADM IV data upload. If this occurs invoke the terminal program and type the following command:*

M21=0(enter)

This will terminate the ADM IV data upload routine.

Schedule Button

Pressing the Schedule button will invoke the ADMSTAT Plus Weld Schedule Edit dialog window. From here the user can Edit, Read, Write, Print, Save, Open and Close the weld schedule used by the ADM IV. From this location the user can edit the Weld Setup specification sheet, Weld Limits, Aux. Limits and ADM Configuration information associated with this schedule. To exit the Schedule Editor dialog without saving any changes press the Cancel button. To save the changes to the system memory press the OK button.

Graph Button

Pressing this button will invoke the graph Weld Data File dialog window. Select the data file to graph then double click the file or press the Open button. The Graph screen will be enabled and the first weld data will be displayed based on the current configuration specified by the Graph Configuration dialog. To display the next weld in the file press the Graph Next Weld arrow key located on the tool bar. To display a previous weld press the Graph Last Weld arrow key.

While displaying Weld data it is possible to zoom an area on the graph. Zooming is the process of using the mouse to select new extents of the graph grid. To Zoom:

1. Press the left mouse button and drag the cursor to select the next extents.
2. Release the mouse button.

To Undo the Zoom press the 'Z' key, or use the pop-up menu to select the Undo Zoom menu item.

To print the graph, press the **Shift + P** key on the keyboard and the Print dialog will appear. To invoke the Graph Pop-up menu click the right-mouse button while over the graph area. To exit the graph routine press the Exit buttons on the control bar or click the Graph Welding Data speed button on the tool bar. Refer to the Graph Pop-up Menu (Section 17.0) for further information.

Limits Button

Opens the Calculate ADM Limits dialog and allows the user to change the Statistical Configuration used to calculate limits for stored weld data

Files. The function will use multiple weld files and grouped schedules to calculate control limits based on a specified Standard Deviation Value. Refer to the Limit Calculation Parameters (Section 14.0) for additional information.

SPC Data Button

Opens the SPC down load dialog window and allows the user to download stored ADM summary data and to generate and view the resulting SPC data graph. The SPC data will be appended to the existing SPC monthly data file and the new data will be plotted.

11.0 STATUS BAR WINDOWS

The status bar is divided into two windows. The first window displays the current status of an operational program. The second will display current settings or any fault or control messages generated by the operating routine.



Figure 7 - Status Bar

Example: During the Collect Data routine The Status will display the Arc on or Arc off Prompt and the Settings window will display the Weld Sched, Weld Number and Station ID for the connected ADM IV.

12.0 SWEEP CHART CONFIGURATION DIALOG

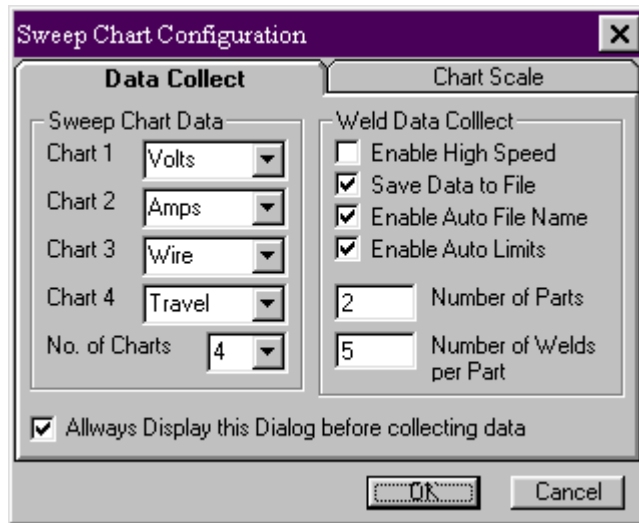


Figure 8 - Sweep Chart Configuration Window
Data Collect Tab

Sweep Chart Data Dialog Window

- Chart 1** This allows the user to select the parameters to display on the first (Top) sweep chart.
- Chart 2** This allows the user to select the parameters to display on the second sweep chart.
- Chart 3** This allows the user to select the parameters to display on the third sweep chart.
- Chart 4** This allows the user to select the parameters to display on the fourth sweep chart.

To select a parameter use the Up/Down buttons to scroll through the available options. To select the Item, click the parameter window. The selected item will be highlighted.

Weld Data Collect Dialog Window

- Enable High Speed** If checked the sweep pointer will be reset at the end of each weld. New data will overwrite the previous weld. If not checked the sweep chart will continue plotting data until the max time is reached after which the sweep pointer will reset to the start of the chart and will overwrite old data with new data.
- Save Data to File** If checked the Sweep Chart will automatically re-scale the chart based on actual weld data. If not checked the sweep chart will use the values set in the Chart Scale window.
- Enable Auto File Name** If **not** checked the user will be prompted for a file name when the user clicks the Collect Button or Collect Weld Data speed button. If checked a date/time file name will be assigned

to the file by the ADMSTAT PLUS Program. The File name will consist of the day/month/year followed by the number of files opened for that date. Example: 17October00-1.dat. This is the first file opened for the 17th of October 2000. All collected weld data will be stored in this file until closed. The next file opened for that day will have a file name of 17October00-2.dat. When the current file is closed and the user clicks the Collect Button or Collect Weld Data speed button, a prompt will be displayed asking if the user wishes to append any files opened for that day. When **Prompted to Append** the file, select **YES** if you wish to collect more data into the file name displayed. If you wish to open another file for the day, select **NO** and the next file name opened for that day will be displayed or a new file will be opened and the Collect Data graph will be displayed. If multiple files have been opened for the day, an **Append Prompt** will be displayed for each file. All the files will be stored in a directory (Windows File Folder) using the ADM IV Station Identification number as the name for that directory.

Enable Auto Limits	If checked this function will collect the data for the number of parts entered in the Number of Parts box and will create an ADM IV Schedule for each weld based on the information entered in the Number of Welds per Part box. The limits will be calculated using the information provided in the Limits Calculations Dialog and the average data collected per weld, per part. After the last weld is collected the ADM IV Weld Schedule Editor will display each schedule and give the user the opportunity to accept or change the limits for the schedule. Example: If the Enable Auto Limits box is checked and the number 2 is entered in the Number of Parts box and the number 3 is entered in the Number of Welds per Part box, the ADMSTAT PLUS software will display 3 schedules after the welding of the two parts is completed.
Number Of Parts	Enter the number of Parts being used to establish limits for the Enable Auto Limits function.
Number of Welds Per Part	Enter the number of welds being conducted on one part.
No. of Charts	Specifies the number of parameters to display on the sweep chart. The user can specify from 1 to 4 parameters

NOTE:

If the REMOTE SCHEDULE Select mode (M14=1) is enabled for the ADM IV, the Number of Parts Box and the Number of Welds per Part box will not be active.

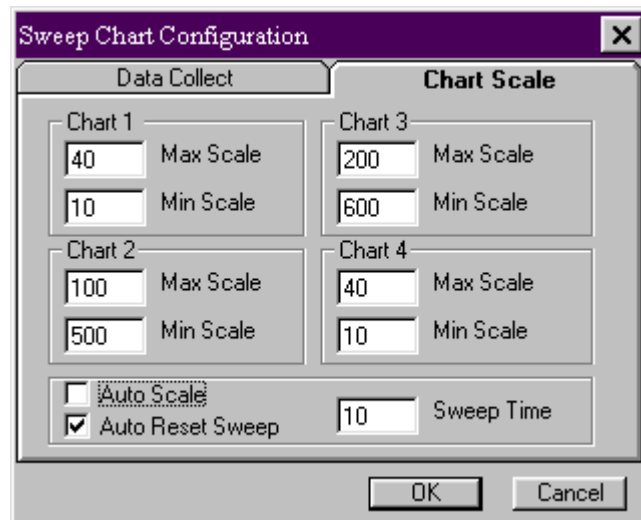


Figure 9 - Sweep Chart Configuration Window
Scale Chart Tab

Chart Scale Dialog Window

Chart 1 Max	Defines the maximum scale value for Chart 1.
Chart 1 Min	Defines the minimum scale value for Chart 1
Chart 2 Max	Defines the maximum scale value for Chart 2.
Chart 2 Min	Defines the minimum scale value for Chart 2
Chart 3 Max	Defines the maximum scale value for Chart 3.
Chart 3 Min	Defines the minimum scale value for Chart 3
Chart 4 Max	Defines the maximum scale value for Chart 4.
Chart 4 Min	Defines the minimum scale value for Chart 4
Sweep Time	Defines the total Sweep Time for the Chart in seconds. The Chart Scale values can be modified only if the Auto Scale option is not checked.

Sweep Chart Configuration Command Buttons

To exit the dialog without saving any changes press the Cancel button. To save the new configurations press the OK button. Pressing either button will terminate the dialog.

13.0 SET GRAPHICAL PARAMETERS DIALOG

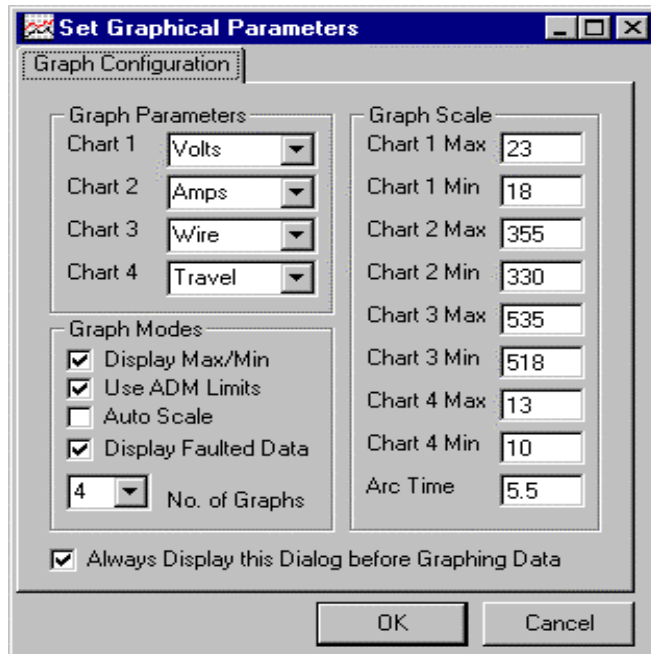


Figure 10 - Set Graphical Parameters Window

Graph Parameters Dialog Window

- Chart 1** This allows the user to select the parameters to display on the first (Top) graphical chart.
- Chart 2** This allows the user to select the parameters to display on the second graphical chart.
- Chart 3** This allows the user to select the parameters to display on the third graphical chart.
- Chart 4** This allows the user to select the parameters to display on the fourth graphical chart.

To select a parameter use the Up/Down buttons to scroll through the available options. To select the Item click the parameter window. The selected item will be highlighted.

Graph Modes Dialog Window

- Display Max/Min** If checked the graph program will display the Max/Min control limits as specified by the values in the Weld Schedule Edit parameters. The Graph will also display the mean value based on the actual weld data. If not checked no control limits or mean values will be displayed.

Use ADM Limits	If Checked, the graph program will use the limits as defined by the Max/Min values for each selected parameter.
Auto Scale	If Checked the graph will automatically re-scale the data based on actual weld data. If not checked the graph will use the values set in the Graph Scale window or the values defined in the ADM Weld Limits Schedule edit window.
No. of Charts	Specifies the number of parameters to display on the graph. The user can specify from 1 to 4 parameters

Graph Scale Dialog Window

Chart 1 Max	Defines the maximum scale value for Chart 1.
Chart 1 Min	Defines the minimum scale value for Chart 1
Chart 2 Max	Defines the maximum scale value for Chart 2.
Chart 2 Min	Defines the minimum scale value for Chart 2
Chart 3 Max	Defines the maximum scale value for Chart 3.
Chart 3 Min	Defines the minimum scale value for Chart 3
Chart 4 Max	Defines the maximum scale value for Chart 4.
Chart 4 Min	Defines the minimum scale value for Chart 4
Sweep Time	Defines the total Arc time for the graph in seconds. The Chart Scale values can be modified only if the Auto Scale option is not checked.

Graph Configuration Command Buttons To exit the dialog without saving any changes press the Cancel button. To save the new configurations press the OK button. Pressing either button will terminate the dialog.

14.0 LIMIT CALCULATION PARAMETERS DIALOG

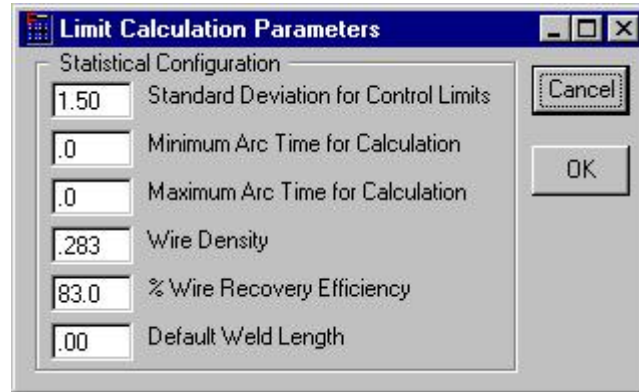


Figure 11 - Limit Calculation Parameters Window

Specifies the standard deviation value that will be used to calculate the control limits from stored weld data files and entry of data for calculation of "Mean Deposition Rates" and "Mean Volume Deposited". To enter new values click on the window and type a new value.

Standard Deviation

The standard deviation is defined as the positive square root of the variance of a data set. The variance for a data set of n items is equal to the sum of the squared distances from the mean divided by $(n-1)$. You can think of the standard deviation as the average of all distances of each data point from the mean.

Max Arc Time Dialog Window

The value entered here will be used to exclude weld data from calculation of samples collected after the specified arc time. The value is specified in seconds. This eliminates the crater fill data from being included into the limit calculation. This time will also set the End Test time for the ADM limit testing

Min Arc Time Dialog Window

The value entered here will be used to exclude weld data from calculation samples collected before the specified arc time. The value is specified in seconds. This eliminates the arc start data from being included into the limit calculation. This time will be used as the start delay test time for each of the ADM IV parameters.

Wire Density Dialog Window

The weld wire density is another parameter that must be provided by the user to permit "Mean Deposition Rates" and "Mean Volume Deposited" data to be calculated. This information can be in either English (Inches) or Metric (mm) units of measure. Below is a table that should prove helpful in inserting the appropriate wire density information for the various materials:

Material	Density (lbs/cu in) (g/cu mm)	
Steel, Carbon	0.283	7.8×10^3
Steel, Stainless	0.294	8.0×10^3
Aluminum	0.0975	2.8×10^3
Copper	0.321	8.6×10^3

Nickel

0.3178

8.6 x 10³

% Wire Recovery Efficiency Dialog Window Recovery efficiency is the actual percentage of the gross weight of the filler material that is being used that will find its way into the base material and be included in the joining process. (For example: Mig welding wire will have spatter loss, Stick Electrode will have flux, stub and spatter loss ect. The "Recovery Efficiency" for the various processes are listed in the table below.) This data is also required to obtain "Mean Deposition Rates" and "Mean Volume Deposited"

<u>Filler Metal Type & Process</u>	<u>Deposition Efficiency (%)</u>
Covered Electrode (SMAW)	
14" lg	55-65
18" lg	60-70
28" lg	65-75
Bare Solid Wire	
Submerged Arc	95-99
Gas Metal Arc	90-95
Electroslag	95-99
Gas Tungsten Arc	99
Flux Cored Electrodes	80-85

Default Weld Length Dialog Window If the travel speed sensor is not used with the ADM IV or is disabled, this default weld length parameter and the arc time will be used to calculate an average travel speed. A Default Weld Length must be entered in order to calculate the "Mean Deposition Rates" and "Mean Volume Deposited" data.

Limit Calculation Parameter Command Buttons To exit the dialog without saving any changes press the Cancel button. To save the new configurations press the OK button. Pressing either button will terminate the Dialog.

15.0 SERIAL TERMINAL PORT PROTOCOL INTERFACE

The ADM IV terminal port is used to off-line program the weld schedule parameters and operating modes / functions. The protocol is a simple ASCII command string that allows the user to upload or download the various data. The user can use any terminal program to perform the programming function. All program command functions are case sensitive. The serial port is configured for the following data format:

Baud Rate: 9600, Full Duplex
Word Length: 8 Data Bits, One Stop and no parity
Hand Shaking: None

Serial Protocol

The protocol consists of a command string and optional data bytes. The command string is an alpha character and an option number followed by a "=" or "?", followed by optional data and terminated with a ASCII "cr" (0dh). The "=" will indicate that data is being sent to the selected parameter/function by the host controller. The "?" will indicate a request for data from the ADM IV to the host controller. If the host is sending data to the ADM IV the data will be placed after the "=" character and will be an ASCII string terminated with an ASCII "cr" (0dh). The following is an example of communicating a VOLT MAX LIMIT Parameter with the ADM IV. To send the Volt Max Limit Parameter to the ADM IV, send the following command:

V4=24(enter) - Sent from Host

To read the Volt Max Limit Parameter from the ADM IV, send the following command:

V4?(enter) - Sent from Host
24 - Received from ADM IV

16.0 TERMINAL COMMAND SUMMARY

The following is a summary of the Terminal Commands supported by the ADM IV™: This command table lists the major categories that are set and changed through the off-line serial terminal port:

COMMAND	DESCRIPTION
"V"	Read/Write Welding Variables
"C"	Calibration Command
"M"	System Control Mode
"R"	Assign Fault Relays
"T"	Set Time (REAL TIME)(hh:mm:ss)
"D"	Set Date (YY/MM/DD)
"O"	Operation Name (Company Name, etc.)
"F"	Read Fault Memory
"P"	Load Fault Message Prompt (Help Screen Display)
"A"	Upload stored Weld Summary Data

All entries or changes to command function values are performed in the same manner as the following example:

To enable or disable the Volt Parameter in the schedule:

Type the following command to check the current value: M2?(cr)
The system responds with the current value in memory: 0 (disabled)
Type the following command to change the value: M2=1(cr)
Type the following command to check the new value: M2?(cr)
The system responds with the current value in memory: 1 (enabled)

Note: "cr" denotes carriage return (Enter)

The following is a summary of the command functions:

Set Time:

To set the time (hour/minute/second) type: T=10:17:35 (cr)
Entire field must be completed as explained below:

Type 6:45 am as T=06:45:00
Type 7:25 PM as T=19:25:00

Note: "cr" denotes carriage return (Enter)

Set Date:

To set the date (year/month/day) type: D=99/06/01 (cr)
Entire field must be completed as explained below:

Type February 4, 1999 as D=99/02/04
Type November 23, 2000 as D=00/11/23

Note: "cr" denotes carriage return (Enter)

Set Operation Name:

To set the operation name: (Maximum of 40 characters)

Type the following command to check the current value: O?(cr)

The system responds with the current text in memory: Computer Weld Technology, Inc.

Type the following command to change the value: O=Your Own Text

Type the following command to check the new value: O?(cr)

The system responds with the current text in memory: Your Own Text

Note: "cr" denotes carriage return (Enter)

A1 – A190 This serial command allows the user to up load any stored Weld summary data to a host controller. To upload a specific weld summary type the following command: A###? (enter). Where ### is the stored weld summary number to send (Number Range 1 – 190). If the weld has been stored the ADM IV will send the data string to the host. The format of the data is as follows:

[Weld Number] [Schedule] [Time] [Stored Average Weld Data]

NOTE: The Save Averages option must be active to use this function.
(M21=1)

C1 – C12 Calibration Values where:

- C1 = Arc Voltage zero value
- C2 = Arc Voltage gain value
- C3 = Arc Current zero value
- C4 = Arc Current gain value
- C5 = Gas Zero value
- C6 = Gas Gain value
- C7 = Temperature Zero value
- C8 = Temperature Gain value
- C9 = AUX 1 Zero value
- C10 = AUX 1 Gain value
- C11 = AUX 2 Zero value
- C12 = AUX 2 Gain value

NOTE: All calibration values are set at the factory. The values displayed are for reference only. Consult the factory prior to changing any of these values.

M1 – M33 System Control Mode functions (ENABLE/DISABLE SENSORS):

The following functions are used to enable sensors, select operation modes and select sensor types.

To enable a sensor it must equal = 1

To disable a sensor it must equal = 0

M1 = Arc Time Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 1)

M2 = Volt Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 1)

- M3 = Amp Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 1)
- M4 = Gas Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 1)
- M5 = Temperature Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M6 = Aux 1 Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M7 = Aux 2 Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M8 = Travel Speed Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M9 = Wire Speed Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 1)
- M10 = Heat Input Parameter (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M11 = Set GTAW Mode (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M12 = Set GMAW Mode (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M13 = Pulse Data (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M14 = Set Remote Schedule Selection (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M15 = Set Remote Arc On (Enable = 1 / Disable = 0)
(DEFAULT = 0) (Input Bit 7)
- M16 = Remote Reset (Enable = 1 / Disable = 0)
(DEFAULT = 0) (Input Bit 8)
- M17 = Auto Reset (Enable = 1 / Disable = 0)
(DEFAULT = 1)
- M18 = Metric Mode (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M19 = Set Network Cell ID (Enter number from 1–255 for Cell ID)
(DEFAULT = 0)
- M20 = Set Temp Sensor Type (Infrared = 0 / Thermocouple = 1)
(DEFAULT = 0)
- M21 = Data Upload to Terminal (data from ADM to terminal)
(Enable for all weld data = 1 /
Enable for summary weld data = 2 /
Enable for Both = 3 / Raw Data = 4 / Disabled = 0)
(DEFAULT = 0)
- M22 = Data Upload to Network
(data from ADM to terminal through network port)
(Enable for all weld data = 1 /
Enable for summary weld data = 2 /
Enable for both = 3 / Disable = 0)
(DEFAULT = 0)
- M23 = 40 Column Print (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M24 = Print Summary Data (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M25 = Print All Data (Enable = 1 / Disable = 0)
(DEFAULT = 0)

- M26 = Save Average Weld Data (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M27 = Schedule (Enter a number from 0 to 63)
- M28 = Data Collection Rate Timer (in 10 msec Increments)
(DEFAULT = 10)
- M29 = Remote Pendant Limits Edit (Enable = 1 / Disable = 0)
(DEFAULT = 1)
- M30 = Printer (Enable = 1 / Disable = 0)
(DEFAULT = 0)
- M31 = Read/Write selected weld schedule
(Read Schedule = 1/ Write schedule = 2)
- M32 = Set Baud Rate (DEFAULT = 0) (0 = 9600, 1 = 19200)
(After setting this value, the ADM IV must be powered down and back up for the setting to take effect. You must go to the Comm Menu in the ADMSTAT Plus and select the Properties option from the pull down menu. Set the Maximum Speed to match the value selected with M32)
- M33 = Clear Memory (**2** = clear Weld Schedules and Weld Memory and load factory default values, **3** = clear Configuration parameters, Weld Schedules and Weld Memory and load factory default values, **4** = clear Sensor scale parameters (Calibration), Configuration parameters, Weld Schedules and Weld Memory and load factory default values) (After setting this value, the ADM IV must be powered down and back up for the setting to take effect)
- **** **Available only with Version 1.33 and higher Firmware** ****
- M34= Enable Station number indication of multiple weld stations on a single fixture. Setting this to 1 will enable the “-A” and “-B” weld station appending to the ADM Station ID number. This function uses “INP 7” to select A or B station. Setting the INP 7 to 0 will select “-A” . Setting INP 7 to 1 will select “-B” identification. The Remote Arc On function must be disabled (M15=0)
- M35= Read remote switch input status. “**M35?**” will display the current status of the ADM remote Inputs.
- M36= Enable Alarms. (Enable = 1 / Disable = 0) This mode must be set by ADM IV Schedule. To enable the alarms for a schedule type the following: M27=# <enter> (# is the schedule number that the Alarms are to be enabled for), M31=1 <enter> (to read the schedule), M36=1 <enter> (to enable the alarms) or M36=0 <enter> (to disable the alarms), M31= 2 <enter> (to write the schedule back to the ADM IV)

NOTE: *If the remote fault reset and the auto fault reset are disabled, the only way to reset the system is to DISABLE the ALARMS from the Remote Pendant Panel or to enable the remote fault reset (M16) or auto fault reset (M17) from a computer terminal.*

R1 – R12

Fault Relay Enable/Disable

ADM IV™ has 8 fault output relays that can be assigned to specific parameter faults. When a fault occurs the corresponding relay(s) enabled will be set. This output can provide an external fault

indication. A relay must be assigned to a specific parameter fault condition to enable this function. Any Parameter fault can have multiple relay outputs assigned.

*NOTE: The ADM IV **will not collect data** if a Fault Occurs and a Fault Reset is not issued.*

R1 - Arc Time Fault Relay

R2 - Volt Fault Relay

R3 - Amp Fault Relay

R4 - Gas Fault Relay

R5 - Temp Fault Relay

R6 - Aux 1 Fault Relay

R7 - Aux 2 Fault Relay

R8 - Travel Speed Fault Relay

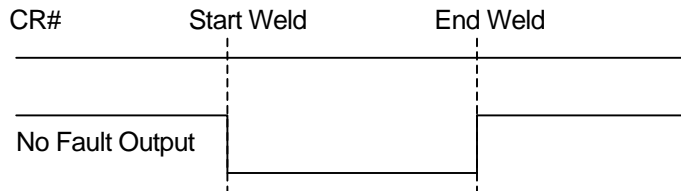
R9 - Wire Feed Speed Fault Relay

R10 - Heat Input Fault Relay

R11 - Is a **NO Fault** output that will provide an output **HIGH** condition until an ARC Start is detected. At that point the output signal will go **LOW**. If **NO Faults** occur during the weld, the Output will return to a **HIGH** state at the end of the weld. If a Fault occurs, the Output will remain **LOW** until a **Remote Fault Reset** is received or the **Fault Reset** soft key is pushed from the **ADM IV Pendant** key pad. R11 will **not reset (HIGH)** when an **Auto Fault Reset** is issued unless a complete weld is conducted **without faults**. R11 will reset (**HIGH**) at the end of the completed **NO Fault** weld. **See diagram below.**

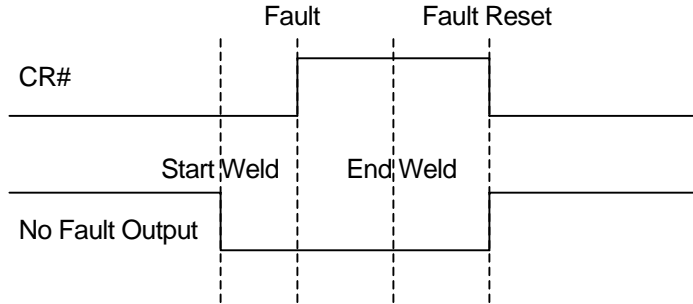
R12 – Is the ADM IV Ready Output. When used the Output will be **HIGH** unless the ADM is turned off or not in an operational status

CR# Output with NO Faults detected:



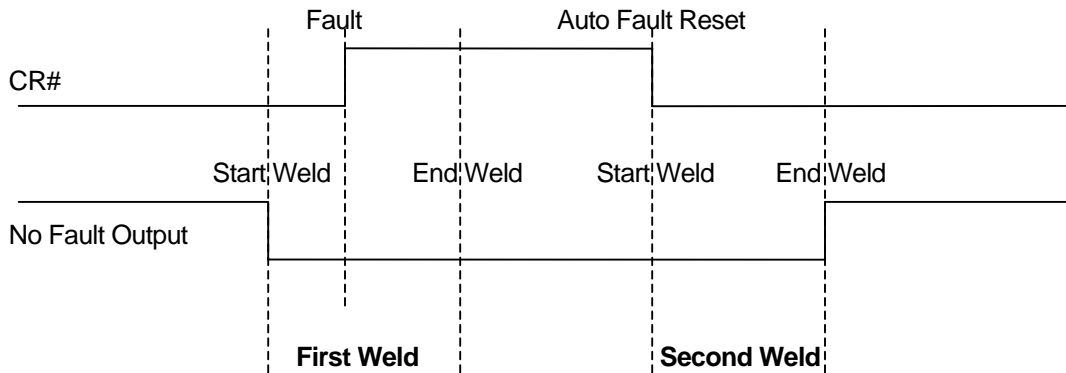
No Fault Output with No Fault detected.

CR# With Fault detected and Reset using Remote Fault Reset or Fault Reset from Pendant



NO Fault Output with Fault detected and Reset using Remote Fault Reset or Fault Reset from Pendant

CR# With Fault Detected and Reset using Auto Fault Reset



NO Fault Output with Fault detected and Reset using Auto Fault Reset.

CR# = Any Selected Fault Relay Output (1 – 8).

The assignment of relays to a parameter fault indication is by the decimal value of the desired relay. As an example: to enable Arc Time Fault output to activate CR1 you enter the following values for R1 (Arc Time Fault Output):

R1=1(enter)

To assign multiple relays you combine the decimal values of the individual relays. As an example to set CR2 and CR3 when a Gas fault occurs enter the following for R4 (Gas Fault output)

R4=6(enter) Where: CR2=2 and CR3=4 (2 + 4 = 6)

The following is the decimal value for individual bits used for the relay outputs:

<i>BIT NUMBER</i>	<i>DECIMAL</i>	<i>RELAY SWITCH</i>
<i>BIT 0</i>	1	<i>CR1</i>
<i>BIT 1</i>	2	<i>CR2</i>
<i>BIT 2</i>	4	<i>CR3</i>
<i>BIT 3</i>	8	<i>CR4</i>
<i>BIT 4</i>	16	<i>CR5</i>
<i>BIT 5</i>	32	<i>CR6</i>
<i>BIT 6</i>	64	<i>CR7</i>
<i>BIT 7</i>	128	<i>CR8</i>

V1 – V53

Variable Parameters (MAX/MIN SETTINGS):

- V1 = Time Max Limit (DEFAULT = 51)
- V2 = Time Min Limit (DEFAULT = 49)
- V3 = End Test Time (DEFAULT = 0)

- V4 = Volt Max Limit (DEFAULT = 205)
- V5 = Volt Min Limit (DEFAULT = 185)
- V6 = Volt Start Test Delay Time (DEFAULT = 40)
- V7 = Volt Fault Time (DEFAULT = 10)

- V8 = Amp Max Limit (DEFAULT = 300)
- V9 = Amp Min Limit (DEFAULT = 280)
- V10 = Amp Start Test Delay Time (DEFAULT = 40)
- V11 = Amp Fault Time (DEFAULT = 10)

- V12 = Gas Max Limit (DEFAULT = 45)
- V13 = Gas Min Limit (DEFAULT = 35)
- V14 = Gas Start Test Delay Time (DEFAULT = 50)
- V15 = Gas Fault Time (DEFAULT = 10)

- V16 = Temp Max Limit (DEFAULT = 600)
- V17 = Temp Min Limit (DEFAULT = 100)
- V18 = Temp Start Test Delay Time (DEFAULT = 40)
- V19 = Temp Fault Time (DEFAULT = 10)

- V20 = Aux 1 Max Limit (DEFAULT = 800)
- V21 = Aux 1 Min Limit (DEFAULT = 200)
- V22 = Aux 1 Start Test Delay Time (DEFAULT = 40)
- V23 = Aux 1 Fault Time (DEFAULT = 10)

- V24 = Aux 2 Max Limit (DEFAULT = 900)
- V25 = Aux 2 Min Limit (DEFAULT = 100)
- V26 = Aux 2 Start Test Delay Time (DEFAULT = 40)
- V27 = Aux 2 Fault Time (DEFAULT = 10)

- V28 = Travel Max Limit (DEFAULT = 125)
- V29 = Travel Min Limit (DEFAULT = 115)
- V30 = Travel Start Test Delay Time (DEFAULT = 40)
- V31 = Travel Fault Time (DEFAULT = 10)

- V32 = Wire Feed Speed Max Limit (DEFAULT = 550)
- V33 = Wire Feed Speed Min Limit (DEFAULT = 500)
- V34 = Wire Feed Speed Start Test Delay Time (DEFAULT = 40)
- V35 = Wire Feed Speed Fault Time (DEFAULT = 10)
- V36 = Heat Max Limit (DEFAULT = 350)
- V37 = Heat Min Limit (DEFAULT = 330)
- V38 = Heat Start Test Delay Time (DEFAULT = 40)
- V39 = Heat Fault Time (DEFAULT = 10)

- V40 = Pulse Amps (DEFAULT = 250)
- V41 = Travel Sensor Scale (DEFAULT = 0)
- V42 = Min Arc Time (DEFAULT = 5)
- V43 = Sample Time (DEFAULT = 1)
- V44 = Default Travel (DEFAULT = 0)
- V45 = Station (DEFAULT = 0)
- V46 = Print Time (DEFAULT = 0)
- V47 = Password (DEFAULT = 0)
- V48 = Arc On Volts (DEFAULT = 40)
- V49 = Arc On Amps (DEFAULT = 10)
- V50 = Fault Count (DEFAULT = 0)
- V51 = Weld Count (DEFAULT = 0)
- V52 = Summary Count (DEFAULT = 0)
- V53 = Weld Data Memory Count (DEFAULT = 0)

P1 – P18

Help Screen Data Entry:

The ADM IV™ provides the user with the ability to program 18 different “HELP” screens to provide the operator with help when a fault occurs. Each screen can deliver a 100-character message as entered by the user. This allows the user the ability to provide assistance to the operator during a fault situation.

- P1 = Arc Time Max Fault (DEFAULT DISPLAY: Check end weld limit or position)
- P2 = Arc Time Min Fault (DEFAULT DISPLAY: Check end weld position and wire drive system)
- P3 = Volts Max (DEFAULT DISPLAY: Check power source and voltage settings)
- P4 = Volts Min (DEFAULT DISPLAY: Check welding grounds and voltage settings)
- P5 = Amps Max (DEFAULT DISPLAY: Check torch height, part position, and program points)
- P6 = Amps Min (DEFAULT DISPLAY: Check torch height, wire drive system and program points)
- P7 = Gas Max (DEFAULT DISPLAY: Check gas flow regulator)
- P8 = Gas Min (DEFAULT DISPLAY: Check torch, gas hose and flow regulator)
- P9 = Temp Max (DEFAULT DISPLAY: Blank)
- P10 = Temp Min (DEFAULT DISPLAY: Blank)
- P11 = Aux 1 Max (DEFAULT DISPLAY: Blank)
- P12 = Aux 1 Min (DEFAULT DISPLAY: Blank)
- P13 = Aux 2 Max (DEFAULT DISPLAY: Blank)
- P14 = Aux 2 Min (DEFAULT DISPLAY: Blank)

- P15 = Travel Max (DEFAULT DISPLAY: Blank)
- P16 = Travel Min (DEFAULT DISPLAY: Blank)
- P17 = Wire Feed Max (DEFAULT DISPLAY: Check Programmed wire feed speed and control)
- P18 = Wire Feed Min (DEFAULT DISPLAY: Check torch liner, conduit assembly and wire drive feed rolls)

17.0 GRAPH POP-UP MENU

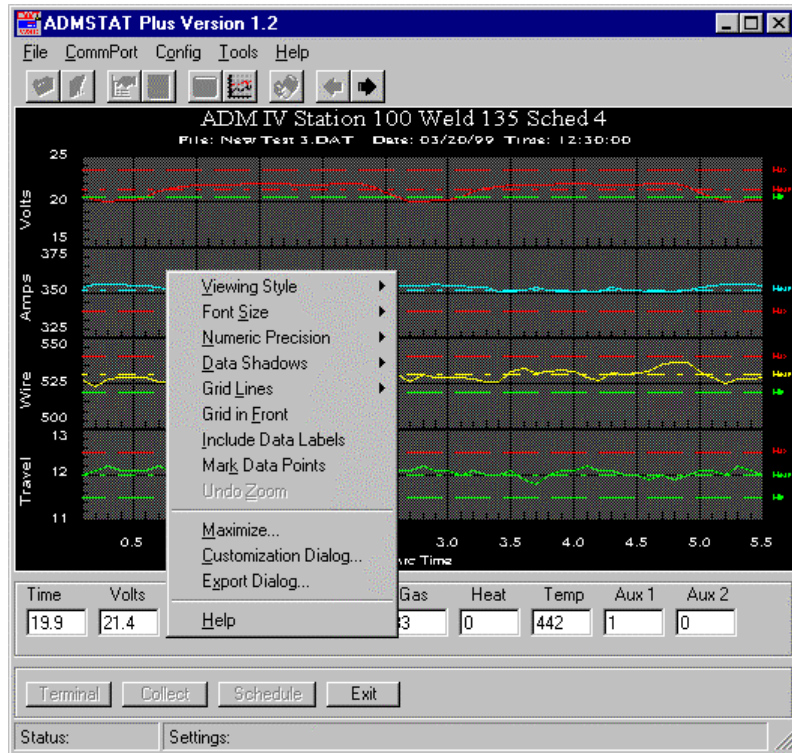


Figure 12 - Graph Pop-up Menu

- Main/Sub Title** These two edit-boxes allow adding, editing, and deleting of main and sub titles. If no title is present, entering one will add one. If you remove all the characters from a title it will be deleted from the image.
- Font Size** The Graph Object supports three font sizes, Large, Medium and Small. Depending on the size of the graph, the user can select the font size that is most readable. When printing the graph, a font size of Medium or Small is suggested. There are occasions (mainly when attempting to generate an image for a highly rectangular graph) that the graph may automatically reduce the size of the font in order to produce a higher quality image.
- Show Annotations** If the object contains annotations, this check box allows you to remove/add the annotations from the image.
- Subsets to graph** This group allows the user to view subset information in a variety of ways.

1. If nothing is selected in the list box and Scrolling Subsets equals zero, then the object will display all subset information (14 subsets graph maximum, and no limit on the amount of subsets tabled).

2. If there are selections in the list box and Scrolling Subsets equals zero, then the object will display only those subsets selected.
3. If nothing is selected in the list box and Scrolling Subsets is non-zero, then the object will scroll through subset information by the amount defined by Scrolling Subsets.
4. If there are selections in the list box and Scrolling Subsets is non-zero, then the object will maintain those selected subsets as permanent subsets and revolve through the remaining subsets in increments of Scrolling Subsets.

Plotting Method

The Graph Object supports 15 plotting methods:

- Area
- Bar
- Box Plot (Candle Stick)
- Bubble
- High-Low Line
- High-Low Bar
- High-Low-Close
- Line
- Open-High-Low-Close
- Points
- Points plus Best Fit Curve
- Points plus Best-Fit-Line
- Points plus Spline
- Spline
- Sticks

Depending on the implementation, some plotting methods may not be available. Also, many but not all of these plotting styles can be set for a secondary comparison plotting style.

If the Graph has multiple y axes, then you can control plotting and comparison plotting styles for each individual axis by selecting the axis in the axis-button group.

Comparisons as Normal Check Box

If the Comparisons as Normal check box is checked, the secondary comparison plotting style is ignored and all subsets are plotted in the primary plotting style.

Data Shadows

Depending on the Plotting Method, this option will draw shadows behind bars, points, and the area of an area graph. The shadow is always black.

Grid Lines

The Graph Object can contain vertical grid lines, horizontal grid lines, both vertical and horizontal grid lines, or no grid lines.

Grid in front of data

By checking this option, the graph's grid is placed in front of the data graphics. Otherwise, the data graphics are drawn on top of the graph's grid.

Numeric Precision	<p>When placing data labels onto the graph, or exporting Text/Data from the Export Dialog, the number of decimal positions can be between 0 to 3.</p> <p>If this option is checked then the object's plotting method will include Data Labels into the graph. Depending upon the implementation, Data Labels will either be numeric values, or text descriptors.</p>
Fonts	<p>The Graph Object only supports True Type fonts (because they are scaleable). The user can select fonts for the:</p> <ul style="list-style-type: none"> Main Title Sub Title Labels <ul style="list-style-type: none"> Including, X axis label, Y axis label, X axis grid numbers or point labels, Y axis grid numbers Tabled Data Data labels included into the graph <p>For the Main Title, Sub Title, and Labels, the user can also select font attributes of Bold, Italics, and Underline.</p>
Colors	<p>The Graph Object supports two sets of color parameters. A Monochrome color set and a Color color set. Depending on the Viewing Style, the Colors Dialog will customize the appropriate set.</p> <p>To adjust colors:</p> <ol style="list-style-type: none"> 1. Select the desired object attribute in the Graph Attributes section. The corresponding color for that attribute will be highlighted in the color selection grid. 2. To change the color, either use the mouse to click an alternate color, or use the keyboard arrow keys to move to adjacent colors. As the highlighted color selection changes position, the sample image will be updated with the newly selected color. 3. Finally, Pressing the OK button will update the color parameters of the object.
Desk Background	<p>This is the color that surrounds the bounding rectangle of the graph's grid.</p>
Desk Foreground	<p>This is the color that is used when placing text onto the Desk Background. This includes the main title, sub title, subset labels, grid numbers, and axis labels.</p>
Shadow Color	<p>The rectangle that make up the graph's grid is bounded at the bottom/right edges with shadows. To remove the shadows, choose the same color as the Desk Background.</p>
Graph Background	<p>This is the color used as the background color of the graph's grid.</p>
Graph Foreground	<p>This is the color used for the bounding rectangle of the grid, and the grid-lines.</p>

Zooming

Zooming is the process of using the mouse to select new extents of the graph's grid.

To Zoom:

1. Press the left mouse button and drag the cursor to select the new extents.
2. Release the mouse button.

To Undo the Zoom:

Press the 'Z' key or use the pop-up menu to select the Undo Zoom menu item.

Mouse

The mouse can be used as follows.

1. Single-Clicking the mouse over objects will give that object the input focus.
2. Controlling object scrollbars, selecting Hot-Spots, and moving the Data-Cursor.
3. Right-Button Single-Clicking invokes a pop-up menu.
4. Double-Clicking a data point shows the value of the data point.
5. Double-Clicking inside a graph's grid shows the coordinates clicked.
6. Double-Clicking desk portion of object invokes the customization dialog.

Keyboard

The objects can also receive the following keyboard commands.

SPACEBAR - Shows the customization dialog.

Q - Shows a pop-up menu

S - Switches between monochrome and color styles

T - Toggles between custom and original parameters

X - Shows the export dialog

M - Maximizes the object to fit the screen

SHIFT+P - Shows the print dialog

D - Shows the Text/Data export dialog

Z - Undo Zoom (Graph only)

ARROWS - Scrolls vertical/horizontal scrollbars and moves cursor

PG-UP/PG-DOWN - Pages vertical scrollbar

SHIFT+PG-UP - Pages horizontal scrollbar to the right

SHIFT+PG-DOWN - Pages horizontal scrollbar to the left

HOME - Moves vertical scrollbar to its first position

END - Moves vertical scrollbar to its last position

SHIFT+HOME - Moves horizontal scrollbar to its left-most position

SHIFT+END - Moves horizontal scrollbar to its right-most position

Customizations All objects have their own individual customization dialogs. The customization dialogs allow the user to adjust visual, and functional attributes of the object as well as gain access to the Export and Maximization dialogs.

Custom and Original Parameters

All objects store two sets of customization parameters. The first set is known as the Original set. The Original set is programmed into the control and the user cannot adjust these parameters. The second set is called the Custom set. The Custom set can be adjusted through the customization dialog. While the object has the input focus, PRESSING "T" will toggle between the Original and Custom parameter sets.

Showing the Customizations Dialog

DOUBLE-CLICKING the MOUSE over the object, or PRESSING SPACEBAR while the object has the input focus will show the customization dialog.

How to

When the customization dialog is shown, the parameters it shows reflect the current state of the object. By making adjustments to the customization dialog and then pressing the OK Button, the user updates the Custom set of parameters controlling the object. By pressing the Original Button the object will show the object with the Original set of parameters. The Apply button is similar to the OK button but does not close the customization dialog.

The Color Tab and Font Tab allow adjustment of color and font attributes. To change colors or fonts, press the tab to show the dialog, make your adjustments and then press the OK/Apply Button to update the image.

Note: The customization dialog cannot be used to toggle between the Original and Custom set of parameters. This is because pressing the OK Button creates a new Custom set of parameters. To toggle between Original and Custom sets of parameters, press the "T" key while the object has the input focus.

Exporting

All objects have the same exporting capabilities. Objects can export the following formats to the listed destinations.

Format Destinations

- Metafile
- Clipboard, File, and Printer
- Bitmap
- Clipboard, and File
- OLE Object
- Clipboard
- Text / Data
- Clipboard, and File

How to	By Pressing 'X' when the object has the focus, or selecting the Export button from the Customizations Dialog. <ul style="list-style-type: none"> 1. Select the type of export desired. 2. Select the destination of the export. 3. If available, select the size of the image to export. 4. Press the Export/Print button.
File Destination	If information is to be exported to a file, then you must enter a target filename. Click the mouse over the Browse button to show the File Save As Dialog. Enter a filename and select OK to close the File Save As Dialog.
File Save As Dialog	Enter a filename and select OK to close the File Save As dialog.
Printer Destination	If you are exporting a metafile to the printer, pressing the Print button will show the Print Dialog. Use the Print Dialog to make changes to the selected printer, orientation, paper bin, and other printer options.
Exporting an OLE Object	
	When exporting an OLE Object, you paste the object into an OLE container. The object is supported by the OLE-MiniServer.
Exporting Text /Data	When exporting Text/Data, pressing the Export button launches the Text/Data Export Dialog.
Text/Data Export Dialog Data to Export	
	You can export all the information from the object, or export only that data which you select in the two list boxes (Subsets to Export, & Points to Export.) If you choose to select the information to export, leaving a list box empty of selections will cause all the information to be exported.
What to Export	You can export the data with or without subset and point labels. Depending on the object, you are offered several possible selections of data to export. <p>Export Format You can export the information in two formats;</p> <ul style="list-style-type: none"> 1. Table Format - which exports the information in a grid fashion in either a Subset by Point or Point by Subset style. 2. List Format - which exports the information one record per line. The data fields can either be separated by tabs or commas.
Export Precision	The data's export precision can either be the current precision state of the object, or 7 decimal positions (the maximum precision stored by the object).

File Save As Dialog Filename

This text box is used to (1) enter the filename, or (2) enter a wildcard expression used to fill the file list box below. If a wildcard expression is entered, then press the OK button to fill the file list box.

Files List box

This list box shows the files that are located in the current working directory and satisfy either the wildcard expression that is in the Filename list box or the wildcard expression that is selected in the File Type Combo box.

File Type Combo Box

This drop down list allows you to quickly change the types of files you want listed in the Files List box.

Directories List Box

This list box allows you to change the current directory. By choosing a selection and pressing 'Enter' or by Double-Clicking a selection, the working directory will change to that selected.

Drives Combo Box

This drop down list shows the available drives on your system. It will also show any network drives that are available.

Print Dialog

The Print Dialog will show the default printer and its current orientation and paper bin. The user can select another printer via the drop down combo box, which will display all available system and network printers. If printer orientation, paper bin, or other printer option needs to be adjusted, press the Setup button to invoke the printer's setup dialog.

Scrolling Subsets Print Options

If the object that is being exported has scrolling subsets (a vertical scrollbar), then the Print Dialog offers two optional ways to export the object.

1. Printing the current image only.

2. Printing the current image and then paging through additional subset information, printing new pages with each new set of subset information. This provides a quick, clear way to print all of the object's information. To print all of the object's information, make sure that the object's vertical scrollbar is in its top most position (prior to exporting), and that the scrollbar controlling the number of additional pages to revolve through is in its right most position (maximum position).

Maximization

Maximization is the process of resizing the object to use the entire video display. All ProEssentials objects support maximization (if available.) When maximizing the object, the object is actually copied to a maximized dialog. The dialog (maximized object) can be closed by pressing 'Escape' or by using the mouse to Click the title bar. Making customizations to the maximized object will not affect the original (non-maximized) object.

Object Embedding

When exporting a Metafile or Bitmap, you are exporting an image. Once the image is exported it is difficult to make adjustments to the image (like transforming a color image in to a monochrome image.) Exporting an OLE object will solve this problem.

The Graph objects allow the user to adjust both visual and functional attributes of the object. Also, the Graph objects also take commands to revolve through various subsets of data and scroll horizontally through large amounts of point data. All this functionality will be lost if you export a Metafile or Bitmap. However, if you export an OLE object, all this functionality will still be accessible.

You export the Graph object as an OLE object to the clipboard. You then paste the OLE object into a document or other OLE container. Once the OLE object has been embedded into the container, it looks as if you have imported a simple Metafile. However, Double-Clicking the OLE object will invoke PEGRPSVR (OLE-Mini Server). PEGRPSVR will display the object and allow all the same functionality as if the object were in its original application.

OLE-Mini Server	PEGRPSVR is an OLE Mini-Server. It is the program that serves the Graph objects exported from an application into a document or other OLE container. It allows the exported OLE object to be functional as if it still existed in the original application from which it was exported. PEGRPSVR's only menu options are available through an extended system menu.
Update Client	Selecting this menu option causes the container (document or other OLE container) to be updated with the current image that is displayed in PEGRPSVR. Pressing U will also perform the update. Note: If the Resize Capabilities Option is set, then updating the container will change the size of the embedded object to the size of the PEGRPSVR window.
Customization Dialog	Selecting this menu option will invoke the customization dialog for the object. Double-Clicking the object, or Pressing SPACEBAR will also launch the customization dialog.
Export Dialog	Selecting this menu option will invoke the export dialog for the object. Pressing X will also launch the export dialog.
Resize Capabilities	This menu item is an option that can be toggled ON or OFF. ON - Updating the image will cause the image in the container to be resized to that of the PEGRPSVR window. OFF - Updating the container image will not effect the original size of the image in the container.
Maximize on Use	This menu item is an option that can be toggled ON or OFF. ON - PEGRPSVR is invoked to a maximized size. OFF - PEGRPSVR is invoked to the size of the object being contained.
Average or Mean	The mean of a set of data is equal to the sum of the data divided by the number of items in the data set.

Standard Deviation The standard deviation is defined as the positive square root of the variance of a data set. The variance for a data set of n items is equal to the sum of the squared distances from the mean divided by $(n-1)$. You can think of the standard deviation as the average of all distances of each data point from the mean.

Best Fit Line The best-fit-line represents how to fit the "best" straight line to a given set of data points. It is calculated from a least-squares-approximations of the data set.

Histogram or Frequency Distribution

The histogram is a graphical representation of the frequency (number of occurrences) of data values within small data ranges (classes) which are created by dividing the total range of data into 5 to 20 equal subintervals. The most common histogram form is the Bell-Curve. Which is also known as a Normal Distribution.

The histogram is a valuable tool in that it allows you to see how the data values are distributed throughout the range of the data set. Outliers (the number of data values that are either much smaller or larger than the rest of the data values) are quickly recognized.

Chebyshev's Rule & The Empirical Rule

You can use these rules to determine if a data value should be considered too far from the rest of the normal data values.

Chebyshev's Rule - any shape frequency distribution

- a. It is possible that very few of the data points will fall within 1 standard deviation of the mean.
- b. At least three-fourths of the data points will fall within 2 standard deviations of the mean.
- c. At least eight-ninths of the data points will fall within 3 standard deviations of the mean.

The Empirical Rule - mound shaped frequency distributions

- a. Approximately 68% of the data points will fall within 1 standard deviation of the mean.
- b. Approximately 95% of the data points will fall within 2 standard deviations of the mean.
- c. Essentially all of the data points will fall within 3 standard deviations of the mean.

17.1 3D MULTIPLE GRAPH DIALOG AND POP-UP MENU

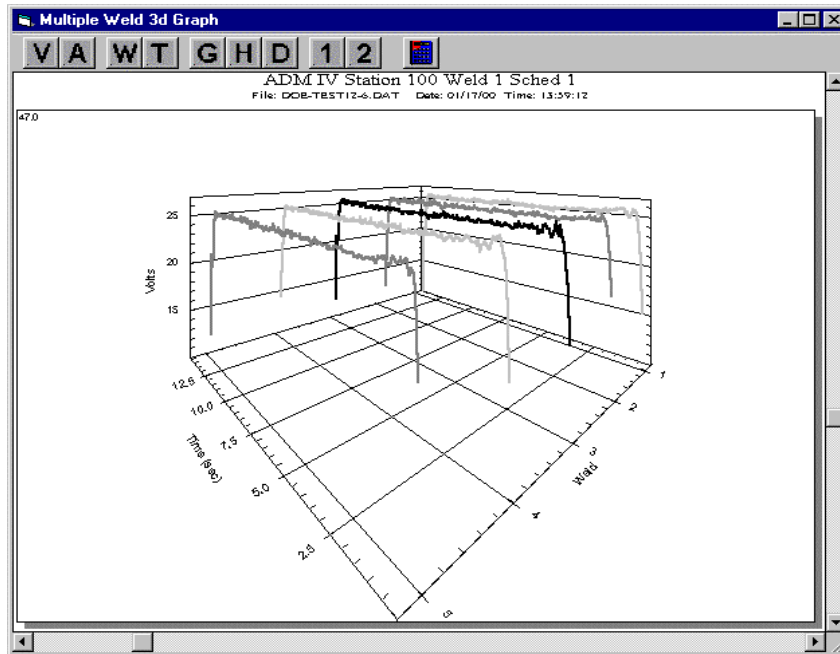


Figure 13 - ADM IV Multiple Weld 3-D Graph

The Multiple Weld Graph routine provides the user with a method of viewing from 1 to 50 welds on a single 3-D graph. The graph allows the user to rotate the data to optimize the presentation. Only one welding parameter at a time can be displayed.

Speed Button Tool Bar To change the parameter being viewed on the graph, simply click on the speed button for the appropriate parameter and the graph will display the data collected for that parameter. The speed buttons represent the following parameter:

V = Arc Voltage Data	A = Arc Current Data
W = Wire Feed Speed Data	T = Travel Speed Data
G = Gas Flow Rate Data	H = Heat Input Data
D = Temperature Data	1 = AUX 1 Data
2 = AUX 2 Data	

Limit Configuration Button is used to set and re-calculate weld parameter limits.

Graph Axis Configuration The X- axis indicates the weld time in seconds. The Y- axis indicates the specific value for the parameter. The Z-axis indicates the weld number.

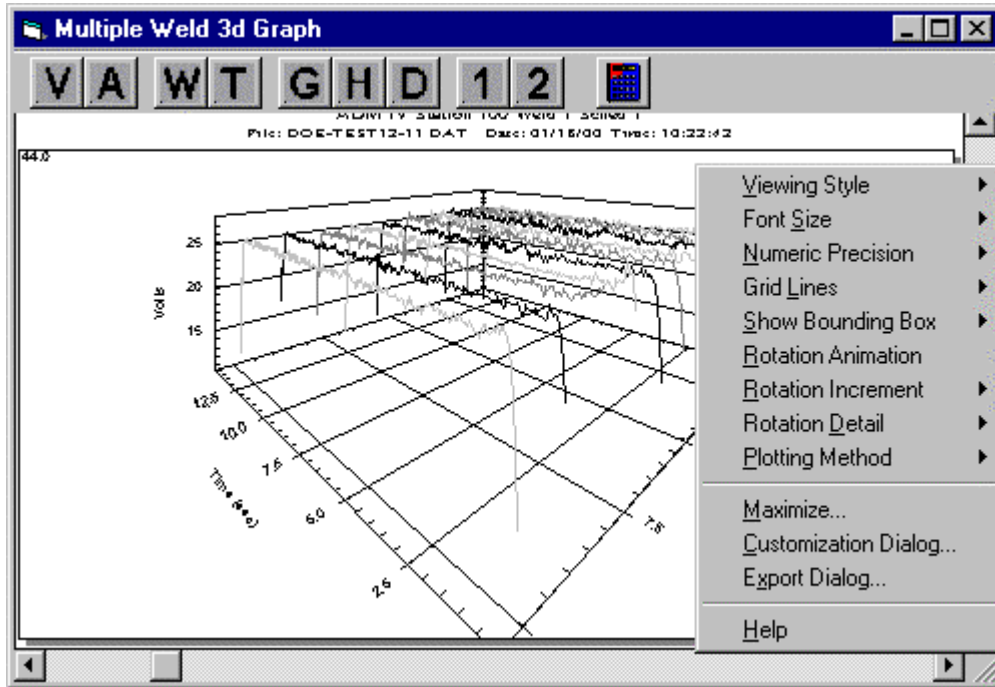


Figure 14 - ADM IV Multiple Weld 3d Graph Pop Up Menu

Graph Pop-Up Menu To invoke the 3-D graph pop up menu click the right mouse button while over the graph area. To exit the graph click the X button on the top of the graph window. While in the Pop up Menu you can change the following graph setting:

Viewing Style The 3-D Scientific Graph Object supports three viewing styles.

Color

Monochrome

Monochrome with Symbols (*Note, Scatter Charts Only)

This customization allows you to quickly adjust the image to best suit printing on a monochrome printer.

For 3-D Scatter Charts: If fewer than four subsets are included in a graph, then the Monochrome setting will probably be the best choice. If four or more subsets are included in the graph, then Monochrome with Symbols will help distinguish the different subsets.

Font Size The 3-D Graph Object supports three font sizes, Large, Medium, and Small. Depending on the size of the graph, the user can select the font size that is most readable. When printing the graph, a font size of Medium or Small is suggested.

Numeric Precision This feature is mainly used with 3-D Scatter Graphs and controls the precision of data labels added to 3-D scatter charts. However, it also controls the precision of data exported from the Export Dialog

Grid Lines The 3-D Scientific Graph Object can contain grid lines on all axes; y, x, and z. The user can limit the number of grid lines to just the y axes, x axis or the z axes, or disable all grid lines.

Show Bounding Box This feature controls when a bounding box is added to a 3D image.

Possible values are:

While Rotating - Only show a bounding box while object is rotated.
Always - Always show a bounding box.
Never - Never show a bounding box.

Rotation Animation This feature will turn-on or turn-off automatic image rotation. The user can also control the direction and rotation increment if needed. If enabled, Double Clicking the 3-D image will stop and start the rotation animation feature.

Rotation Increment This feature controls the increment of rotation while the object is automatically rotating (Rotation Animation). Changing the increment changes the rotation speed and/or direction.

Possible values are:

15 Increment 15 degrees with each new update.
10 Increment 10 degrees with each new update.
5 Increment 5 degrees with each new update.
2 Increment 2 degrees with each new update.
1 Increment 1 degree with each new update.

-1 Decrement 1 degree with each new update.
-2 Decrement 2 degrees with each new update.
-5 Decrement 5 degrees with each new update.
-10 Decrement 10 degrees with each new update.
-15 Decrement 15 degrees with each new update.

Rotation Detail This feature controls the complexity of the image while the image is rotated.

Possible values are:

Wireframe The simplest and fastest rotation method.
Plotting Method Draws object as normal but with no axes or labels.
Full Does not limit image detail during rotation.

Plotting Method This feature is used to set or change the plotting method for the displayed graph.

Possible values are:

Point Displays the graphed data by data points.
Line Displays the graphed data by line.
Point + Line Displays the graphed data by point and line.

- Maximize** Sets the displayed window to maximum size.
- Customization Dialog** This dialog displays all the current settings for the graph being viewed.
- Export Dialog** This dialog is used to select the settings for exporting selected data files.

18.0 PARAMETER FAULT DATA DIALOG

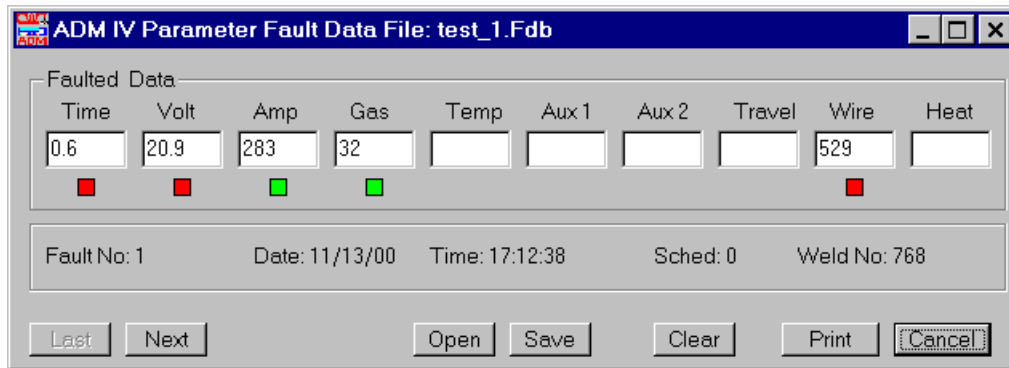


Figure 15 - ADM IV Parameter Fault Data

This function is used to upload and display the ADM IV stored fault data from the ADM IV or open a previously saved fault data file. To use the Fault Data Dialog, click on the TOOLS window then click on the Display Fault... option. A "Display ADM IV Fault Data" dialog will appear.

To Upload Fault Data from the ADM IV: A PC must be connected to the ADM IV to upload stored fault data. Click on the "YES" button and the program will first display all of the Fault data from the ADM IV. If no fault data is available a "No Fault Data Available" dialog will appear and the Display Fault Data function will terminate when the "OK" button is pressed. During the upload of fault data from the ADM IV, a Status window is displayed. The Status window shows the total number of fault records and the record being read. To exit the upload function, press the cancel button. After completing the upload the "Fault Data" dialog is displayed.

To Save Fault Data to a File: Once the data is uploaded from the ADM IV and displayed in the Fault Data Dialog, click on the "Save" button of the dialog. The "Save Fault Data File" dialog will appear. Enter a file name and click on the "Save" button and the file will be saved into the Fault Data folder.

To Open Saved Fault Data from a File: Click on the "NO" button in the "display ADM IV Fault Data" dialog. The "Open Fault Data File" dialog will appear. Click on the file name you wish to open and then click on the "Open" button. The "ADM IV Parameter Fault Data File: File Name.fdb" dialog will appear.

Fault Data Window

The Fault data window displays the weld data at the time when the first fault occurred. If a parameter is in a faulted condition a LED indicator will be illuminated below the faulted data window. A **Red** LED indicates a **HIGH LIMIT FAULT** condition and a **Green** LED indicates a **LOW LIMIT FAULT**. The Time window is the arc time, in seconds, when the first fault occurred. The LEDs will indicate all faults that occurred during the complete weld cycle. The parameter that faulted first will be indicated by a flashing LED under that parameter.

Fault Status Window

This window displays the Fault Number, Date and Time of the Fault, the schedule used for testing and the ADM IV Weld No: count.

Last/Next Command Buttons	Allows the user to scroll through the fault data information read from the ADM IV.
Open Command Button	Allows the user to Open a previously saved Fault Data File.
Save Command Button	Allows the user to Save uploaded Fault Data from the ADM IV to a file.
Clear Command Button	Selecting this function will reset the ADM IV fault counter. When invoking this function the user will be prompted to verify the Reset command. To continue with the reset command, press the OK Button. To abort the command, press the Cancel button. When the ADM IV fault counter is reset the old Fault data will be over written with new fault data.
Print Command Button	Selecting this function will invoke the ADMSTAT fault data print function. All of the collected fault data will be printed. Follow the on screen prompts to complete the print operations.
Cancel Command Button	Selecting this function will terminate the fault parameter dialog.

19.0 SPC WELD DATA DIALOG

This chapter is designed to instruct the user on set-up of the ADM IV for SPC (Statistical Process Control) Data Collection and how to download and graph the data. A brief explanation of the SPC process can be found in Appendix A of this manual for more information.

To set the ADM IV up for SPC Data Collection:

1. The ADM IV must be in the Save Average Weld Data Mode. There are three ways to place the ADM IV in this mode.
 - a. If the ADM IV has a pendant, the operator can press the CONFIG soft key, then the EDIT soft key and TAB to the SAVE AVERAGE field and press the YES/NO soft key to change the field to YES. Then press the CANCEL soft key and the EXIT soft key.
 - b. The user can open the SCHEDULE Editor in the ADMSTAT Plus software and select ADM CONFIG tab. Locate and click on the Save Summary Data Box then write the schedule to the ADM IV. Make sure the Schedule number matches the Schedule number you wish to use for Summary Data collection.
 - c. From the Terminal Mode the Save Average Weld Data mode command M26 must be set to 1. Type the following terminal mode command: M26=1 <enter>. This command will place the ADM IV in the Save Average Weld Data Mode.

In this mode the ADM IV can store up to 190 Average Weld Data samples. Once the ADM IV reaches 190 samples it will stop saving samples. The user must establish a procedure for downloading the saved samples on a routine basis to prevent loss of Summary Weld Data samples.

2. To retrieve the data from the ADM IV, click on the SPC speed button. A "SPC Data Collect" dialog will appear. Click the YES button.

NOTE:

If a "Warning- Communications Error. ADM not responding" dialog appears, ensure that power is applied to the ADM IV and that the RS-232 cable is connected to the system and the computer.

If a "No Weld Summary Data Available" dialog appears verify that M26 is set to 1 by typing M26? <enter> from the Terminal. If the ADM IV responds with the number 1, the system is in the Save Average Weld Data Mode. Verify if the data has been downloaded and the Weld Summary Counter has been reset. If the ADM IV responds with a 0 perform the procedures in step 1 above.

3. A "Read ADM IV Summary SPC Data" dialog will appear with the number of summary welds being read and the total number of summary welds saved. The ADMSTAT software will read the data into a monthly file that is placed in a directory under SPC Data\ADM #(Station Number)\Sched #\Month. If the monthly file already exist the ADMSTAT will append the file with the new information.
4. When the ADMSTAT software has finished reading the summary data into the monthly file the "ADM IV Weld Summary Counter Reset" dialog will appear. Click on

the OK or CANCEL button and the ADMSTAT will calculate SPC Limits by weld parameter based on the data collected and the Standard Deviation for Control Limits (Sigma) value entered into the Limit Calculation Parameters dialog. An “Edit SPC Limits” dialog will appear. The user can view and accept or change the calculated limits by clicking on the tab for the parameter. Once all changes are completed the user will click on the “Calc” button and the changes will be used to plot the data. If there are no changes to be made click the OK button. See figure 16.

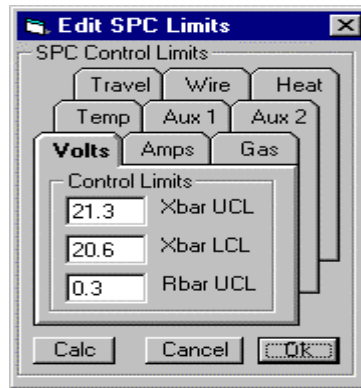


Figure 16 – Edit SPC Limits Dialog

5. The Open SPC Data File dialog will appear. Locate the ADM Station number folder for the data you wish to view and open that folder. Once in the ADM # (Station Number) folder locate and open the schedule number folder for the data you wish to view. Once in the Schedule folder locate and open the month file folder you wish to view.
6. The “Plot SPC Weld Data” graph chart dialog will appear with the SPC Data graphed and plotted. See figure 17.

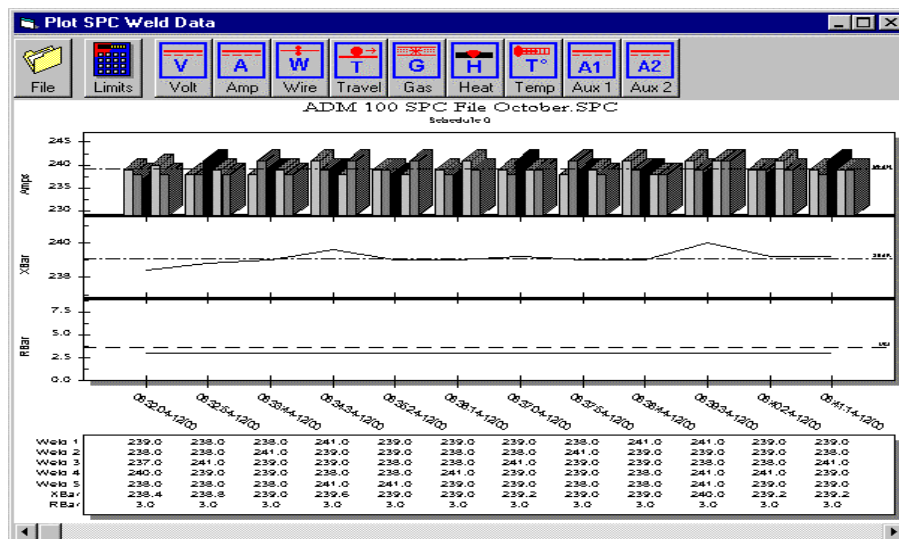


Figure 17 – Plot SPC Weld Data Dialog

The following is a description of the SPC Weld Data Graph dialog and its components.

The Plot SPC Weld Data top tool bar:

- File** Invokes the Open SPC Data File dialog.
- Limits** Invokes the Edit SPC Limits dialog and is used to set and re-calculate SPC Weld Parameter Limits.
- Weld Parameters** To change the parameter being viewed on the graph, simply click on the speed button for the appropriate parameter and the graph will display the SPC data collected for that parameter.

The SPC Weld Data Graph:

- Weld Parameter Graph** This Bar Graph displays the average data collected in multiple weld groups (Sample Sets) of five welds.
- Double X Bar Graph** This graph displays the average value of the averaged data collected. This value is calculated by taking the average weld data samples collected and placing them in groups of five, adding them together and dividing them by five. (an Average of Averages)
- R Bar Graph** This graph displays the range of change between the highest value collected and the lowest value collected in a multiple weld group. If the highest average Current sample in a five group sample set is 450 amps and the lowest current in that same sample group is 448 amps, then the range of change is 2.0.

SPC Weld Data Summary Table This table displays the average data collected by weld, the average value calculated from that data and the range of change with in that sample set.

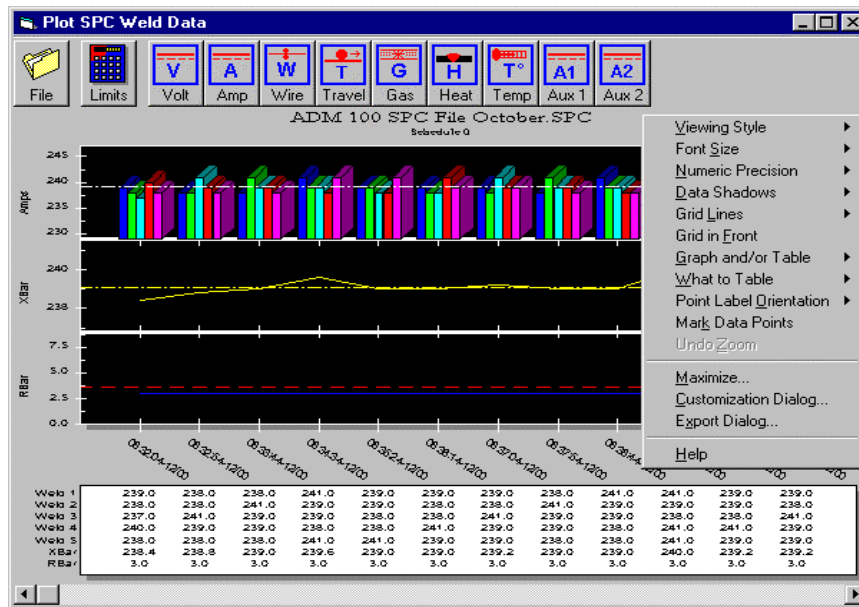


Figure 18 – Graph Pop-Up Menu

Graph Pop-Up Menu To invoke the graph pop up menu click the right mouse button while over the graph area. To exit the graph, click the X button on the top of the

<u>V</u>iewing Style	<p>graph window. While in the Pop up Menu you can change the following graph setting: The Graph Object supports three viewing styles.</p> <p><i>Color</i></p> <p><i>Monochrome</i></p> <p><i>Monochrome with Symbols</i> (*Note, Scatter Charts Only)</p> <p>This customization allows you to quickly adjust the image to best suit printing on a monochrome printer.</p>
<u>F</u>ont Size	<p>The Graph Object supports three font sizes, Large, Medium, and Small. Depending on the size of the graph, the user can select the font size that is most readable. When printing the graph, a font size of Medium or Small is suggested.</p>
<u>N</u>umeric Precision	<p>This feature is mainly used with Scatter Graphs and controls the precision of data labels added to scatter charts. However, it also controls the precision of data exported from the Export Dialog.</p>
<u>D</u>ata Shadows	<p>This feature is used to turn the shadow feature off, add just the shadow feature to graphics or add 3D features to graphics.</p>
<u>G</u>rid Lines	<p>The Graph Object can contain grid lines on all axes; y, x, and z. The user can limit the number of grid lines to just the y axes, x axis or the z axes, or disable all grid lines.</p>
<u>G</u>rid in Front	<p>The Grid in Front feature enables the user to bring the grid lines to the front of the graphics display or move the grid line behind the graphics display.</p>
<u>G</u>raph and/or Table	<p>This feature enables the user to display the graph function, the table function or the graph and table function.</p>
<u>W</u>hat to Table	<p>This function enables the user to select only Graphed Subsets or All Subsets for viewing in the table.</p>
<u>P</u>oint Label Orientation	<p>This function enable the user to set the orientation of the Point Labels for chart. The options are Auto, Vertical, Horizontal, Slanted.</p>
<u>M</u>ark Data Points	<p>This feature will display all plotted data points.</p>
<u>M</u>aximize	<p>Sets the displayed window to maximum size.</p>
<u>C</u>ustomization Dialog	<p>This dialog displays all the current settings for the graph being viewed.</p>
<u>E</u>xport Dialog	<p>This dialog is used to select the settings for exporting selected data files.</p>

APPENDIX A

1.0 The Nature of Manufacturing Processes

The main reason that products and the processes, which produce these products, need to be inspected is *variation*. Just as in nature no two snowflakes are exactly alike, the same is true of manufactured products. These variations in products, welds, for our interest, have many causes, both known and unknown.

It is the job of quality control to detect variations in order for the people working with the process to identify problems and correct them. Sometimes variation occurs due to the process itself. This is known as *inherent variation*. Usually nothing can be done about inherent variation in a process. As long as the inherent variation in your process is acceptable to you, nothing should be done about it.

Listed below are principles that describe variation:

1. No two welds are exactly alike.
2. Variation in your welding process can be measured.
3. Variation in your welding process occurs in a definite pattern.
4. Whenever you examine the parameters of your welding process (voltage, current, wire feed speed, etc.), a large portion of the measurements will tend to cluster (group) about a middle point.
5. The shape of the distributions for each of your weld parameters can be determined mathematically for examination.

Since little or nothing can be done about inherent variation except for changing your process, variation due to identifiable causes must be kept to a minimum. In order to do this, you must have some measure of quality characteristics of your welds. This leads us into the area of quality control. By using the basics of quality control, your process can be enhanced to reduce the number of weld that have to be discarded and the number of re-welds.

2.0 Quality Control

Statistical Process Control is only one part of an overall quality control program. All personnel involved in your welding process should be dedicated to quality control, from the shop floor worker up to the president of the company. Quality control is an all-or-nothing situation. A dedication to quality control will go a long way in today's competitive marketplace. An overall quality control program should consist of the following minimum requirements:

1. Inspection of the material that is about to be used in your welding process.
2. The monitoring of the process itself. This is the statistical process control part of quality control.
3. The routine inspection of the welds produced by your weld

process.

If possible, all employees working with the process should be allowed to engage in some quality control curriculum so they may ask more detailed questions concerning quality control. Your local university can probably set up a 4 or 8 hour introductory course for familiarization course, or better yet, a course taught by your own quality control personnel may be the answer.

3.0 Statistical Process Control

The term *statistical process control* means many things to different people. *Statistical* means having to do with numbers. By using certain *statistics* (functions of the data measurements from your welding process), you can determine if your process might need some adjustment. The word *process* means exactly what it says. Your welding process. With the ADM(tm) hardware and software, you measure and display data from the weld parameters of your process. These are, for example, voltage, current, wire feed speed and travel speed, just to name a few.

The word *control* in the term statistical process control is sometimes misinterpreted. The use of statistical analysis allows you to examine your process to see if any adjustments might be needed. In other words, you make the decisions as to whether your process needs adjustment. The software does not attempt to control (make adjustments) to the process. Adjustments to the process, if determined necessary should be made by you, the ADM(tm) is used to help you make these decisions.

4.0 Tools of the Trade: Control Charts

The main tools used in the analysis of data from welding parameters are the following three *control charts*:

1. The Average Control Chart
2. The Range Control Chart
3. The Sample Standard Deviation Control Chart

A *control chart* is a sequential listing of data statistics from a weld parameter. The Average control chart takes the data from your welding process and groups it into sets of 15 points, called a *record* by the ADM(tm) and then computes the average of each individual record and plots the record averages on a graph with respect to the record number.

The Range control chart takes the range, which is defined as the difference between the maximum and minimum values in a record, and plots it with respect to the record number.

The Sample Standard Deviation control chart takes the standard deviation of each record and plots it with respect to the record number on a graph.

The purpose of a control chart is two-fold. First, it helps you determine if your process needs adjustment and second, it helps you notice patterns in the data, which might later on cause problems with your welding process. The average control chart measure the mean (or average) of a weld parameter. The range and sample standard deviation control chart measure the dispersion of your data. This is a measure of uniformity for the weld.

By the examination of these three control charts, decisions can be made as to whether or not you might need to adjust one or more of the weld parameters of your process.

5.0 Understanding Control Charts

The science of interpreting control charts has been steadily increasing in the past few years. Many articles have been produced explaining new ways of chart interpretation or a new modification for different applications to different types of manufacturing processes.

The main idea to keep in mind here is that things should be kept as simple as possible, due to the incredible amount of data that is taken from your welding process.

Many ideas have been suggested for the analysis of control charts. Below are just a few widely used "rules of thumb."

1. Control Limits must first be chosen for your individual weld process. The most common control limits are based on what is called the *three standard deviation principle*. This means that limits are chosen such that the upper limit value is the average of the data plus three times the standard deviation of the data and the lower limit is the average of the data minus three times the standard deviation of the data. For example, if the average of a parameter is 50 and its standard deviation is 1.5, then the upper control limit is 54.5 and the lower control limit is 45.5.
2. If all data points in the weld data file fall within your specified limits, the process should be left alone.
3. It is acceptable to have an occasional point be outside specified limits, usually this is one in about every 40 points examined.
4. Most of the data points will lie near the center line (or average) of the data.
5. Only a few of the data points will lie near the control limits.
6. The data should appear in a random manner and show no trending characteristic.

These rules are for determining the status of the process: in control or out of control. However, once you have established your limits for a weld process parameter, the following rules may be used at your discretion to determine if an unfavorable trend is happening in your welding process.

1. It is unlikely to have two out of three consecutive points outside of the average plus or minus 2 times the standard deviation.
2. It is unlikely to have four out of five consecutive points outside of the average plus or minus one standard deviation.
3. It is unlikely to have eight consecutive data points on one side of the average line.

The above three "rules of thumb" were first introduced in 1956 by the Western Electric Company, one of the first companies to develop an internal quality control department.

These rules are provided as a guideline for helping you to begin the use of statistical process control for your welding process. They are not carved in stone and should be taken with a grain of salt.

The best way to learn the characteristics of your welding process is by experimentation. Make a few welds and take a look at the data. Compare and contrast the test welds with the data. This perhaps can give you an idea of the limits you wish to set for your welding process parameters. It is best not to look at the first and last record of a weld since these values are not viable due to the start-up and power-down sections of the weld.

6.0 Actions to Take When a Process is "Out-of-Control"

If you have determined that one or more of your welding process parameters is out-of-control, the process should be stopped for examination and testing. Out of control conditions can usually be grouped into one of the following five categories:

1. The *machine* may have changed over a period of time. An example would be the wearing down of the welding tip in a weld process.
2. *Materials* that do not meet required specifications can also be a major problem in the process.
3. The *method* in which the product is produced can also affect the data. Switching from one method to another might possibly change the data. When changing methods, new process limits should be determined.
4. The *environment* also has an impact on the manufacturing process. Factors such as dust, humidity and extreme temperature changes can be detrimental to the process.
5. Last but not least, there is *human error*, the catch-all category. Forgetting to perform a part of the process or incorrectly setting parameters of a process will continue to be a thorn in the side of quality control.

Once you have located the cause of the trouble, it can be corrected and the process can continue. It is a good practice to keep record of all problems with your welding process for future use. A complete maintenance history is a valuable tool in the determination of process problems.

7.0 Further Reading

This work was produced to give you, the customer a very light overview of statistical process control. It is by no means a definitive guide for you to follow. The following texts are suggested for further reading to provide more detailed information on statistical process control:

Amsden, Robert T., Butler, Howard E., and Amsden, David M., SPC Simplified: Practical Steps to Quality, Quality Resources, White Plains, New York, 1989

Grant, Eugene L. and Leavenworth, Richard S., Statistical Quality Control, 6th Edition, McGraw-Hill, Inc., New York, 1988

Oakland, John S., Statistical Process Control: A Practical Guide, John Wiley and Sons, Inc., New York, 1986

Wadsworth, Harrison M., Stephens, Kenneth S., and Godfrey, A. Blanton, Modern Methods for Quality Control and Improvement, John Wiley and Sons, Inc., New York, 1986

