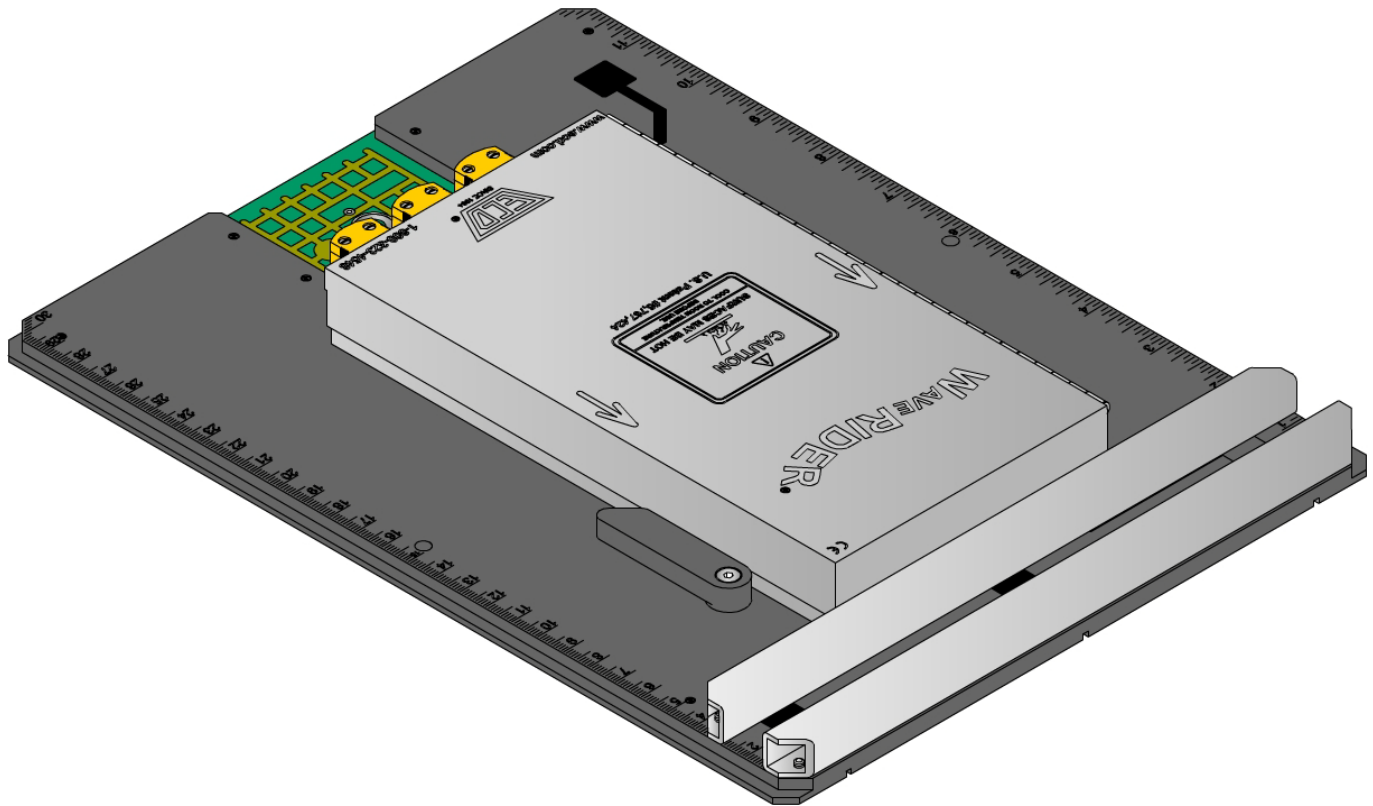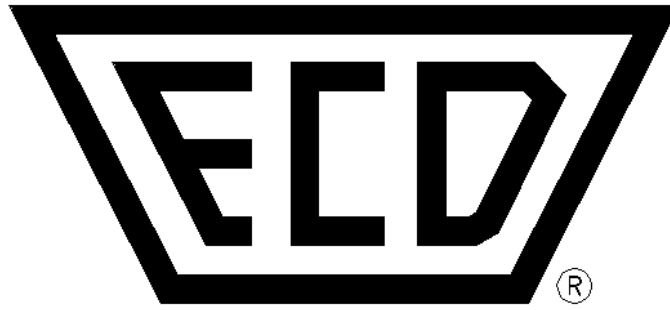# WaveRIDER®
Hardware & Software Users Guide

WaveRIDER®
Wave Solder Machine Analyzer

A36-9283-00   Rev 2.1

ECD

SINCE 1964

ECD

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WaveRIDER® Users Guide

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Introduction

This **User's Guide** explains how to use ECD's (Electronic Controls Design Inc.) WaveRIDER Wave Solder machine analyzer.

You **do not need** to be a computer expert to use this manual or the WaveRIDER software.

The manual assumes you are familiar with Microsoft Windows.

> **The hardware portions of this manual are written to reflect SuperM.O.L.E. Gold firmware versions 9.08 and higher. The software portions reflect versions 5.22 and higher.**

ECD. introduced the original M.O.L.E (Multichannel Occurrent Logger Evaluator) in 1986. Over the years ECD has produced several models of the M.O.L.E. for use in a wide variety of applications. In this manual, we may refer to the SuperM.O.L.E. **Gold** data recording device as the **M.O.L.E.**.

- **Informs the user that the note includes important information.**

- **Informs the user that the note includes a handy tip.**

The following statements describe special terms that will be used in this manual.

<u>**Hardware Terms:**</u>

- **Informs the user that the note identifies conditions or practices that could result in damage to the equipment.**

- **Informs the user that the note identifies conditions or practices that could result in personal injury or damage to property other than the equipment.**

- **WARNING – Surfaces may be Hot!**

- **SuperM.O.L.E. Gold**, may be referred as the **M.O.L.E.**.

- **WaveRIDER Ready** refers to the M.O.L.E. being configured to collect wave solder data when used with the WaveRIDER kit.

- **Thermocouple**, may be referred to as **T/C**.

<u>**Software Terms:**</u>

- WaveRIDER SPC software may be referred to as **WR SPC**.

- **Workbook**, contains all of the worksheets and the uploaded data set saved with file extension (**.MWR**).

- **Worksheet**, the individual pages or sheets in the workbook file.

- **Data Set**, multiple data runs uploaded into the workbook file.

- **Data Run / Experiment,** the data uploaded from the M.O.L.E..

• Fonts Used in this Manual

This manual uses a special font to indicate terms or words that can be found directly on the PC display.

For Example: Select the *Open Workbook* command from the *File* menu to open a new workbook file. This font indicates the words *Open Workbook* and *File* are actually found in the PC display.

• Computer Hardware Requirements

CPU, RAM, Hardware: 300mhz processor or equivalent
128 megabytes of RAM (minimum).
50 megabytes of free disk space.

Operating System: Windows XP & 2000.

Disk Drive: CD Rom drive.

Mouse: Windows compatible mouse.

Communication Port: Serial Port, USB (with port replicator).

Video: Color VGA or better video card and appropriate video monitor. (SVGA is highly recommended)

It is recommended that the minimum computer display area be set to 800 x 600. For best performance set the display to 1024 X 768 (Refer to your Microsoft® Windows® documentation for details).

Printer: Color printer is recommended.

Operators Safety Information

The safety information in this summary is for the benefit of operating personnel. Warnings and Cautions will also be found throughout the manual where they apply.

- **Hardware changes or modifications to the components are not expressly approved by ECD could void the product's warranty.**

For protection of the kit components, observe the following:

- **Do not** subject the components to sharp impacts.

- **Do not** expose the components to corrosive environments.

- **Do not** expose the RIDER, above the specified maximum temperature.

The warranty will not cover damage caused by neglect or abuse of this product. To maintain the safety features incorporated in this product, operation must be in strict compliance with the requirements specified herein.

1.0 System Description

The main WaveRIDER hardware component is called the RIDER. The RIDER is a solder machine data collection pallet with ECD's SuperM.O.L.E. Gold at the heart of it. When the M.O.L.E. is connected to the RIDER it takes on a special WaveRIDER configuration for proper data interpretation. While riding on the solder machine, conveyor data from the solder machine is collected by the RIDER and stored in the internal memory of the M.O.L.E. After the RIDER has completed the data collection, it is then connected to a PC and the data is uploaded into the WR SPC software for analysis.
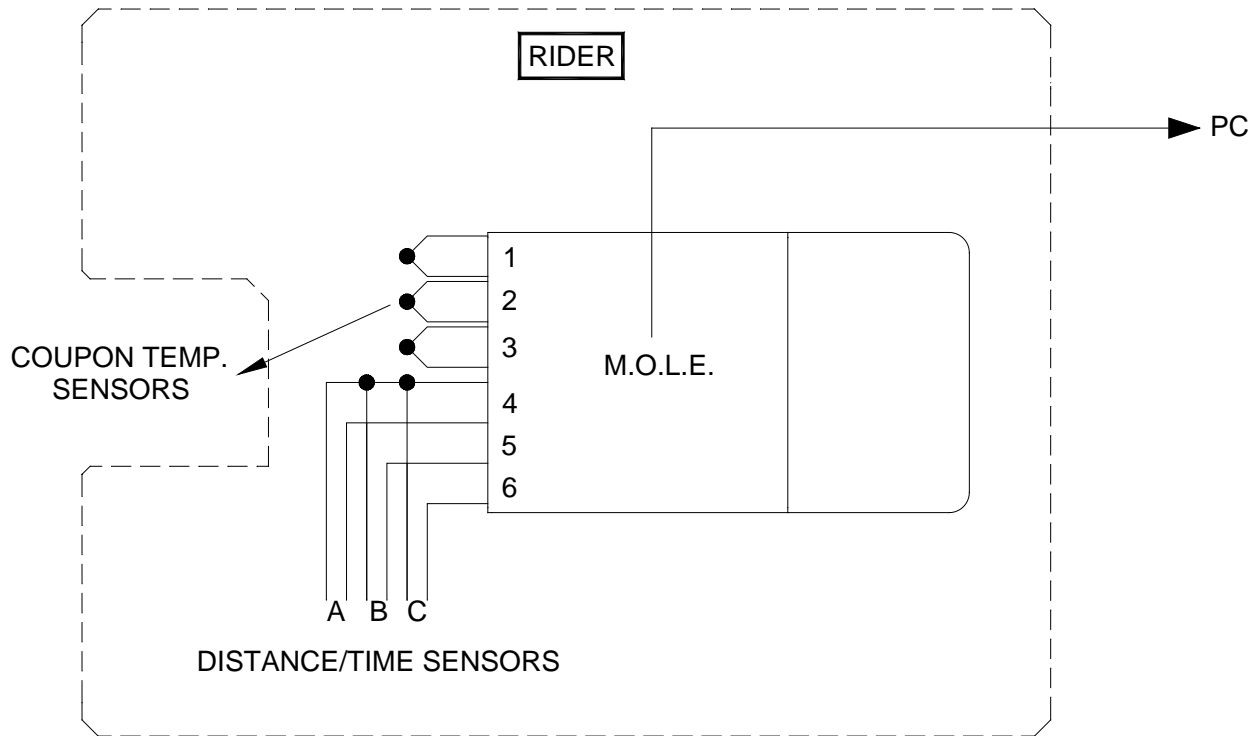
Figure 1- 1: System Block Diagram

1.1 Rider Description

This section covers brief descriptions for the external and internal features of WaveRIDER.

External features:

- **Barrier box:** This is the thermal protective barrier for the M.O.L.E..

- **Barrier locking latch:** This latch secures the cover of the barrier to prevent it from opening.

- **Coupon:** Sensors that record temperature data from the solder machine. (Refer to section *1.2 Coupon Description* for more information).
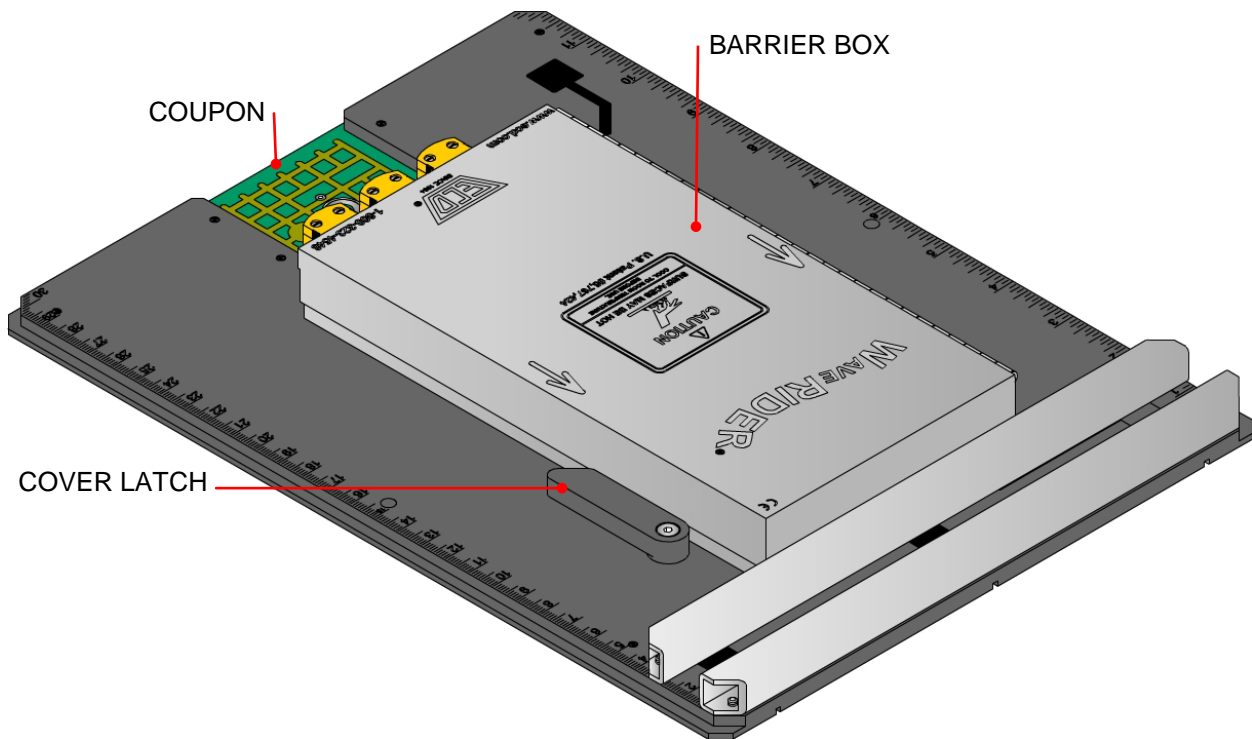
Figure 1- 2: WaveRIDER

Internal Features:

- **Connector bridge:** This is where the M.O.L.E. plugs into the WaveRIDER so it can collect data from the RIDER sensors.

- **Extractor handle:** This handle assists in the removal of the M.O.L.E..

- **Configuration plug:** This plug configures the M.O.L.E. to operate in "WaveRIDER" mode.

CONNECTOR BRIDGE

EXTRACTOR HANDLE

CONFIGURATION PLUG
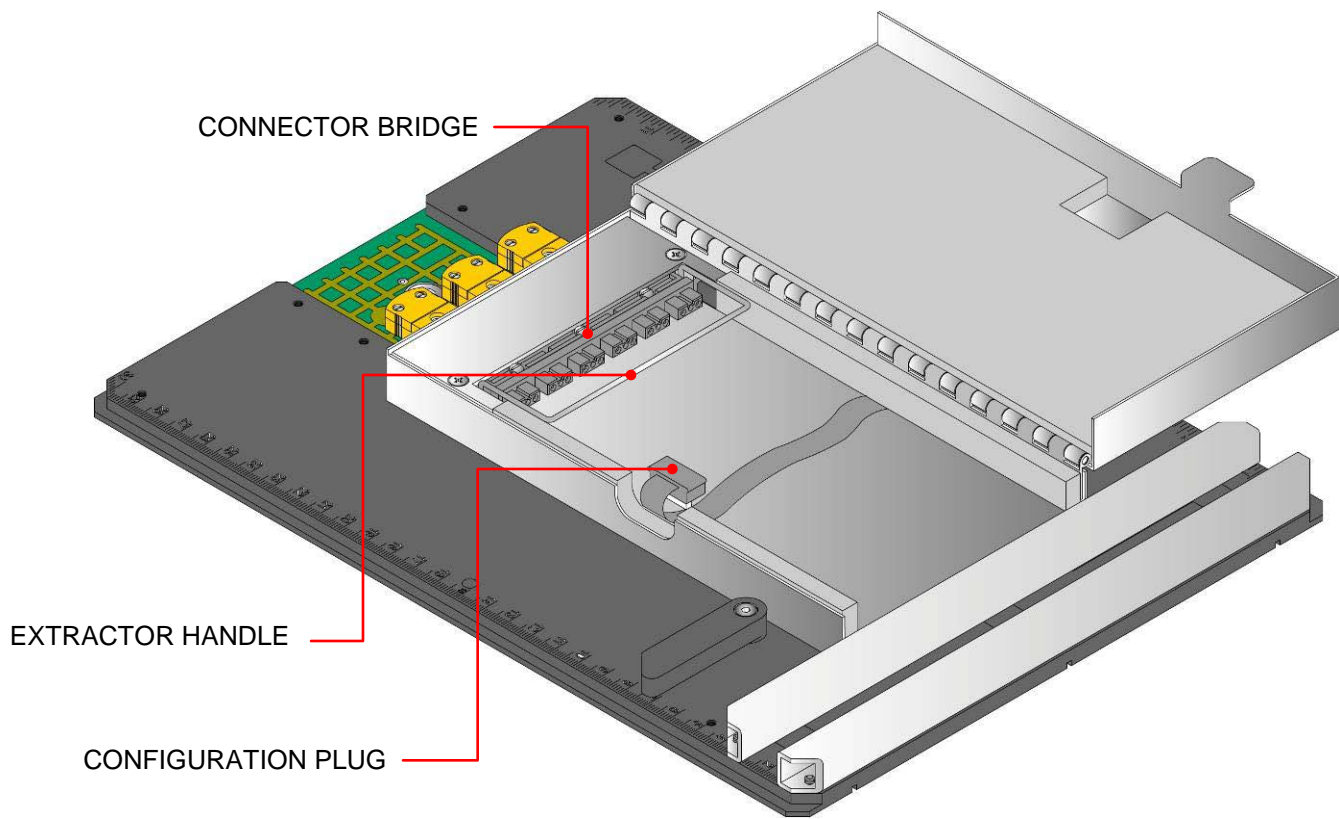
Figure 1- 3: WaveRIDER Internal Features

1.2 Coupon Description

Temperature data about a solder machine is taken from three type "K" thermocouples (T/C) attached to the Coupon. Their purpose is to sense the impact of a solder machine setup on circuit board "like" material, as opposed to the RIDER pallet material.
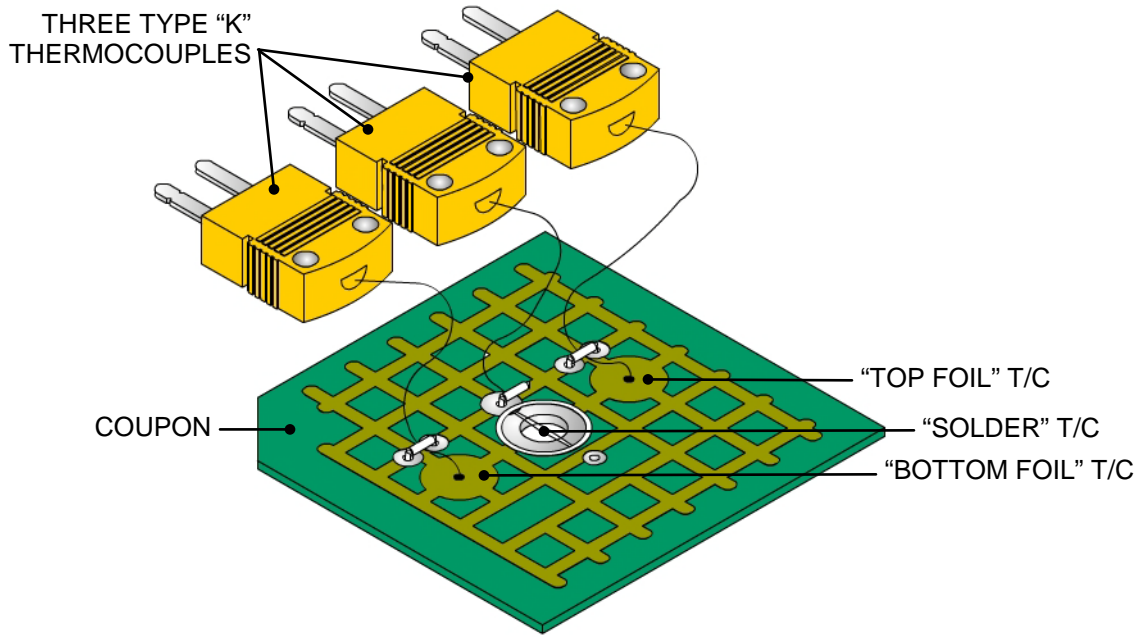
Figure 1- 4: Coupon Description

The "Bottom Foil" T/C is inserted into the coupon as close to the bottom surface as possible without breaking through. The "Solder" T/C is exposed below the bottom surface of the coupon so it will contact the solder. The "Top Foil" T/C is inserted into the coupon near the top surface.
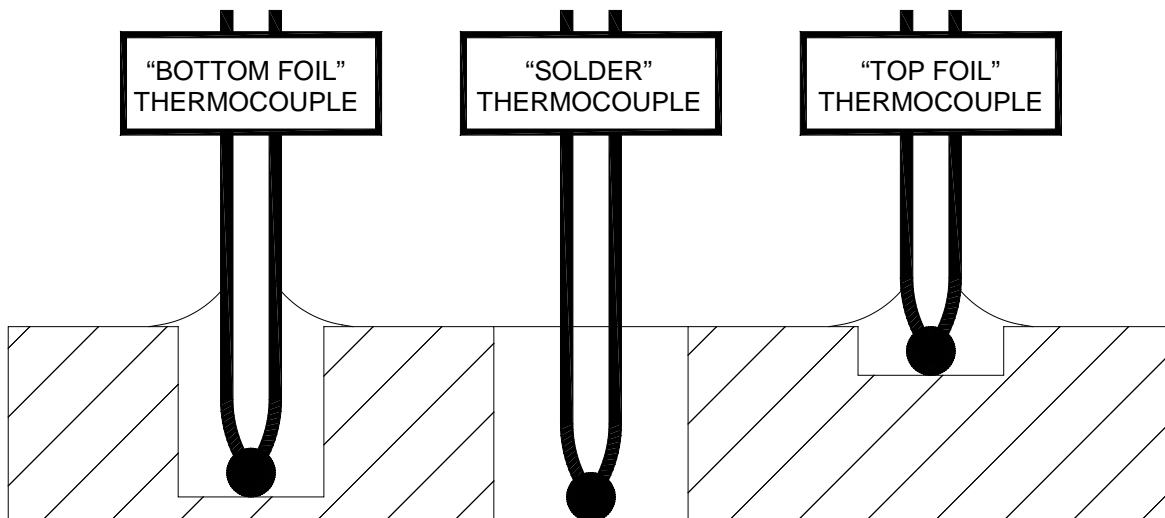
Figure 1- 5: Coupon Cross section

1.3 Software Description

This section presents an overview of a workbook management window. When the software is started, it will automatically load the previously saved workbook file.

> **The first time the software is started a sample file (i.e. WRSample.mwr) will be opened for users to familiarize themselves with the program. It is recommended when the user starts collecting process data, a new or existing workbook should be used.**

1.3.1 WR SPC Workbook Features

The workbook has several features as described in the following section.
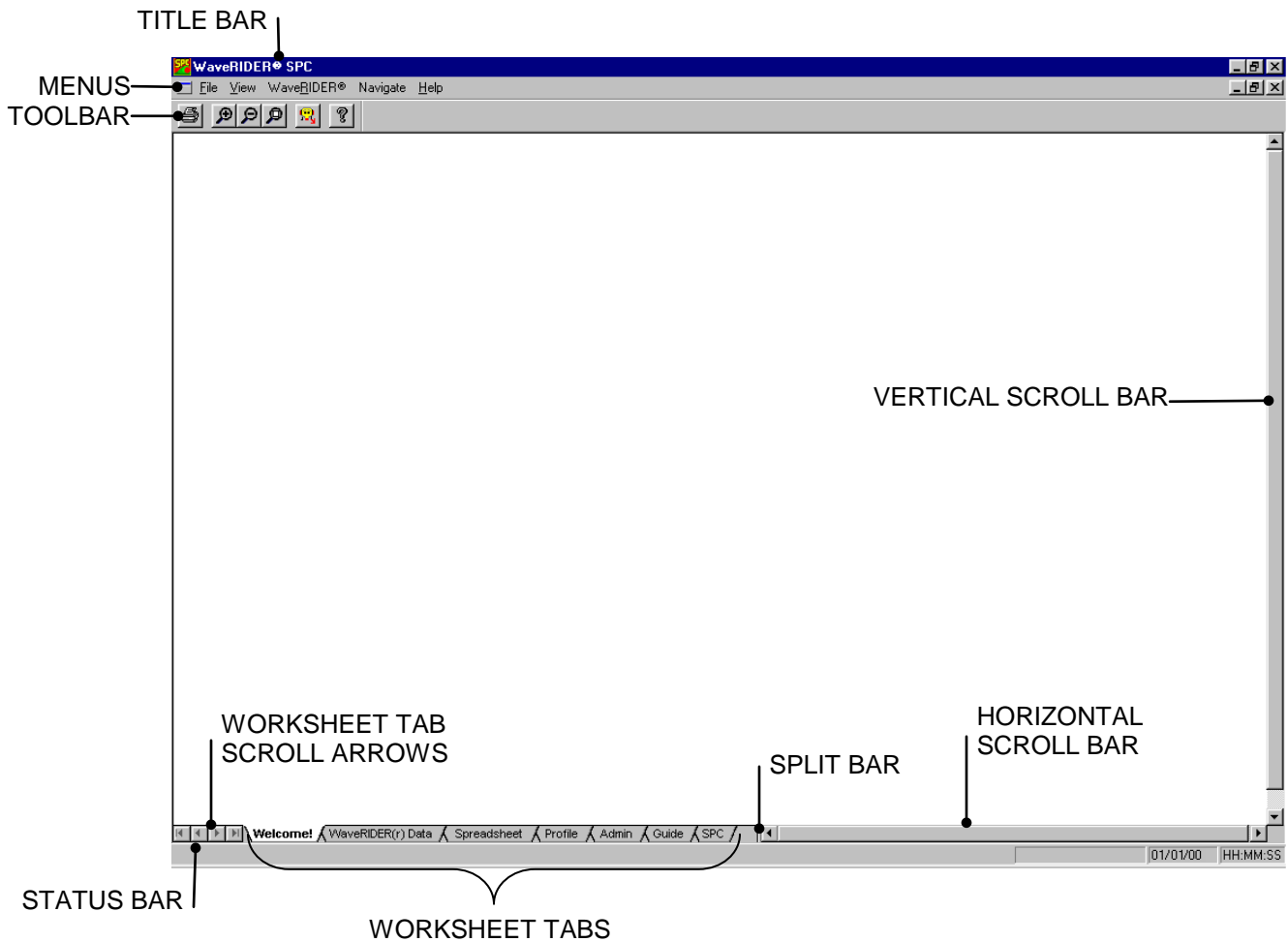
Figure 1- 6: Workbook Features

- **Title Bar:** This bar contains the program name, version, and the active workbook file name.

- **Menus:** These menus contain the commands and tools for each worksheet. Each worksheet may contain different commands that supply specific support for each worksheet. Individual worksheet menus are described in detail in their specified sections of this manual.

- **Toolbar:** The Toolbar has buttons to serve as shortcuts to the menu commands. Individual worksheet toolbar buttons are described in detail in their specified sections of this manual. Each worksheet may have different items on the toolbar because of the different features offered by each worksheet.

- **Worksheet Tabs:** These tabs are used to gain access to each worksheet.

- **Tab Scroll Arrows:** These arrows are used to view other worksheet tabs if the Horizontal scroll bar is covering them.

- **Split-bar:** This bar slides the Horizontal Scroll bar to the left or right so all or part of the worksheet tabs can be viewed.

- **Status Bar:** This bar on the bottom of the worksheet display, shows the available Help information, mouse pointer X-Y position, current date and time.

- **Horizontal Scroll Bar:** This bar scrolls the worksheet display horizontally left and right.

- **Vertical Scroll Bar:** This bar scrolls the worksheet display vertically up and down.

1.4 Standard WR SPC Worksheet functions

1.4.1 Worksheet tabs

There are six standard worksheets and up to nine optional SPC sheets. These tabs are located on the bottom left of the display.
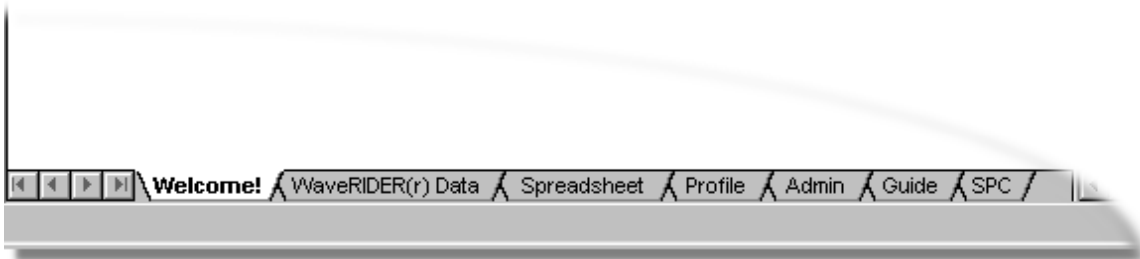
Figure 1- 7: Worksheet Tabs

1.4.2 Selecting Worksheets

To a view worksheet, use the mouse pointer to click on a worksheet tab. The worksheet tab will then become highlighted, and the worksheet will now be visible.

The keyboard does not allow access to the worksheets. The only way to select the worksheet is by using the mouse pointer.
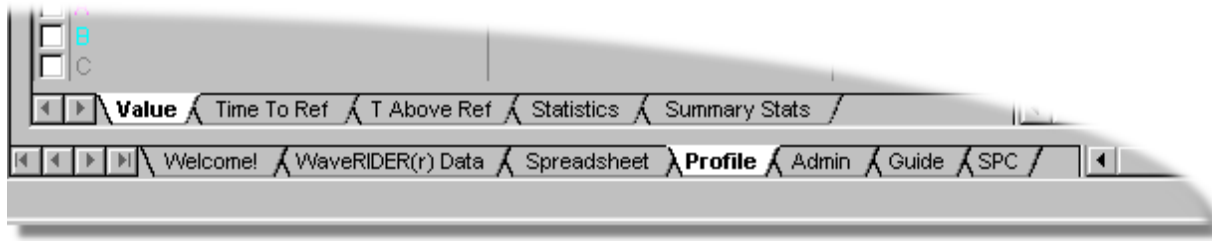
Figure 1- 8: Selecting a Worksheet

1.4.3 Split-bar

The Split-bar on the tab bar lets the user slide the Horizontal scroll bar to the left or right, so all of the worksheet tabs can be viewed. This feature is located on the left edge of the Horizontal scroll bar.

1.4.4 Worksheet Tab Scroll Arrows

Worksheet tabs may be hidden behind the horizontal scroll bar. To view them, the user can either use the Tab Scroll Arrows located on the left of the worksheet tabs, or use the Split-bar.

1.4.5 Scrollbars

The worksheets have both Horizontal and Vertical screen scroll bars so the non-visible areas of the worksheet can be scrolled into view. The Horizontal scroll bar is located in the lower right corner and can be scrolled left or right by pressing the left or right arrows located on each end of the scroll bar. The user may also scroll the display by sliding the center scroll bar left or right. The Vertical scroll bar located on the right side of the screen has the same features as the Horizontal scrollbar except it scrolls the worksheet display up and down.

CLICK TO
SINGLE STEP
WORKSHEET
VIEW LEFT OR
RIGHT

CLICK HERE TO SCROLL WORKSHEET TABS

CLICK AND DRAG TO VIEW
WORKSHEET TABS

Welcome! | WaveRIDER® Data | Spreadsheet | Profile | Admin | 01/01/00   HH:MM:SS

CLICK AND DRAG TO SLIDE THE
VIEW HORIZONTALLY
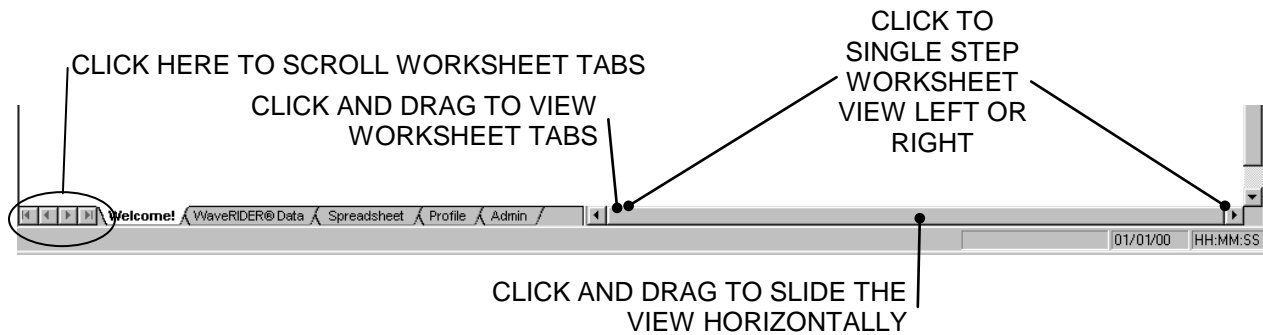
Figure 1- 9: Worksheet Options

It is recommended that the minimum PC display area be set to 800 x 600. For best performance set the display to 1024 X 768 (Refer to your Microsoft® Windows® documentation for details).

2.0 Setup

This section provides the necessary information to setup M.O.L.E. components for data collection.

2.1 Charging the Power Pack Battery

Because the M.O.L.E. is powered by a rechargeable Power Pack battery, it is important that it is charged and operating properly prior to performing every experiment. A spare Power Pack battery may be ordered so the one battery is charging while the other one is being used.

Charging:

1) Remove the Power Pack battery by separating from the unit.
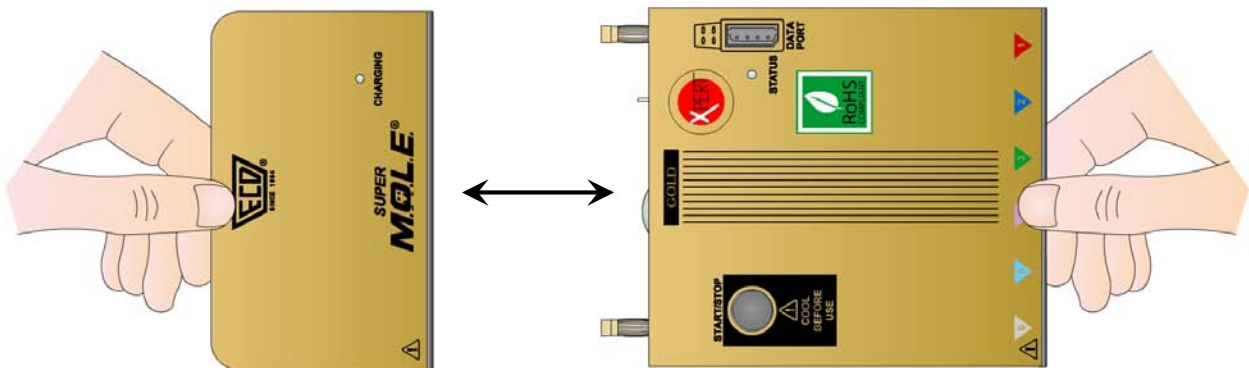
Figure 2- 1: Removing the Power Pack Battery

2) Plug the transformer end of the charger into a (60Hz 120VAC, in North America) or (230VAC) wall outlet and the connector end into the Power Pack.

POWER PACK BATTERY
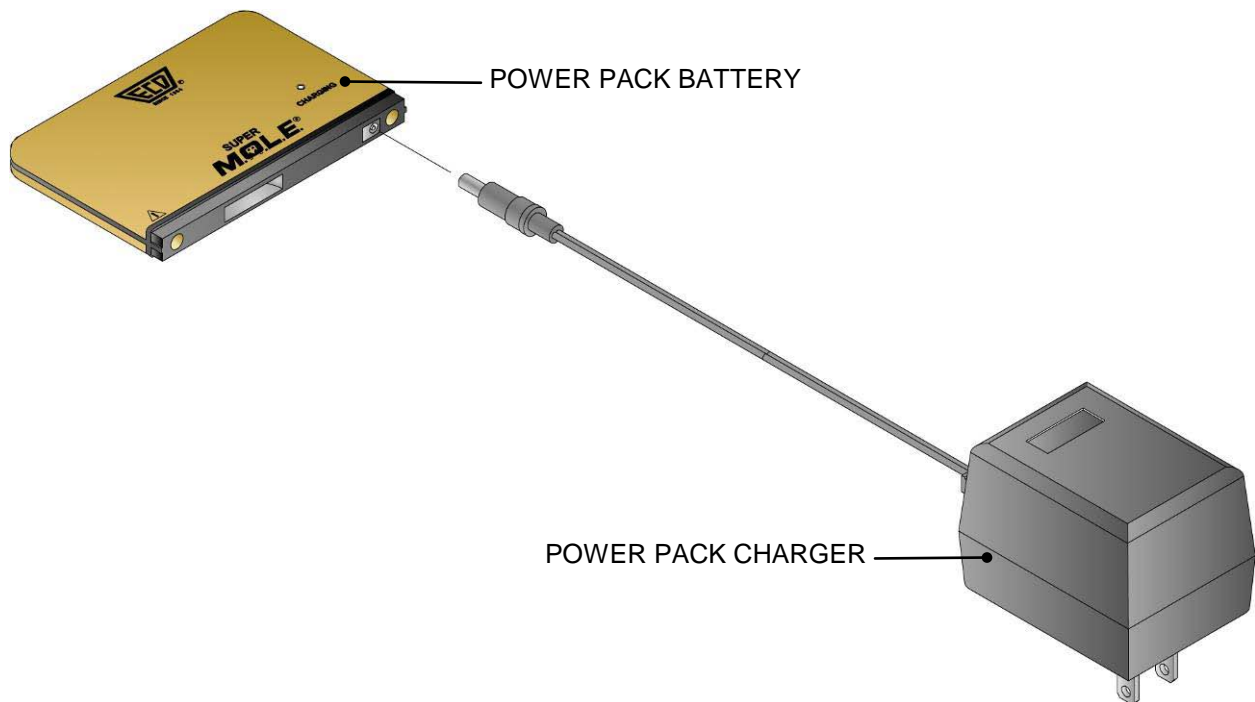
POWER PACK CHARGER

Figure 2- 2: Power Pack Charger

> **A completely discharged Power Pack takes about 14 hours to be fully charged.**

3) When the charging cycle is complete, connect the Power Pack to the M.O.L.E.. When the Power Pack is first connected, the LED will flash once to indicate that the M.O.L.E. is ready to collect data. If the LED flashes more than once, a complete reset has occurred and the M.O.L.E. will need to be re-configured. (Refer to the software manual for detailed configuration information).

> **The Power Pack battery can be charged continously whenever the M.O.L.E. is not being used, however, if the M.O.L.E. is going to sit idle for five days or more, you may want to remove it from the charger.**

2.2 Software Installation

1) Insert the CD in the drive.

2) Select *Run* from the *Start* menu.

3) Select the *Browse* command button and navigate to the software CD. Double-click the installation **.EXE** file.

4) Select the *OK* command button to start the installation.
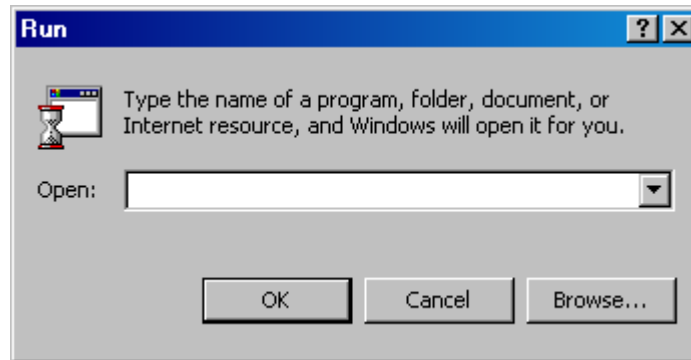
Figure 2- 3: Run Dialog Box

5) Closely follow the setup instructions provided with the software.

2.2.1 Starting the Software

Prior to starting, click the README icon from the WaveRIDER sub-menu in the documentation program menu to read the latest release notes

After the software is installed, start the software program by double-clicking the WaveRIDER SPC icon from the desktop.

Figure 2- 4: Program Icon

Once the software installation is complete, it is important to start the software and configure the software to communicate with the M.O.L.E. (refer to section *2.3 Communications Setup*).

2.3 Communications Setup

1) Locate the PC Interface cable and plug the 9-pin connector into a PC COM port and the other end into the M.O.L.E. Data Port.

> **If no Serial port exists, use the included USB adaptor to connect the interface cable to the computer.**
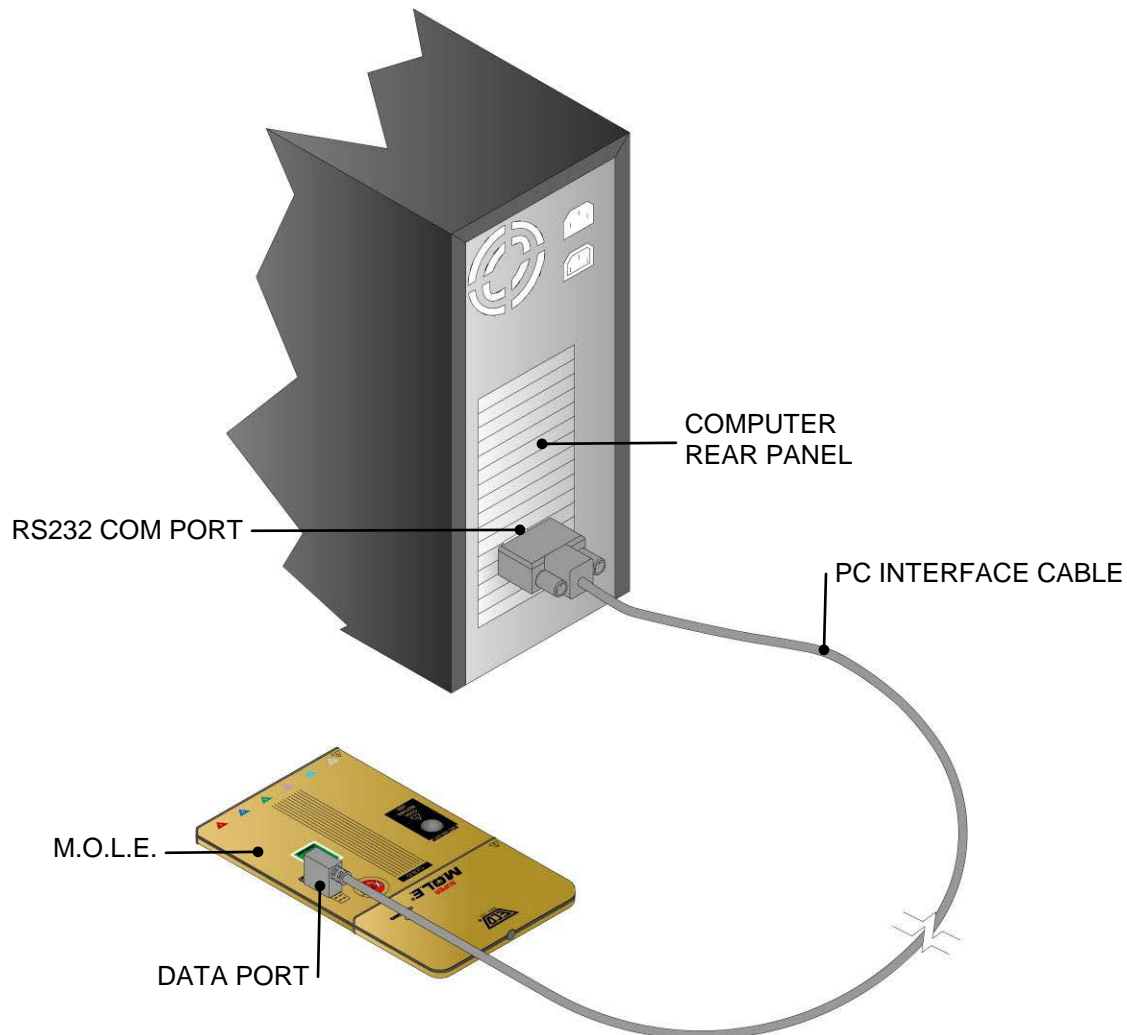
Figure 2- 5: PC to M.O.L.E. Connection

2) After the Computer interface cable is connected to a computer and Station, the Communication (COM) port must be configured in the software to match the same COM port as the oven computer so they can communicate.

3) Start the software program by either double-clicking the WaveRIDER SPC icon or selecting it from the program sub-menu.

Figure 2- 6: Program Icon

4) Once the software is running, select the *Admin* worksheet tab.
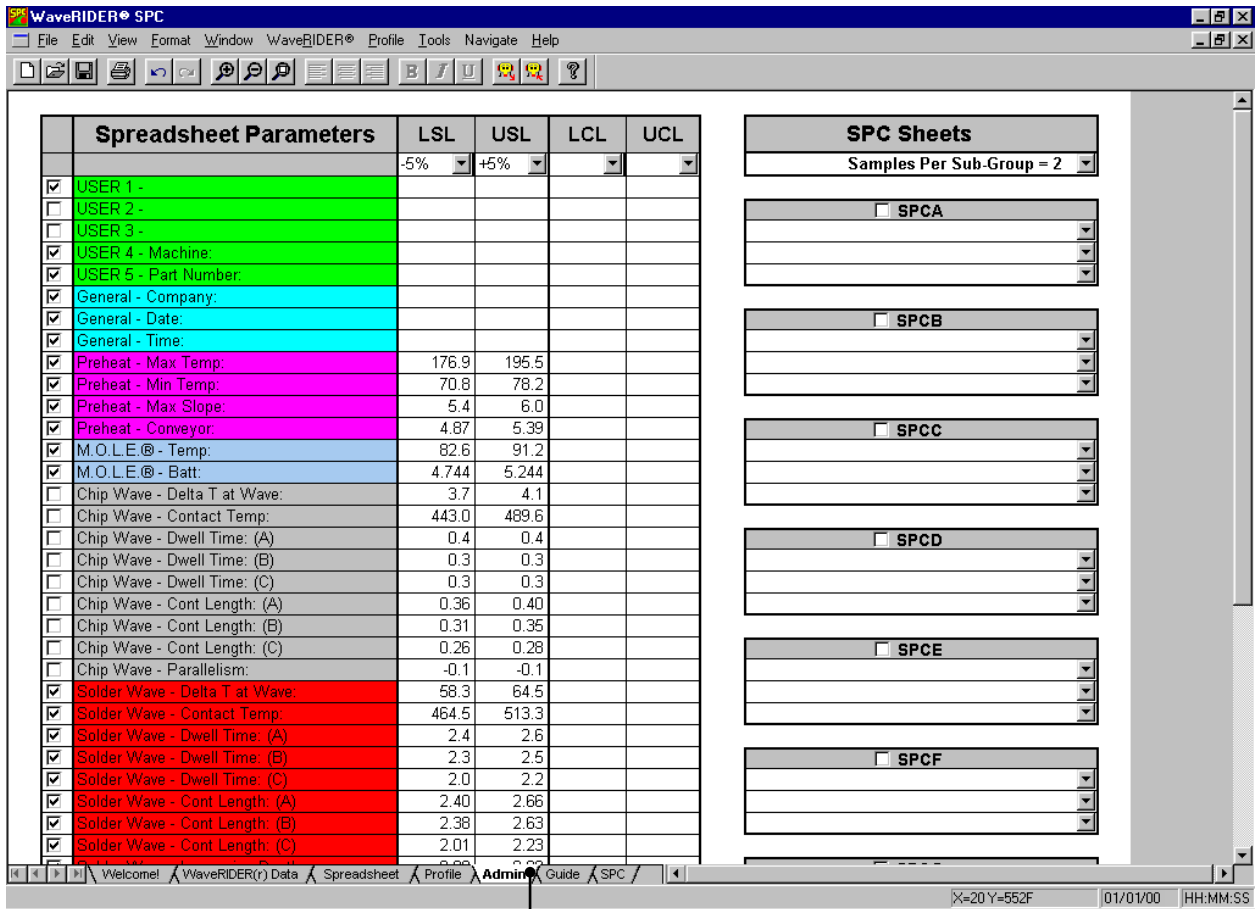
ADMIN WORKSHEET TAB

Figure 2- 7: Admin Worksheet

5) Select the *Configuration* command from the *File* menu on the Admin worksheet and the Configuration dialog box appears.

CONFIGURATION
COMMAND
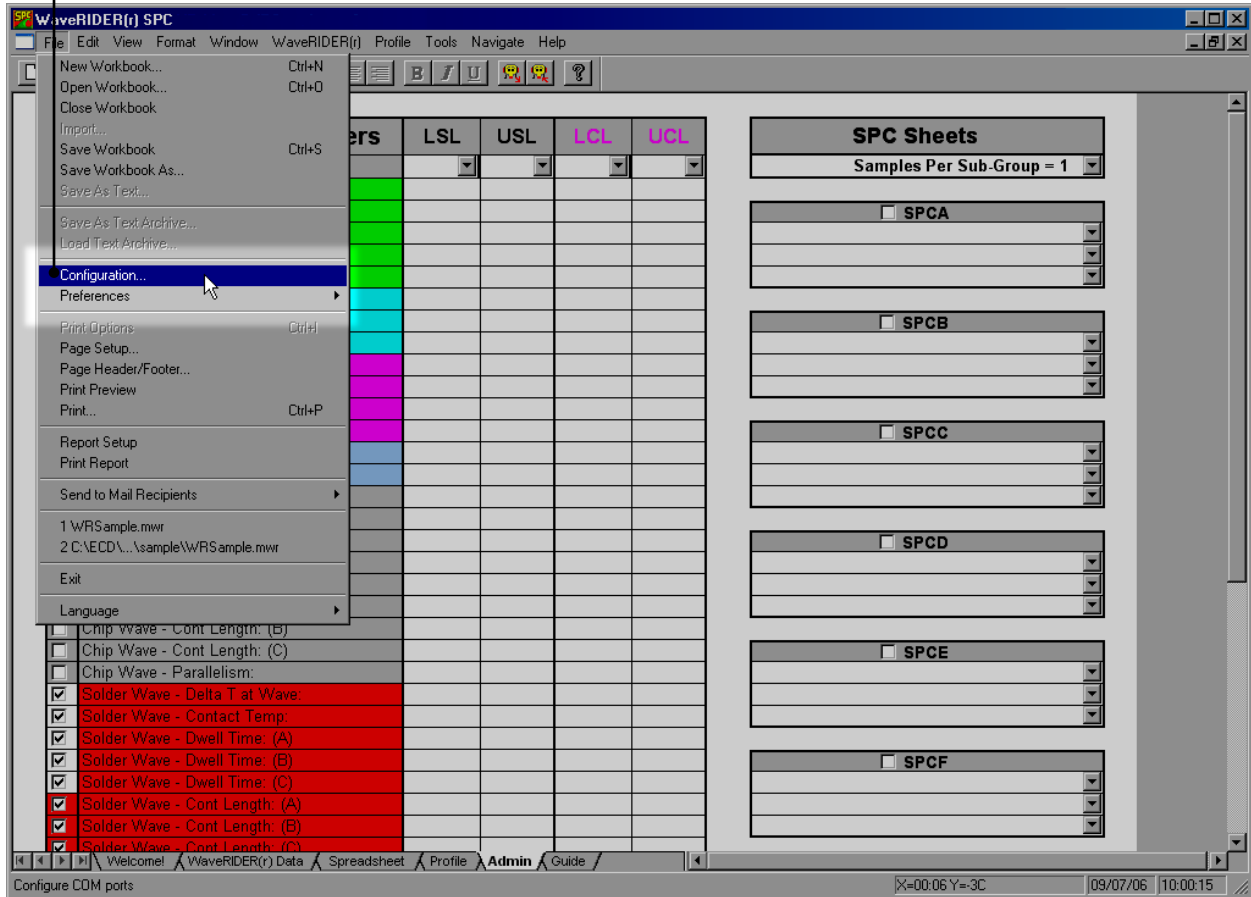
Figure 2- 8: Configuration Command

6) Click the *Auto* command button to have the software automatically find the COM port the M.O.L.E. is connected. If the M.O.L.E. is not detected, there is a communication problem (Refer to section *6.0 Service and Calibration* for help).
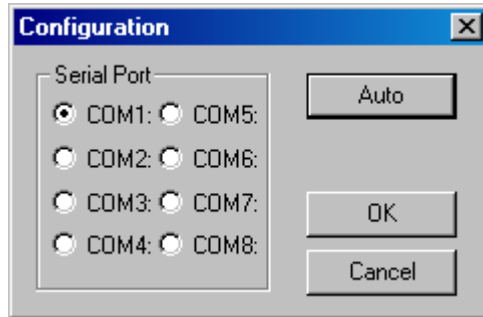
Figure 2- 9: Port Configuration Dialog Box

7) Click the *OK* command button to finish.

2.4 M.O.L.E. Installation

When inserting the M.O.L.E. into the WaveRIDER, make sure it is properly connected to the RIDER thermocouple bridge and the configuration plug is secure.

CONNECTOR BRIDGE

EXTRACTOR HANDLE

M.O.L.E.

CONFIGURATION PLUG
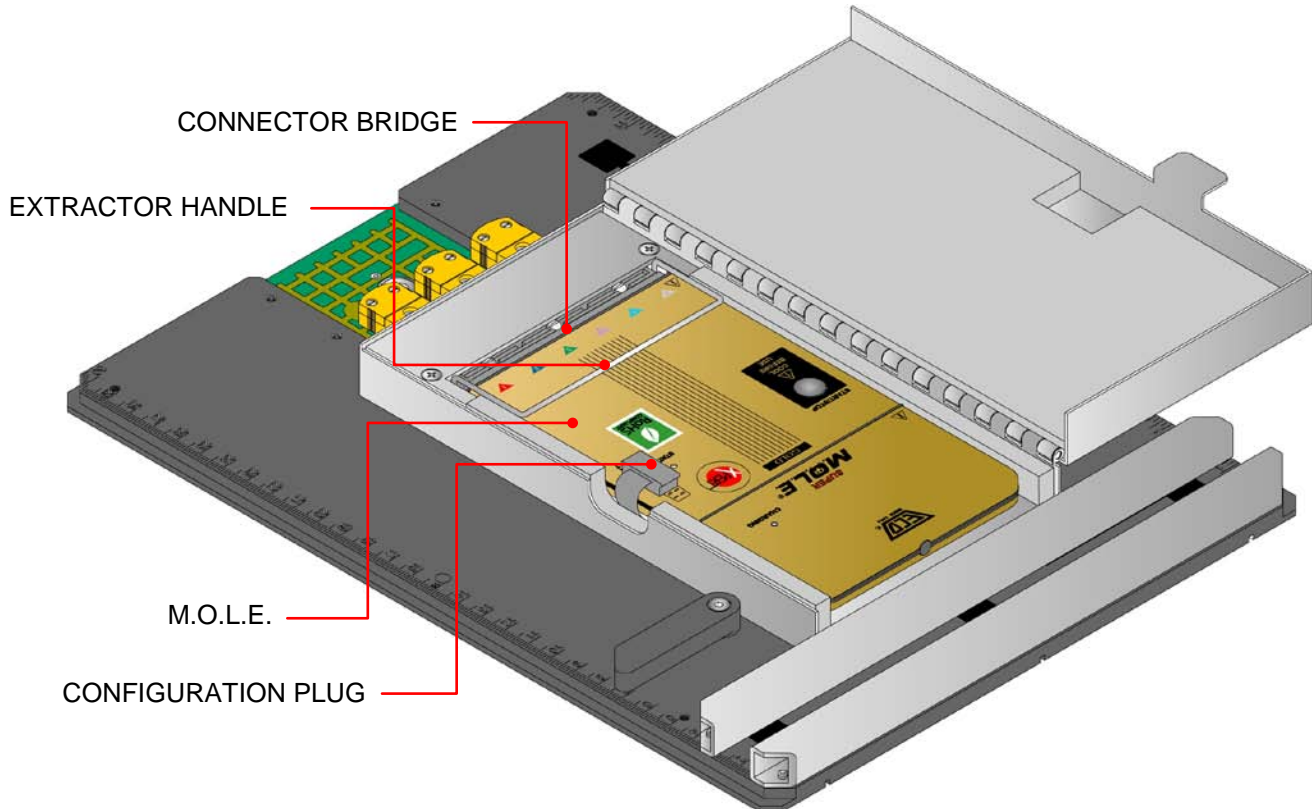
Figure 2- 10: M.O.L.E. Installation

To remove, pull the extractor handle up and slide the M.O.L.E. away from the connector bridge.

3.0 Operation

The following section will guide the user through a typical data collection process. These steps may vary depending on the process your company uses.

> **Prior to data collection, the M.O.L.E. must be "WaveRIDER Ready" as indicated by a "WaveRIDER Ready" or "Xpert" sticker on the front of the M.O.L.E..**

3.1 Data Collection

1) To start collecting data, the width of the conveyor must be set to match the width of the RIDER.

2) Set the solder wave, pre-heat temperatures and conveyor speed, as a common product would be processed.

> **If the Wave solder machine has an in-line conveyor washer, it must be turned "OFF" or the RIDER must be removed before it reaches the washer. Washing the RIDER with the M.O.L.E. installed may cause damage.**

3) Open the barrier box and make sure the configuration plug is in place and the M.O.L.E. is connected to the Connector Bridge.

4) Press the start/stop button once to start the M.O.L.E.. When the M.O.L.E. turns "ON" the activity light will flash and then illuminate and stay constant for the duration of the run.

5) Close the barrier box cover and latch securely.
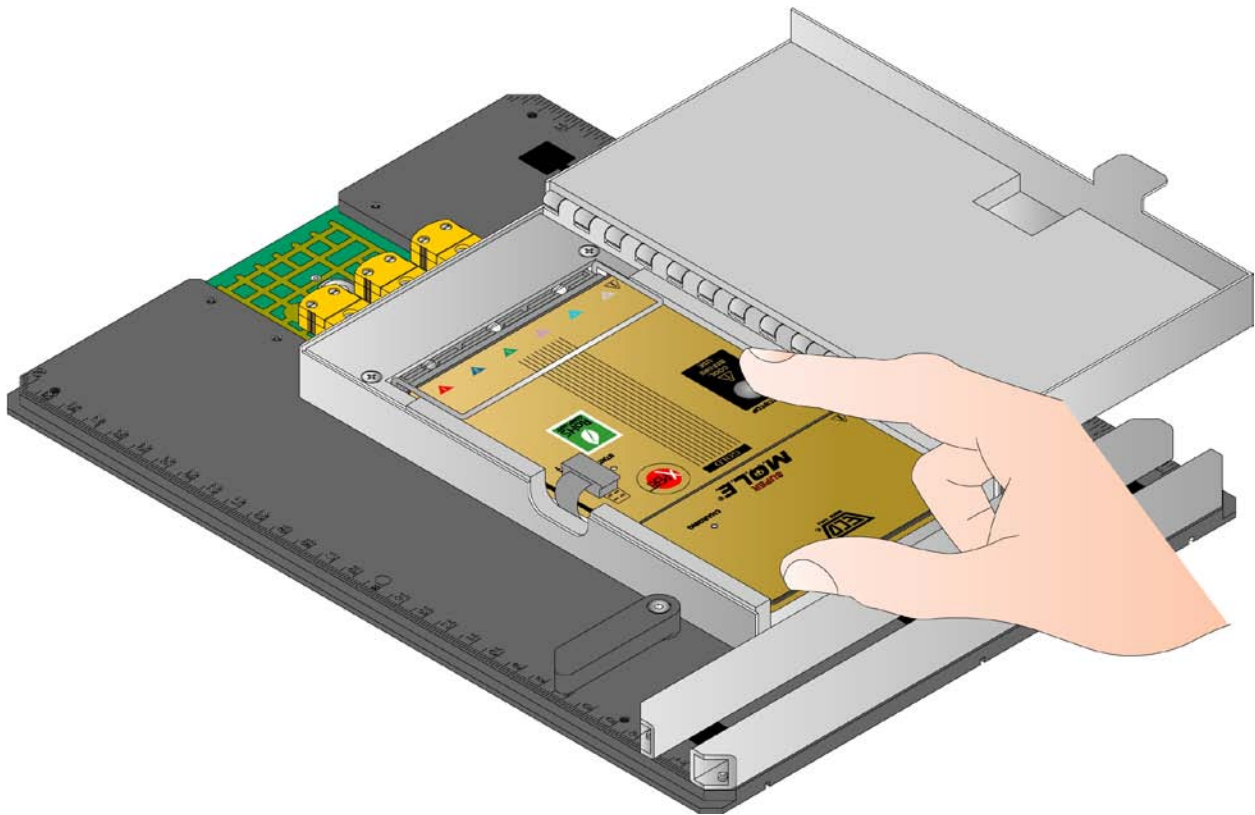
Figure 3- 1: Starting the M.O.L.E.

6) Place the RIDER on to the Wave solder machine conveyor. Make sure the RIDER is being fed into the machine in the proper direction. There are two arrows on the RIDER barrier that indicates the proper direction. If a manual feed wave solder machine is being used, hold the RIDER until the conveyor fingers have completely grabbed the RIDER.

CONVEYOR

DIRECTION
ARROW
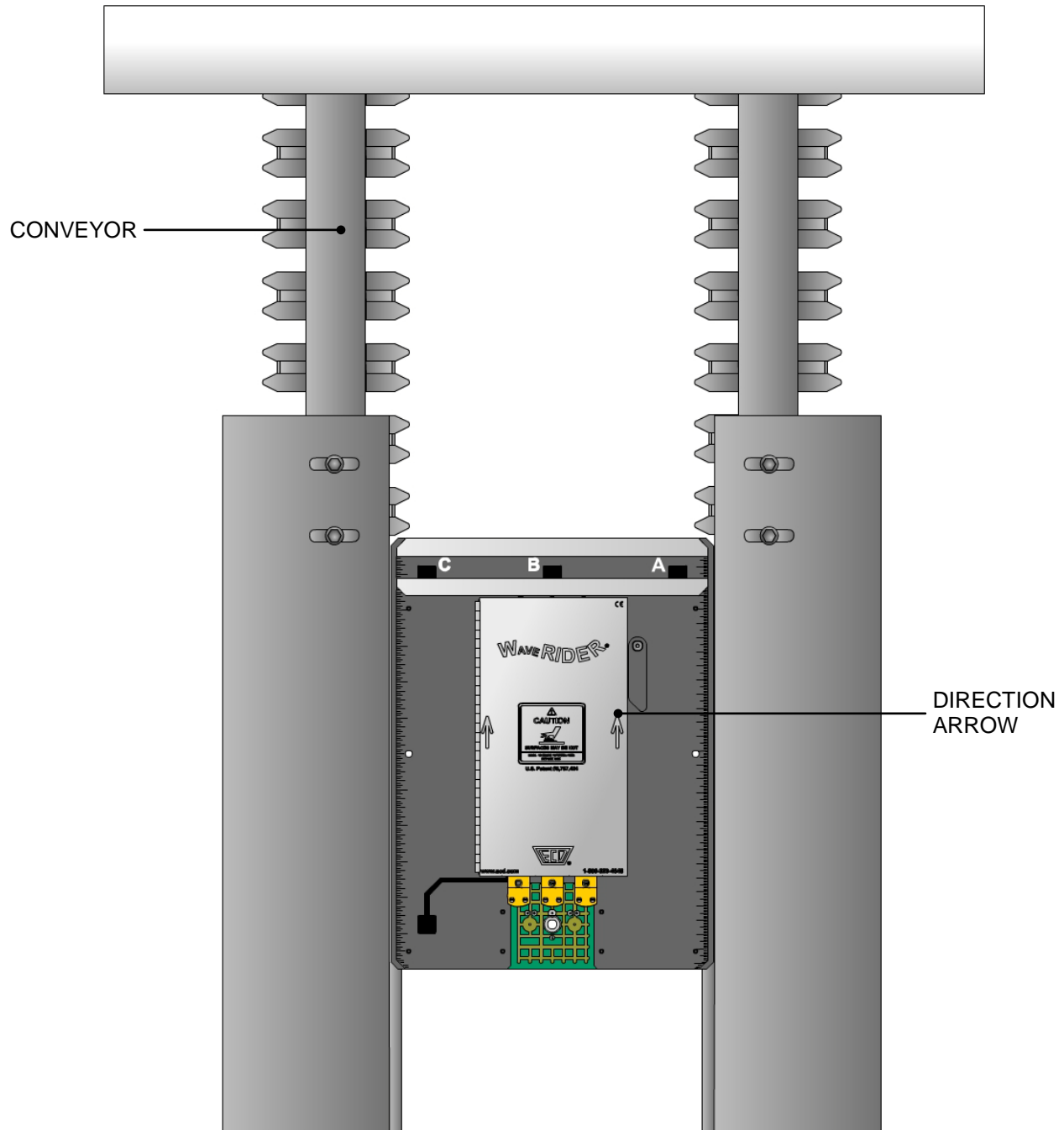
Figure 3- 2: Proper RIDER Loading

7) Retrieve the RIDER when it has traveled completely through the wave solder machine. The bottom of the RIDER will be **HOT** so using protective gloves, retrieve the RIDER from the conveyor. The best way to handle the RIDER when retrieving from the solder machine is to place one hand under the RIDER and use the other hand to grab the barrier box cover.

8) Now that the data collection is complete, it is important to open the barrier box cover to prevent the internal temperature of the M.O.L.E. to rise above operating temperature specification. To turn the M.O.L.E. "OFF", press and **HOLD** the Start/Stop button until the M.O.L.E. indicator light turns off, then release the button.

9) Remove the M.O.L.E. from the barrier by removing the configuration plug and pulling the extractor handle up. Allow the RIDER and M.O.L.E. cool to room temperature before collecting data again.
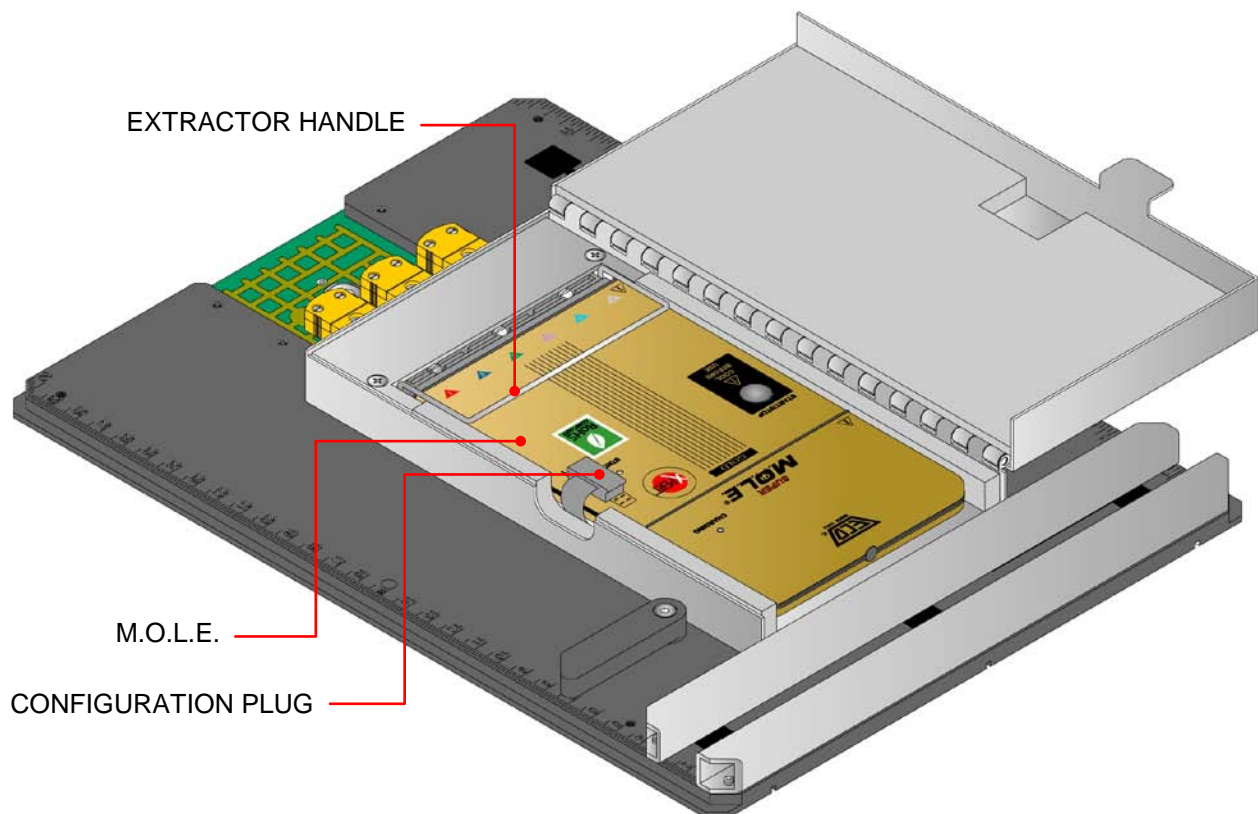
Figure 3- 3: Removing the M.O.L.E.

T <u>Data Collection Tips:</u>

- When turning the WaveRIDER "OFF" after the data collection process is complete, do not release the button until the light goes off. Pressing the Start/Stop button briefly will restart the data collection process and erase all the data in memory.

- The WaveRIDER continues to capture data until its memory is full or until it is turned "OFF". It is recommended to turn RIDER "ON" after it is placed on the wave solder machine conveyor, then turn it "OFF" as soon as possible after it exits the solder machine.

- If the production process uses pallets, the WaveRIDER sensors may not come in contact with the solder wave. If this condition occurs, try the following options:

a) Install the RIDER into one of the pallets, which can adjust to fit the RIDER.

b) Raise the solder wave(s) height. (This does not represent actual machine use so this option should be avoided).

3.2 Transferring Data

When the data collection process is complete, data can then be analyzed using the WR SPC software.

To read WaveRIDER data:

1) Connect the M.O.L.E. to the PC (refer to section *2.3 Communications Setup* for more information).

2) Start the software and select the ***Read WaveRIDER Data*** command from the ***WaveRIDER*** menu. A status bar dialog box appears indicating that data retrieval from the M.O.L.E. has begun.
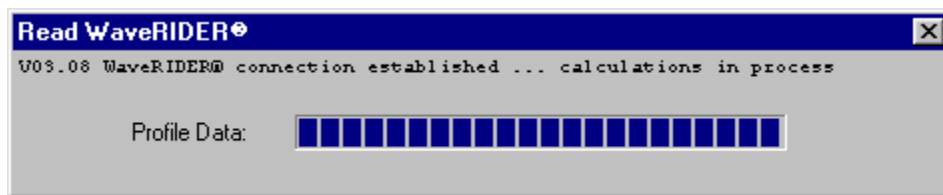
Figure 3- 4: Read WaveRIDER Dialog Box

Once data transfer is complete, the dialog box will disappear and will return to the current worksheet.

> **If the WaveRIDER has not collected enough data to create a complete profile a message box appears.**

Figure 3- 5: Communication Error Dialog box

3.3 Expert Matrix

If the WaveRIDER has detected a problem during the data collection process, the Expert Matrix is designed to guide the Operator (Expert) to trouble-shoot potential causes that may have been discovered while interpreting the data printout. The kit includes an Expert Matrix to be used in conjunction with the WaveRIDER Data worksheet in the software to help diagnose and correct soldering problems caused by solder machine setup or malfunction.

There are three main areas on the expert guide:

Problem (1): This column is used to indicate the wave solder machine problem.

Potential Cause (2): This is a list of potential machine causes.

WaveRIDER Parameter (3): This column is a list of information the WaveRIDER supplies on the printout that correlates to the potential cause.

The numbers assigned to the Potential Causes are on a scale of 1-3. (1) Low impact on that particular cause and (3) would mean that it has a High impact.

WaveRIDER Parameter (3) — **Potential Cause (2)** — **Problem (1)**

Parameter columns (left to right): Solder Wave Parallelism · Solder Wave Immersion Depth · Solder Wave Contact Lengths (A, B, C) · Solder Wave Dwell Times (A, B, C) · Solder Wave Temp · Delta Temp at Solder Wave · Chip Wave Parallelism · Chip Wave Immersion Depth · Chip Wave Contact Lengths (A, B, C) · Chip Wave Dwell Times (A, B, C) · Chip Wave Temp · Delta Temp at Chip Wave · Conveyor Speed · Maximum Preheat Slope · Minimum Preheat Temperature · Maximum Preheat Temp.

Problem columns (inner to outer): Cracked Components · Solder Balls on Assembly · Cold Solder Joints · Grainy or Disturbed Joints · Solder Wave Over Flooding Board · Unfiltered Via Holes · Solder Bridges · Solder Skips

(Catalog no. A36-9283-06 Rev 1.2)

Abbreviations used in the table below — Parameters: SWP = Solder Wave Parallelism; SWID = Solder Wave Immersion Depth; SWCL = Solder Wave Contact Lengths; SWDT = Solder Wave Dwell Times; SWT = Solder Wave Temp; DTSW = Delta Temp at Solder Wave; CWP = Chip Wave Parallelism; CWID = Chip Wave Immersion Depth; CWCL = Chip Wave Contact Lengths; CWDT = Chip Wave Dwell Times; CWT = Chip Wave Temp; DTCW = Delta Temp at Chip Wave; CS = Conveyor Speed; MPS = Maximum Preheat Slope; MinPT = Minimum Preheat Temperature; MaxPT = Maximum Preheat Temp. Problems: CC = Cracked Components; SBA = Solder Balls on Assembly; CSJ = Cold Solder Joints; GDJ = Grainy or Disturbed Joints; SWOF = Solder Wave Over Flooding Board; UVH = Unfiltered Via Holes; SB = Solder Bridges; SS = Solder Skips.

Potential Cause (2)	SWP	SWID	SWCL	SWDT	SWT	DTSW	CWP	CWID	CWCL	CWDT	CWT	DTCW	CS	MPS	MinPT	MaxPT	CC	SBA	CSJ	GDJ	SWOF	UVH	SB	SS
Conveyor speed too fast….Reduces dwell time in wave and forces preheat to be to high			1	2					1	2			3				3		3			3	3	1
Preheat temp low….Solder pads not within 100°F of solder wave temperature										1				2	3				3	3			3	3
Conveyor speed too low….increases dwell time in solder wave			1	2					1	2			3				3			2			3	
Carrier bent or damaged….Board must run parallel (flat) over wave																			2	3			3	
Conveyor fingers bent….Board may not be parallel over solder wave	2								2										2	2			2	2
Vibrator, 2nd wave OFF….Solder is not evenly distributed																			3				3	
Flux applied is insufficient….Spotty application or weak activity flux																	3			1	2			
Rails not parallel (flat) over nozzles….One side of board deeper in solder wave than the other	3								3										1	2			2	
Wave or nozzles not level….Must be parallel to conveyor	3		1	2															1	1			2	
Wave temperature too high….Solder and components are getting cooked				3	1						3	1					3			2				1
Conveyor width too tight….May warp board up or down while in wave																				3				1
Preheat too high….Heating slope is too steep					1							1		2	3		2			2				
Assembly too heavy….Weight or components bending board																				3				
Board too wide….Wide boards lack strength to support their weight																				3				
Conveyor jerky or vibrating….Disturbs solder joints while cooling			1	3					1	3			3						3					
Flux not uniform across bottom of board….Spotty application of flux																				3				
Preheat slope too steep….Heats components faster than recommended					1					1			3				3							
Chip wave OFF….Solder is not evenly distributed					3	3	3	3															3	3
Chip wave activity too low….Solder is not evenly distributed					3	3	3	3															3	3
Wave height/exit incorrectly set….Exit speed of solder should match conveyor speed		3	3	3																			3	
Wave solder splash….Too active wave splashes solder on exit																	3							
Assembly removed too early….Solder not hardened before distributed										3									3					
Carrier too tight….May warp board up or down while in wave																				3			3	
Conveyor too low….Boards below wave		3	3	3					3	3	3									3			3	
Chip nozzle clogged….Solder is not evenly distributed		3	3	3					2		2													3
Vibrator, 2nd wave too low																				3				
Wave height too high….Wave height greater than thickness of board		3																		3				
Flux air knife too strong….Blows flux off board																	2						1	1
Board not run in best direction….Component shadowing																							1	1
Flux activator low….Low flux density																	2							
Flux activity too low….Flux not aggressive enough																		2						
Cooling rate too slow….Solder not hardened before distributed												2	3						1				1	
Dross recirculating from pot to wave….Excessive dross build up																			1				1	
Pallet center support missing or poor																			1					
Vibrator, 2nd wave too high….Causes splashing of liquid solder		2	3	3													1							
Chip wave lower in spots….Solder is not evenly distributed									2	3													1	
Air knife after wave set incorrectly….Air knife not effectively blowing off excess solder																			1				1	
Flux liquid in holes….Flux density too high or too much flux applied to board																			1					

Typical Values

Parameter	Value
Solder Wave Parallelism	<0.3 sec
Solder Wave Immersion Depth	0.062
Solder Wave Contact Lengths (A, B, C)	2.0 inches
Solder Wave Dwell Times (A, B, C)	3 sec
Solder Wave Temp	495°F
Delta Temp at Solder Wave	100°F
Chip Wave Parallelism	<0.3 sec
Chip Wave Immersion Depth	.062 inches
Chip Wave Contact Lengths (A, B, C)	0.5 inches
Chip Wave Dwell Times (A, B, C)	1 sec
Chip Wave Temp	495°F
Delta Temp at Chip Wave	N/A
Conveyor Speed	4 ft/Min
Maximum Preheat Slope	5°F/Sec
Minimum Preheat Temperature	Room Temp
Maximum Preheat Temp.	225°F

Impact legend: 1 = Low Impact · 2 = Moderate Impact · 3 = High Impact

Interpreting the Expert Guide:
Example problem: Use the troubleshooting Expert's Guide shown below*.*

PROBLEM (1)

In the example, Solder Bridges is the problem that has been detected.

➲ The next step is, follow the row to the right. Now determine the potential cause that best fits the problem. In the columns, there are impact numbers rated 1,2 or 3. These impact numbers help the user to decide which potential cause is most important to the problem. There is a legend on the Expert Guide, 3 = High Impact, 2 = Moderate Impact, and 1 = Low Impact. Now read and sort out the potential causes that best fit the problem. In the example, the solder bridges row has several columns with impact numbers. All the probable causes should be read and the highest potential cause that was selected is in the next step.

POTENTIAL CAUSE (2)

Conveyor speed to slow.......Increases dwell time in solder wave.

➲ Once the potential cause has been determined, continue following the column down to the rows with impact numbers.

> **If there are no impact numbers in the WaveRIDER parameter rows, the WaveRIDER cannot assist the user in this area.**

➲ Now read all the WaveRIDER parameters that have impact numbers. Once the problem WaveRIDER parameter has been determined, correct adjustments can be made. In the example, there are several impact numbers and the one that has been selected is in the next step.

WaveRIDER® PARAMETER (3)

*It is determined that the Conveyor Speed best indicates the likely cause and the proper adjustments should be made.*

WaveRIDER Parameter (3) | **Problem (1)**

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Parameter columns (left to right):
- Solder Wave Contact Lengths (A, B, C)
- Solder Wave Dwell Times (A, B, C)
- Chip Wave Contact Lengths (A, B, C)
- Chip Wave Dwell Times (A, B, C)
- Conveyor Speed

Potential Cause (2) | Problem: Solder Bridges

Potential Cause (2)	Solder Wave Contact Lengths (A,B,C)	Solder Wave Dwell Times (A,B,C)	Chip Wave Contact Lengths (A,B,C)	Chip Wave Dwell Times (A,B,C)	Conveyor Speed	Solder Bridges
Conveyor speed too fast….Reduces dwell time in wave and forces preheat to be to high						3
Preheat temp low….Solder pads not within 100°F of solder wave temperature						3
Conveyor speed too low….increases dwell time in solder wave	1	2	1	2	3	3
Carrier bent or damaged….Board must run parallel (flat) over wave						3
Conveyor fingers bent….Board may not be parallel over solder wave						2
Flux applied is insufficient….Spotty application or weak activity flux						2
Rails not parallel (flat) over nozzles….One side of board deeper in solder wave than the other						2
Wave or nozzles not level….Must be parallel to conveyor						1
Wave height/exit incorrectly set….Exit speed of solder should match conveyor speed						3
Board not run in best direction….Component shadowing						1
Dross recirculating from pot to wave….Excessive dross build up						1
Air knife after wave set incorrectly….Air knife not effectively blowing off excess solder						1

Typical Values:
< 0.3 sec · 0.062 · 2.0 inches · 3 sec · 100°F · 495°F · < 0.3 sec · .062 inches · 0.5 inches · 1 sec · 495°F · N/A · 4 ft/Min · 5°F/Sec · Room Temp · 225°F

1 = Low Impact
2 = Moderate Impact
3 = High Impact

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Figure 3- 6: Troubleshooting Process

3.4 Cleaning the Rider

After completing the data collection process, cleaning the RIDER is very important because some types of flux tend to build up on the RIDER very quickly. The following information will discuss various cleaning machines and methods used to clean the RIDER, and how to get it ready for the data run.

The M.O.L.E. must be removed before the RIDER is cleaned because it may be damaged or destroyed by water or solvents.

1) Turn the locking latch and the raise barrier box cover until it comes to a rest. Remove the configuration plug, and pull the extractor handle to remove the M.O.L.E..
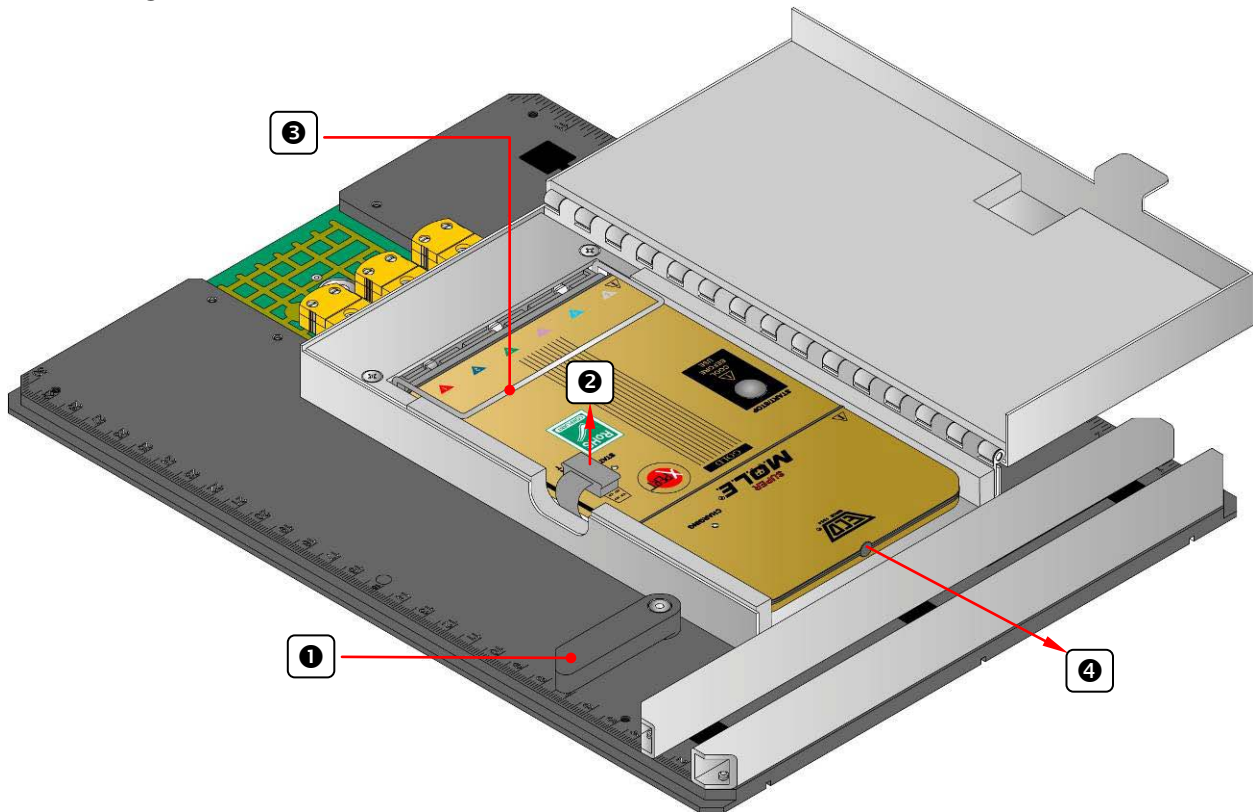
Figure 3- 7: SuperM.O.L.E. Gold Removal

2) Using a brass wire brush with fine bristles, clean the contact sensors on the bottom of the RIDER pallet. When cleaning the sensors, use enough force to get them cleaned and free from debris but not too much that they will be damaged.

3) Once the M.O.L.E. is removed, make sure that the configuration plug is tucked under the cover while it is closed and rotate the locking latch to secure.

4) Open the barrier box cover allowing inside completely dry. Once the RIDER is dry and insert the M.O.L.E. into the RIDER.

3.5 Storing the RIDER

The operator has several options when deciding how to store the RIDER. Deciding where and how to store the RIDER will depend on how the work area is set up. The RIDER has two holes on the left and right side so the operator can hang the RIDER in a place that is out of the way of normal production flow. If there is not an available area to hang the RIDER, put it back into the packaging case.

If the RIDER is not going to be used for a long period of time, the Power pack battery may lose its charge and may need to be recharged.

STORAGE HOLES
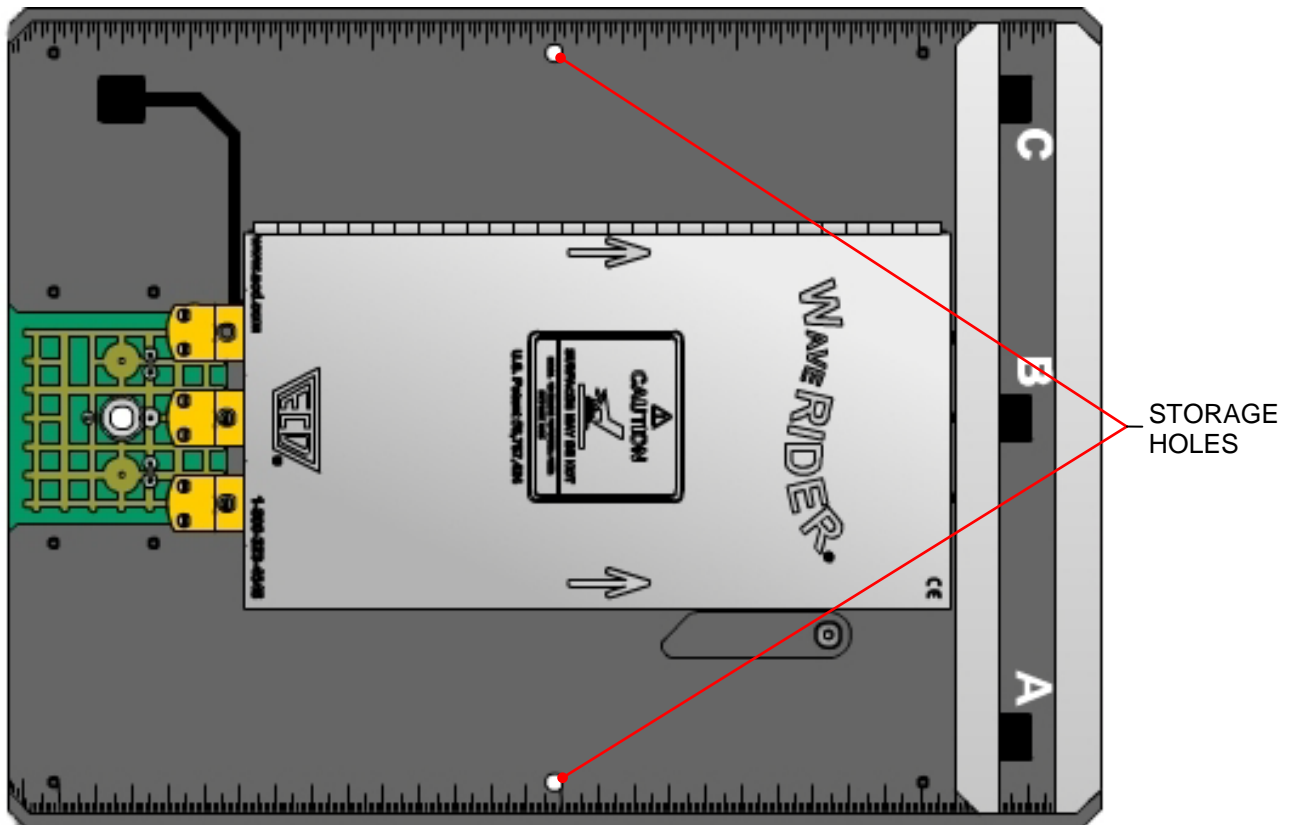
Figure 3- 8: Proper RIDER Storage

4.0 Worksheet Descriptions

The following sections offer brief explanations for the worksheet functions, and how they benefit the user. Refer to section *5.0 Menu and Tool Commands* for information on the menu commands.

4.1 The Welcome Worksheet

The Welcome worksheet is the introductory worksheet. This worksheet contains a WaveRIDER introductory illustration and a text box for entering a company or workbook name.

Welcome worksheet features:

- Menus and Toolbar

- Company/Report Name Text Box
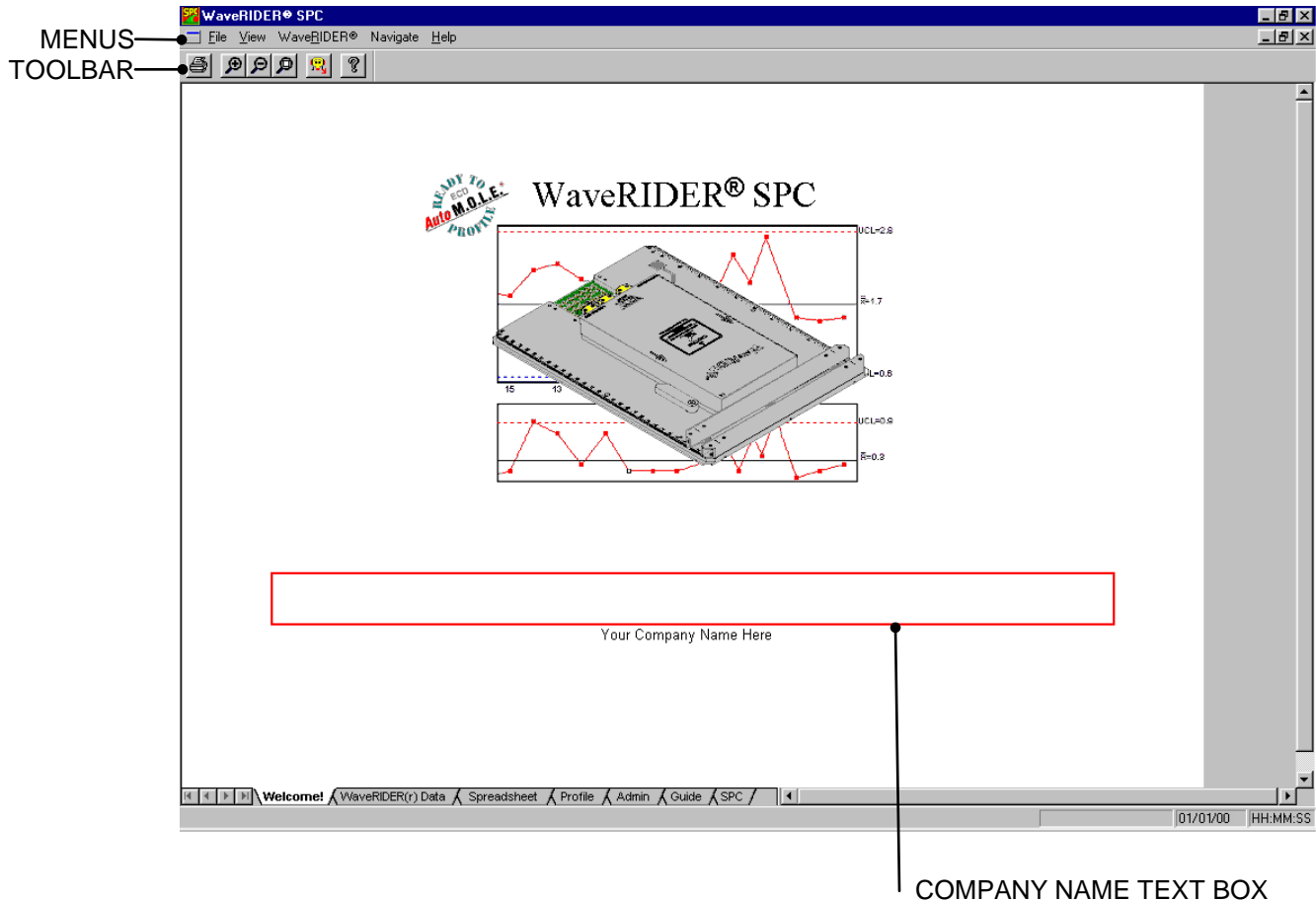
Figure 4- 1: Welcome Worksheet

4.1.1 Welcome Worksheet Menus and Toolbar

- **Menus:** File, View, WaveRIDER, Navigate, and Help.

- **Toolbar Buttons:** Print, Zoom In, Zoom Out, 100%, Read WaveRIDER Data, and About.
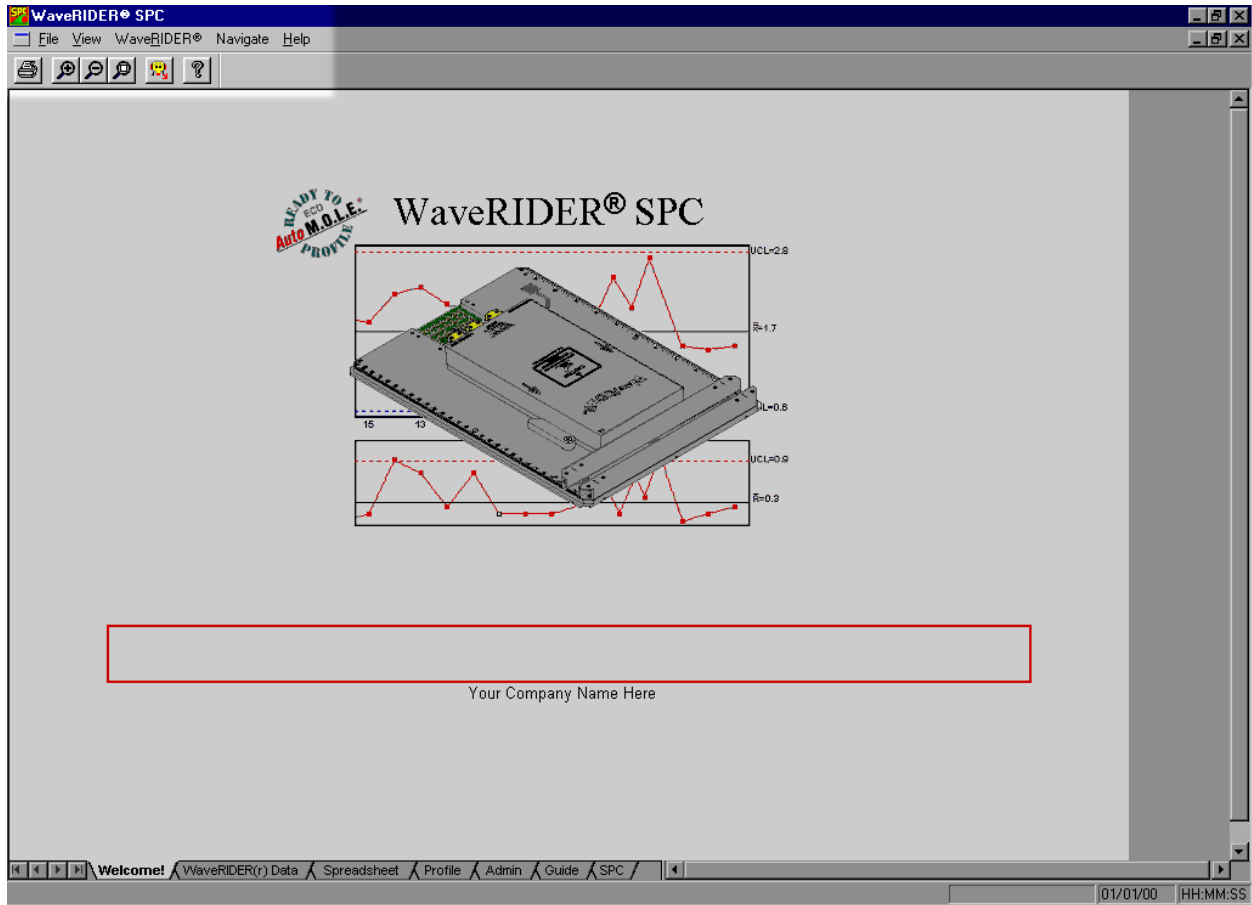
Figure 4- 2: Welcome Worksheet Menus and Toolbar Buttons

4.1.2 Company/Report Name

The text box located on the bottom half of the Welcome worksheet allows the user enter a company or report name.

To enter a name:

1) Using the mouse pointer, click in the text box.

2) Type a desired name and then hit the [*enter*] key to accept or **[*esc*]** to cancel.
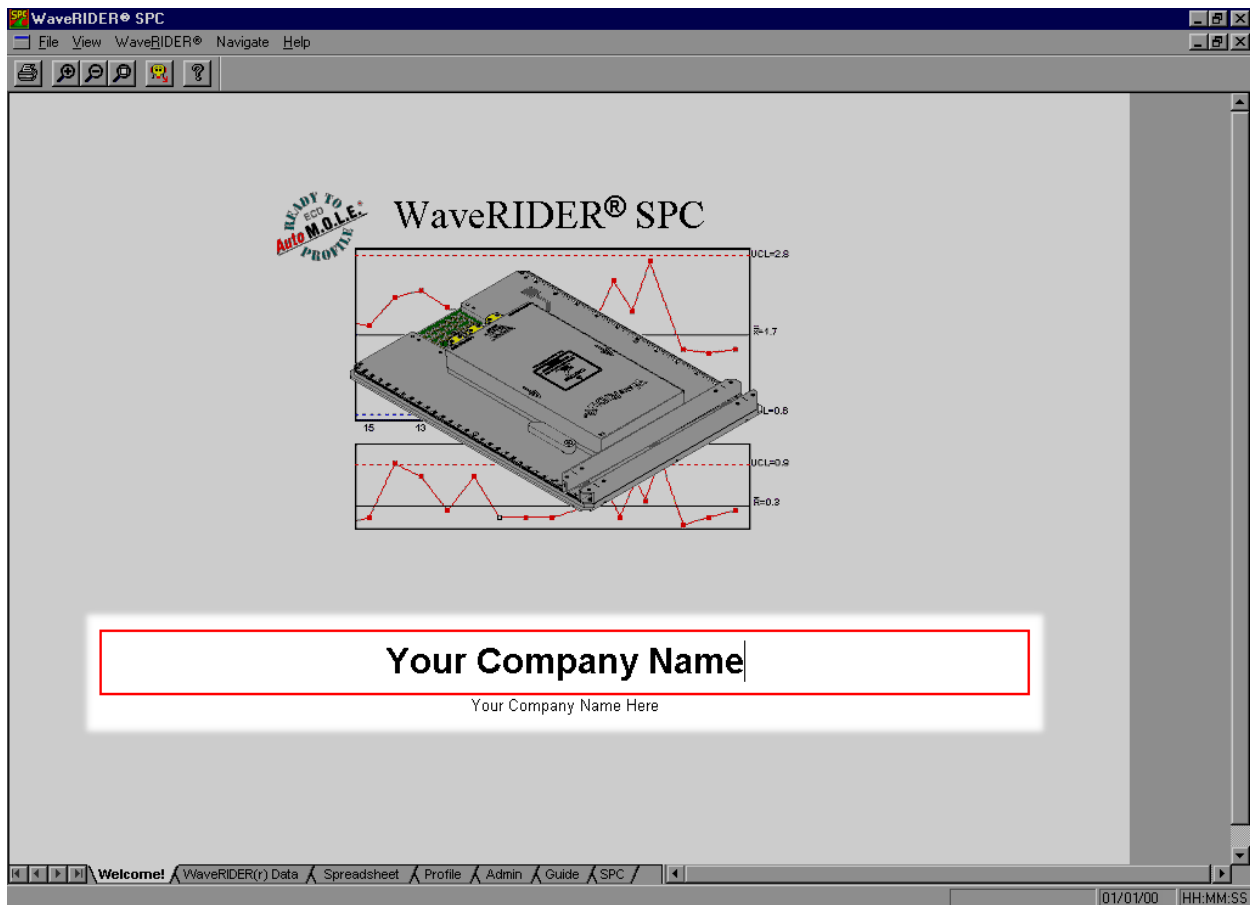
Figure 4- 3: Entering a Company Name

4.2 WaveRIDER Data Worksheet

The WaveRIDER Data worksheet is where individual data runs are viewed in single page format.

WaveRIDER Data worksheet features:

- Menus and Toolbar

- Data sheet

Figure 4- 4: WaveRIDER Data Worksheet

4.2.1 WaveRIDER Data Worksheet Menus and Toolbar Buttons

- **Menus:** File, View, WaveRIDER, Navigate, and Help.

- **Toolbar buttons:** Print, Zoom In, Zoom Out, 100%, Read WaveRIDER Data, About, First (data run of the data set), Back (to previous data run), Forward (to the next data run), and Last (data run of the data set).

Figure 4- 5: WaveRIDER Data Worksheet Menus and Toolbar Buttons

4.2.2 Interpreting the WaveRIDER Data Sheet

The following section defines the features of the WaveRIDER Data sheet. The Group Parameters on the data sheet are color coded so when they are viewed on other worksheets they can be easily associated with the Label Parameters.

Company:	**(1)**		File Tag	WR999999		Date:	05/05/99	
Machine:			Part Number:			Time:	20:23:17	

(2) Preheat			**(3)** Chip Wave				**(4)** Solder Wave			
Max Temp:	184	F	Delta T at Wave:		5	F	Delta T at Wave:		69	F
Min Temp:	73	F	Contact Temp:		443	F	Contact Temp:		488	F
Max Slope:	5.5	F/Sec	Dwell Time:	(A)	0.2	Sec	Dwell Time:	(A)	2.6	Sec
				(B)	0.3	Sec		(B)	2.5	Sec
Conveyor:	5.12	Ft/Min		(C)	0.2	Sec		(C)	2.0	Sec
			Cont Length:	(A)	0.20	In	Cont Length:	(A)	2.66	In
				(B)	0.31	In		(B)	2.56	In
				(C)	0.20	In		(C)	2.05	In
(5) M.O.L.E.®										
Temp:	88	F					Immersion Depth:		0.10	In
Batt:	4.981	Volts	Parallelism:		0.0	Sec	Parallelism:		-0.6	Sec

(6) Coupon Temperature Statistics

Ch	MinF	MaxF	Max (-) Slope			Max (+) Slope			Time	
Top	72	257	-3.0	deg	F/Sec	8.0	deg	F/Sec	0.0	Sec>361 F
Solder	56	488							8.0	Sec>361 F
Bottom	71	269	-2.5	deg	F/Sec	17.0	deg	F/Sec	0.0	Sec>361 F

Figure 4- 6: Document View

(*1*)   Company Name, Machine Name, and Part Number configured by user.
(*2*)   Pre-heat Parameters and Conveyor speed.
(*3*)   Chip Wave Parameters (Blank column if there is no chip wave).
(*4*)   Solder Wave Parameters.
(*5*)   M.O.L.E. Internal Status.
(*6*)   Overall Coupon Parameters.

> **Refer to *APPENDIX C: Measurement Definitions* for Parameter defintions**

> **If a parameter has no value (blank) that means that there was insufficient contacts detected to give a complete reqort.**

4.2.3 Data Coloring and LSL / USL

The parameter data and the user specified LSL (Lower Specification Limit) and USL (Upper Specification Limit) text fields on the Admin (Administration) worksheet are linked to indicate that a parameter has exceeded a user specified specification limit. If a USL has been exceeded, that parameter will be underlined and appear on the Data sheet in **Red** (indicating it is above the specification limit). If a parameter is less than the user specified LSL, that parameter will be underlined and appear in the Data sheet in **Blue** (indicating below the specification limit).
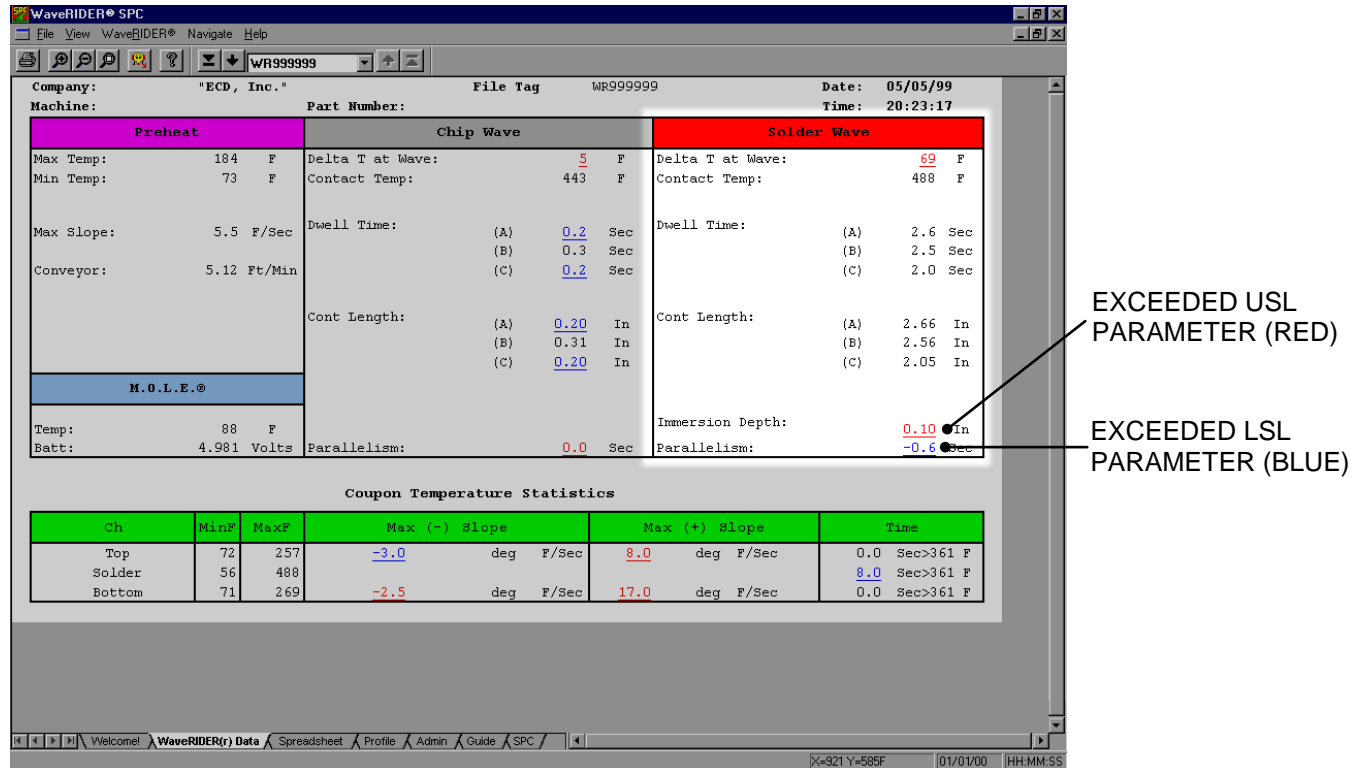
Figure 4- 7: Data Coloring

> **See section** *4.5.4 Specification and Control Limit Cells* **for information on how to enter user LSL and USL values.**

4.3 Spreadsheet Worksheet

The Spreadsheet worksheet contains data that is collected by the WaveRIDER, and is put into standard spreadsheet format. Each row in the spreadsheet represents one data run. Using the Admin worksheet in conjunction with the Spreadsheet worksheet the user can select parameters to be displayed on the worksheet.

Spreadsheet Worksheet features:

- Menus and Toolbar
- Parameter Group (color coded)
- Parameter Labels
- Data Run Rows

- Statistics
- User Definable Columns
- Parameter Units
- Filters
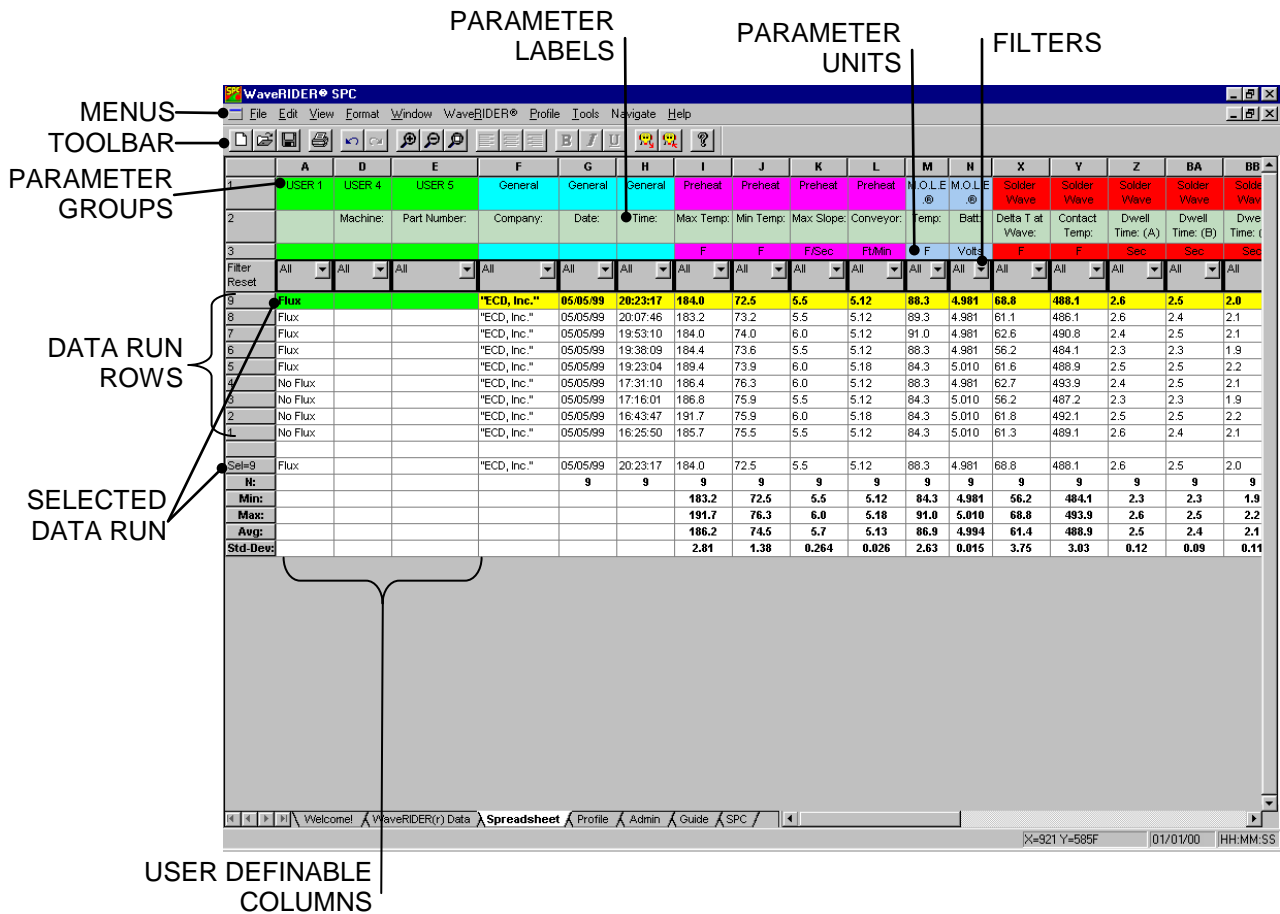
Figure 4- 8: Spreadsheet Worksheet

4.3.1 Spreadsheet Menus and Toolbar Buttons

- **Menus:** File, Edit, View, Format, Window, WaveRIDER, and Help.

- **Toolbar buttons:** New, Open, Save Workbook, Print, Undo, Redo, Zoom In, Zoom Out, 100%, Align left, Center, Align right, Bold, Italic, Underline, Read WaveRIDER Data, Dock Printout Settings, and About.

	A	D	E	F	G	H	I	J	K	L	M	N	X	Y	Z	BA	BB
1	USER 1	USER 4	USER 5	General	General	General	Preheat	Preheat	Preheat	Preheat	M.O.L.E.®	M.O.L.E.®	Solder Wave	Solder Wave	Solder Wave	Solder Wave	Solde Wav
2		Machine:	Part Number:	Company:	Date:	Time:	Max Temp:	Min Temp:	Max Slope:	Conveyor:	Temp:	Batt:	Delta T at Wave:	Contact Temp:	Dwell Time: (A)	Dwell Time: (B)	Dwe Time: (
3							F	F	F/Sec	Ft/Min	F	Volts	F	F	Sec	Sec	Sec
Filter Reset	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All	All
9	Flux			"ECD, Inc."	05/05/99	20:23:17	184.0	72.5	5.5	5.12	88.3	4.981	68.8	488.1	2.6	2.5	2.0
8	Flux			"ECD, Inc."	05/05/99	20:07:46	183.2	73.2	5.5	5.12	89.3	4.981	61.1	486.1	2.6	2.4	2.1
7	Flux			"ECD, Inc."	05/05/99	19:53:10	184.0	74.0	6.0	5.12	91.0	4.981	62.6	490.8	2.4	2.5	2.1
6	Flux			"ECD, Inc."	05/05/99	19:38:09	184.4	73.6	5.5	5.12	84.3	4.981	56.2	484.1	2.3	2.3	1.9
5	Flux			"ECD, Inc."	05/05/99	19:23:04	189.4	73.9	6.0	5.18	84.3	5.010	61.6	488.9	2.5	2.5	2.2
4	No Flux			"ECD, Inc."	05/05/99	17:31:10	186.4	76.3	6.0	5.12	88.3	4.981	62.7	493.9	2.4	2.5	2.1
3	No Flux			"ECD, Inc."	05/05/99	17:16:01	186.8	75.9	5.5	5.12	84.3	5.010	56.2	487.2	2.3	2.3	1.9
2	No Flux			"ECD, Inc."	05/05/99	16:43:47	191.7	75.9	6.0	5.18	84.3	5.010	61.8	492.1	2.5	2.5	2.2
1	No Flux			"ECD, Inc."	05/05/99	16:25:50	185.7	75.5	5.5	5.12	84.3	5.010	61.3	489.1	2.6	2.4	2.1
Sel=9	Flux			"ECD, Inc."	05/05/99	20:23:17	184.0	72.5	5.5	5.12	88.3	4.981	68.8	488.1	2.6	2.5	2.0
N:					9	9	9	9	9	9	9	9	9	9	9	9	9
Min:							183.2	72.5	5.5	5.12	84.3	4.981	56.2	484.1	2.3	2.3	1.9
Max:							191.7	76.3	6.0	5.18	91.0	5.010	68.8	493.9	2.6	2.5	2.2
Avg:							186.2	74.5	5.7	5.13	86.9	4.994	61.4	488.9	2.5	2.4	2.1
Std-Dev:							2.81	1.38	0.264	0.026	2.63	0.015	3.75	3.03	0.12	0.09	0.11

Figure 4- 9: Spreadsheet Worksheet Menus and Toolbar Buttons

4.3.2 Parameter Groups

Parameter Groups are the headers for a specific group of data parameters collected by the M.O.L.E.. They are color coded with the associated Parameter Labels so they can be easily identified together.

The width of each parameter column can be adjusted to be larger or smaller by placing the mouse pointer over a split line dividing the parameter columns and sliding it to the desired width.

PARAMETER GROUP   SPLIT-LINE POINTER.

I	J	K	L
Preheat	Preheat	Preheat	Preheat
Max Temp:	Min Temp:	Max Slope:	Conveyor:
F	F	F/Sec	Ft/Min
All	All	All	All
184.0	72.5	5.5	5.12
183.2	73.2	5.5	5.12
184.0	74.0	6.0	5.12
184.4	73.6	5.5	5.12

Figure 4- 10: Parameter Group

The Parameter Groups are defined as the following:

User Defined Parameter Group: These parameter columns can be used to enter text to help identify the row with unique information about that run (i.e. shift, operator, line number, part number). This information will also appear in the Tool Status box on the Profile worksheet.

General Parameter Group: This group contains file information associated with the run such as; date and time, (of profile) and the data file tag.

Preheat Parameter Group: This group contains Pre-heat Temperature Data.

M.O.L.E. Parameter Group: This group contains the physical condition of the M.O.L.E. at the end of the run.

Chip Wave Parameter Group: This group contains the thermal and mechanical data from the Chip Wave (first of two waves).

Solder Wave Parameter Group: This group contains the thermal and mechanical data from the Solder Wave.

Coupon Parameter Group: This group contains the coupon temperature, and Slope data.

4.3.3 Parameter Labels

The Parameter Labels are where all of the specific parameters for each group are listed. The user can decide which parameters will be shown on the Spreadsheet worksheet from the Admin worksheet as discussed in section *4.5.3 Parameter check boxes*.

PARAMETER LABEL

Figure 4- 11: Parameter Label

4.3.4 Parameter Units

The Parameter Units are the units of measurement for that parameter. For example, in the Preheat Group Parameter, the Parameter Label Temp: is in °F.

PARAMETER UNITS

Figure 4- 12: Parameter Units

4.3.5 Data Run Rows

All of the data runs uploaded into a workbook file are listed on the Spreadsheet worksheet as individual rows. The first data run uploaded into the workbook file is on the bottom and the most recent data run uploaded is on the top.

When any data run row is selected, all of the cells in the entire row are highlighted in purple and blue. The purple cells indicate that the cells can be modified and the blue cells indicate the data cannot be modified.

When any individual data cell in a data run row is selected, all of the cells in the entire row are highlighted in green and yellow. The green cells indicate that the cells can be modified and the yellow cells indicate the data cannot be modified.

The data run rows can also be moved into any order desired. This is useful when the user wants to place similar data runs together.

To change the order of the data run:

1) Select the number cell of a data run row with the mouse pointer. The row will then become highlighted in purple and blue.

2) Drag the row and drop it to a desired location.

Filter Reset	All ▼	All ▼	All ▼	All ▼	All ▼	All ▼
9	**Flux**			**"ECD, Inc."**	**05/05/99**	**20:23:17**
8	Flux			"ECD, Inc."	05/05/99	20:07:46
7	Flux			"ECD, Inc."	05/05/99	19:53:10
6	Flux			"ECD, Inc."	05/05/99	19:38:09
5	Flux			"ECD, Inc."	05/05/99	19:23:04

Figure 4- 13: Drag and Drop Data Rows

4.3.6 Selected Run

When a data run row is selected, the data for that row will be shown in the *Sel=* row located at the bottom of the data run rows. This row also allows the user to easily compare the selected data row to the statistics calculations located below the selected run row.

> **Entire selected rows and columns can be "copied" by pressing keys (CTRL + C) and then "pasted" (Ctrl + V) into other spreadsheet applications.**

4.3.7 Filters

There are Filters for each parameter label that filter specific data out of runs listing.

> **Filtering more than one column at a time acts as a Logical AND Function. All conditions of all set filters must be met for data row(s) to remain visible.**

How to use the Filter function:

1) Click the *Filter* button to reveal the unique data as populated in that column under that particular parameter label.

2) Select a desired data value to filter, or the two standard filters *All* and *Special*.

Figure 4- 14: Filter Function

To use the All option:

1) Select *All* to reset the filter for that column and view all of the data run rows that meet the other column filters.

To use the Special option:

1) Select *Special* to select data run rows within a range of values. There are multiple options to select information to filter by clicking the appropriate relational operators option button (*See Figure 4- 15*). The user can either select data from a populated list or type it in the text box on the top of the column.

=	equal to	>=	greater than or equal to
>	Greater than	<=	less than or equal to
<	less than	<>	Not equal to

Figure 4- 15: filter option buttons

2) Select a data filter by:

Clicking the greater than relational operator option button beside the left data column.

Click a parameter value from the list or type it in the text box.

Click the AND logical operator option button.

Click the less than relational operator option button beside the right data column.

Click a parameter value from the list or type it in the text box.

> **The *Clear* command button can be selected at any time to clear the selections and the new values can be selected.**

3) Click the *OK* command button to accept the selected data filters or *Cancel* to return to the worksheet without executing the filter request.
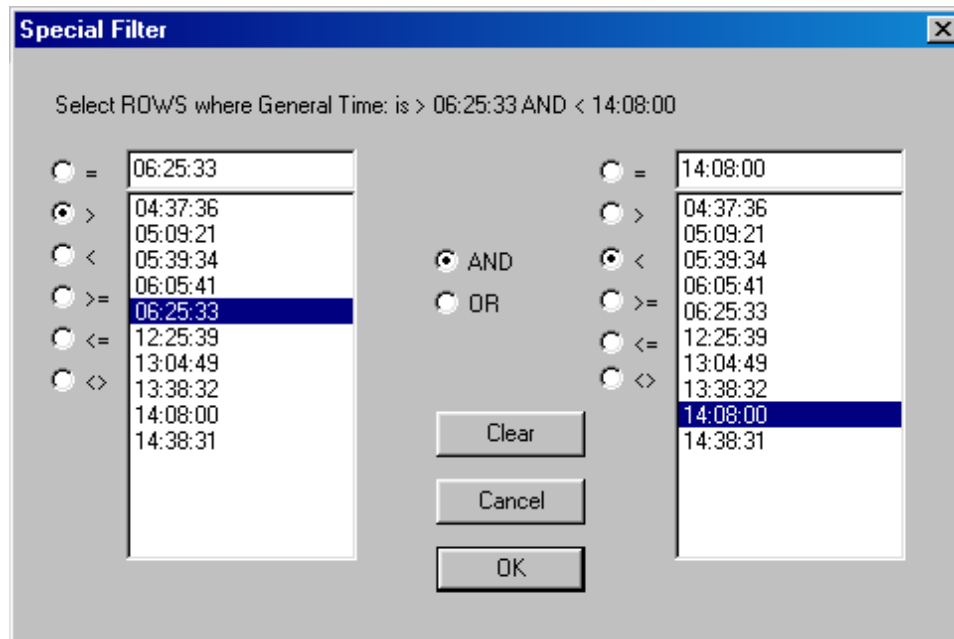
Figure 4- 16: Special Filter Feature Dialog Box

In this example, the data filtered would be all times between, but not including 06:25:33 and 14:08:00.

> **To reset all of the data set rows to restore the entire set of collected data, click the *Filter Reset* button on the Spreadsheet worksheet.**

4.3.8 Statistics

There are rows located on the bottom of the Spreadsheet worksheet, which are the combined calculations for all the data runs that are currently being viewed in the Spreadsheet worksheet display. The following information is the definitions for each Statistics row:

- N = Number of samples included in the calculations

- Min. = The lowest value in the parameter column.

- Max. = The highest value the parameter column.

- Avg = The average of all values in the parameter column.

- Std. Dev. = The standard deviation of the values in that column.

4.4 Profile Worksheet

The Profile worksheet is where a selected data run is represented graphically. The software allows the user to analyze the data and to compute statistics based on the data.

Profile worksheet features:

- Menus and Toolbar
- M.O.L.E. Status
- Tool Box Status
- Magnify Map
- Sensor Locations
- Channel Check Boxes

- Data Tabs
- Status Bar
- Data Table
- Scale
- Data Graph
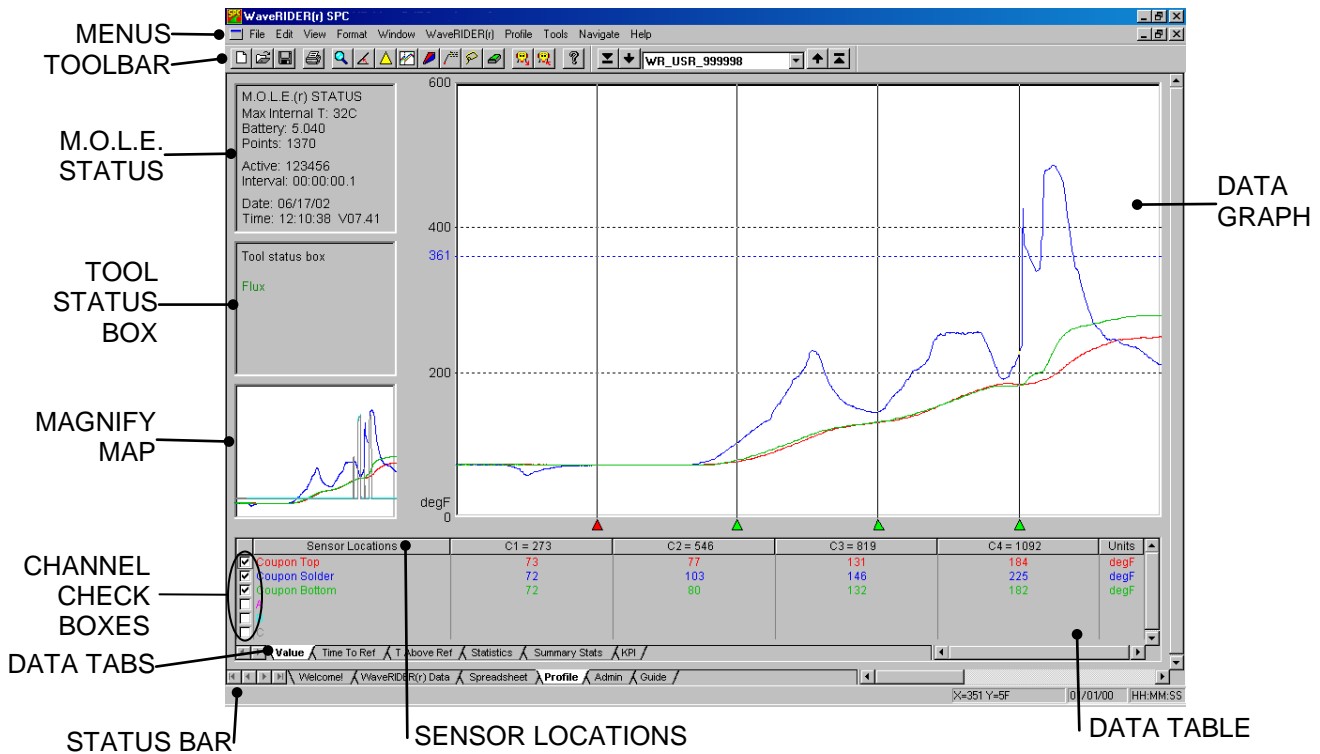
Figure 4- 17: Profile Worksheet

4.4.1 Profile Menus and Toolbar Buttons

- **Menus:** File, Edit, Window, WaveRIDER, Profile, Tools, Navigate, and Help.

- **Toolbar buttons:** New, Open, Save Workbook, Print, Magnify, Slope, Peak Difference, Overlay, 3-D, Notes, Erase Object(s), Erase All, Read WaveRIDER Data, Dock Printout Settings, About, First (data run of the data set), Back (to previous data run), Forward (to the next data run), and Last (data run of the data set).
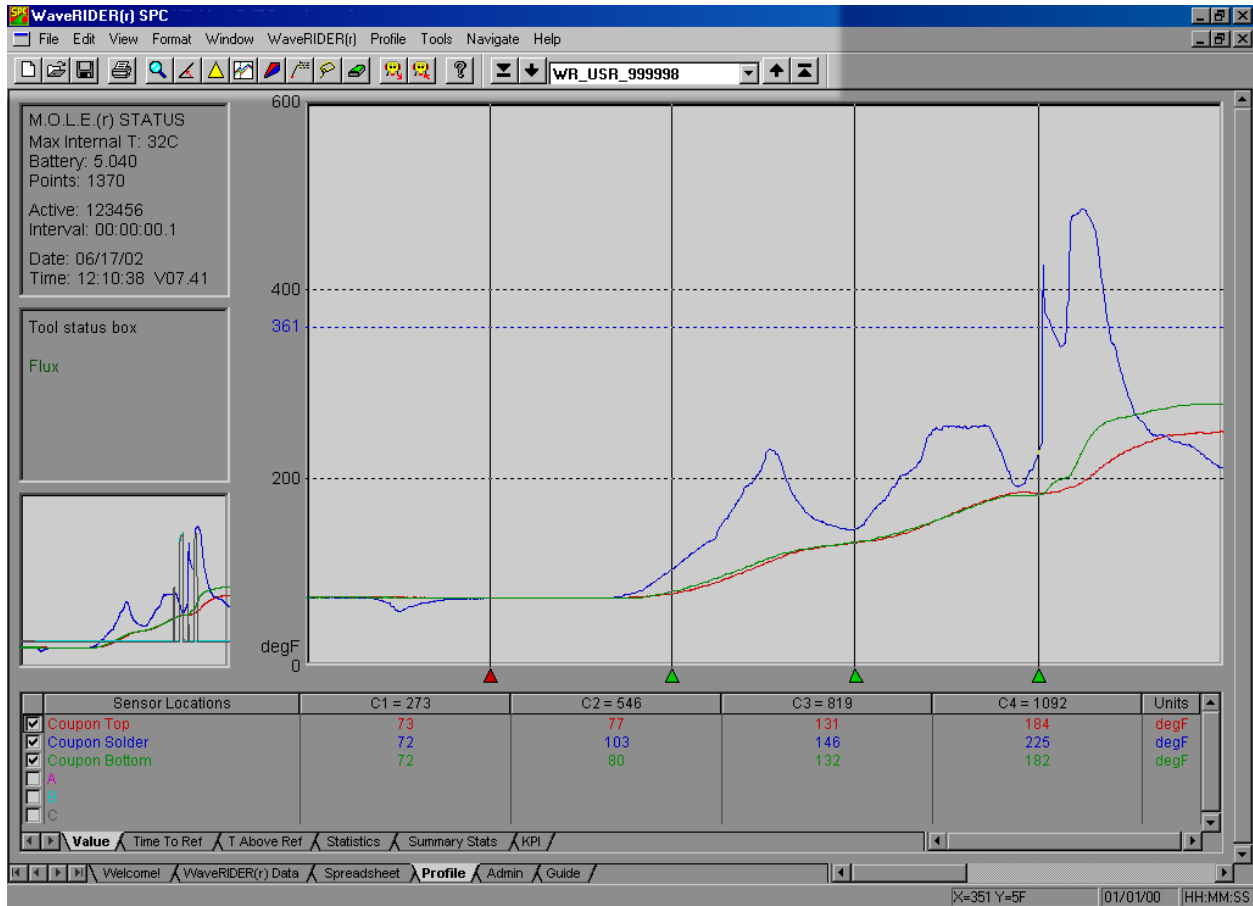
Figure 4- 18: Profile Worksheet Menus and Toolbar Buttons

4.4.2 M.O.L.E. Status

The *M.O.L.E. STATUS* box contains information about the status of the M.O.L.E. while it collected the data the selected run.
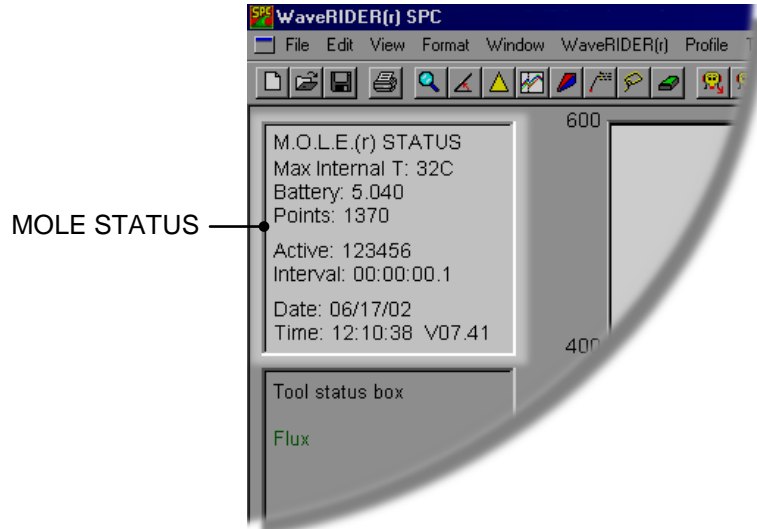
Figure 4- 19: M.O.L.E. Status Window

Max Internal T: This is the highest internal temperature logged during the displayed profile and is displayed in degrees Celsius. If the highest temperature logged is in the specified internal operating temperature range of is 0-54°C, it appears in BLACK. When the internal temperature is 55-64°C, it appears in YELLOW indicating that the M.O.L.E. has reached the Warning zone and is approaching the maximum recommended operating temperature of 65°C. If the internal operating temperature is above 65°C, it appears in RED indicating that the maximum internal operating range has been reached.

Battery: The battery voltage measured during the upload of that run. The nominal range for normal operation is 5.1 to 4.7V.

Points: The number of data samples recorded at the configured interval.

Active: Indicates which channels were active during the experiment. A number means an active channel; a "*O*" is an inactive channel. An "*X*" means an open or out of range T/C was detected on that channel during the data run.

Interval: Time between data shown in hours, minutes, seconds, and tenths of seconds data points: hh:mm:ss.t.

Date: Date of last data point logged.

Time: Time of last data point logged.

V: Firmware Version displays the operating code of the M.O.L.E. (This is where customer service will ask you to find the version number for the M.O.L.E.)

4.4.3 Tool Status Box

The Tool Status box displays information on how to use a selected tool command and other information during tool use. Prior to using a tool command, the Tool Status box displays the Spreadsheet worksheet User definable column information that is associated with the selected data run.

When a Tool command, such as Magnify, is selected, a message appears in the box stating "Click and drag to select area".
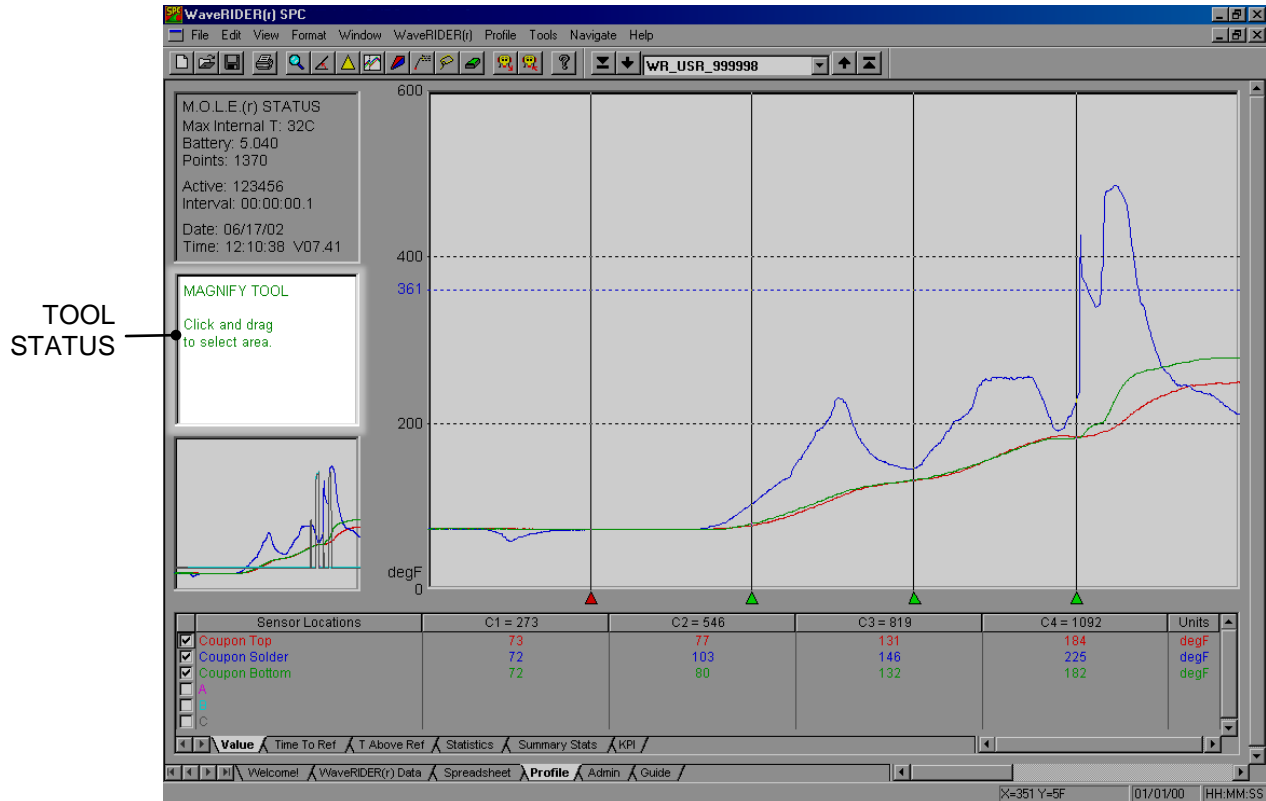
Figure 4- 20: Tool Status Message

Once the user has completed the tool command, the user data will be displayed again.

4.4.4 Magnify Map

The Magnify Map displays a small map of the entire profile and indicates the area currently magnified with a red crosshatched box.
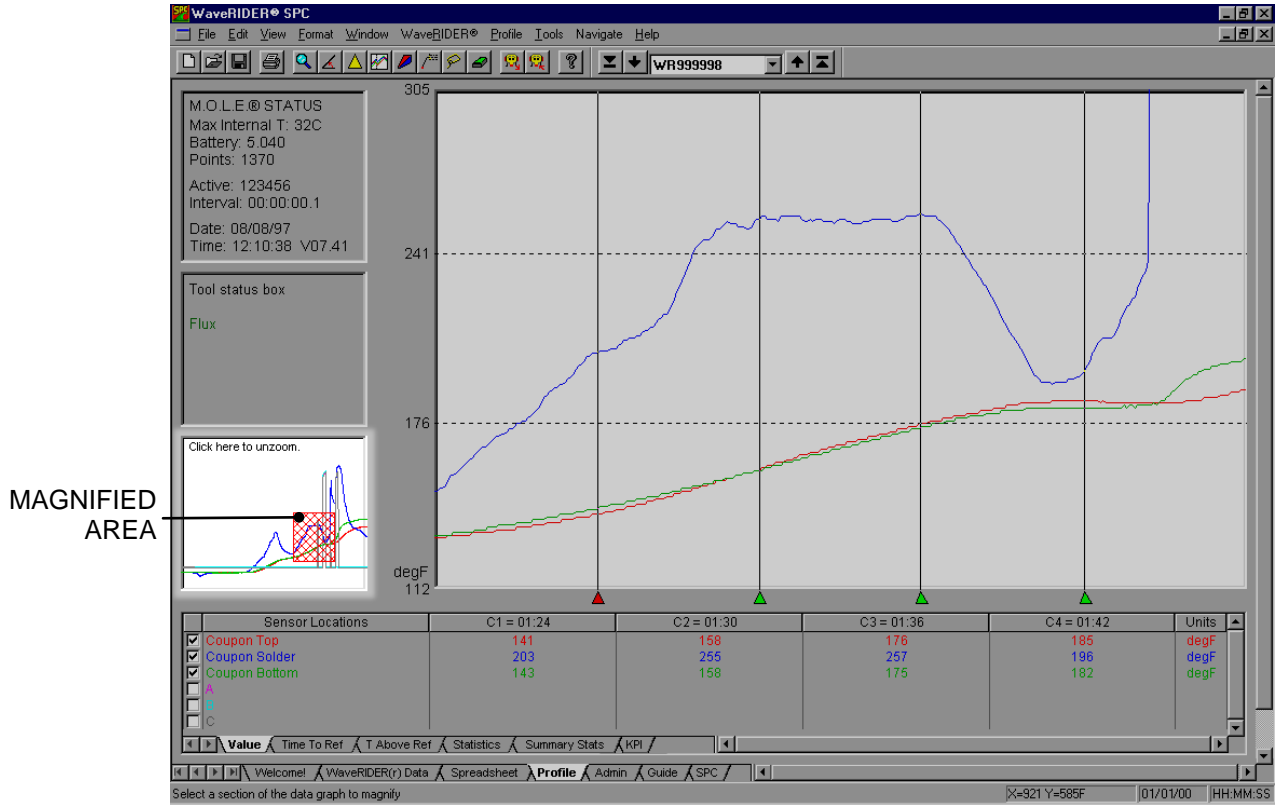
Figure 4- 21: Magnify Map

4.4.5 The Data Table

The Data Table includes various values depending on which Data Tab is selected. The rows always indicate the channel and the columns vary depending on which data tab is active.
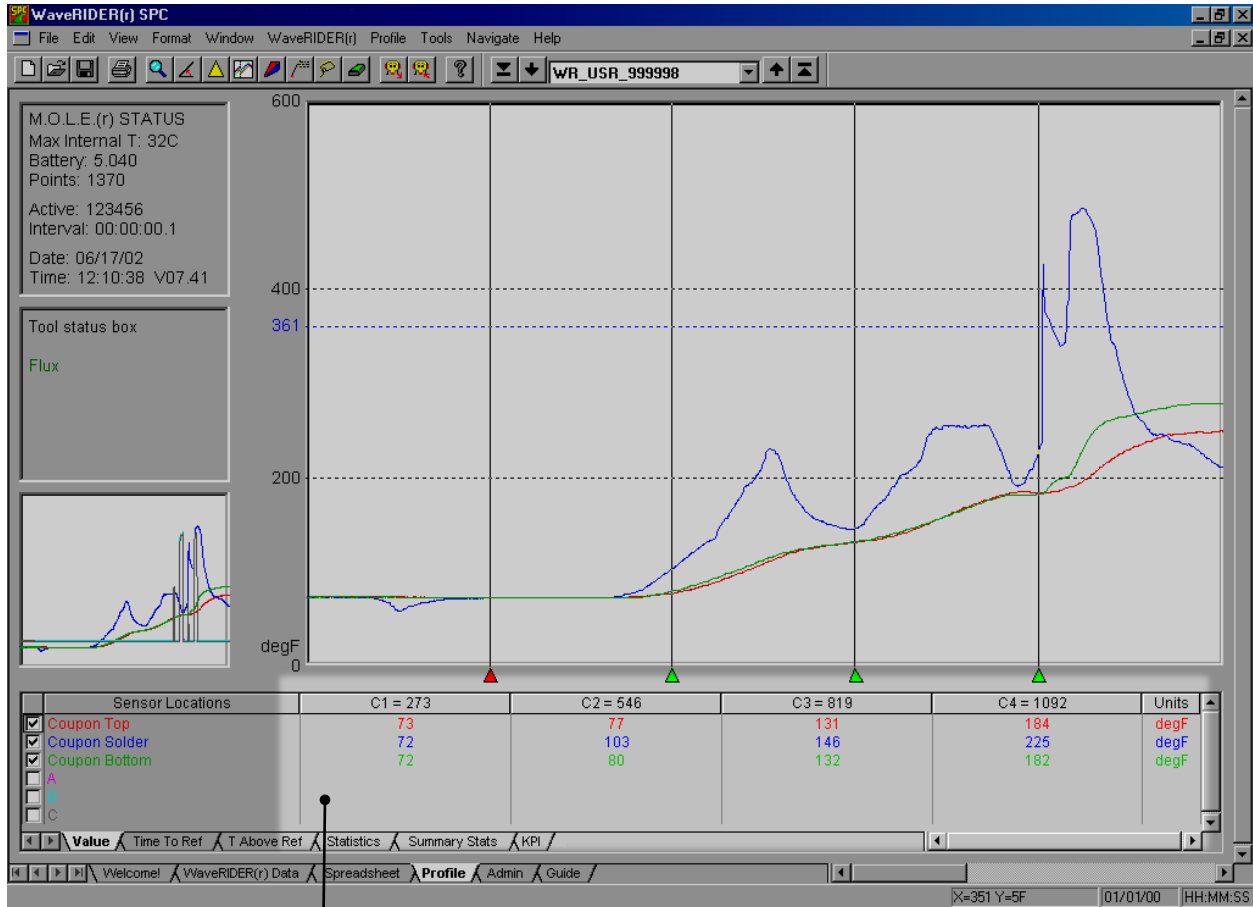
DATA TABLE

Figure 4- 22: Data Table

4.4.5.1 Value Pop-up

Each value in the Data Table can be displayed as a Value Pop-up. A Value Pop-up is graphically illustrated on the Data Graph showing how and where that value was extracted from the profile.

⚠	**Only one Value Pop-up can be displayed on the Data Graph at a time.**
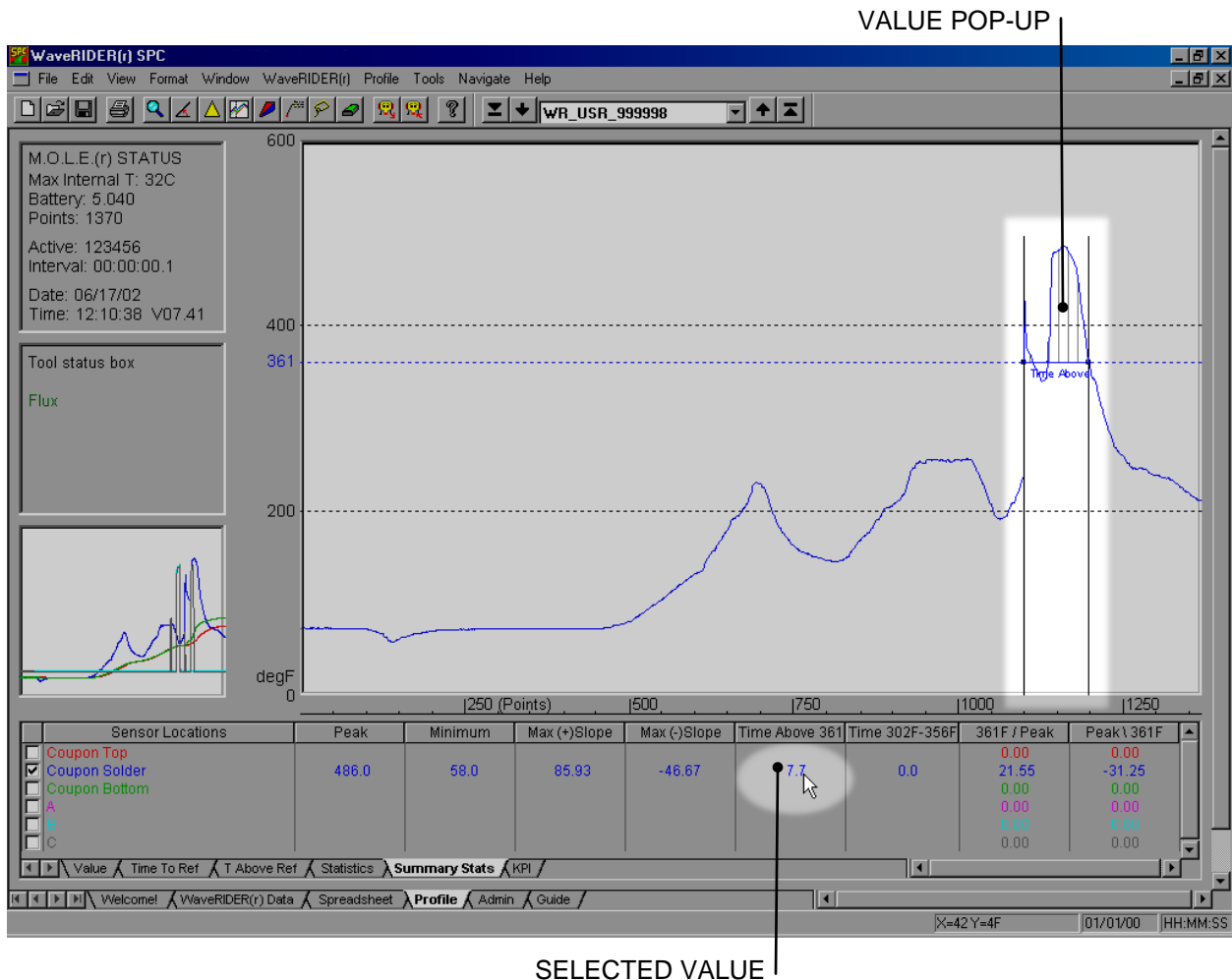
Figure 4- 23: Value Pop-up

To display a Value Pop-up:

1) Select the Profile worksheet.

2) Move the mouse cursor and pause over a desired value in the Data Table. That value will automatically be displayed on the Data Graph where that value was extracted.

⚠	**The last displayed Value Pop-up will remain on the Data Graph until the user selects a different worksheet.**

4.4.5.2 Show/Hide Columns

Data Table parameter columns on the Profile worksheet can be hidden. This is useful when an operator wants to focus attention to the most important parameter columns.
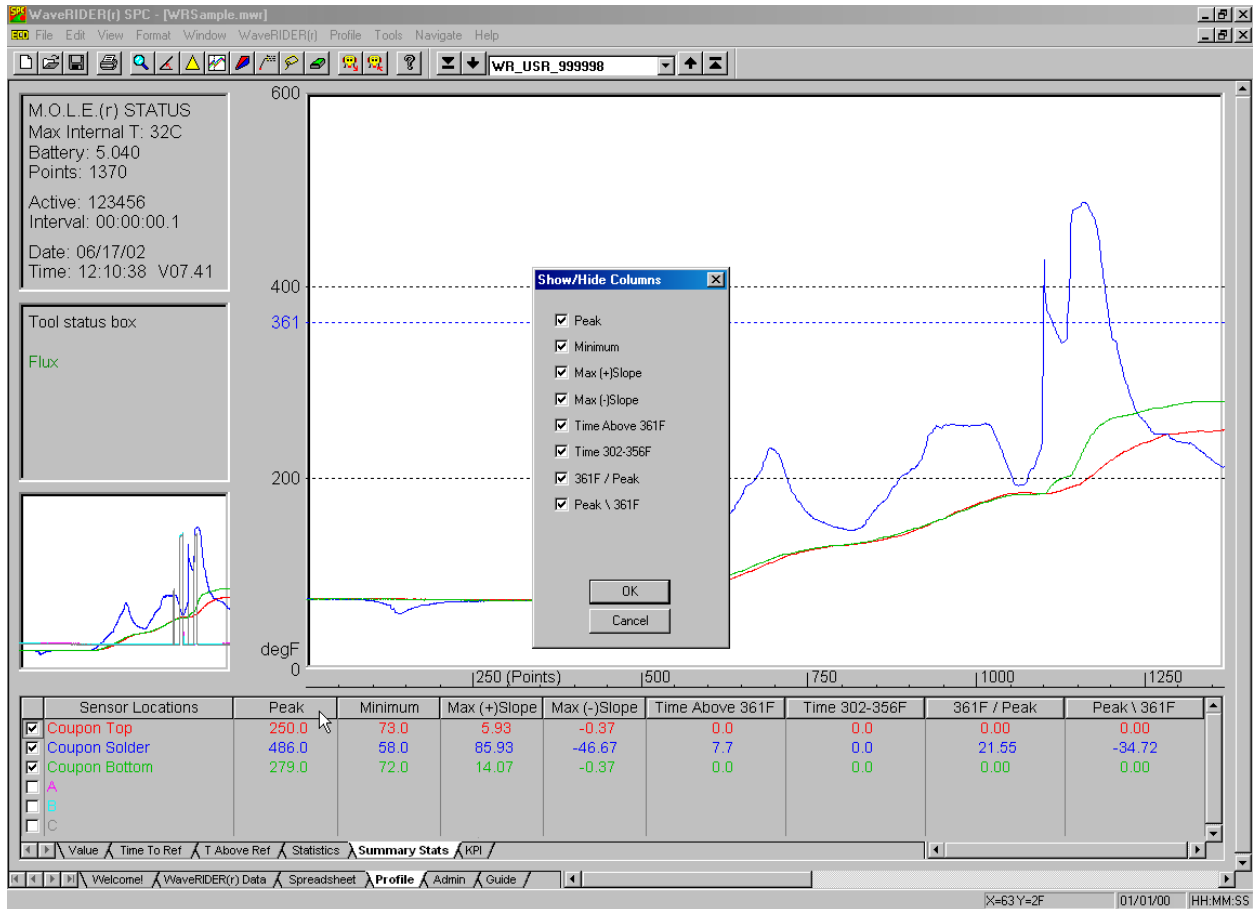
Figure 4- 24: Show/Hide Columns

To display Show/Hide columns:

1) Select the Profile worksheet.

2) Right click a parameter column header.

3) Clear a parameter check box to hide or select to display.

> **Hidden Parameter columns do not affect the data being collected for that parameter. If all Parameter columns are hidden, right-click the Sensor locations column header to open the Show/Hide column dialog box.**

4.3.5.3 Change Summary Stats Settings

When creating a new workbook, a dialog box appears allowing the user to specify Summary Statistics settings based on user selected values.

If the process changes or an operator wishes to perform test experiments, these settings can be changed by clicking a parameter column header on the Profile worksheet.
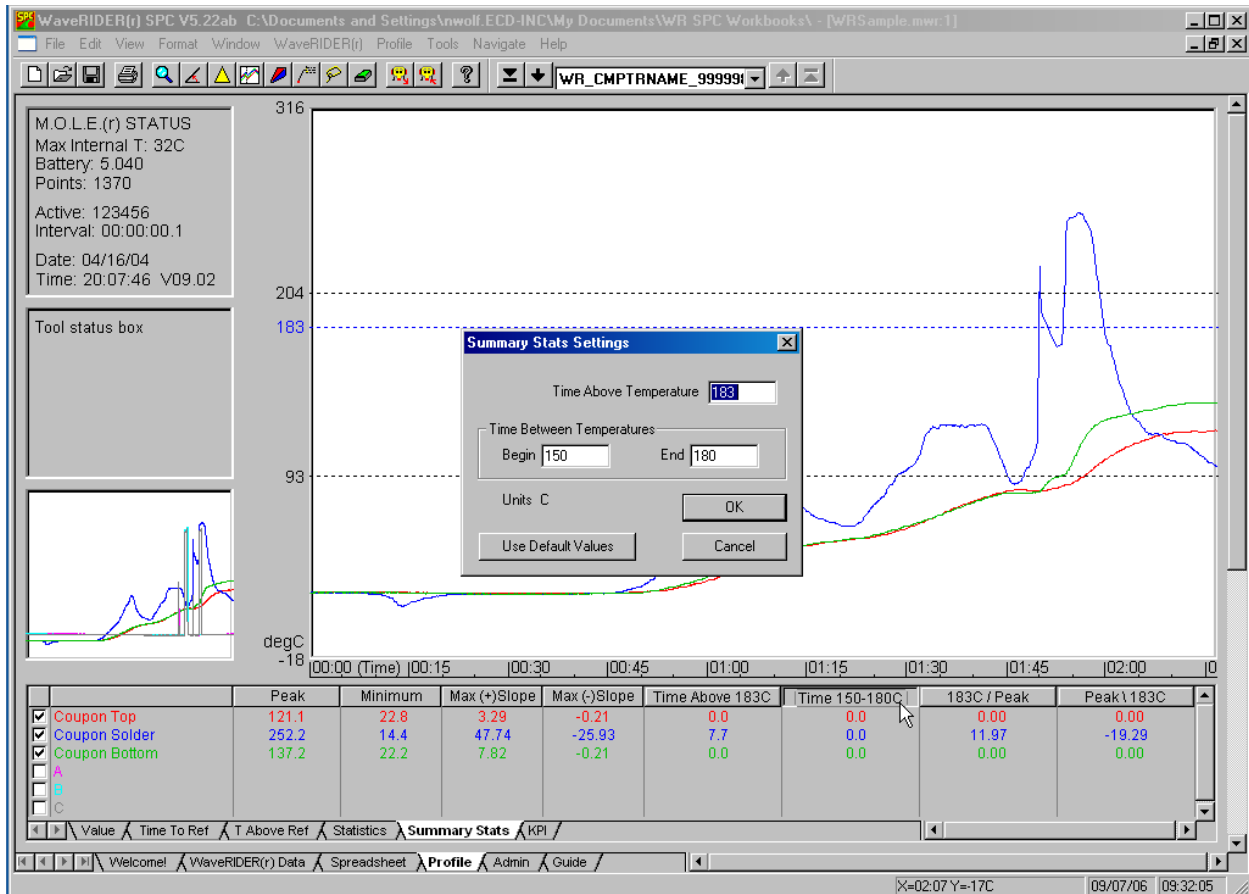
Figure 4-25: Modify Summary Stat Settings

To Change Summary Stats Settings:

1) Select the Profile worksheet.

2) Select the Summary Stats tab.

3) Click the Time Above or Time between column header.

4) Change the desired Summary Stats settings and select the *OK* command to accept.

5) Once the new settings have been accepted, the software prompts the user to decide if these new settings should be applied to future data run profiles.

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4.3.5.4 Change Slope Calculator

Positive and negative slope profile parameter calculator allows the user to calculate straight line slopes between any two temperatures. (Default to liquidous and liquidous to peak).

If the process changes or an operator wishes to perform test experiments, these settings can be changed by clicking a parameter column header on the Profile worksheet.
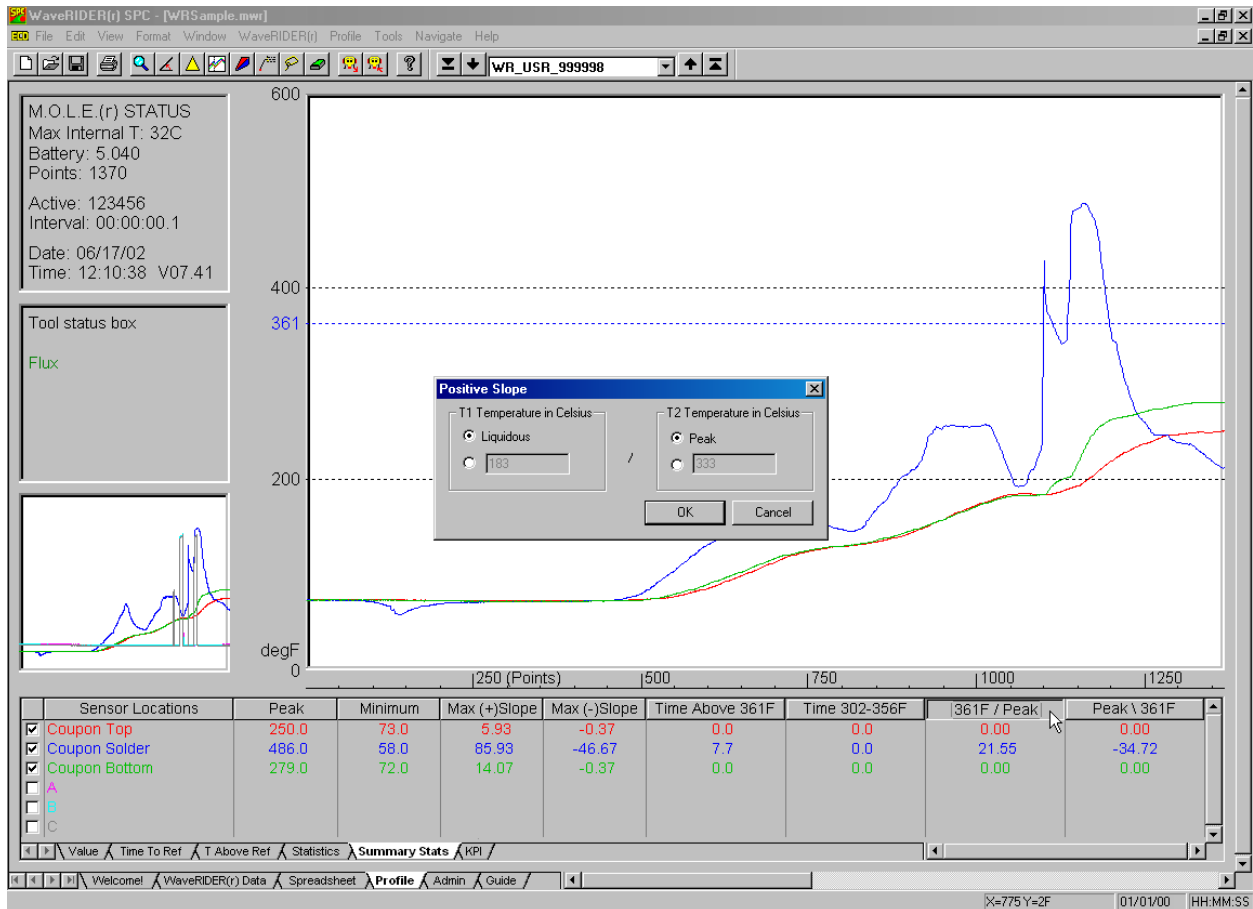
Figure 4- 26: Modify Summary Stat Settings

<u>To Change Slope Calculator:</u>

1) Select the Profile worksheet.

2) Select the Summary Stats tab.

3) Click a Peak Slope column header.

4) Change the desired settings and select the *OK* command to accept.

5) Once the new settings have been accepted, the software prompts the user to decide if these new settings should be applied to future data run profiles.

4.4.6 Sensor Locations

The location for each sensor labeled in the Data Table. The color and description indicates which Data Plot on the Data Graph it designates. The top three sensor location descriptions are the Coupon Top, Coupon Solder, and Coupon Bottom sensors. The bottom three are the A, B and C speed sensors.
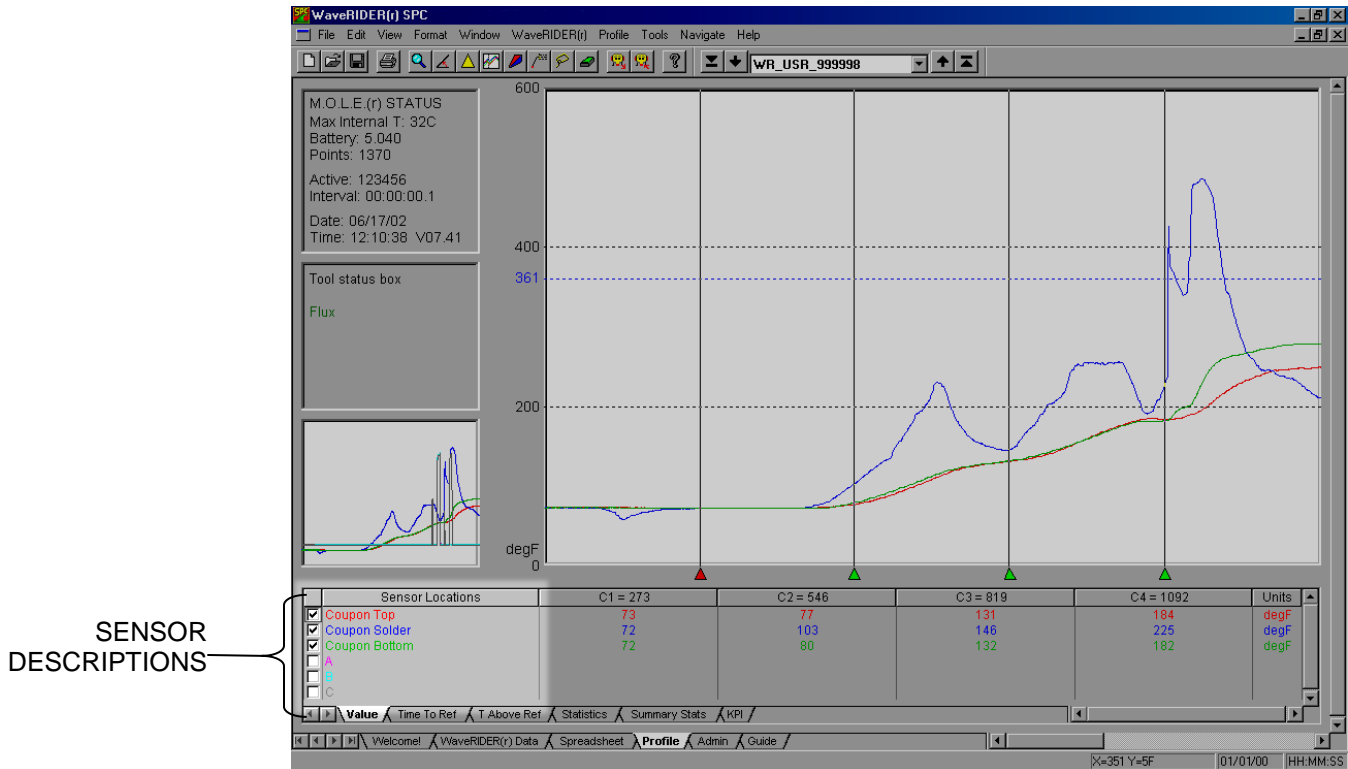
Figure 4- 27: Sensor Location Descriptions

4.4.7 Channel Check Boxes

The Channel check boxes control whether the associated Data Plot is displayed on the Data Graph and whether the data for that channel are included in the data table. To view or remove a Data Plot, click the channel check box beside a sensor location description to turn it "ON" or "OFF".
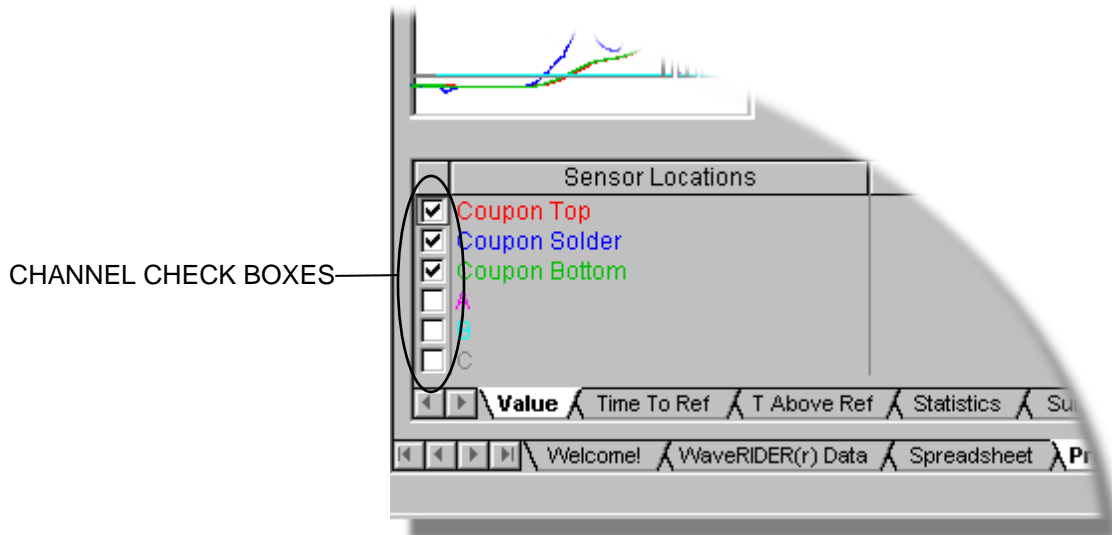
Figure 4- 28: Channel Check Boxes

4.4.8 Status Bar

The Status Bar shows the available Help information, X-Y position of the mouse pointer, current date and time.
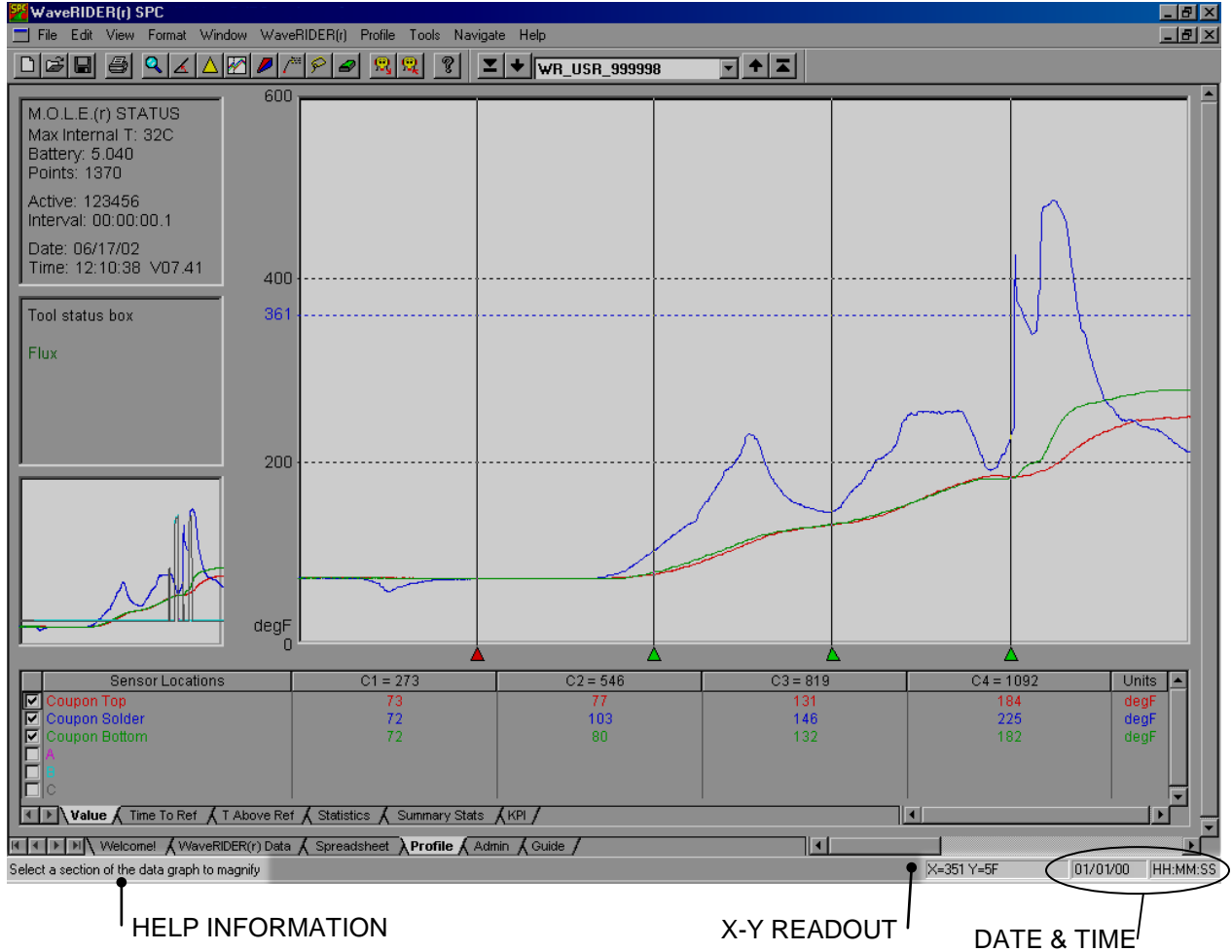
Figure 4- 29: Status Bar Features

- **Help Information**

When the mouse pointer is placed over a Toolbar button the left side of the Status bar will display the action that button performs.

- **X/Y Readout**

It is easy to find the exact X and Y-values of any point on the Data Graph using the mouse pointer. The X/Y Readout continuously displays the X and Y-axes values of the mouse pointer location.

The units displayed for X and Y-values are the same as those displayed on the graph. The user can select between °F and °C for the Y-value units. The X-value units can be a data point number, time, or distance. Units can be changed on the X and Y-axes at any time by selecting the *Units* command in the *Profile* menu.

While using the Magnify tool, the X/Y Readout displays the size of the selected area of interest.

Other ways to view exact X- and Y-coordinates of a data point is to select the Value Tab.

- **Date and Time**

This area of the Status bar displays the current time and date of the PC.

4.4.9 Data Tabs

Data Tabs is where the user can view a variety of sensor information in the Data Table.

The Data Tabs are:

- Value
- Time to Ref
- T above Ref
- Statistics
- Summary Statistics
- KPI (Key Process Indicators)

Only one data tab can be active at a time. Each is described below.

When the Magnify tool is used to zoom in on a portion of the Data Graph, the Data Table displays the statistics for those values that are displayed. (This feature does not apply to the Summary Stats Data Tab).

4.4.9.1 Value

When the *Value* Tab is selected, the Data Table lists the temperature at the point where an X-cursor intersects a Data Plot. There are four X-cursors and the positions can be changed at any time by moving the X-cursor (Refer to the descriptions in section *4.4.10.5 X-Cursors*). As an X-cursor is moved, the values in the Data Table are automatically updated.
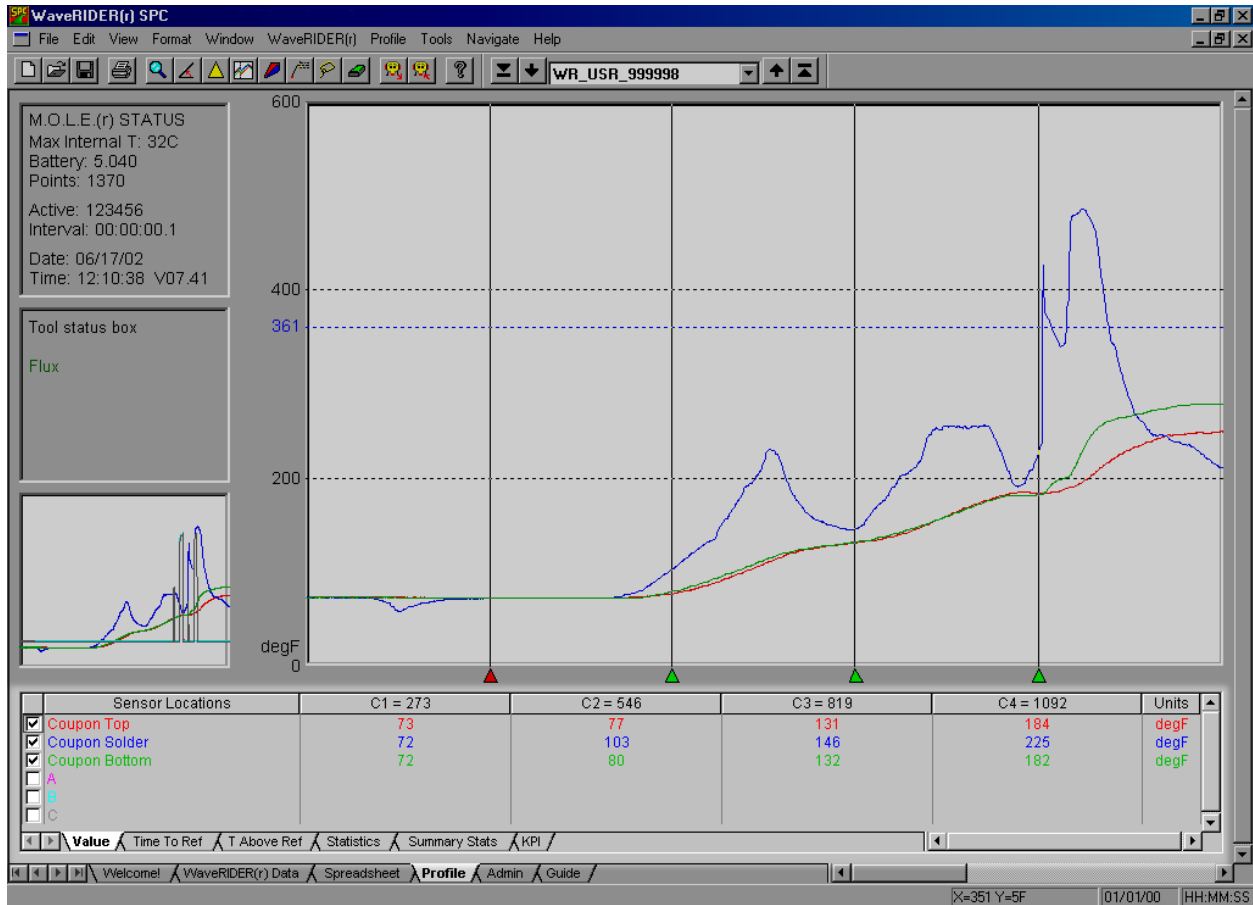
Figure 4- 30: Value Data Tab

Values in the Data Table depend on the units of the X and Y-axis.

4.4.9.2 Time to Reference

When the *Time to Reference* Tab is selected, the Data Table displays the time it takes the channels to reach fixed Temperature Reference Line(s). Times are expressed as HH:MM:SS (H=hours, M=minutes, S=seconds). Up to three Temperature Reference Lines can be added to the Data Graph that are used in this statistic by using the *Temp Ref Lines* command in the *Profile* menu.
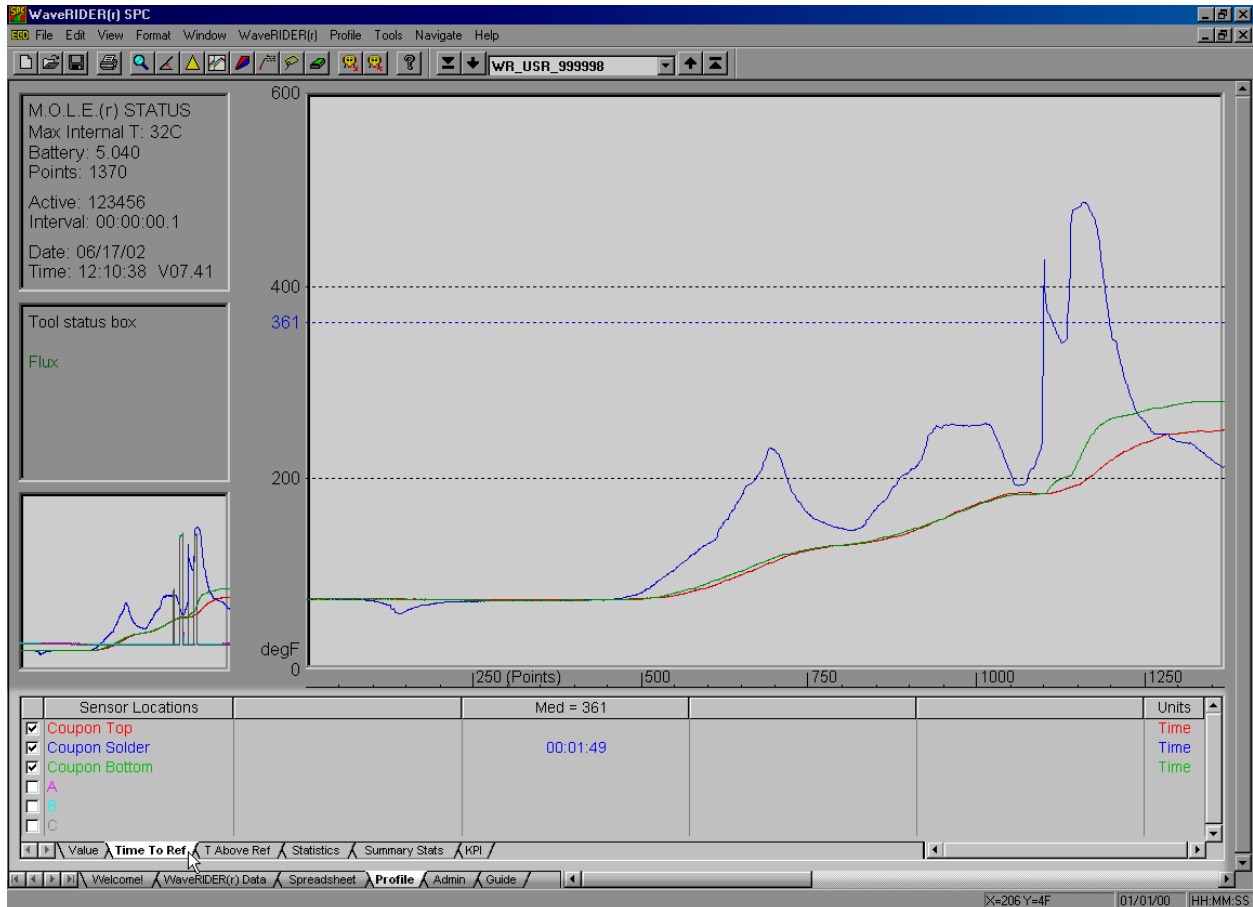
Figure 4- 31: Time to Ref Data Tab

4.4.9.3 T Above Ref

When the *T Above Ref* Tab is selected, the Data Table shows the amount of time each sensor measured data above the Temperature Reference Lines. Times are expressed as HH:MM:SS (H=hours, M=minutes, S=seconds) and are the total time above reference line regardless of when the value was above.
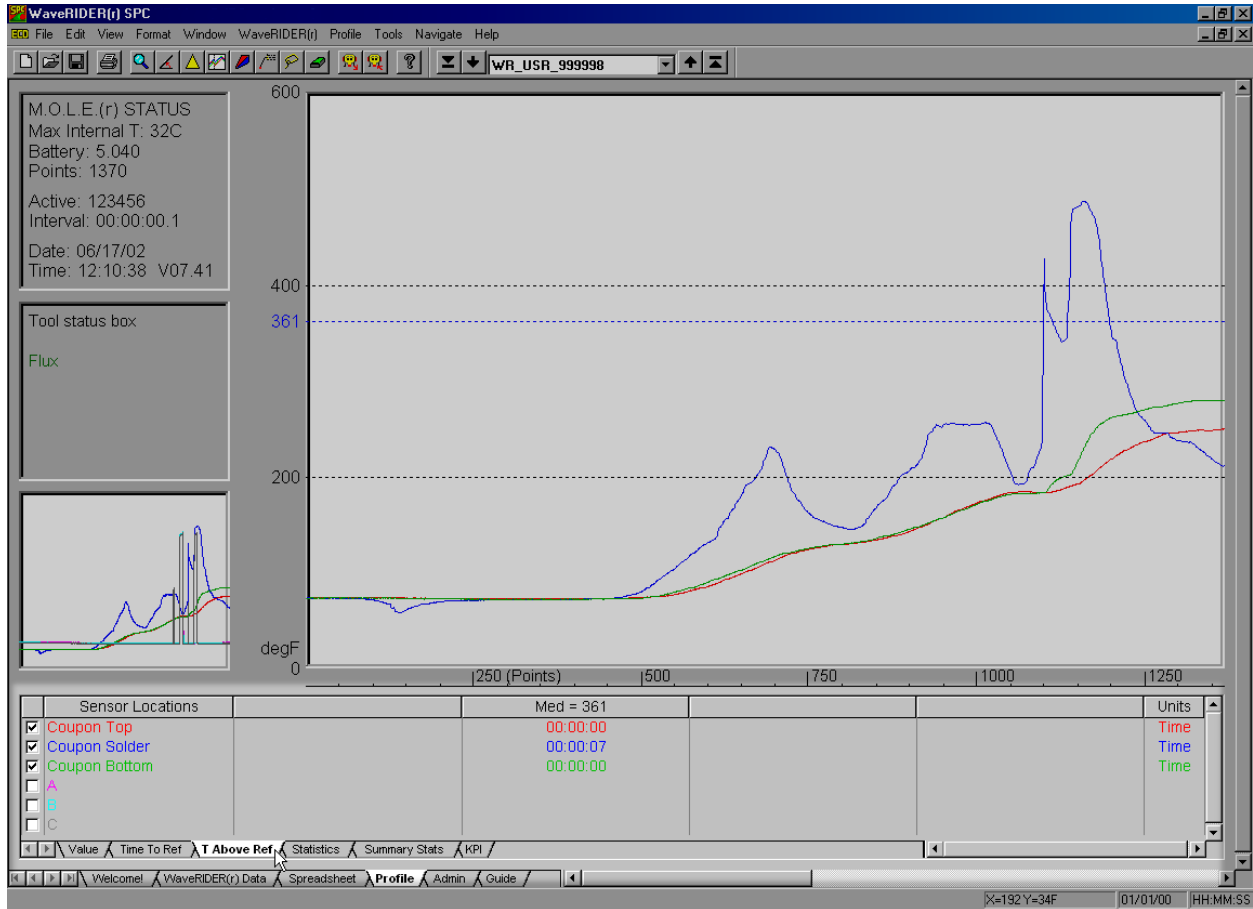
Figure 4- 32: T Above Ref Data Tab

| ⚠ | **Temperature Reference Lines can be added, deleted, or moved at any time using the *Temp Ref Lines* command in the *Profile* menu.** |

4.4.9.4 Statistics

When the *Statistics* Tab is selected, the first four columns of the Data Table displays the minimum and maximum temperature found for each Data Plot and the value of X (time, distance, or point number) at which it occurred.

The last two columns of the Data Table displays the Average (Mean) and Standard Deviation of the temperature values recorded for each sensor.

Figure 4- 33: Statistics Data Tab

| ⚠ | **If a portion of the Data Graph is magnified using the Magnify tool, the Data Table displays the Mean and Standard Deviation of the values currently displayed.** |

4.4.9.5 Summary Statistics

When the *Summary Stats* Tab is selected, the Data Table displays a summary of primary statistics from the entire data set. These summary statistics always display the statistics derived from the entire profile regardless of the level the Data Graph is zoomed.
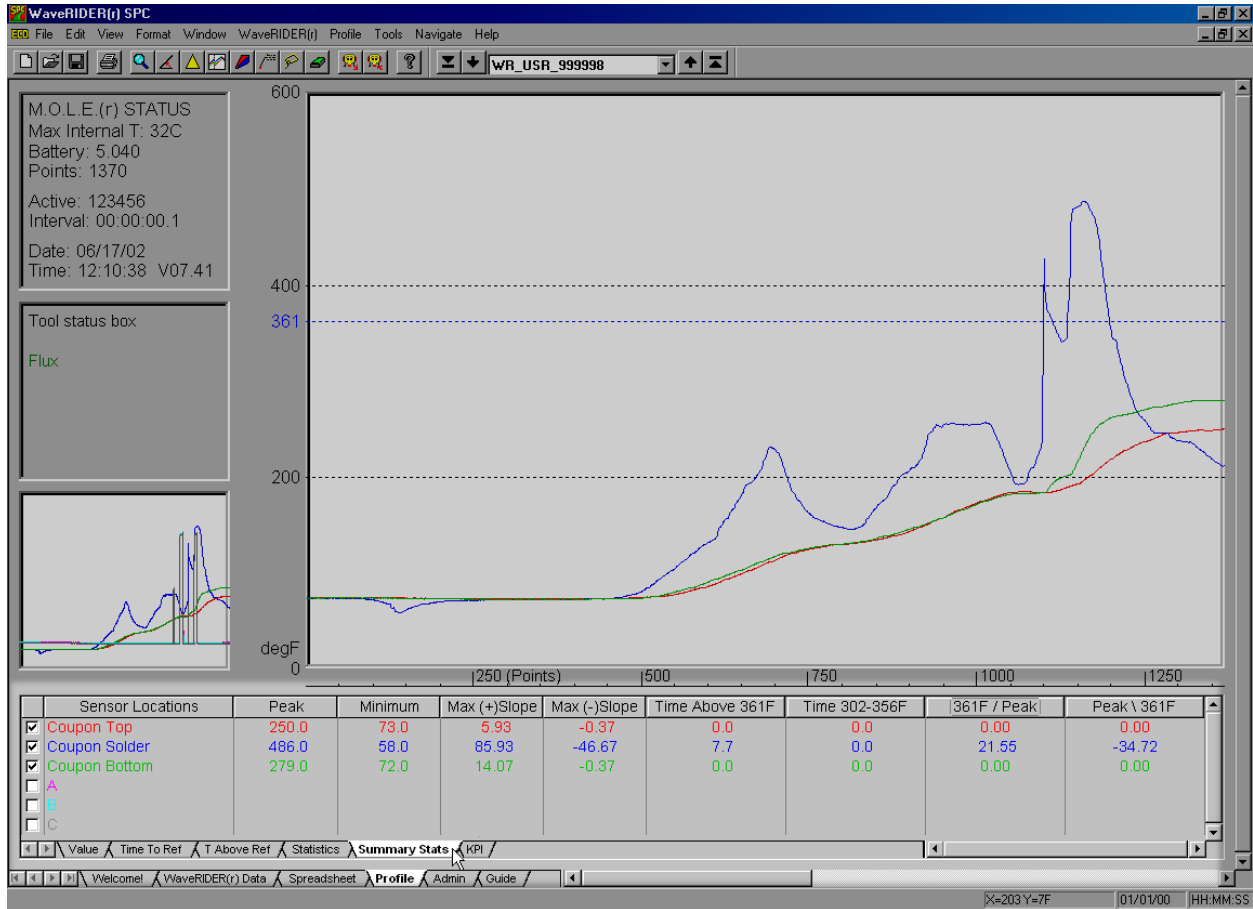
Figure 4- 34: Summary Statistics

4.4.9.6 KPI (Key Process Indicators)

When *KPI* is the active data tab, the Data Table displays statistics from the Profile configured by the user. This is useful so the user can display the most important information that best suits their needs or application.
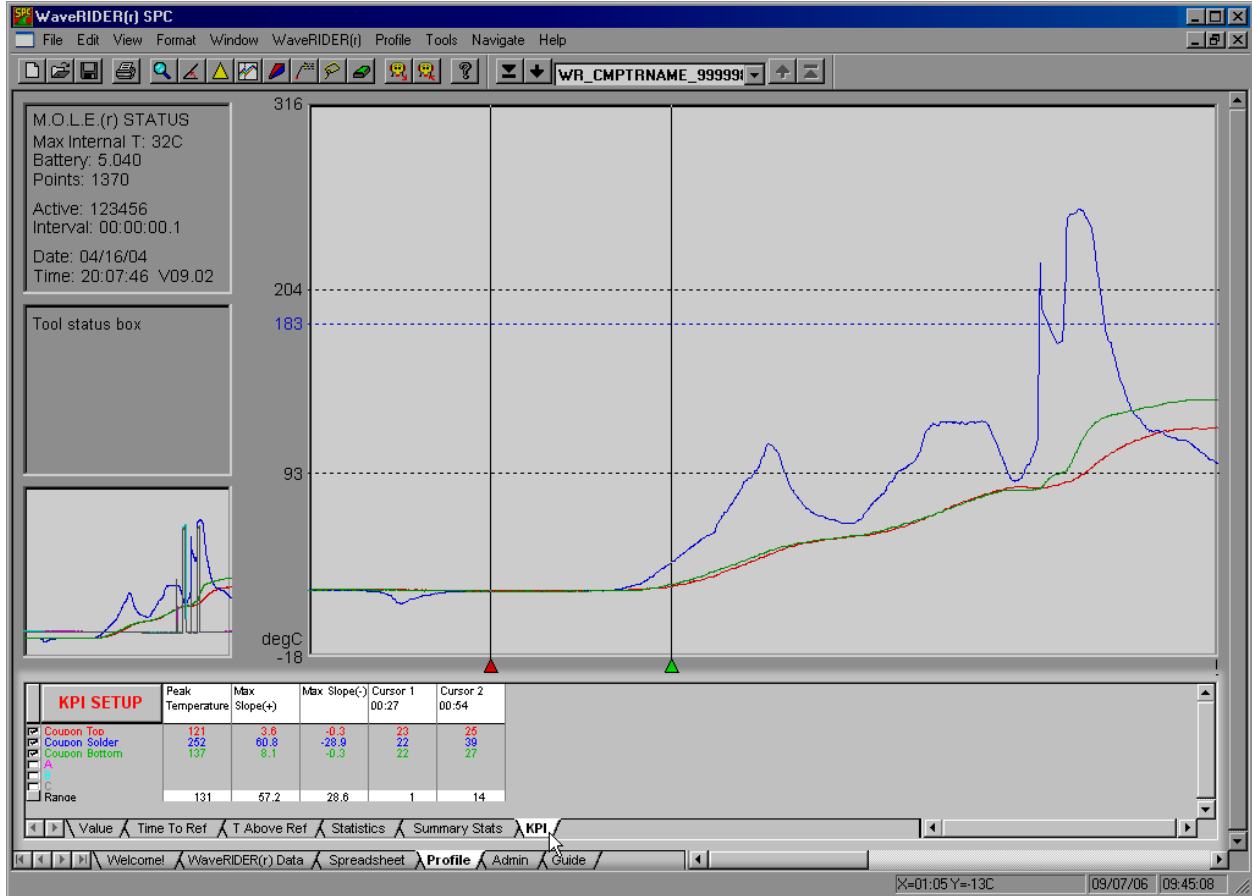
Figure 4- 35: KPI Data Tab

Key Process Indicators Setup:

1) Make sure the KPI Data Tab is active.

2) Click the KPI Setup button above the Sensor Locations descriptions.

> ⚠ **The KPI Setup can also be activated by right-clicking a column header.**
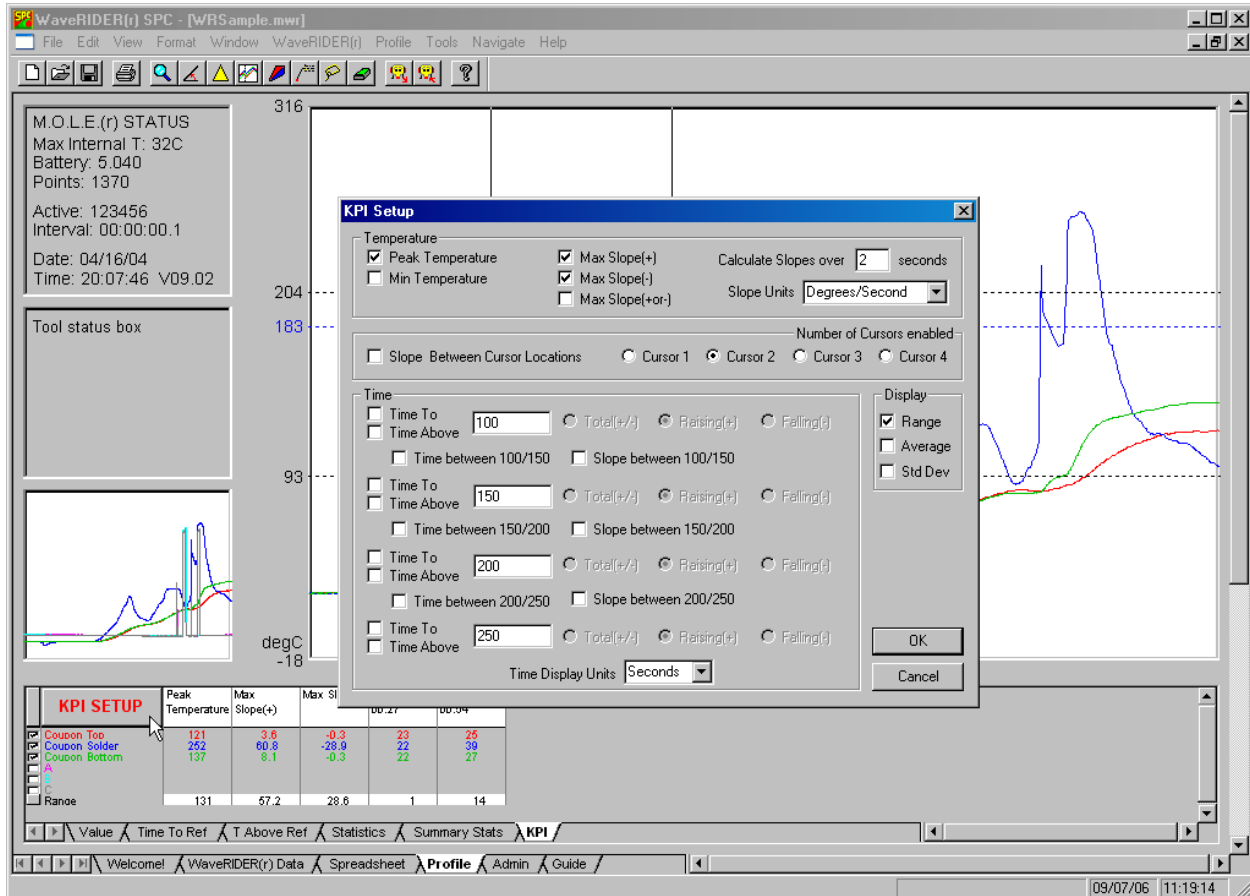
Figure 4- 36: KPI Setup

3) Click the desired parameters to display in the Data Table. The parameters are grouped by Temperature, Cursor data with slope between, and Time. The user can also select to display Range, Average and Standard Deviation rows for each of the columns.

4) When finished select the *OK* button to display the new settings or *Cancel* to return to the worksheet without making any changes.

> ⚠ **A maximum of 12-16 parameter columns can be displayed at one time. As columns populate the Data Table, they are automatically sized to fit. It is recommended that the most beneficial column information is displayed to achieve the best results.**

4.4.10 The Data Graph

The Data Graph is a display that shows the data collected from the data run overlaid on a graph. The user can analyze and highlight various process features with the tools listed below.

- X and Y-Axes and Labels

- Autoscaling

- Data Plots

- Process Origin

- X-Cursors

- X-axis Units

- Temperature Reference Lines

The Data Graph features are described in the sections that follow. Some of these features described are also controlled using the appropriate menu options. Refer to section *5.0 Menu and Tool Commands* for more information.

4.4.10.1 X and Y-Axes and Labels

The Y-axis (vertical) displays the scale of the measured temperature. Lower values are at the bottom and higher values at the top.

The Y-axis includes temperature labels on the left side of the graph. These four temperatures divide the vertical axis into four equal parts and are automatically scaled to fit the current Y-axis limits. These units can be displayed in Celsius or Fahrenheit using the *Units* command in the *Preferences* sub-menu on the Admin worksheet.

The X-axis (horizontal) displays values data points collected. The X-axis can be converted from data points to time or distance using the *X-Axis Units* command in the *Profile* menu.

To see the X-value of any location on the Data Graph, the software provides two different methods:

- The X/Y Readout in the Status bar continuously displays both X and Y-values at the location of the mouse pointer. Details of this feature are described in section *4.4.8 Status Bar*.

- The X-value at the position of each X-Cursor is displayed in the Data Table when the Value statistic is active.

4.4.10.2 Autoscaling

The software includes a powerful *Autoscaling* option to automatically scale the Data Graph so the data will always be visible and easy to work with. The software will automatically select a range of values for both the X and Y-axes to ensure that all the data fits on the screen. The user can change the range of Y-values displayed in *Manual* mode by entering a manual mode using the *Scaling* command in the *Profile* menu.

> **Another way to scale the graph's X and Y-axes is to use the Magnify tool described in section *5.8.1 Magnify Tool*.**

4.4.10.3 Data Plots

The Data Plots in the Data Graph represent the data for each of the WaveRIDER sensors. Each sensor is represented by a different color that corresponds to the color of its sensor location description in the Data Table.
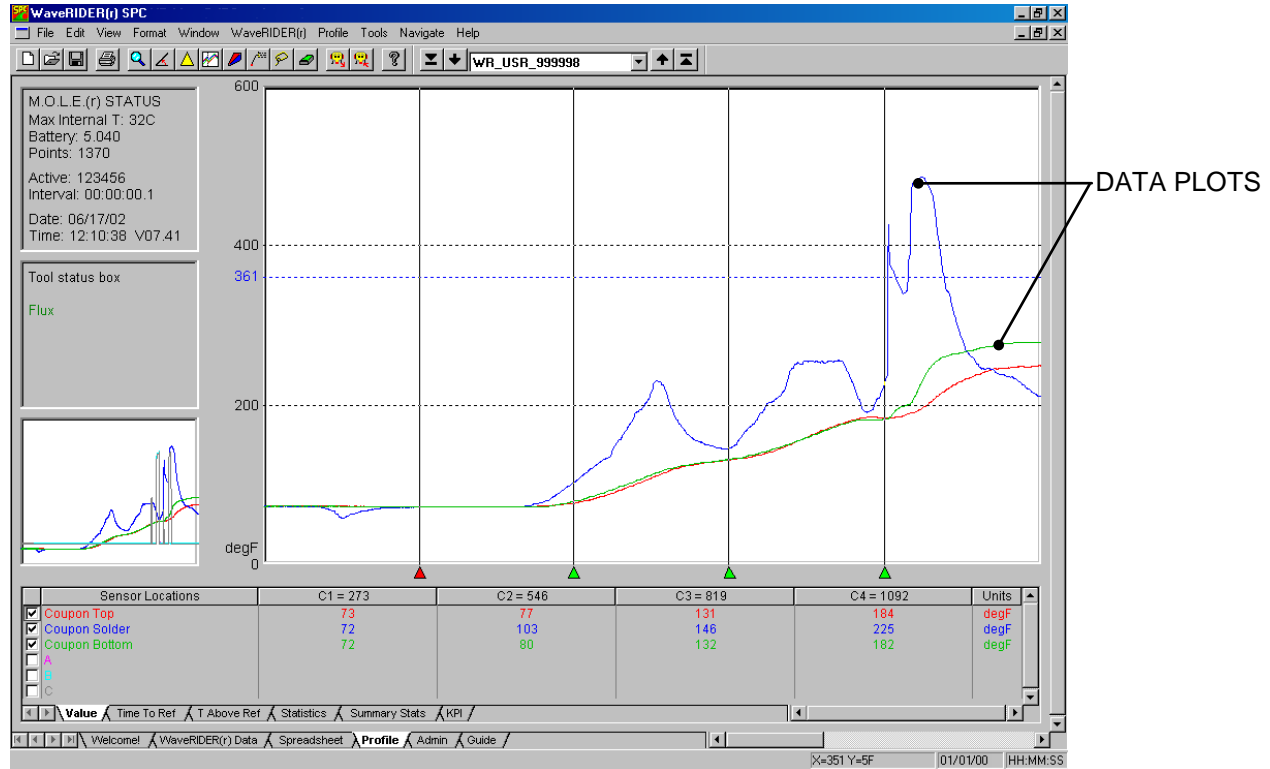
Figure 4- 37: Data Plots

A Data Plot in the Data Graph can be suppressed or restored at any time by clicking the check box with the corresponding sensor description in the Data Table. This allows the user to view any combination of the Data Plots or individually.

> **When two or more Data Plots overlap the same values, the Data Plots overwrite each other. For example, if the Data Plot that represents the Coupon Top sensor and Coupon Bottom have the same value, the Coupon Top Data Plot will only appear unless the user suppresses it.**

When printing a Data Graph in black and white, suppressing one or more Data Plots is useful for clearing a view of a Data Plot that is obscured by others near it.

> **When printing the Data Graph in black and white, the Notes tool can be used to help identify each Data Plot.**

4.4.10.4 Process Origin

The Process Origin is a gray vertical line at the left edge of the Data Graph to indicate where the process starts. The Process Origin is automatically set by the software when the data is uploaded from the M.O.L.E.. When Points or Distance units are being used for the X-values, the X-values to the left of the Process Origin are displayed as negative and those to the right as positive.
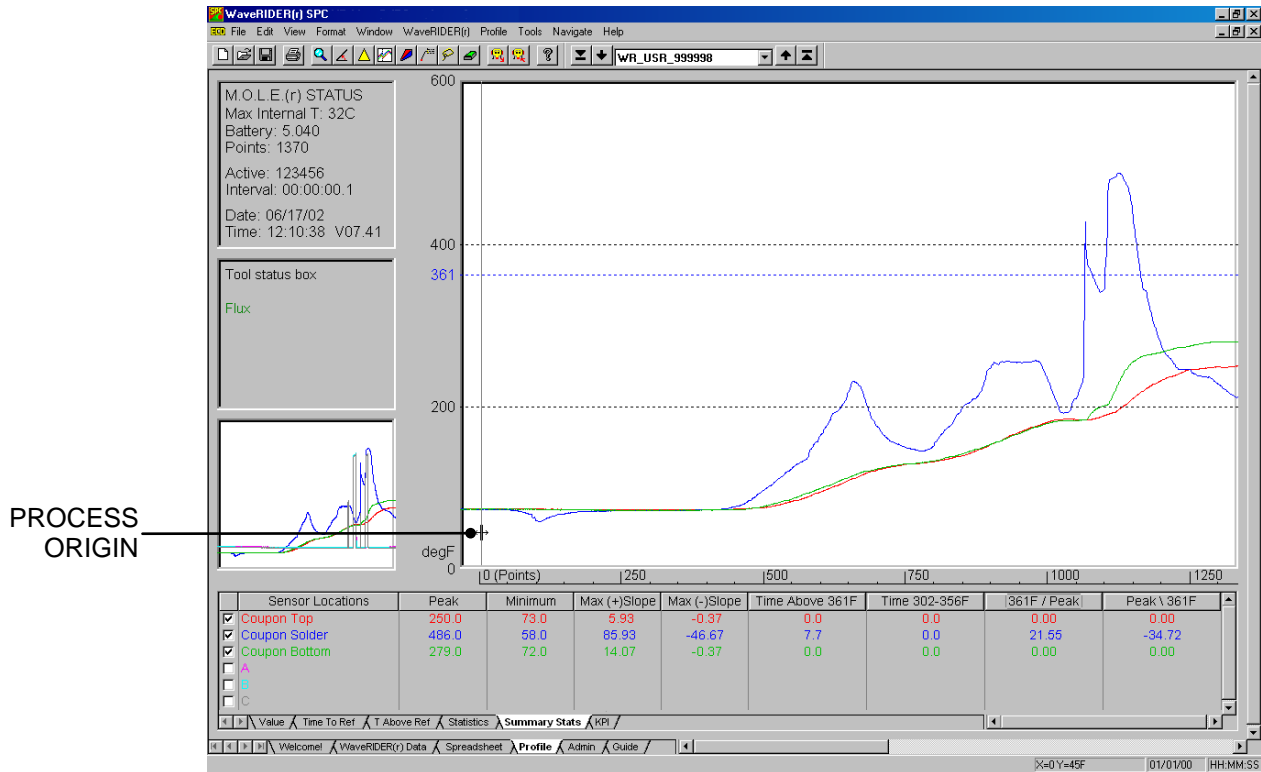
Figure 4- 38: Process Origin

To move the Process Origin:

1) Select the Process Origin line by positioning the mouse pointer anywhere on the line.

2) Press and hold the left mouse button.

3) Move the line by dragging it left or right.

4) Release the mouse button when the Process Origin is at the desired location.

The X/Y Readout in the Status Bar indicates the true position of the Process Origin while it is being moving. After the mouse button is released, the X-Readout changes to zero at the Process Origin and displays negative numbers for X when the mouse pointer is moved to the left of the Process Origin.

X-Cursor values are automatically adjusted when the Process Origin is moved.

4.4.10.5 X-Cursors

The Data Graph has four X-cursors that indicate the temperature values at the intersection of a Data Plot with each X-cursor. When the *Value* Data Tab is selected, these values are displayed in the Data Table in four data columns labeled *C1, C2, C3,* and *C4*, representing X-cursor 1 through X-cursor 4 respectively.
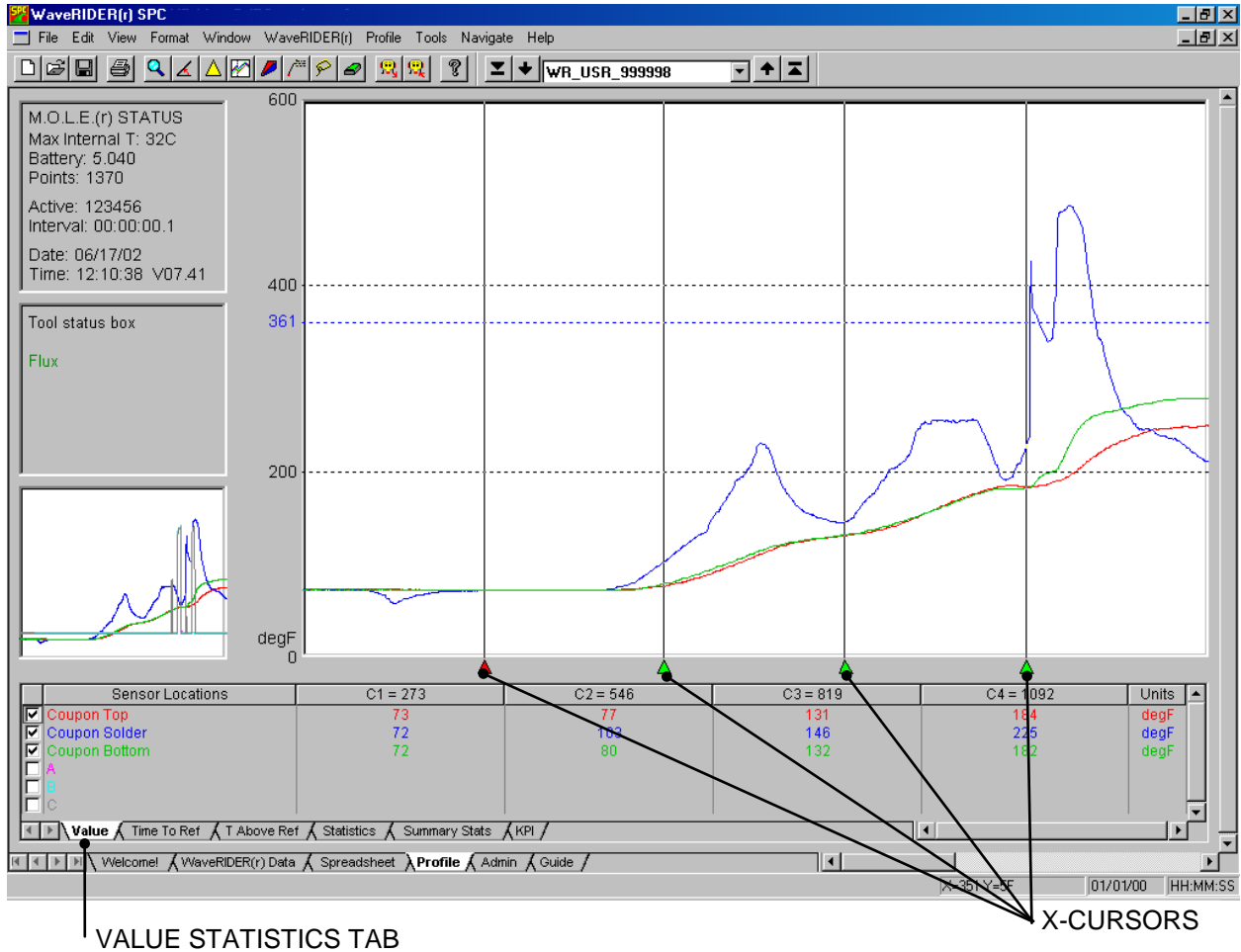
Figure 4- 39: X-Cursors

To move an X-cursor:

1) Select the *Value* Data Tab.

2) Position the mouse pointer over the X-cursor grip (the small triangle below a X-cursor) then press and hold the left mouse button and drag it left or right releasing the mouse button when the X-cursor is at the desired location.

- The user can also press the **[*tab*]** key to toggle select an X-cursor. When the desired X-cursor is selected, the small triangle will turn red. Then pressing either the left or right arrow keys will step the X-cursors. Each step is one pixel or one degree which ever is larger. This feature achieves cursor positions that are more precise.

Moving the selected cursor can be pushed into other cursors causing them to move them ahead of it.

The position of an X-cursor controls the values displayed in the Data Table. When an X-cursor is moved, values in the Data Table are automatically updated.

The Data Table includes a row for each of the sensors on the WaveRIDER. The numbers in the four columns indicate the Y-values at the intersection of a Data Plot with an X-cursor. (Refer to section *4.4.9 Data Tabs*)

When an X-cursor is dragged to a new position, it automatically snaps to the closest real X-value. Notice on highly magnified graphs that the cursor jumps from point to point. In an extreme case, if the graph is so highly magnified that there are no real X-values to move to, the X-cursors cannot be moved at all.

The Process Origin is the initial point from which all X-axis position data is calculated. After releasing the Process Origin at the appropriate point on the graph, X-cursor values are recalculated and displayed.

4.4.10.6 X-axis Units

The user can select three different types of X scales for the X-axis. The scales are Point, Time (time measure from process origin), and Distance. To change, select the *X-axis Units* command in the *Profile* menu.

⚠️ **The scale is displayed only when a data tab other than *Value* is selected.**
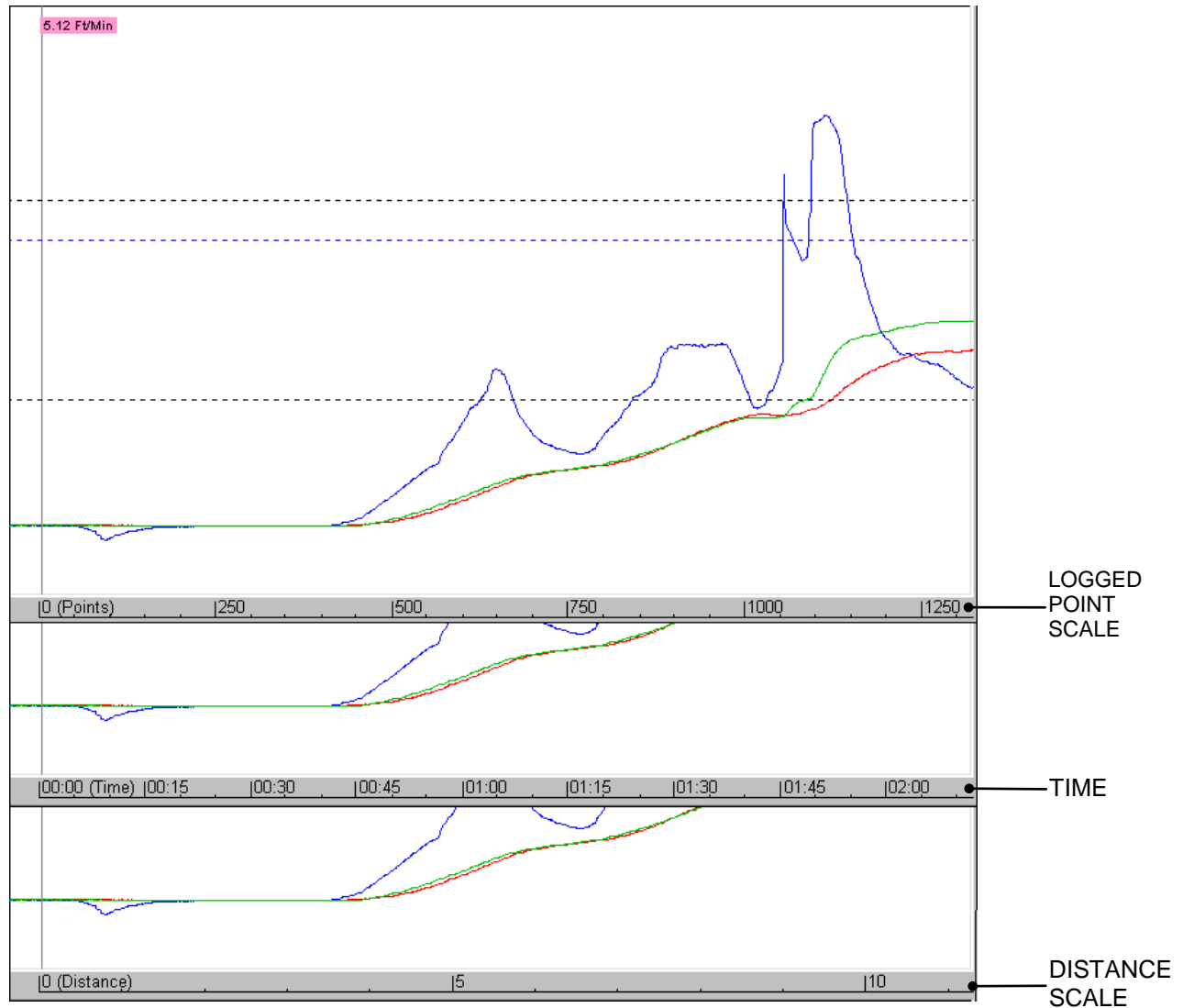
Figure 4- 40: Scale Types

4.4.10.7 Temperature Reference Lines

Temperature Reference Lines are colored horizontal lines that are positioned within the range of Y-values in the graph. Up to three Temperature reference lines can be added to the Data Graph using the *Temp Ref Lines* command in the *Profile* menu.
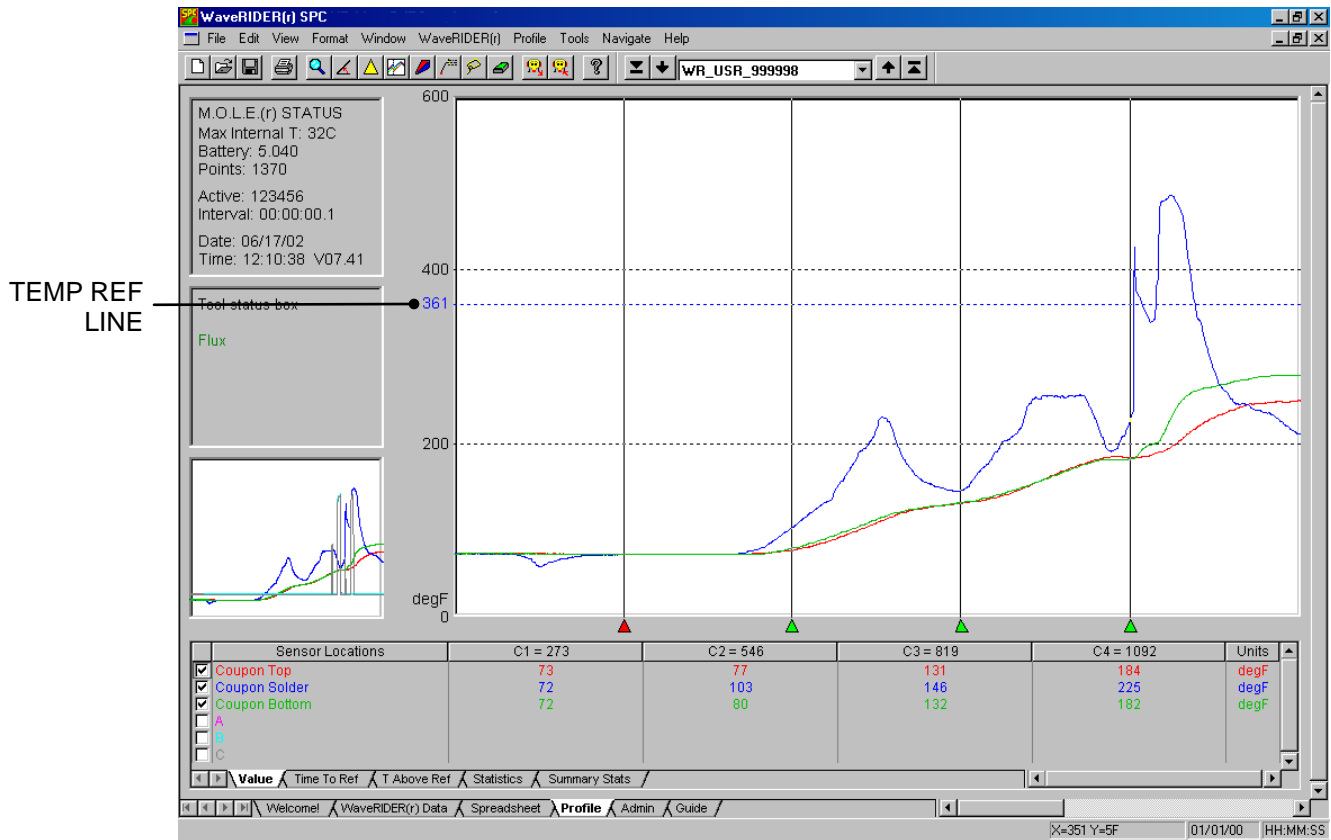
Figure 4- 41: Temp Ref Lines

Temperature Reference Lines are used in analysis when the *T Above Ref* (Time above the Reference Line) statistic is active. (*T Above Ref* statistic is described in section *4.4.9.3 T Above Ref*).

4.5 Administration Worksheet

The Administration worksheet is where all of the WaveRIDER parameters are controlled. The parameters collected by the M.O.L.E. are in the Spreadsheet parameter column located on the left side of the worksheet. Each parameter has a check box for viewing (or not) on the Spreadsheet worksheet. The right side of the Admin worksheet contains SPC sheet setup boxes, for defining the SPC charts. There is also an option to specify LSL (Lower Specification Limits), USL (Upper Specification Limits), LCL (Lower Control Limits), and UCL (Upper Control Limits) in the cells located to the right of each parameter.

Admin Worksheet features:

- Menus and Toolbar buttons
- Spreadsheet Parameters
- Parameter check boxes

- Spec and Control Limit Cells
- SPC Sub-Group Size
- SPC Sheet Parameter Boxes

Figure 4- 42: Administration Worksheet

4.5.1 Administration Menus and Toolbar Buttons

- **Menus:** File, Edit, View, Format, Window, WaveRIDER, and Help.

- **Toolbar buttons:** New, Open, Save, Print, Undo, Redo, Zoom In, Zoom Out, 100%, Align left, Center, Align right, Bold, Italic, Underline, Read WaveRIDER Data, Dock Printout Settings, and About.
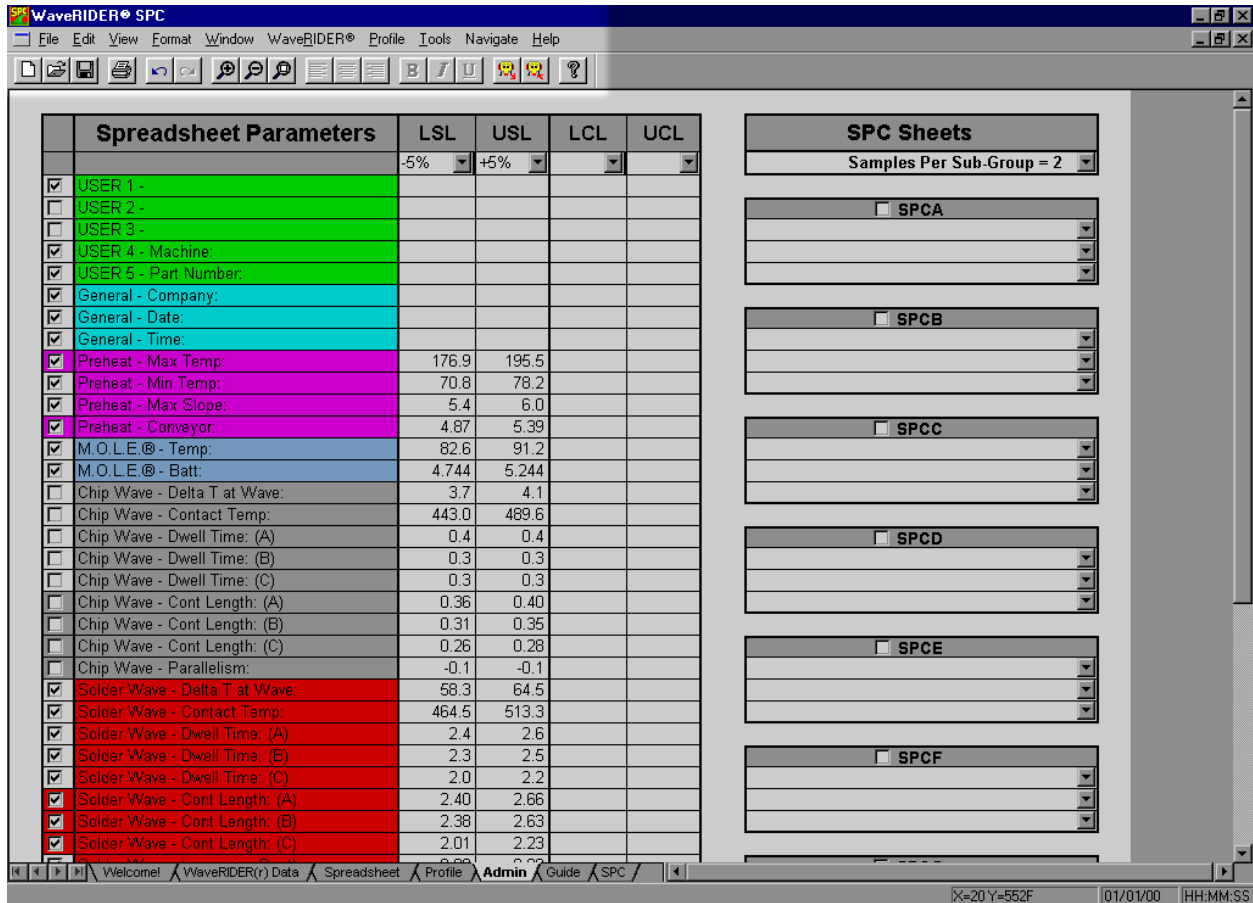
Figure 4- 43: Admin Worksheet Menu Bar and Tool Buttons

4.5.2 Spreadsheet Parameters

The Spreadsheet Parameters are arranged in a column that contains all of the parameters that the WaveRIDER collects during a data run. The parameters are arranged by colors as described in section *4.3.2 Parameter Groups*. Each cell has the Group Parameter listed first and the Label Parameter listed second.

Figure 4- 44: Spreadsheet Parameters Defined

4.5.3 Parameter check boxes

The Admin worksheet has a corresponding check box located on the left of each Spreadsheet parameter. To display a parameter on the Spreadsheet worksheet, click the corresponding check box. Similarly if you do not want to view the parameter, remove the check mark by clicking the check box. When a parameter check box is colored, this indicates these parameters are typically more significant and are helpful to analyze.

4.5.4 Specification and Control Limit Cells

There are cells to the right of each parameter for specifying an LSL (lower specification limit) and an USL (upper specification limit) for each parameter. The user can also specify an LCL (upper control limit) and UCL (upper control limit) to be applied to a SPC chart.

• LSL and USL Cells

These limits notify the user if the parameter is above or below the LSL or USL during a data run. When a parameter is below the user specified LSL, it appears on the WaveRIDER Data worksheet in **blue** and will be underlined. When a parameter is above the user specified USL it appears on the WaveRIDER Data worksheet in **red** and will be underlined.
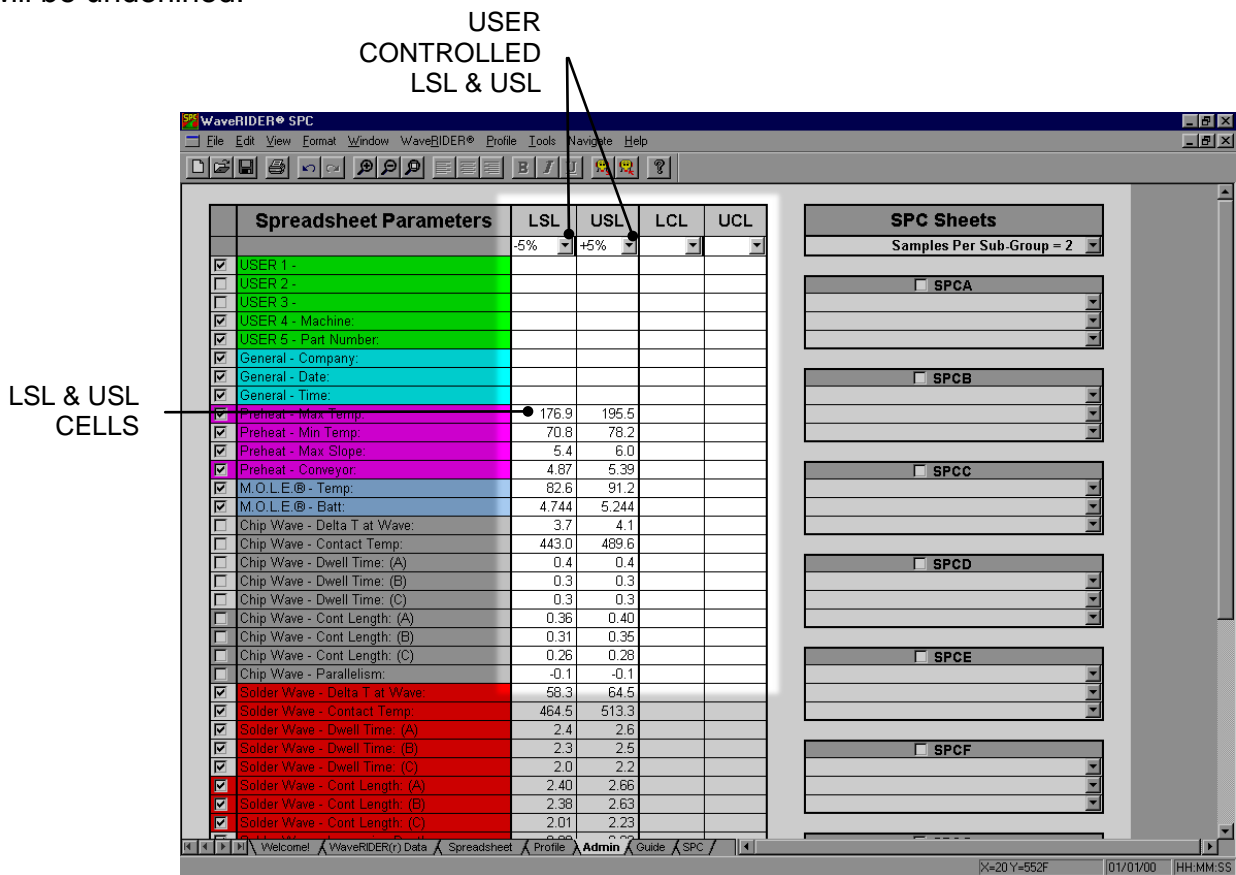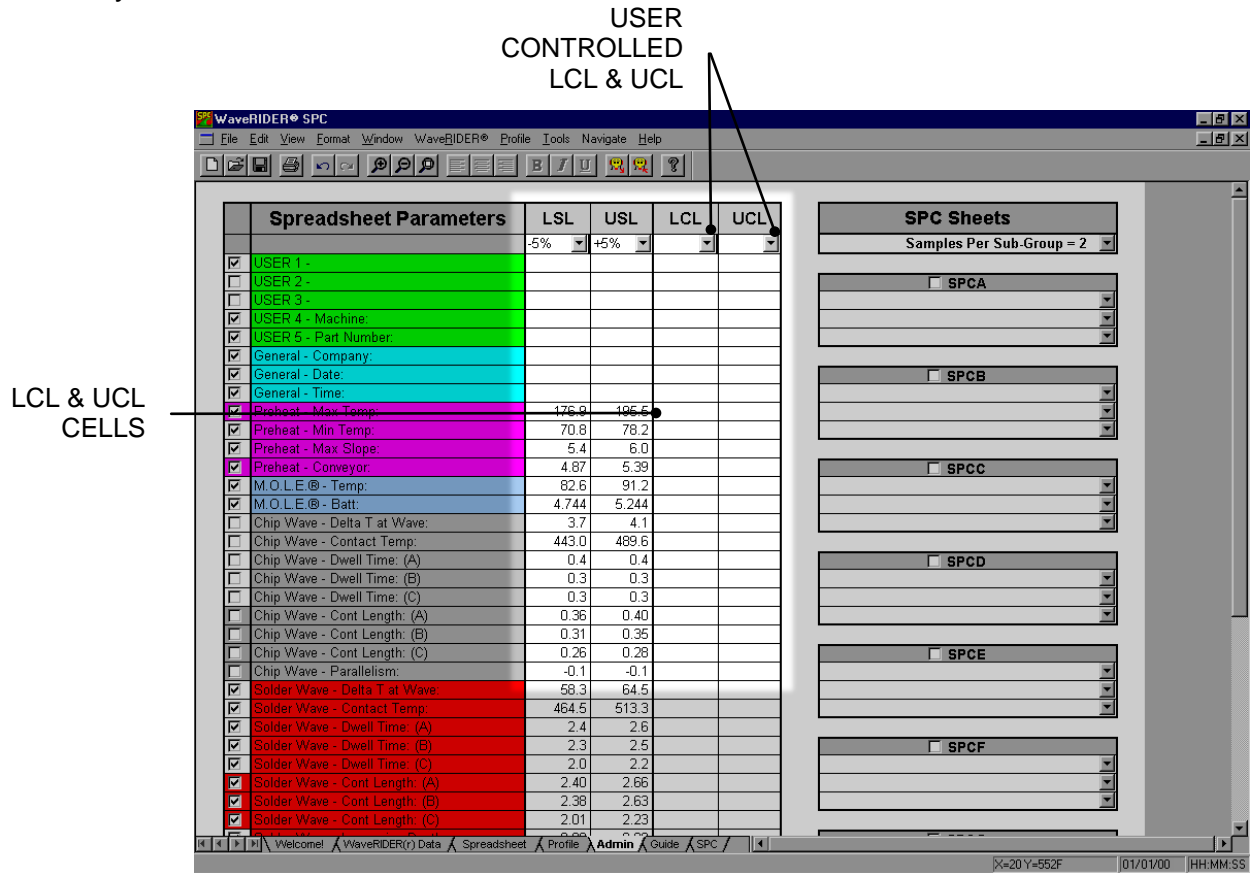

Figure 4- 45: User Specified Specification Limits

● User Controlled LSL and USL

The user can automatically set a LSL and USL for each parameter by using a drop down list box that contains options to set the LSL to -3, -2, -1, standard deviation or –10% and –5%. The USL can be set to +3, +2, +1 standard deviation or +10% and +5%.

Figure 4- 46: User Controlled LSL and USL

The values calculated are taken from the current data viewed on the Spreadsheet worksheet.

• LCL and UCL Cells

Lower and Upper control limits are automatically calculated from the Spreadsheet parameter data and displayed on the SPC control charts when an SPC worksheet is created. The LCL and UCL cells allow the user to override the calculated limits and manually set them.

Figure 4- 47: User Specified Control Limits

● User Controlled LCL and UCL

The user can automatically set a LCL and UCL for each parameter by using a drop down list box that contains options to set the LCL to -3, -2, -1, standard deviation or – 10% and –5%. The UCL can be set to +3, +2, +1 standard deviation or +10% and +5%.

Figure 4- 48: User Controlled LCL and UCL

The values calculated are taken from the current data viewed on the Spreadsheet worksheet.

4.5.5 SPC Sheet Boxes

The right side of the Admin worksheet contains nine SPC sheet boxes. These boxes are used to create the SPC worksheets.
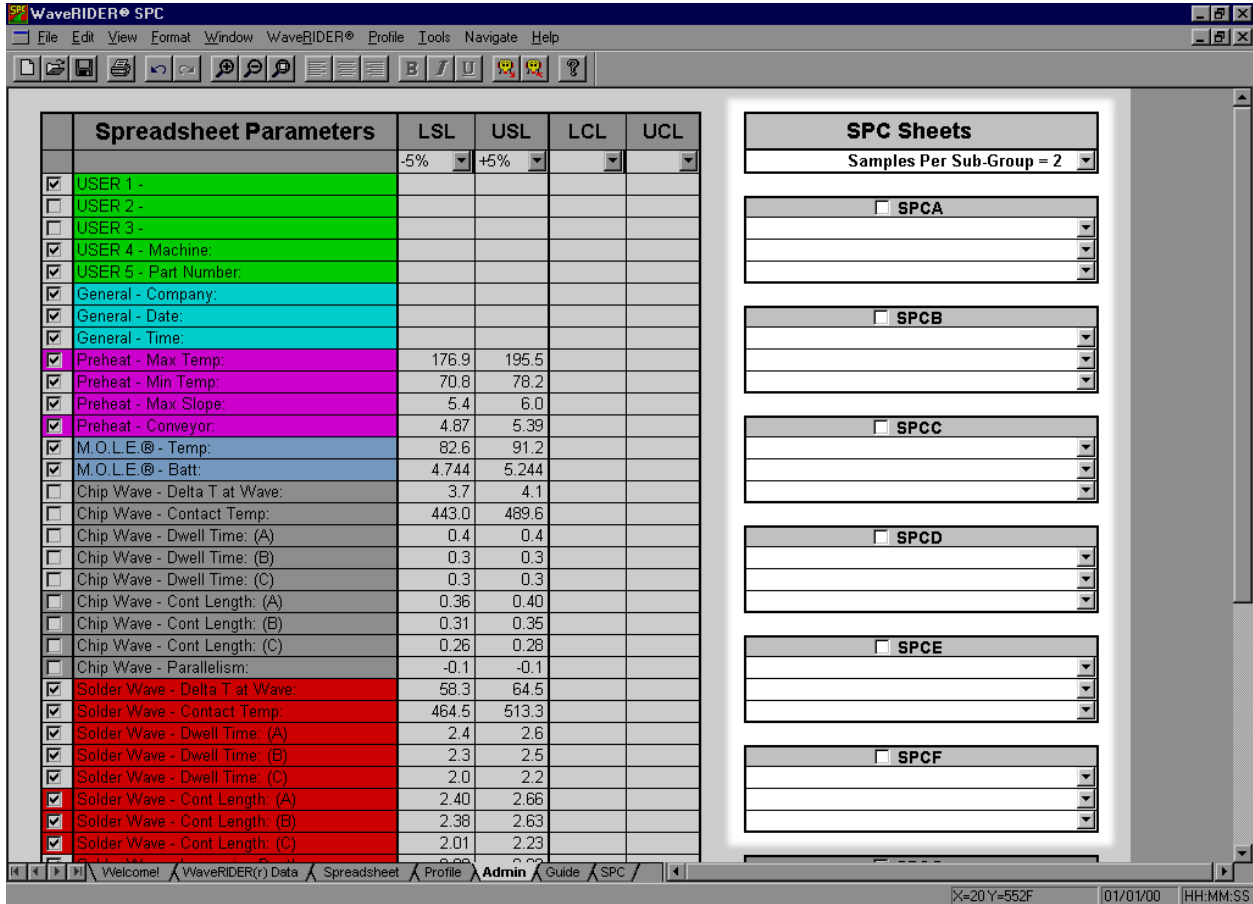

Figure 4- 49: SPC Sheet Boxes

An SPC worksheet can be created by dragging and dropping a parameter or by using the drop down list box.

To create a SPC Worksheet:

Drag and Drop:

1) Select a parameter and drag it from the Spreadsheet Parameter column and drop it into a SPC Sheet cell. Up to three parameters per SPC Sheet can be selected.
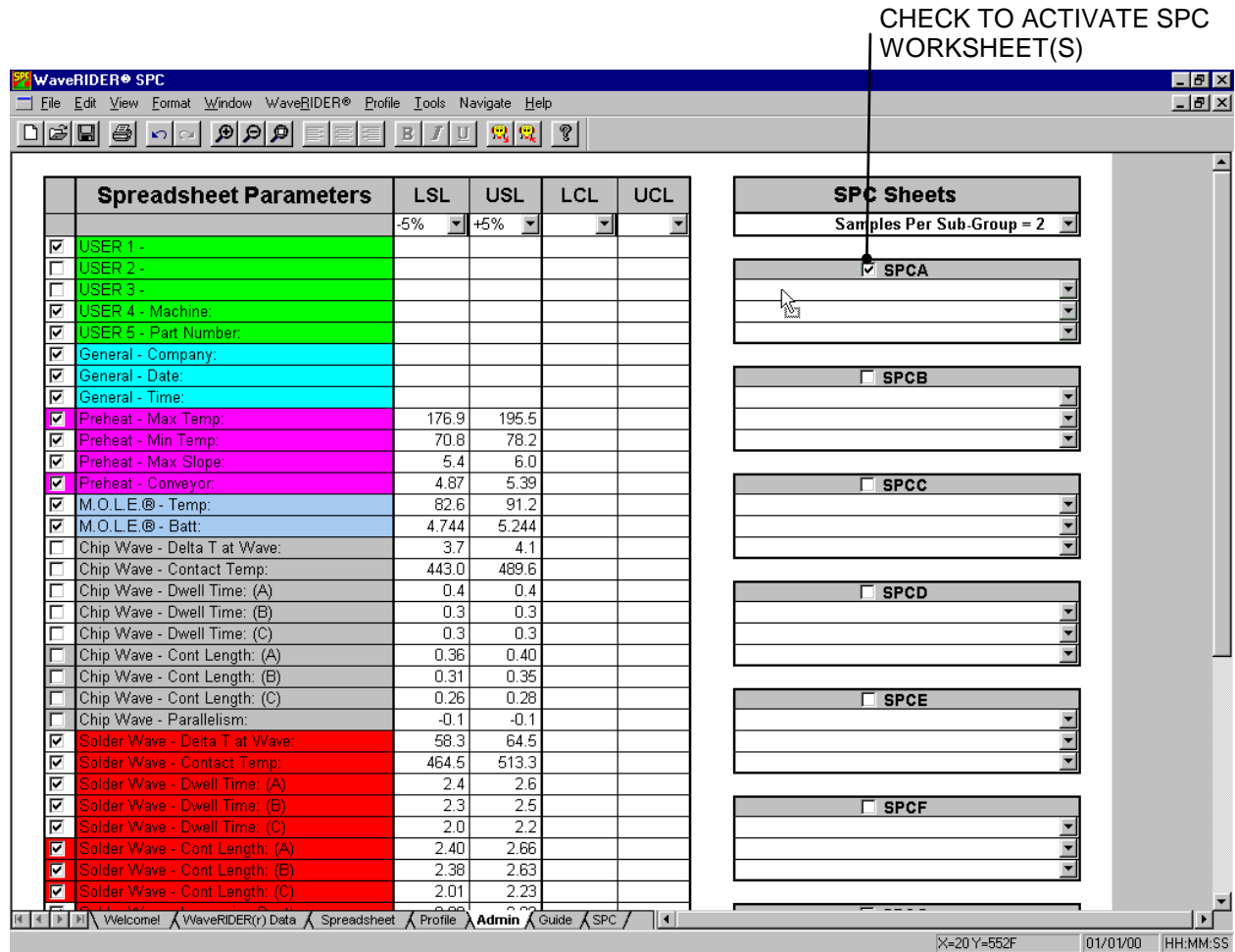
CHECK TO ACTIVATE SPC WORKSHEET(S)

Figure 4- 50: Drag and Drop Parameter

2) When finished, click the check box in the SPC Sheet Label to activate the SPC sheet.

3) To view the SPC Sheet, click the new SPC worksheet tab (See section *4.7 SPC Worksheet* for more details).
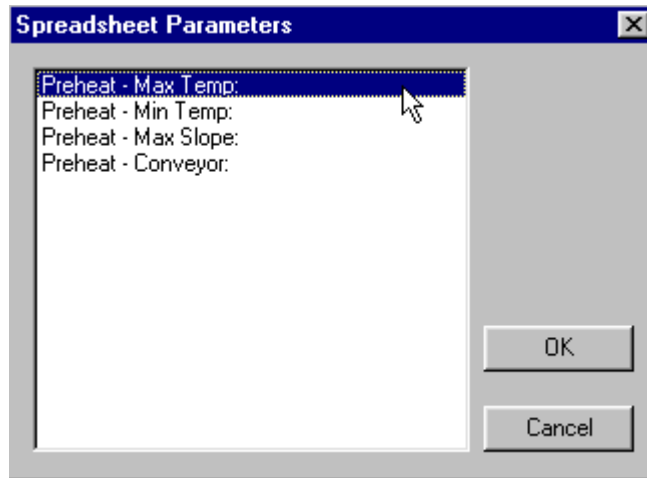
Parameter list:

1) All of the SPC sheet boxes have drop down list boxes located on the right side of the parameter cell. To select a parameter click the drop down list box arrow button and a list of parameter groups appears.

Figure 4- 51: Drop Down List Box

2) Select the group from the drop down list that includes the desired parameter. A dialog box will then appear listing all of the parameters in that particular group.

3) Select the desired parameter from the list and click the *OK* command button.

Figure 4- 52: Parameter Dialog Box

4) When finished, click the check box in the SPC Sheet Label to activate the sheet.

5) To view the SPC Sheet, click the new SPC worksheet tab (See section *4.7 SPC Worksheet* for more details).

Replacing and Deleting SPC Parameters:

To change the parameters in the SPC Sheet boxes, drag and drop a different parameter over of the existing parameter or repeat the drop down list method of selecting a parameter.

To delete a parameter, click and drag the parameter off the SPC Sheet box to remove.

Figure 4- 53: Erase Bar

4.6 Guide Worksheet

The Guide worksheet is a quick reference guide to assist new and experienced users through basic operation steps.
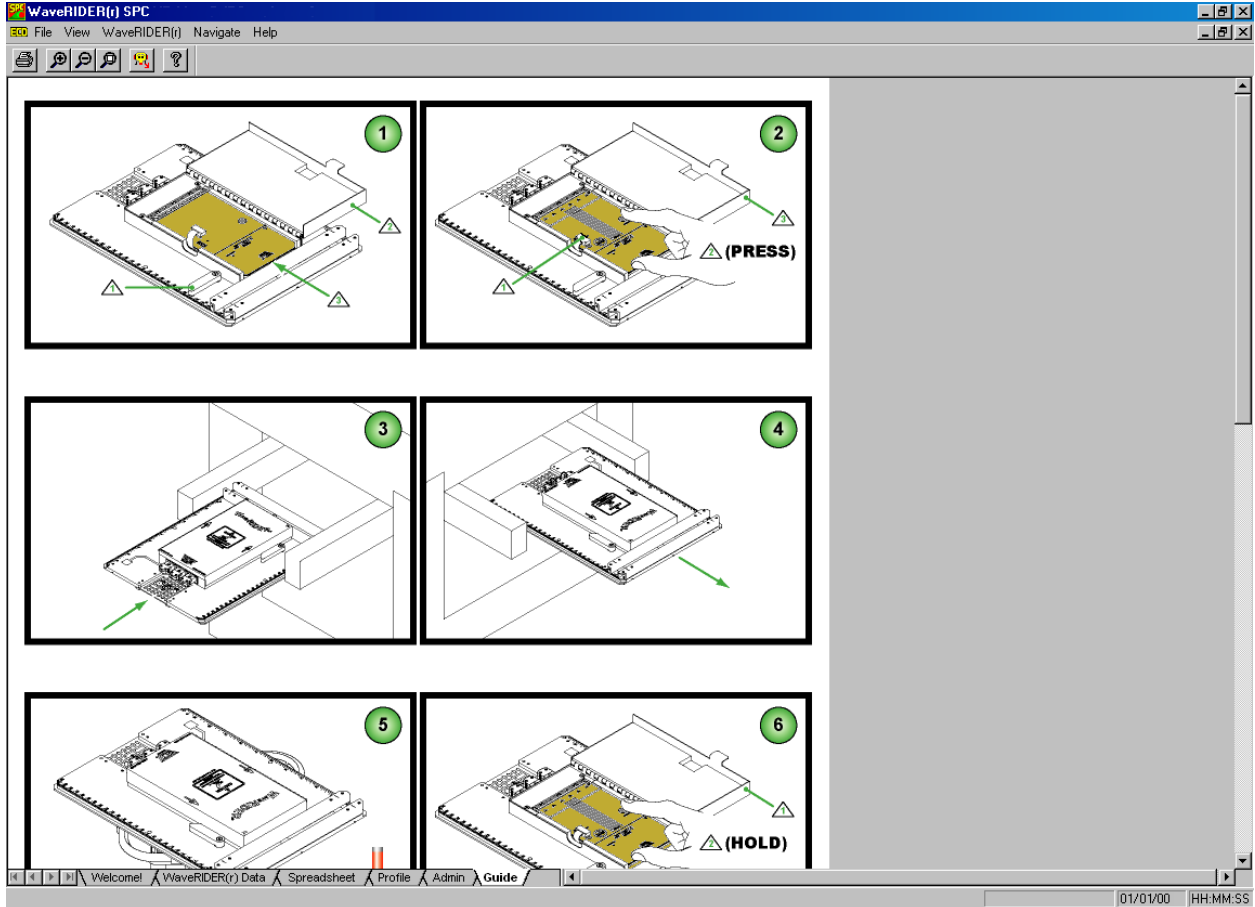
Figure 4- 54: Guide Worksheet

4.7 SPC Worksheet

The SPC worksheets display the assembled Spreadsheet parameters using the Admin worksheet. Each SPC worksheet can display three X-bar and R charts and up to a maximum of nine SPC worksheets can be created.

<u>SPC worksheet features:</u>

- Menus and Toolbar buttons

- X-Bar Chart

- R Chart

- Statistics box
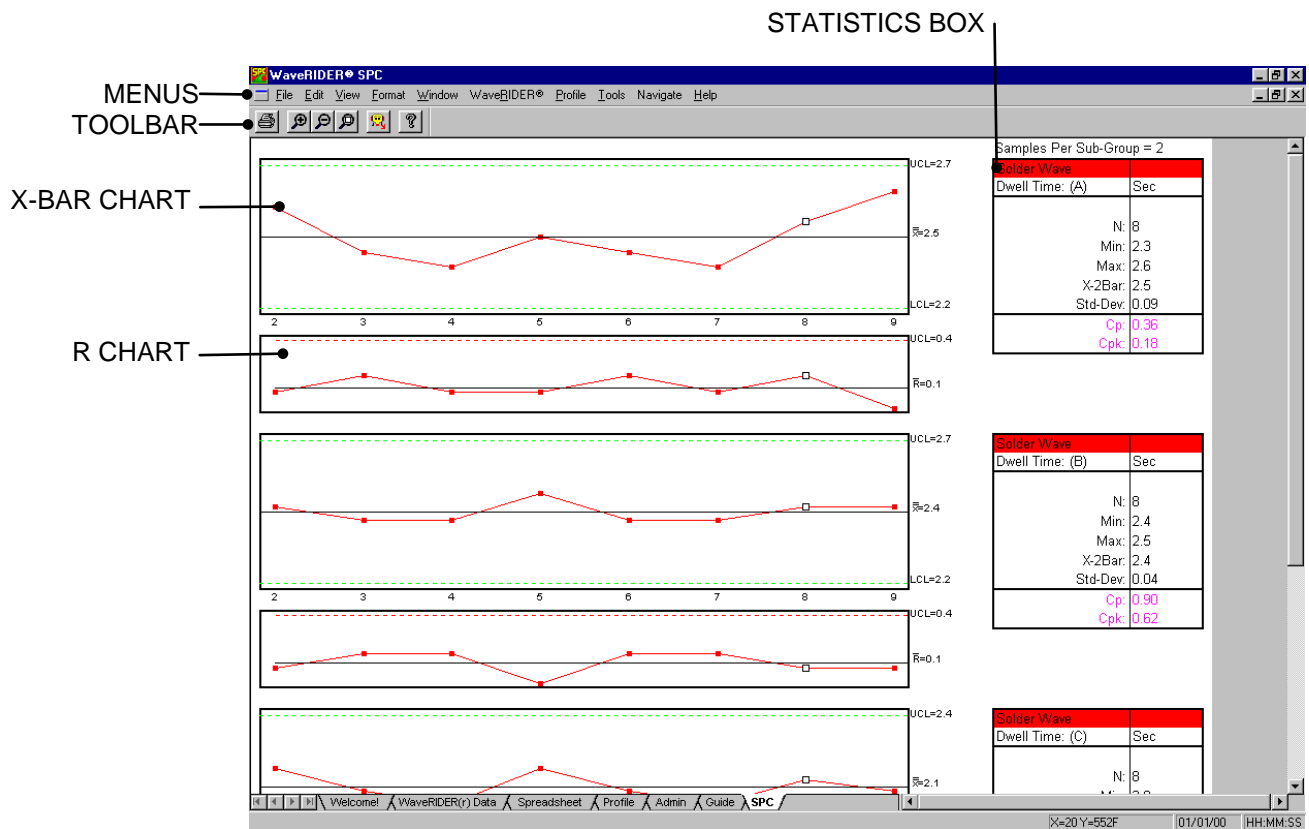
Figure 4- 55: SPC Worksheet

4.7.1 Menus & Toolbar

- **Menus:** File, View, Window, WaveRIDER Data, and Help.

- **Toolbar buttons:** Print, Zoom In, Zoom Out, 100%, Read WaveRIDER Data, About, and Context Help.
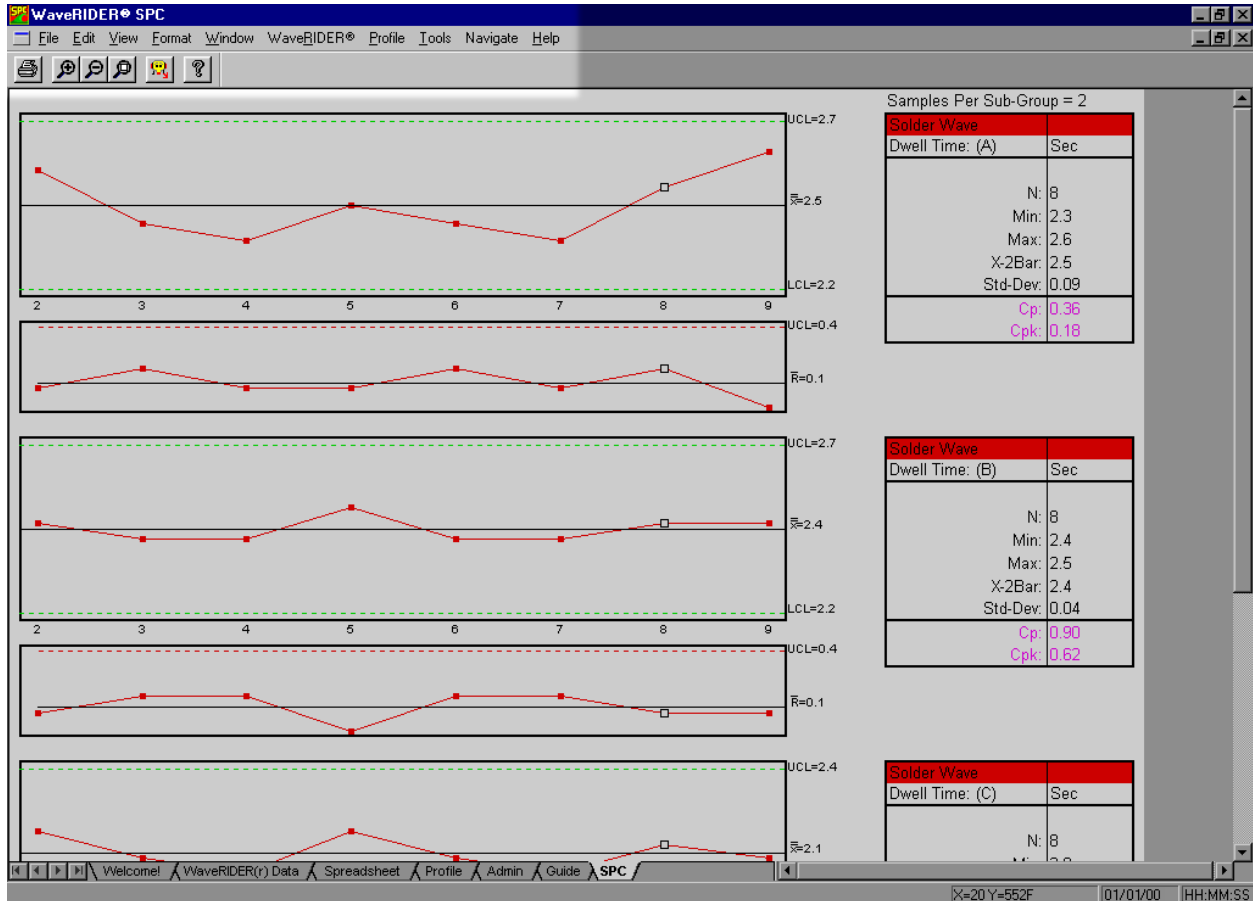
Figure 4- 56: SPC Worksheet Menu Bar and Tool Buttons

4.7.2 X-Bar Chart

The X-Bar Chart is the graphical chart produced from samples of a selected parameter. The chart uses a rolling average of 2 through 6 sample points specified by the user. The X-bar is the average of the data samples and the UCL and LCL are calculated using a formula based on the Range data.
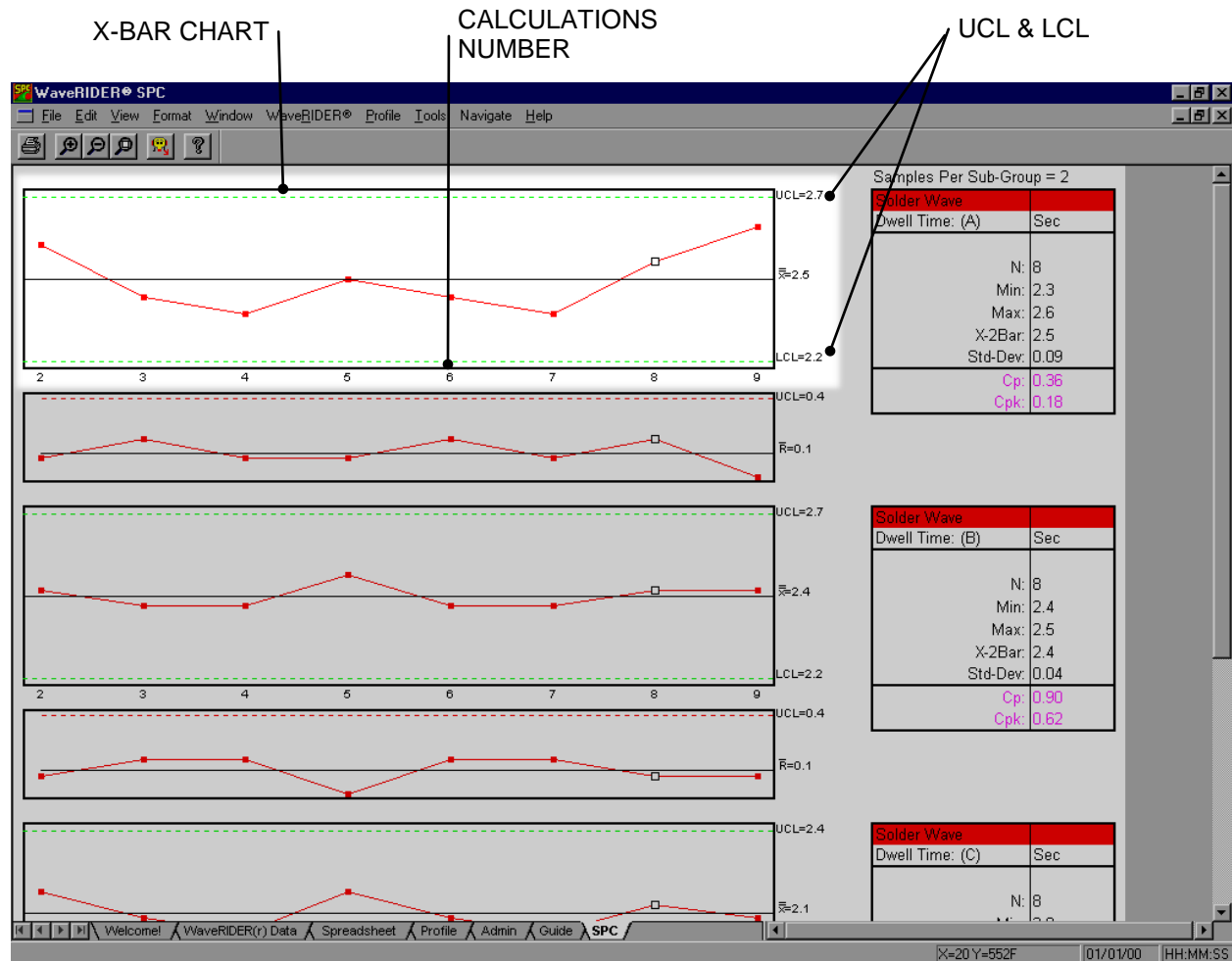
Figure 4- 57: X-Bar Chart

⚠️ **The calculation numbers vary depending on the data in the Spreadsheet worksheet. Using the filter function or the hide command allows the user to select the specific data runs to include on the SPC chart.**

4.7.3 R Chart

The R Chart is the graphical chart produced from the selected parameter. The R-Bar is the averages of the range samples.

> ⚠️ **If the Sub-Group size is set to 1, the R chart becomes a moving range (mR) chart. The moving range is the difference between a specified X value and the one preceding it.**
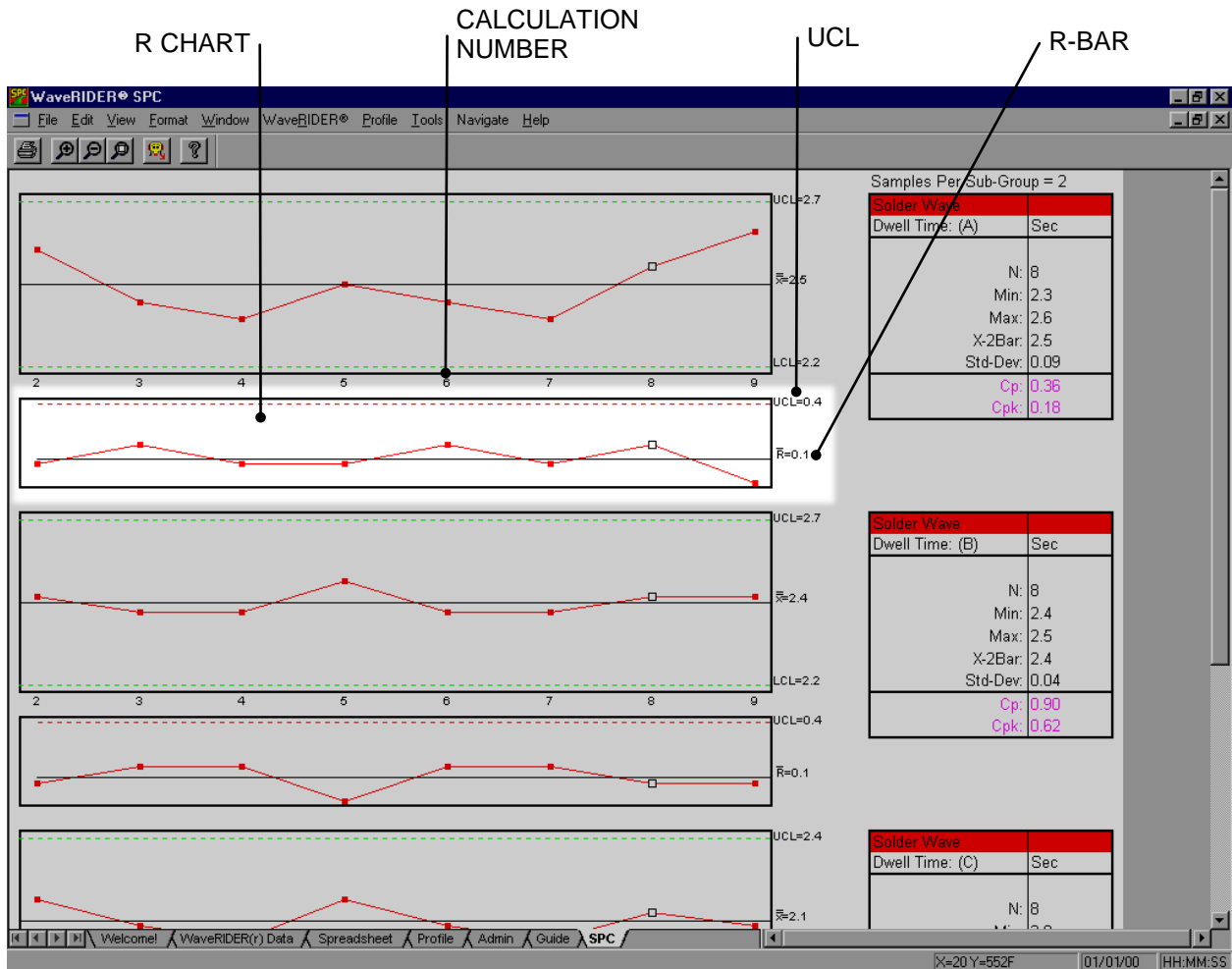
Figure 4- 58: R Chart

> ⚠️ **The calculation numbers vary depending on the data in the Spreadsheet worksheet. Using the filter function or the hide command allows the user to select the specific data runs to include on the SPC chart.**

4.7.4 Statistics Box

The Statistics Box reflects the current SPC data from the selected, sorted and filtered data set parameter.

Statistics box data:

- *N* = Number of subgroups.

- *Min.* = The lowest data point on the graph.

- *Max.* = The highest data point on the graph.

- *X-2 bar* = The current X-Bar Bar calculation.

- *Std. Dev.* = The Standard Deviation of the selected parameter.

- *Cp; Cpk* = Process capability indeces (Refer to Appendix A for more information).
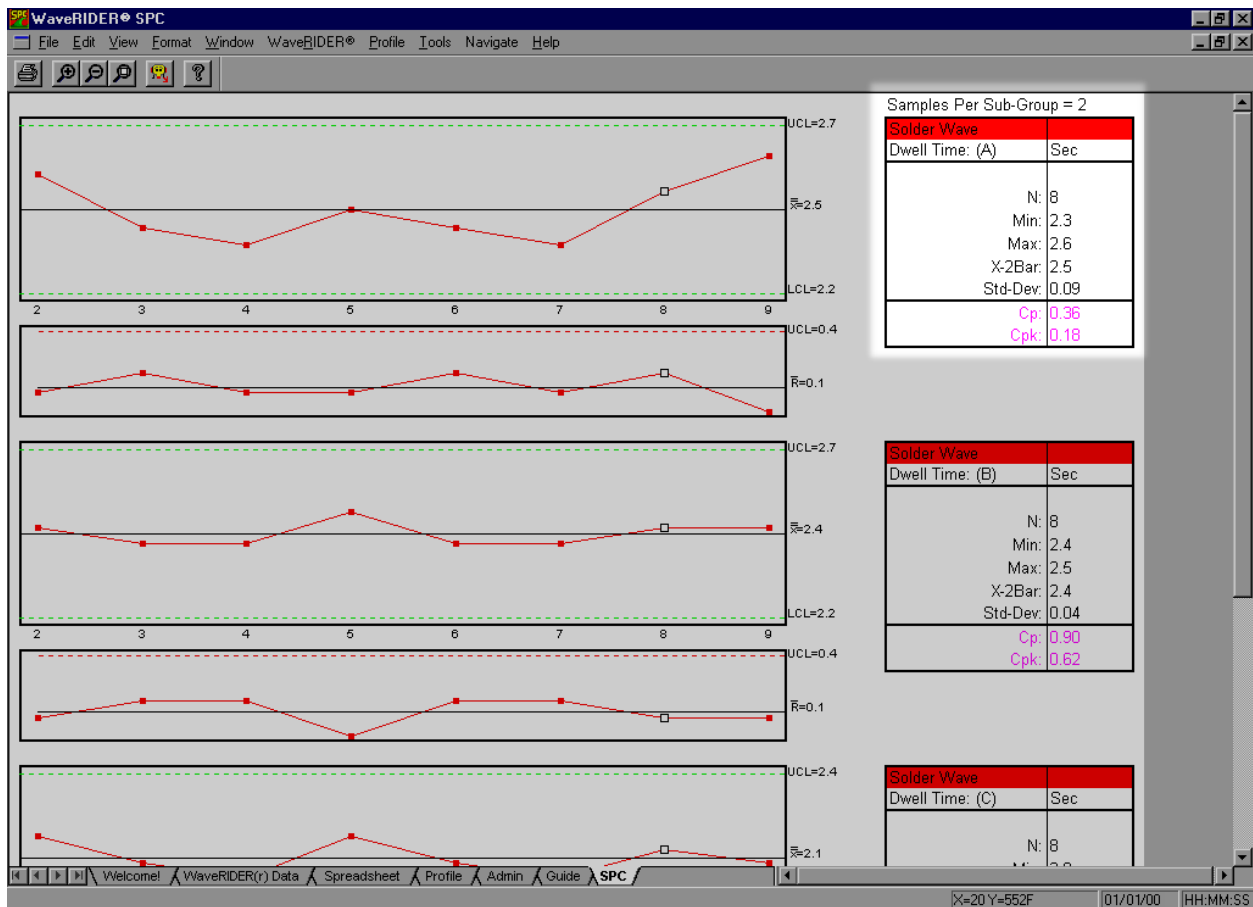
Figure 4- 59: Statistics Box

4.7.5 Renaming SPC Worksheets

The user has the ability to rename all of the SPC worksheet tabs to best reflect the worksheet data.

<u>To change a worksheet name:</u>

1) Double-click the desired SPC worksheet tab and a pop-up text box appears above the worksheet tab.
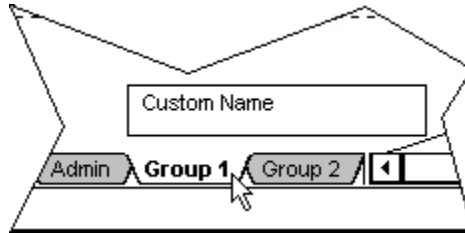
Figure 4- 60: Pop-up Text Box

2) Type a new name in the pop-up text box and hit the **[*enter*]** key to accept or the **[*esc*]** key to cancel.

5.0 Menu and Tool Commands

This section explains how to use all of the Menu and Toolbar button commands. Each of the following sections will list all of the commands specific to each of the menus.

The dimmed menu commands are used in other worksheets.

5.1 File Menu

Commands in the File menu are used to manipulate and configure workbook files.

5.1.1 New Workbook

Select the *New Workbook* command from the *File* menu to start a new workbook. A message box appears requesting the user select a file folder directory to save the new workbook.

After the file location has been determined, a dialog box appears allowing the user to specify Summary Statistics settings for the workbook based on user selected values.
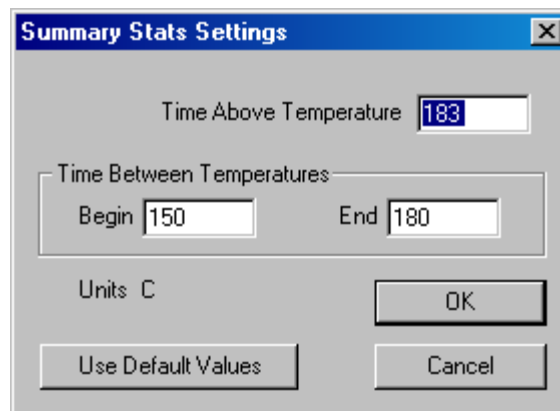
Figure 5- 1: Summary Statistics Settings

When a new workbook is created, it uses these values as thresholds for the Summary Statistics Data. A table of these values extracted from the profile can be viewed on the Summary Stats tab.

Workbook files are saved with a file extension of (.MWR), and the Profile data from the Profile worksheet are saved with an extension of (.MDM). These two file types will automatically be saved in the same file folder directory because they are inter-dependent on each other and should not be seperated.
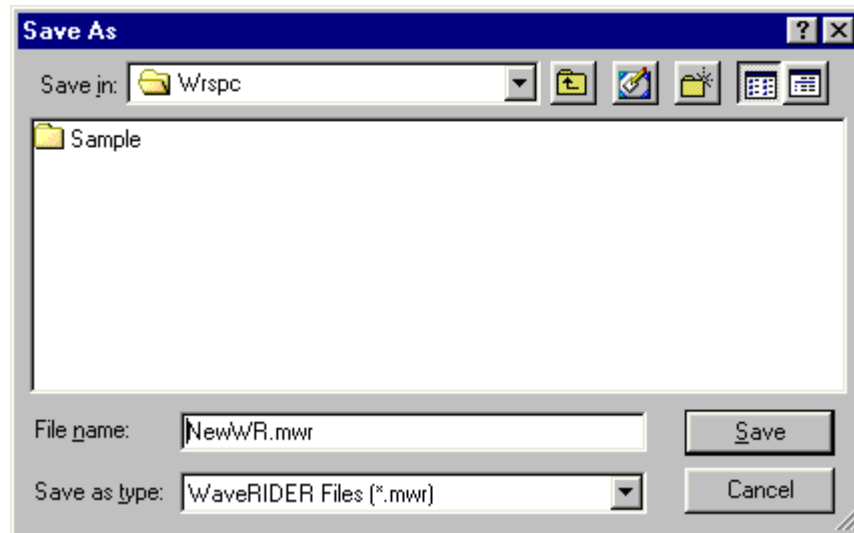
Figure 5- 2: New List Box

The New Workbook command can be accessed on the Toolbars of the Spreadsheet, Profile, and Admin worksheets. This command can also be used by pressing *CTRL + N*.

- **New Workbook Button:**

5.1.2 Open Workbook

The Open Workbook command enables the user to open existing workbook files.

To open a workbook file:

1) Select the *Open Workbook* command from the *File* menu. A list box of workbook files with an extension of **(.MWR)** files appears.
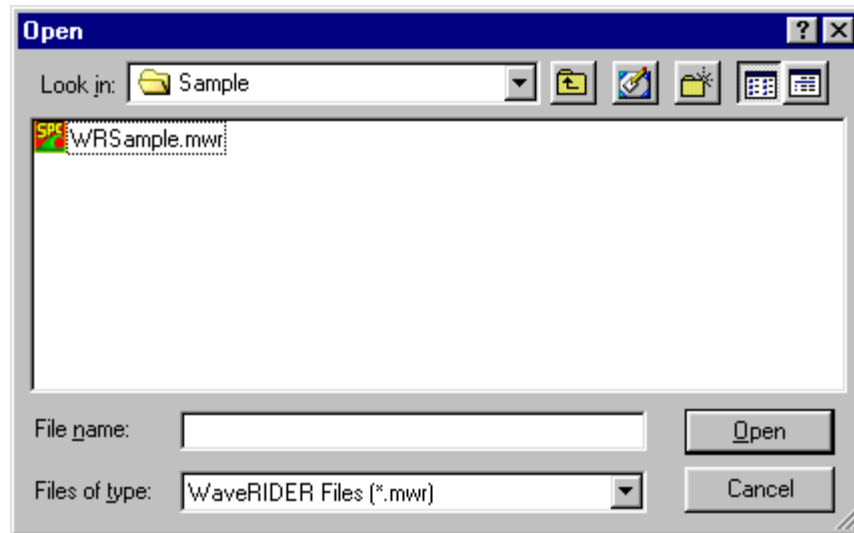
Figure 5- 3: Open List Box

2) Highlight the desired workbook file to open by clicking.

3) Click the *Open* command button to open, or *Cancel* to return to the current worksheet.

> **More than one workbook file can be open at a time and can be viewed by using the commands on the Window File menu (refer to section *5.5 Window Menu*).**

The Open command can be accessed on the Spreadsheet, Profile, and Admin worksheet Toolbars. This command can also be used by pressing *Ctrl + O*.

- **Open Workbook Button:** 🗁

5.1.3 Close Workbook

Select the *Close Workbook* command from the *File* menu to close the current workbook. If there is a second workbook open, closing a workbook will return to the previous workbook.

5.1.4 Import

The Import command imports existing (.mdm), files into the Spreadsheet worksheet. This process will copy all documentation information (i.e. part, process) from the file being imported, into the user definable cells on the Spreadsheet worksheet. The data can now be saved in the new format as described under the *Save* and *Save As* menu commands.

> **When importing (.MDM) files, they are automatically copied into the directory of the current workbook file.**

To import:

1) Select the *Import* command from the *File* menu and the Import list box appears.
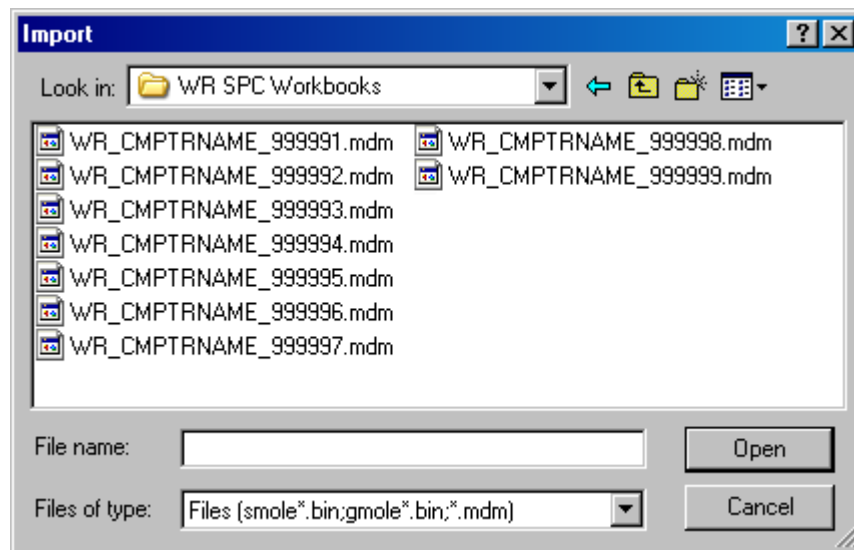
Figure 5- 4: Import List Box

2) Navigate to the file folder where the file(s) to import are located. (The path and file name can also be typed in the *File of type* text box).

3) Select the file(s) to import by clicking it once.

4) Click the *Open* command button.

5.1.5 Save Workbook

Select the *Save Workbook* command from the *File* menu to save the current workbook file after changes have been made. When the user saves the file, all of the current data sets and options in the workbook are saved.

The Save Workbook command can be accessed on the Spreadsheet, Profile, and Admin worksheet Toolbars. This command can also be used by pressing *Ctrl + S*.

- **Save Button:** ▣

5.1.6 Save Workbook As

Select the *Save Workbook As* command from the *File* menu to save the current workbook with a different file name. When the user saves the file, the current appearance of the workbook and the options that have been set are saved to a new file name.
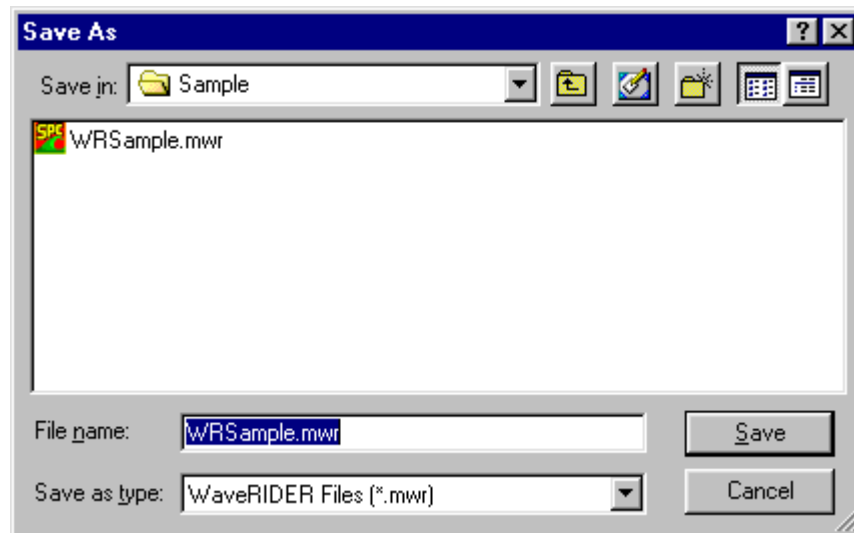
Figure 5- 5: Save Workbook As List Box

The Save Workbook As command can also be used to save selected set of profiles out of a worksheet that includes a large data set. When unwanted profiles are filtered out of a large data set and then the Save Workbook As command is used, the selected data runs are saved in a new workbook file along with the profile data.

This command is also useful when the user wants to transfer selected MDM data run(s) to a floppy disk.

5.1.7 Save As Text

Select *Save As Text* from the *File* menu to save the Spreadsheet worksheet information as a text file in the current unit of temperature and distance configurations. The saved text files have a file extension of **(.TXT)**. This command will save the data so it can be opened with software programs that open standard text files.
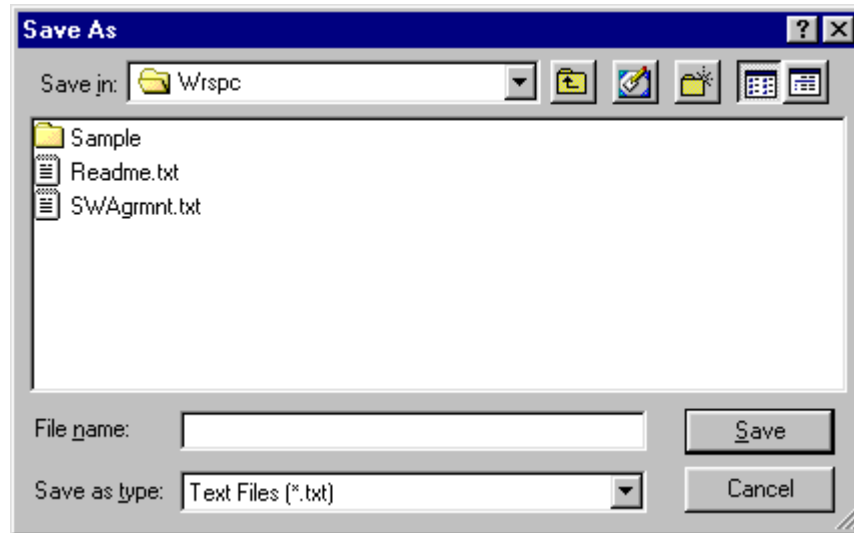
Figure 5- 6: Save As Text Dialog Box

5.1.8 Save as Text Archive

Select the *Save As Text Archive* command from the *File* menu to save all of the data sets in the workbook file as a text archive with a file extension of **(.WRA)**. This is a useful way to save large worksheets because text archive files are much smaller than saving in workbook file format. This allows saving large workbook spreadsheet data in a compressed format. They can be restored using the *Load Text Archive* command.
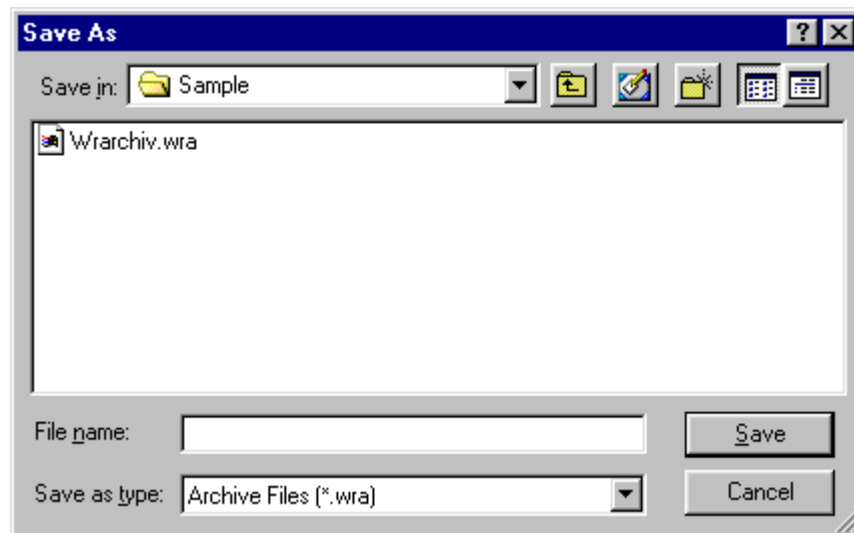
Figure 5- 7: Save As Text Archive List Box

5.1.9 Load Text Archive

Select the *Load Text Archive* command from the *File* menu to load a previously saved text archive file. This command will clear the currently loaded data and load the selected text archive file in its place.
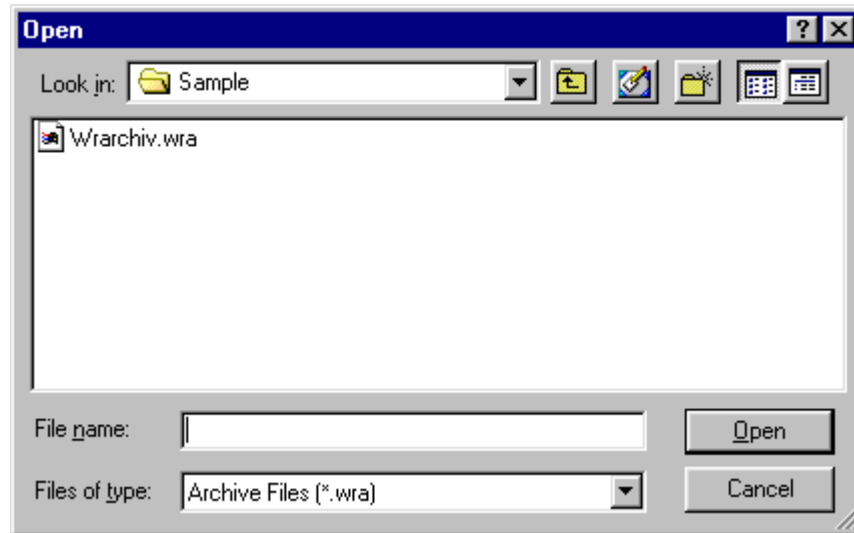
Figure 5- 8: Load Text Archive List Box

> **To avoid loosing valuable data, it is recommended to load text archive files into a new workbook file because as previously stated, this command clears all currently loaded data.**

5.1.10 Configuration

The Configuration command is used to set a communication (COM) port so the PC and the M.O.L.E. can communicate. This command is very important when the software is first installed or PC hardware configurations have changed.

<u>To configure a COM port:</u>

1) Connect the M.O.L.E. to the PC (refer to the appropriate section in the Hardware manual).

2) Select the *Configuration* command from the *File* menu on the Admin worksheet and the Configuration dialog box appears.
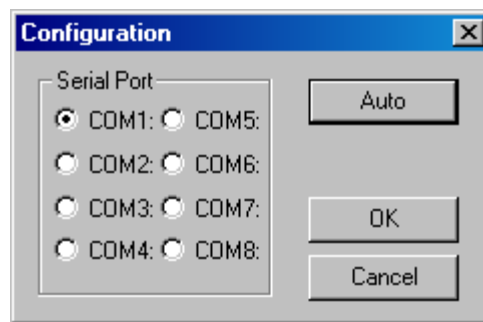
Figure 5- 9: Port Configuration Dialog Box

3) Click the option button next to a COM port which the PC is set up for RS-232 communications or the *Auto* command button to have the software automatically find the COM port the M.O.L.E. is connected.

4) Click the *OK* command button to accept or *Cancel* to exit without changing.

5.1.11 Preferences

The Preferences sub-menu lets the user perform custom software setup tasks.
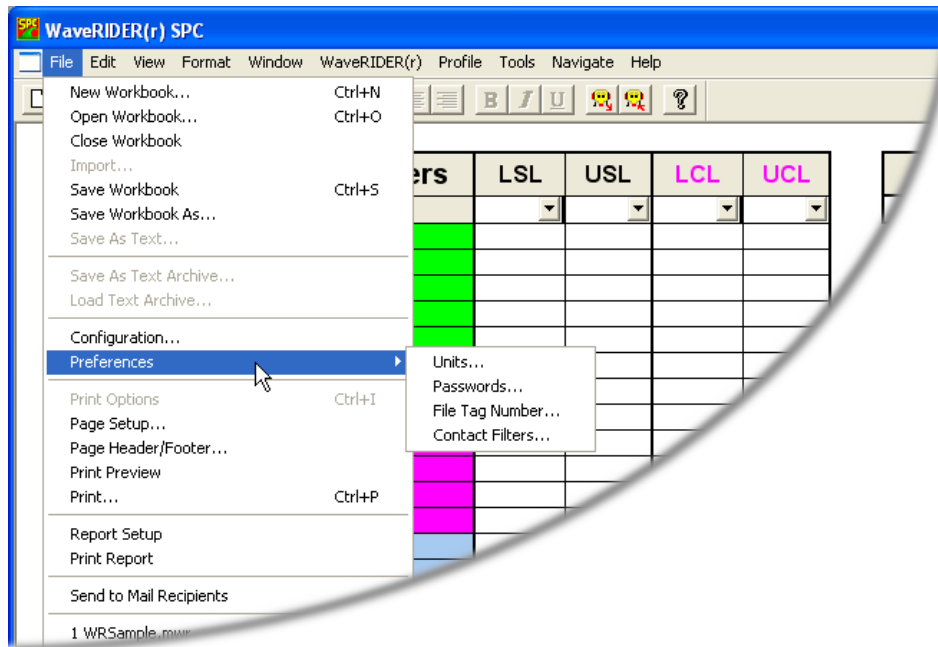
Figure 5- 10: Preferences Menu

5.1.11.1 Units

The software can be configured to operate with different units of temperature and distance.

> ⚠️ ℹ️ **This command does not set the units reported by the M.O.L.E. It applies only to the software.**

To change Units of Temperature or Distance Units:

1) Click the *Units* command from the *Preferences* sub-menu.

2) Click the option button beside a unit of temperature and/or unit of distance.

3) Click the *OK* command button to use the choices as defaults whenever the software is started or *Cancel* to return to the worksheet without making any changes.
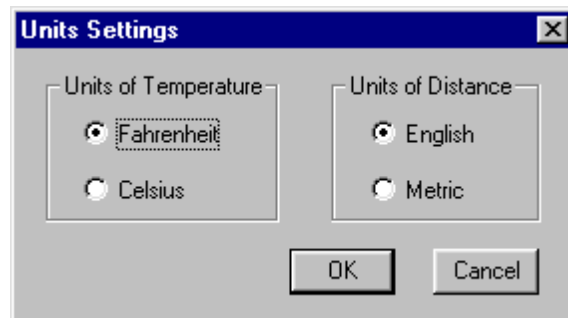
Figure 5- 11: Units Configuration Window

5.1.11.2 Passwords

The software has a password protection feature that uses case-sensitive text for securing access to a worksheet. When a worksheet is password protected, the worksheet tab will be highlighted in yellow and the user will not be able to access the protected worksheet without proper password privileges.

If there are worksheets password protected, the password protect command will not affect data when uploading from the M.O.L.E.. The protected worksheets just cannot be viewed without the password.

Once the user opens a workbook and uses the Passwords command to gain access to a protected worksheet all of the worksheets remain unprotected until that workbook is closed.

The password command also works on a global basis. The password currently assigned applies to all existing or new workbook files.

The software has a default password <u>Admin</u>. This password will be needed the first time the password is changed or to password protect a worksheet. When the password is changed it is very important to remember the password or write it down.

To password protect worksheets:

1) Click the *Passwords* command from the *Preferences* sub-menu, and a Password Protection dialog box appears.

Figure 5- 12: Password Protection Dialog Box

2) Select which worksheet(s) to password protected by clicking the corresponding check box.

3) Click the *OK* command button to accept or *Cancel* to return to the worksheet without password protecting any worksheet(s).

If the *OK* command button has been selected, a dialog box appears prompting the user to enter the current password.

If the default password has not been changed, the current password is <u>Admin</u>.
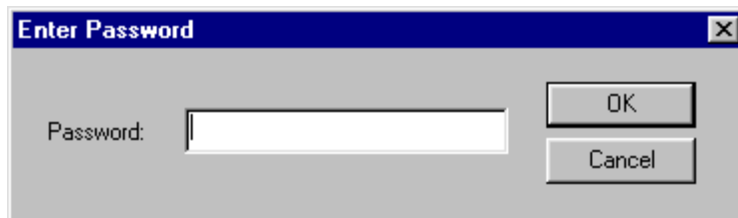
Figure 5- 13: Enter Password Dialog box

4) Enter the current password in the text box and click the *OK* command button to accept or *Cancel* to return to the worksheet without password protecting the selected worksheet(s).

To change a password:

1) Select the *Passwords* command from the *Preferences* sub-menu and a Password Protection dialog box appears.

Figure 5- 14: Password Protection Dialog Box

2) Click the *Change Password* command button and the Password Change dialog box appears.
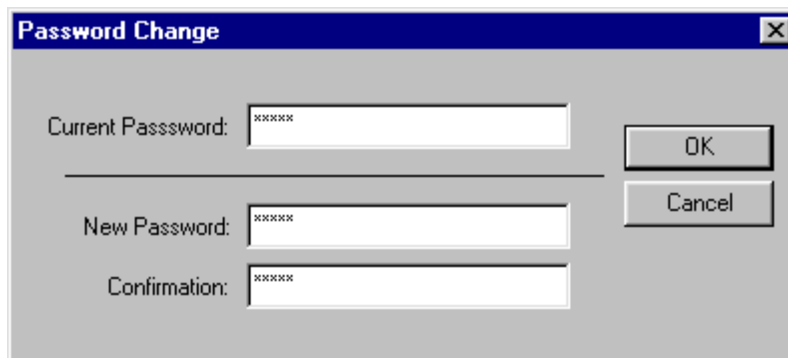
Figure 5- 15: Change Password Dialog Box.

> ⚠ **The software has a default password Admin. When the password is changed for the first time, Admin will need to be entered in the "Current Password" text box.**

3) Enter current password in the *Current Password* text box.

4) Enter a new password in the *New Password* text box.

> ⚠ **The software only accepts passwords with a minimum of 4 characters.**

- Enter the new password again in the *Confirmation* text box and then click the *OK* command button to accept or *Cancel* to not change the password.

To disable a password:

1) Select the *Passwords* command from the *Preferences* sub-menu and a Password protection dialog box appears.

Figure 5- 16: Password Protection Dialog Box

2) The current password protected worksheet(s) will have a check mark in the corresponding check box. Click the check box to remove the check mark to unprotect the worksheet.

3) Click the *OK* command button and a dialog box appears asking the user to enter the current password.
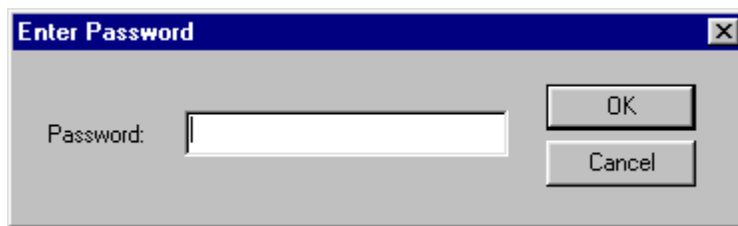
Figure 5- 17: Enter Password Dialog box

The software has the default case-sensitive password <u>Admin</u>. When password protection is removed from a worksheet and the preset password has not changed, <u>Admin</u> will need to be entered in the password text box.

4) The current password must now be entered in the text box. When finished click the *OK* command button or *Cancel* to keep the current password protection.

5.1.11.3 File Tag Number

When data is uploaded from the M.O.L.E., the **(*.MDM)** portion of the data run is automatically assigned a special File Tag number. The first two characters are automatically assigned **WR.** The next nine characters are the first nine characters from the user/computer login name and the remaining six characters are in numerical sequence that can be specified by the user.

For example, if the User login name is "**JSMITH**", a File Tag number would be "**WR_JSMITH_000100.mdm**".

> **If there is no user login name available, the software will automatically assign the first nine characters from the computer name (i.e. Production, Engineering). If both the user name and computer name are not available "USER" will be assigned to the File Tag number (i.e. WR_USER_000100.mdm).**

To change the File Tag number sequence:

1) Select the *File Tag Number* command from the *File* menu.

2) A dialog box appears so a file tag number can be entered in the text box, or the number automatically assigned by the software can be used.
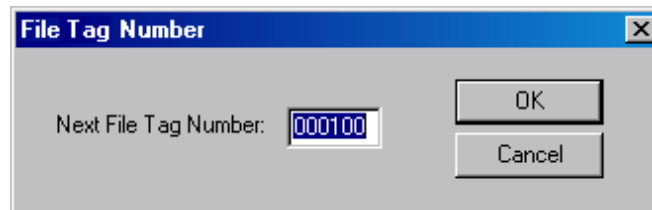
Figure 5- 18: File Tag Number Dialog Box

3) Click the *OK* command button to set the File Tag Number or click *Cancel* to close the window without changing the number.

> **If a file tag number is entered that currently exists, the (.MDM) file will be incremented automatically to avoid that file from being overwritten.**

5.1.11.4 Contact Filters

The Contact Filters command allows the user to enter a drop out filter and Hot air knife window values.

<u>To set dropout time contact filter:</u>

1) Select a time value from the drop-down box. The user can select values of 0.5, 1.0, and 1.5 seconds. The most common value is 1.0 and is the software default. These values are used to reject contact bounce caused by turbulent waves.

<u>To set hot air knife contact filter:</u>

1) If your wave solder machine has an air knife, you can select the hot air knife distance check box to activate the filter. This software default for this filter is **OFF**.

2) Set the hot air knife distance. This settable distance is typically the distance from the solder wave to the Hot air knife. This may be less if it is seen that the hot air knife influences this temp prematurely. Range is from 0 to 30.5 cm (0 to12.0 in).
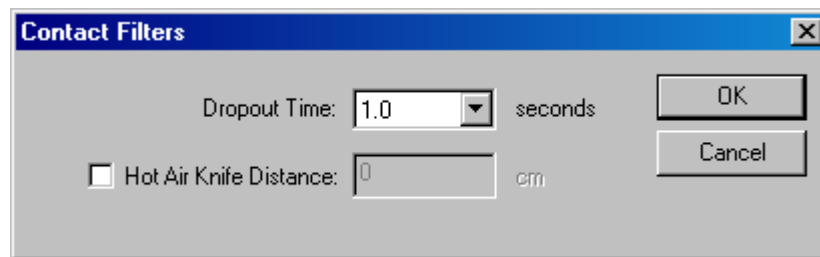
Figure 5- 19: Contact Filters Dialog box

5.1.12 Page Setup

The Page Setup command sets page parameters for the Spreadsheet and Admin worksheets.

To set page parameters:

1) Select the *Page Setup* command from the *File* menu and the following dialog box appears.
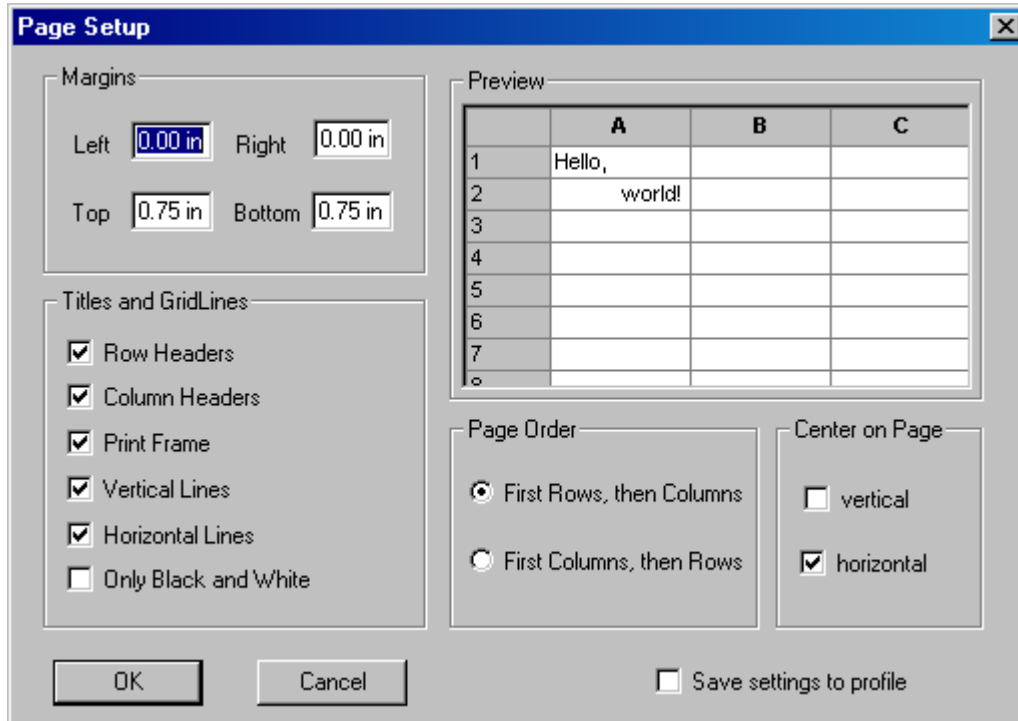
Figure 5- 20: Page Setup Dialog Box

2) Select desired parameters to apply to the worksheet.

3) Click the *OK* command button to use the current page setup selections.

4) Click the *Cancel* command button to leave the page setup command without changing anything.

> **Selections made using the *Page Setup* command will not be visible on the worksheet it is only used for print formatting. To view the selections, use the *Print Preview* command decsribed in section *5.1.15 Print Preview*.**

5.1.13 Print Options

The Print Options command is where additional Data Table statistics can be selected to be printed along with the Data Graph. Additional documentation can also be selected that will be printed on a second page.

To select print options:

1) Select the *Print Options* command from the *File* menu and the following dialog box appears.
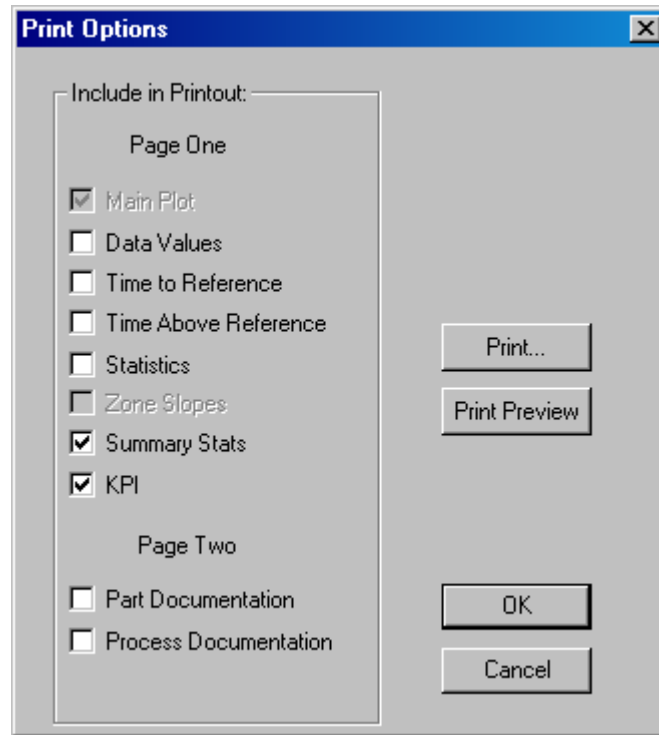
Figure 5- 21: Print Options Dialog Box

2) Click the check box beside desired Statistic(s) to be printed along with the Main Plot.

3) Click the check box beside desired documentation to be printed on a second page.

- Click the Print command button to close the print options process and initiate printing.

- Click the Print Preview command button to view the report appearance.

4) Click the *OK* command button to accept or *Cancel* command button to leave the print options command without making any changes.

Only five Statistic(s) can be printed at one time.

This command can also be used by pressing *CTRL + I*.

5.1.14 Page Header / Footer

The Page Header / Footer command places text on the top and bottom of the printed worksheet.

> **Some of the worksheets contain default information in the Header and Footer fields, to view use the Print Preview command. Refer to section *5.1.15 Print Preview.***

To add a Header and/or Footer

1) Select the *Page Header/Footer* command from the *File* menu and the following dialog box appears.
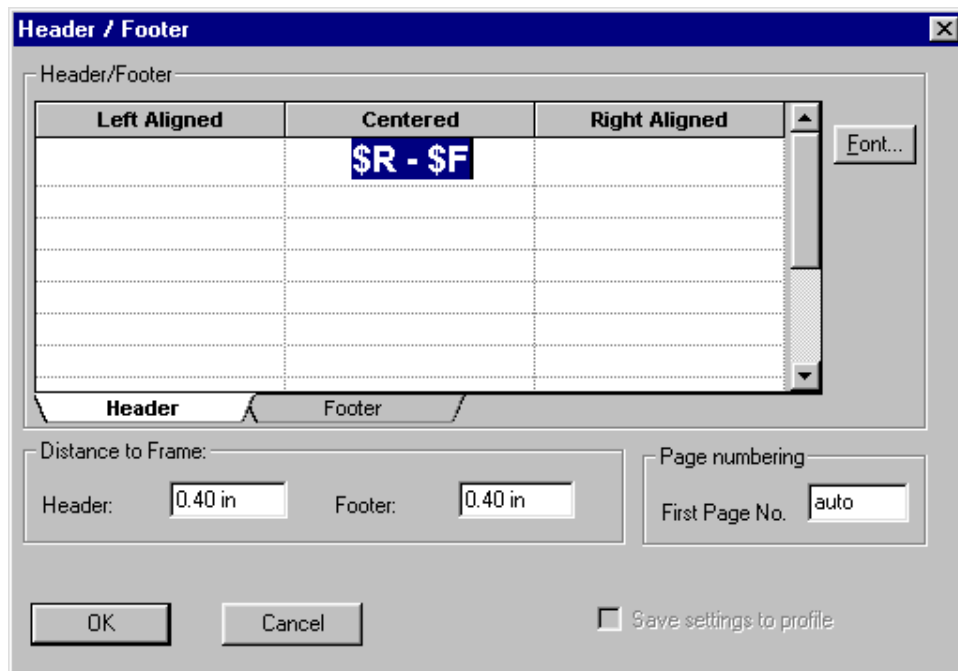
Figure 5- 22: Header / Footer Dialog Box

2) Click the Header tab or the Footer tab.

3) Determine where to locate the text: left, center or right side of the worksheet. Click a text field and type the desired text.

- The user can also change the text font, distance the note is from the frame edges and type of page numbering.

4) Click the *OK* command button to accept the Header / Footer or click *Cancel* to return to the worksheet without changes.

> **The Header / Footer information will not be visible on the worksheet. It is only used for printing. To view the Header / Footer information, use the Print Preview command (refer to section *5.1.15 Print Preview.***

5.1.15 Print Preview

The Print Preview command shows a preview of the page(s) to be printed. This command is useful when confirming print options.

To view a print preview:

1) Select the *Print Preview* command from the *File* menu and the Print Preview window appears.
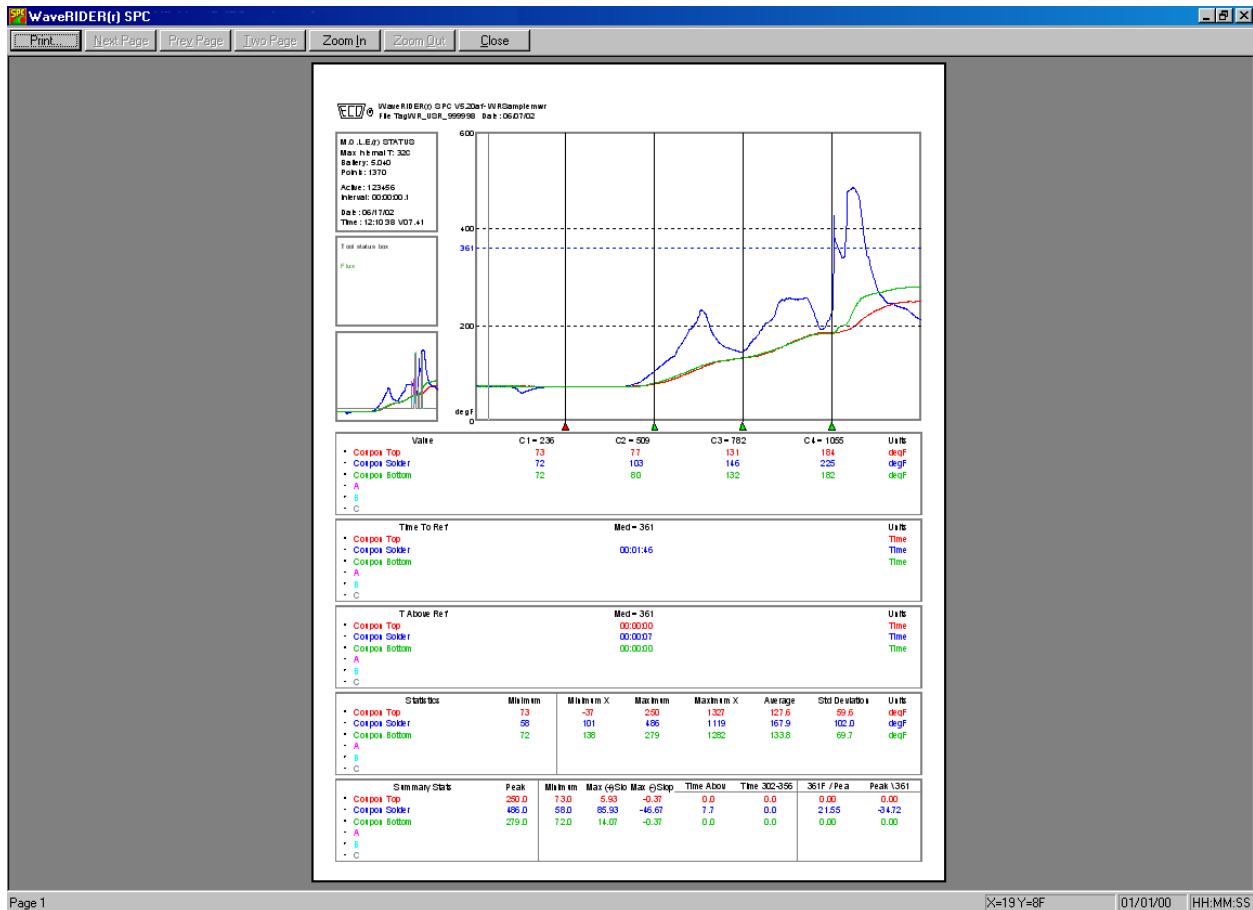
Figure 5- 23: Print Preview Window

2) Click the *Print* command button to proceed with printing.

3) Click the *Two‑Page* command button when there is more than one page in the report to view them side by side.

4) Click the *Next Page* or *Prev Page* command button to view other pages of a multiple page report.

5) Click the *Zoom In* command button to observe small details, and *Zoom Out* to restore.

6) Click the *Close* command button to close the Print Preview window.

5.1.16 Print

The Print command prints worksheet information from the workbook. The options that appear on the Print dialog box will depend on the type of printer and the installed printer driver.

To print a worksheet:

1) Select the *Print* command from the *File* menu and standard Windows or driver-dependent print dialog box appears.

2) Select desired print options.
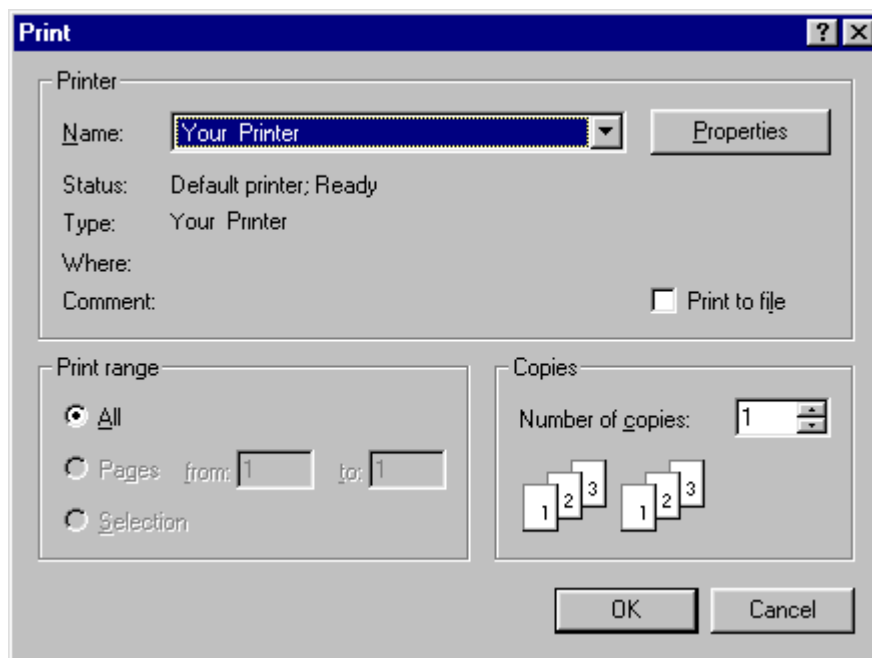
Figure 5- 24: Print Dialog Box

3) Click the *OK* command button to close the Print dialog box and initiate printing the current worksheet.

4) Click the *Cancel* command button to close the print window without printing.

The Print command can be accessed on all worksheet Toolbars This command can also be used by pressing *CTRL + P*.

- **Print Button:** 🖨

5.1.17 Report Setup

Select the *Print Report* command from the *File* menu to print the select worksheets to print a workbook in a report style.

To setup a report:

1) Select the *Report Setup* command from the *File* menu and the Report Setup dialog box appears.
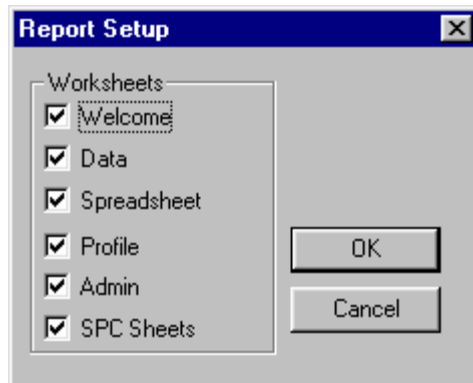
Figure 5- 25: Report Setup Dialog Box

2) Click the check box(es) to enable the worksheet(s) to be printed.

3) Click the *OK* command button to accept the selection(s) and return to the worksheet, or click *Cancel* to return to the worksheet without any changes.

5.1.18 Print Report

Select the *Print Report* command from the *File* menu to print the selected worksheets from the Report Setup dialog box as discussed in section *5.1.17 Report Setup.*

5.1.19 Send to Mail Recipients

The Send to Mail Recipients sub-menu commands let the user send a Screen image, MDM, or Workbook and associated MDM's to an email recipient. This command is useful when the user would like to share profiles and/or workbooks with other locations or when troubleshooting problems.

Figure 5- 26: Preferences Menu

To send:

1) Launch an email program (i.e. Outlook, endora).

2) Select the desired email command described below:

- Select *Screen Image* to capture the current displayed worksheet screen.

> **When selecting the Screen Image command, the software captures the current screen image where the command is activated and converts it into a Bitmap (filetag.bmp) file.**

- Select *MDM File* to send the MDM file from the currently selected data run.

- Select *Workbook and associated MDM's* to send the current Workbook and associated MDM files.

3) Enter an email address in the email text box and select the *OK* command button to send the file and return to the worksheet where the command was activated.
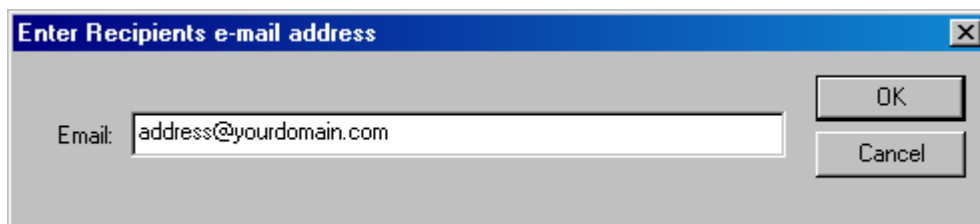
Figure 5- 27: Enter Recipients

> **When sending files the email program may display an message dialog that informs the user that it is sending the email.**

5.1.20 Recent Files <u>1</u>, <u>2</u>, <u>3</u>, etc...

The most recently loaded workbook file names are displayed at the bottom of the File menu. To open one of these files, click the name of the desired workbook file or press the appropriate number beside it.

5.1.21 Exit

Select the *Exit* command to quit the program. A message box will prompt the user to save changes. If the user decides to save the changes, all data and configuration changes will be saved with the workbook file.

5.1.22 Language

All of the menus and commands have been translated in five different languages. After the software is installed, the user can select a different language from the *Languages* sub-menu in the File menu.

5.2 Edit Menu

The Edit menu commands enable the user to modify the data set on the Spreadsheet and Admin worksheets so the most beneficial data is assembled in the workbook file.

5.2.1 Undo

Select the *Undo* command to undo any previous action. For example if the filter command is used and then the user decides that command was not necessary, the Undo command will restore it back to its original format.

The Undo command can be accessed on the Toolbars of the Spreadsheet and Admin worksheets. This command can also be used by pressing $CTRL + Z$.

- **Undo Button:**

5.2.2 Redo

Select the *Redo* command to restore the action made by using the Undo command. Like Undo, the user can use Redo to restore all of the Undo actions.

The Redo command can be accessed on the Toolbars of the Spreadsheet and Admin worksheets. This command can also be used by pressing $CTRL + R$.

Redo Button:

5.2.3 Copy

Select the copy command to copy the data in the Spreadsheet cells for pasting into other user definable cells or different programs. This command can also be used by pressing $CTRL + C$.

5.2.4 Paste

Select the Paste command to insert collected data in the user definable cells or different programs. This command can also be used by pressing $CTRL + V$.

5.2.5 Remove Row

Select the *Remove Row* command to remove a data run row that is not wanted. This command is helpful when data has been collected and the user feels it is not beneficial to the workbook data set or has a corrupted MDM file.

This command is permanent and the data run cannot be retrieved. The software program will warn the user with a message box.

5.2.6 Hide Row

Select the *Hide Row* command to exclude a row without eliminating it completely from the workbook file. This command is similar to the filter function, and is helpful when data has been collected and it may not be beneficial to the data set. To restore hidden data set row(s) click the Red *Filter Reset* button located on the Spreadsheet worksheet (refer to section *4.3.7 Filters*).

5.3 View Menu

The View menu commands enable the user to manipulate which areas are viewed on the worksheet display.

5.3.1 Zoom In

Select the *Zoom In* command from the *View* menu to make the current worksheet view larger. The Zoom In command has the capability to zoom in multiple times. When the maximum zoom level has been reached the Zoom In command will be dimmed.

The Zoom In command can be accessed on all worksheet Toolbars excluding the Profile worksheet. This button will speed up the Zoom In process if multiple zooms are desired.

- **Zoom In Button:**

5.3.2 Zoom Out

Select the *Zoom Out* command from the *View* menu to make the current worksheet view smaller. The Zoom Out command has the capability to zoom out multiple times. When the minimum zoom has been reached the Zoom Out command will be dimmed.

The Zoom Out command can be accessed on all worksheet Toolbars excluding the Profile worksheet. This button will speed up the Zoom Out process if multiple zooms are desired.

- **Zoom Out Button:**

5.3.3 100%

Select the *100%* command from the *View* menu to return the worksheet to its default display size.

The 100% command can be accessed on all worksheet Toolbars excluding the Profile worksheet.

- **100% Button:**

5.3.4 Data Table Tabs

The *Data Table Tabs* sub-menu commands let the user show or hide the Data Table tabs on the Profile worksheet. When a Data Table tab is displayed a check mark appears beside the command on the menu.

5.4 Format Menu

The Format menu includes commands that change the layout or pattern of the text in user configurable cells.

5.4.1 Bold

Select the *Bold* command from the *Format* menu to turn data in a user configurable cell **bold**. Select the Bold command again to return to standard format.

The Bold command can be accessed on the Toolbar of the Spreadsheet and Admin worksheets.

- **Bold Button:**

5.4.2 Italic

Select the *Italic* command from the *Format* menu to turn data in a user configurable cell *italic*. Select the Italic command again to return to standard format.

The Italic command can be accessed on the Toolbar of the Spreadsheet and Admin worksheets.

- **Italic Button:**

5.4.3 Underline

Select the *Underline* command from the *Format* menu to <u>underline</u> data in a user configurable cell. Select the underline command again to return to standard format.

The Underline command can be accessed on the Toolbar of the Spreadsheet and Admin worksheets.

- **Underline Button:**

5.4.4 Alignment (Left, Center, Right)

Select the *Left*, *Center* or *Right* command from the *Format* menu to align data in a user configurable cell.

The alignment commands can be accessed on the Toolbar of the Spreadsheet and Admin worksheet.

- **Alignment Buttons:** (*Align Left, Center, and Align Right*)

5.5 Window Menu

The Window menu arranges opened workbook files for viewing and quick access.

5.5.1 Cascade

Select the *Cascade* command from the *Window* menu to cascade opened workbook files from the upper left corner overlapping the workbooks downward so each workbook Title bar is visible.
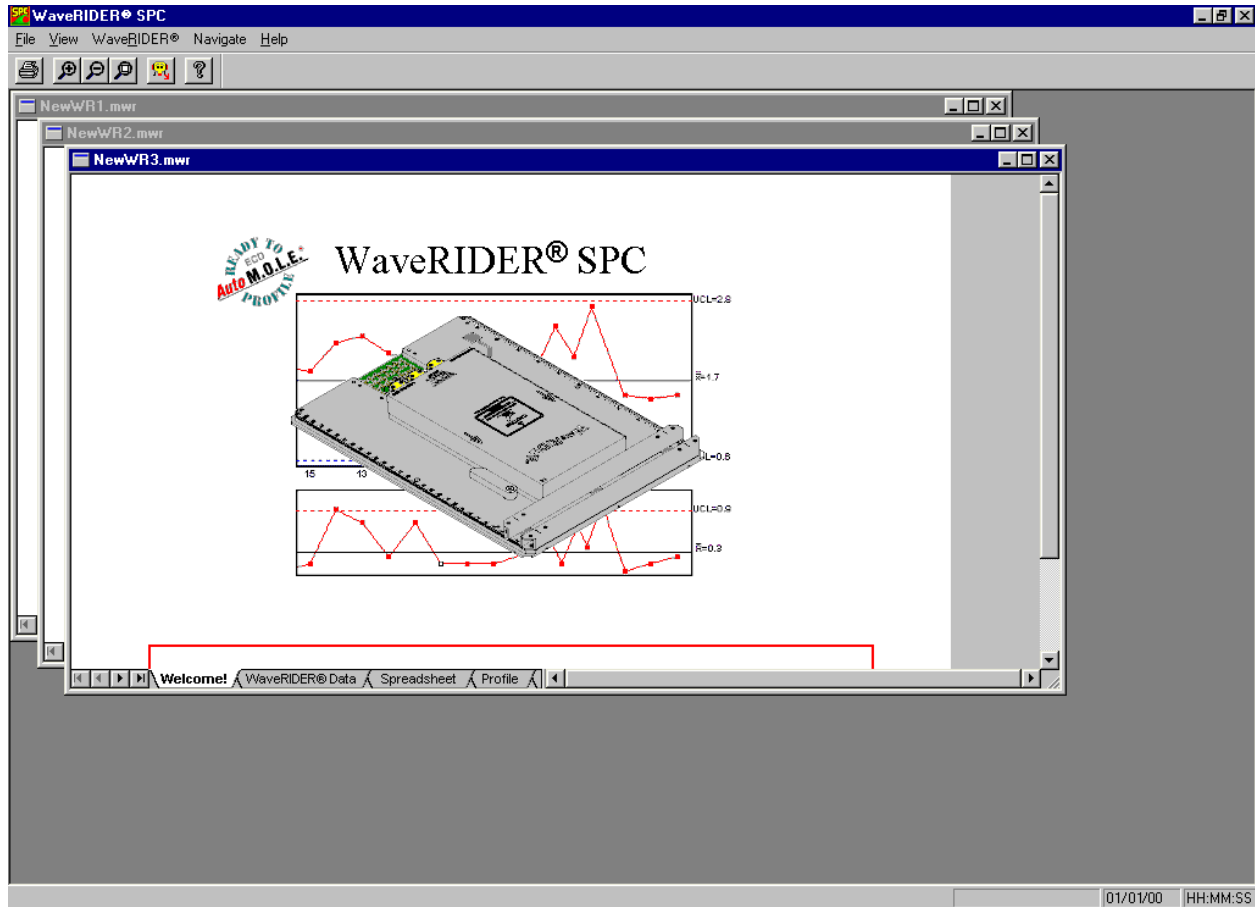
Figure 5- 28: Cascaded Workbook Files

5.5.2 Tile

Select the *Tile* command from the *Windows* menu to arrange the open workbook files in a rectangular fashion dividing the workbook files into smaller sizes arranged so they fit next to each other on the display.
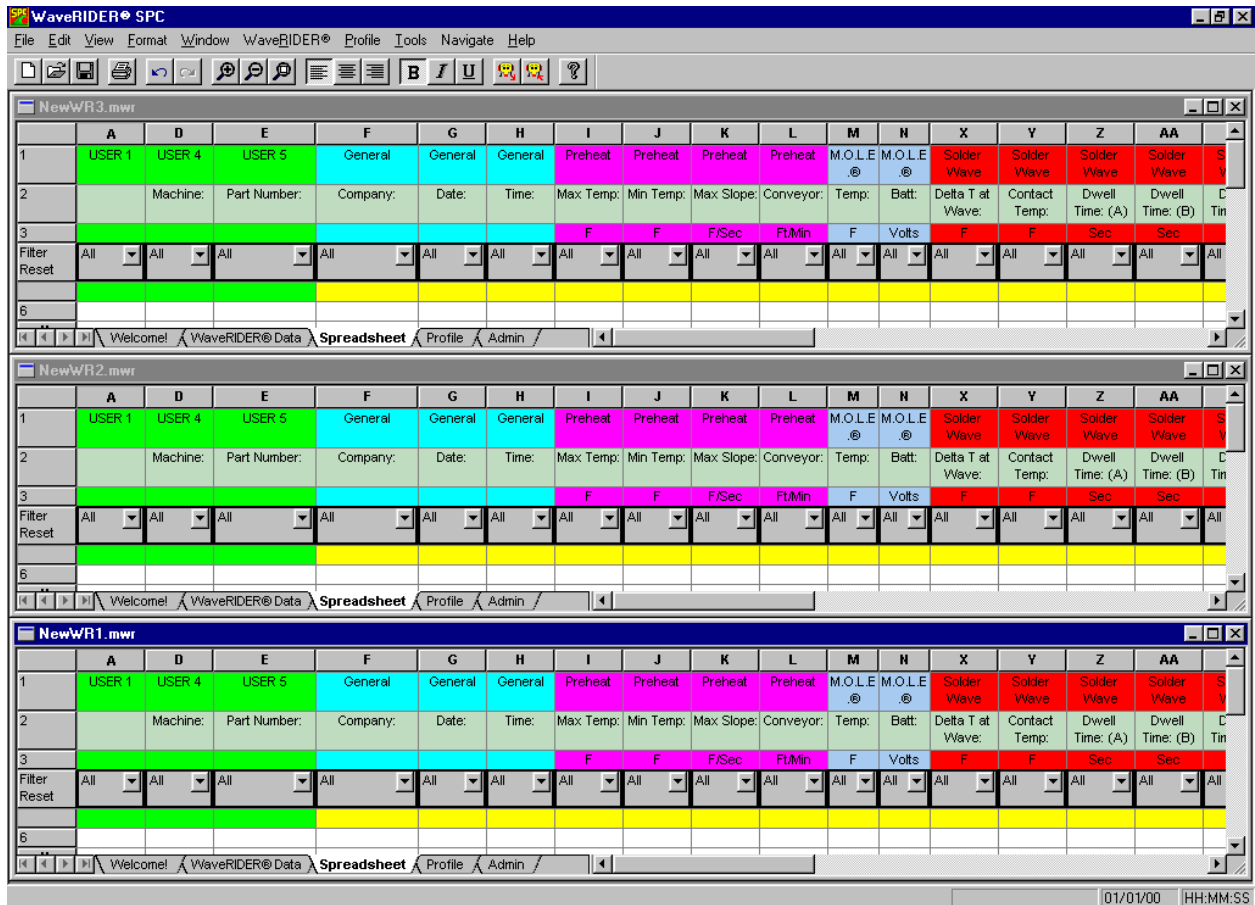
Figure 5- 29: Tiled Workbook Files

5.5.3 Open File

This section of the Window menu shows the currently opened workbook files. This allows quick access to all of the opened workbook files. Selecting a workbook file name to bring it to the front of the opened workbooks and make it active.

5.6 WaveRIDER Menu

The WaveRIDER menu commands configure the M.O.L.E. for collecting data.

> ⚠️ **The M.O.L.E. must be connected to a PC and the proper communication port must be configured to properly use the WaveRIDER menu commands.**

5.6.1 Configuration Wizard

This wizard guides a user through the communications setup process so the software and M.O.L.E. can communicate. Communications configuration needs to be done when the software is first installed or PC hardware configurations have changed.

> 🔧 **The wizard steps can be accessed individually on the *File* and *WaveRIDER* menus.**

To configure communications:

1) Connect the M.O.L.E. to the PC (refer to the appropriate section in the Hardware manual).

2) Select the *Configuration Wizard* command from the *M.O.L.E.* menu and the Configuration dialog box appears.
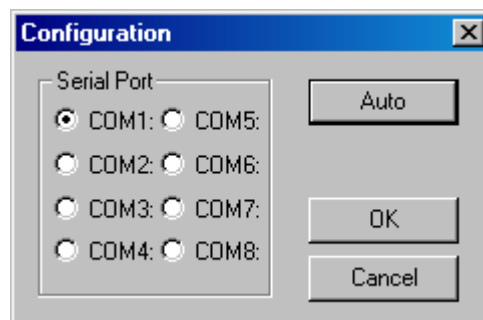
Figure 5- 30: Wizard Step 1 – Configuration

3) Click the option button next to a COM port which the PC is set up for RS-232 communications or the *Auto* command button to have the software automatically find the COM port the M.O.L.E. is connected.

> 🔧 **The user can exit the Configuration Wizard any time by selecting the *Cancel* button.**

4) Enter the correct month, day, year, hour, minute, and second by adjusting the slider(s) or manually typing in the corresponding text box.
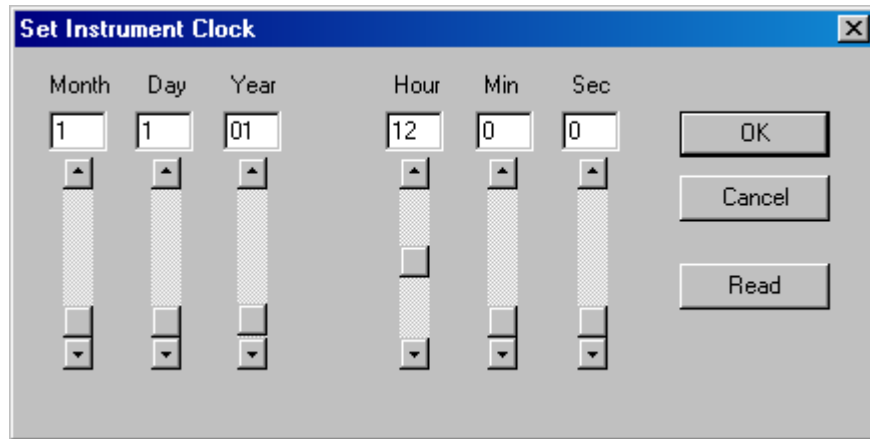
Figure 5- 31: Wizard Step 3 -Set Instrument Clock

⚠️ **When the Set Instrument Clock dialog box appears the current computer clock setting is automatically entered in the text boxes.**

5) Click the *OK* button to reset the clock.

Configuration is now complete and the M.O.L.E. is ready to collect data.

5.6.2 Set M.O.L.E. Clock

The M.O.L.E. has an internal clock it uses to identify the time and date of each data run and to control when each measurement is recorded. The M.O.L.E. clock should be set prior to data collection to ensure that the proper time was recorded.
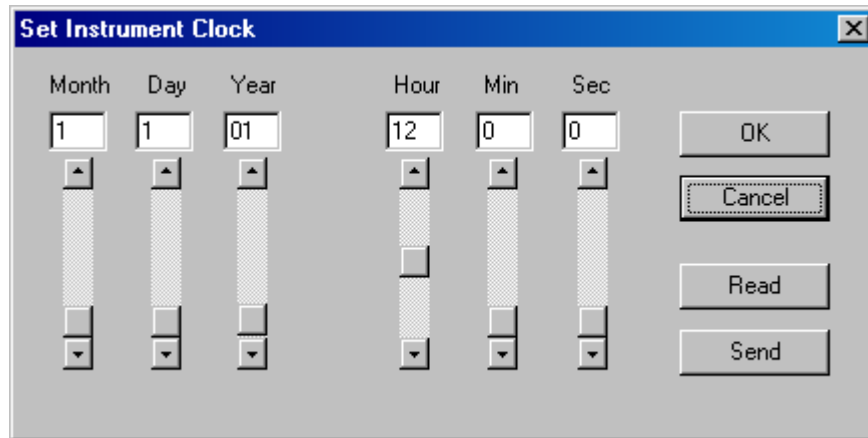
Figure 5- 32: Set M.O.L.E. Clock Dialog Box

To set the M.O.L.E. clock:

1) Connect the M.O.L.E. to the PC (refer to the appropriate section in the Hardware manual).

2) Select the *Set M.O.L.E. Clock* command from the *WaveRIDER* menu.

3) Enter the correct month, day, year, hour, minute, and second by adjusting the slider(s) or manually typing in the corresponding text box.

> **When the Set Instrument Clock dialog box appears the current computer clock setting is automatically entered in the text boxes.**

4) Click the *Send* button to reset the clock.

When the setting of the clock is completed, a dialog box with the configuration data appears.

To read the M.O.L.E. clock:

1) Connect the M.O.L.E. to the PC (refer to the appropriate section in the Hardware manual).

2) Select the *Set M.O.L.E. Clock* command from the *WaveRIDER* menu.

3) Click the *Read* command button to display the current date and time from the M.O.L.E.. If the clock is set wrong, the date or time will be incorrect.

5.6.3 WaveRIDER Settings

The M.O.L.E. can be configured to store the name of your company, operator or machine name.

To select WaveRIDER settings:

1) Connect the M.O.L.E. to the PC (refer to the appropriate section in the Hardware manual).

2) Select the *WaveRIDER Settings* command from the *WaveRIDER* menu.

3) Type a company, operator, or machine name in the text box.
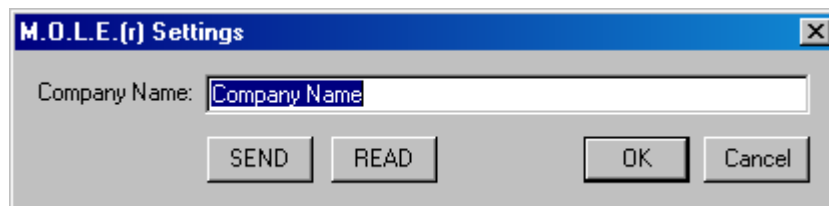
Figure 5- 33: WaveRIDER Settings

4) Click the *Send* command button to store the information in the M.O.L.E.

5) When the process is complete, a dialog box appears confirming the information sent. Click the *OK* command button and the Set M.O.L.E. Clock dialog box appears for verification of the clock settings. Click the *OK* command button and the software will return to the worksheet.

Using this command may cause the M.O.L.E. to lose any previous data collected.

The WaveRIDER Settings command can be accessed on the Toolbars of the Spreadsheet, Profile, and Admin worksheets.

- **WaveRIDER Setting Button:**

5.6.4 Read WaveRIDER Data

The Read WaveRIDER Data command starts the data transfer process after completing the data collection process.

To read WaveRIDER data:

1) Connect the M.O.L.E. to the PC (refer to the appropriate section in the Hardware manual).

2) Select the *Read WaveRIDER Data* command from the *WaveRIDER* menu and a status bar dialog box appears indicating that data retrieval from the M.O.L.E. has begun.
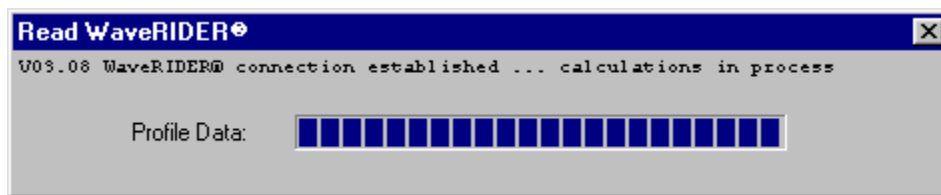
Figure 5- 34: Read WaveRIDER Dialog Box

Once data transfer is complete, the dialog box will disappear and will return to the current worksheet.

⚠ℹ **If the WaveRIDER has not collected enough data to create a complete profile a message box appears (*See Figure 5- 35*).**

Figure 5- 35: Communication Error Dialog box

The Read WaveRIDER Data command can be accessed on all worksheet Toolbars.

• **Read WaveRIDER Data Button:**

5.7 Profile Menu

The Profile menu includes special commands specifically used on the Profile worksheet. Commands in this menu enable the user to view and edit experimental documentation, change the appearance of the display and design experiments.

5.7.1 Part

Part documentation is information about the part being profiled. There are also fields for entering the date the data was recorded, a user name, part number or identification of the component being profiled. To enter Part Documentation select the *Part* command from the *Profile* menu and a dialog box appears.

The part date field automatically updates when reading data from the M.O.L.E.

Figure 5- 36: Part Dialog Box

5.7.2 Process

Select the *Process* command from the *Profile* menu to enter and edit information about the process that generated the profile data.
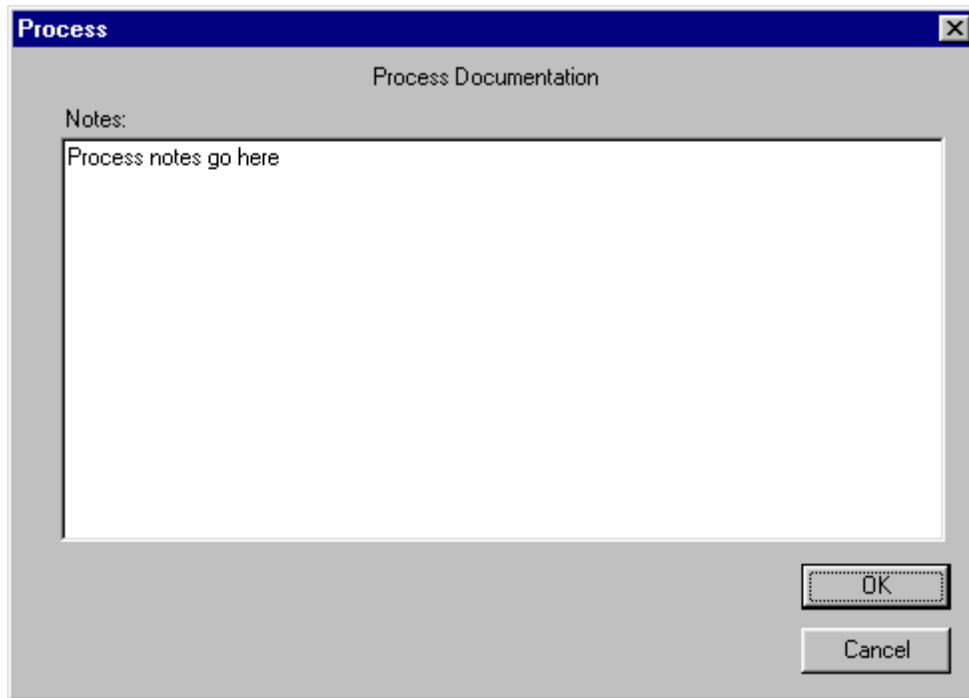
Figure 5- 37: Process Dialog Box

5.7.3 Scaling

The Scaling command controls the scale of the X and Y axis units of the Data Graph on the Profile worksheet.

To use the scaling command:

1) Select the *Scaling* command from the *Profile* menu, and the scaling dialog box appears. This dialog box identifies the current settings of the displayed Y-axis units and the maximum and minimum values of the Y-axis.
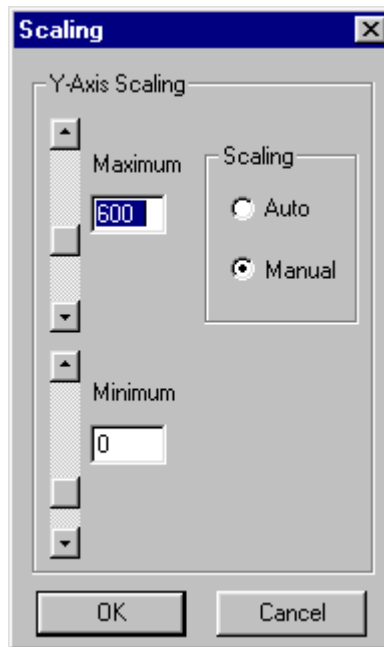
Figure 5- 38: Scaling Window

2) Select between *Auto* or *Manual* mode. In Auto mode, the software selects the scale of the Y-axis to ensure all data point values and the highest zone temperature settings are visible in the Data Graph. In Manual mode, the range of values for the Y-axis can be manually set.

3) Click the *OK* button to use the new settings or *Cancel* to return to the Profile worksheet with no changes.

The Scaling command is not avalible if the Data Graph has been magnified.

5.7.4 X-Axis Units

The X-Axis Units command is where the unit type for the Data Graph X-axis is selected.

To select a X axis unit:

1) Select the *X-axis Units* command from the *Profile* menu and the Units dialog box appears.
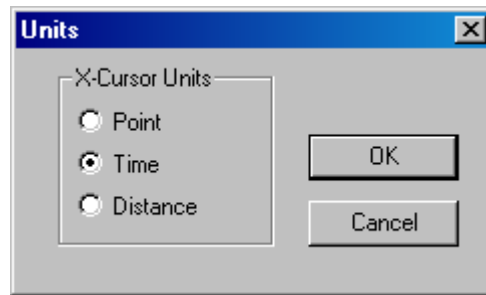
Figure 5- 39: Units Dialog Box

2) Click the option button beside *Point*, *Time* or *Distance* to select the units for the X-axis.

- Point: the data points collected from the Process Origin.

- Time: Time measured from the Process Origin

- Distance: Distance from the Process Origin (Meters, Centimeters, Feet or Inches).

3) Click the *OK* command button to return to the worksheet using the new settings or *Cancel* to make no new changes.

5.7.5 Temp Ref Lines (Temperature Reference Lines)

Temperature Reference Lines are colored horizontal lines and can be positioned anywhere within the range of Y-values in the graph using the *Temp Ref Lines* command in the *Profile* menu.

Temperature Reference Lines are used for analysis when the T Above Ref (Time above the Reference Line) statistic is active (refer to section *4.4.9.3 T Above Ref*)
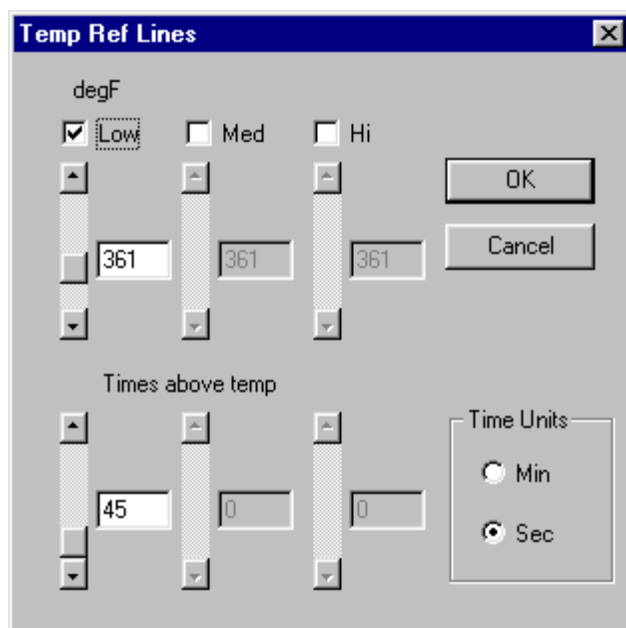
Figure 5- 40: Temp Ref Lines Dialog Box

The Temp Ref Lines dialog box identifies the units of the Y-axis and the current values of any Temperature reference lines in the Data Graph. Temperature reference lines can be added or changed at any time and must be created before the T Above Ref statistic will produce valid data in the Data Table.

To add Temperature Reference Lines to the Data Graph:

1) Select the *Temp Ref Lines* command from the *Profile* menu.

2) Click the check box above *Low*, *Med*, or *Hi* to draw that line in the graph.

3) Enter Y-axis value(s) by adjusting the slider position or typing it in the text box.

4) Click the *OK* command to return to the Profile worksheet using the new settings or *Cancel* to not make any changes.

5.7.6 Profile Colors

The Profile Colors command changes the display and print colors for the sensor Data Plots.

To change sensor channel colors:

1) Select *Profile Colors* from the *Profile* menu and the Select Colors dialog box appears.

When the colors are changed it will affect all existing and new workbooks.
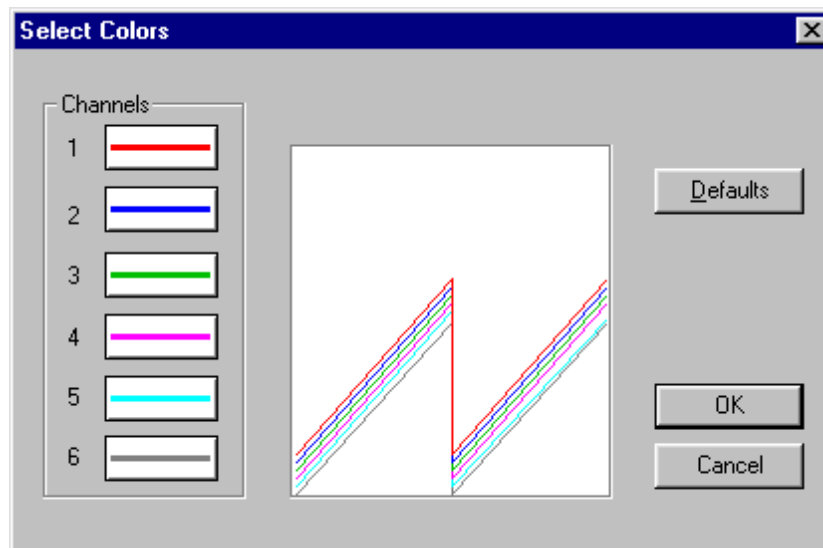
Figure 5- 41: Profile Colors Dialog Box

2) Click the desired sensor and a Windows default color pallet appears.

3) Selected a new color and click the *OK* command button to accept and exit the color pallet. (Repeat for all of the other channels).

4) Click the *OK* command to accept or *Cancel* to not make any changes.

• Click the *Defaults* command button to restore the colors to the original default colors.

5.8 Tools Menu

Options in this menu help you manipulate and analyze the profile data.

5.8.1 Magnify Tool

The Magnify tool enlarges any selected area of the data graph for easy visual examination.

<u>To Magnify a portion of the Data Graph:</u>

1) Click the *Magnify* tool from the *Tools* menu.

2) Position the mouse pointer on a corner of the area to enlarge.

3) Press the left mouse button and drag the pointer diagonally to the opposite corner to form a box around the area to be magnified. An outline of the box appears as you drag.

4) Release the left mouse button when the outline of the area to be magnified is visible. The area inside the box is then magnified to fill the entire Data Graph.

To show even more detail in the Data Graph, Magnify can be performed multiple times. If the Magnify tool reaches the maximum zoom capability the software will display a message box informing that the user has "Zoomed to Tight".

When using the Magnify tool, the Magnify Map uses a red box to indicate the area currently magnified. If the Data Graph was previously magnified, the current level of magnification is the red box and previous magnified areas are noted with gray boxes.

Figure 5- 42: Magnify Map

When the Magnify tool has been used multiple times, click a red box in the Magnify map once to go back to a previously selected level of magnification or the white area to return to the full view.

Magnify Applications:
Magnify is useful for visually examining data, when statistics are used. The statistics (Value, Time to Ref., T Above Ref, and Statistics) compute only data points that fall within the area of the Data Graph. This enables the user to focus the statistical analysis on any portion of time, distance, or data point number in the graph.

The Magnify command can be accessed on the Profile worksheet Toolbar.

• **Magnify Button:**

5.8.2 Slope Tool

The Slope tool finds the average slope between any two points in the Data Graph.

<u>To find the average slope of a line:</u>

1) Select the *Slope* tool from the *Tools* menu.

2) Position the mouse pointer at a point on the curve.

3) Press and hold the left mouse button.

4) Drag the pointer to the end of the desired slope line.

5) Release the left mouse button when the pointer is at the desired location. The software will draw a slope line on the Data Graph, and label the slope value.
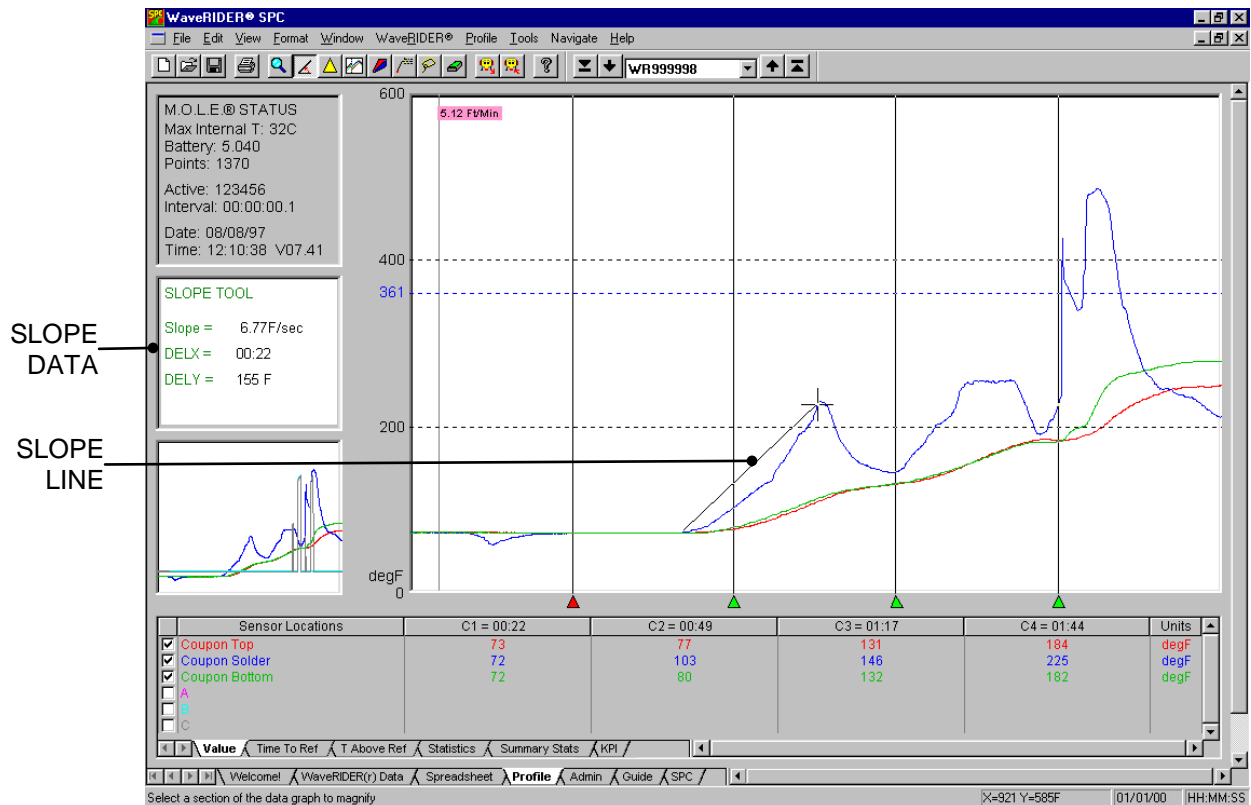
Figure 5- 43: Slope Tool

To obtain more accurate slopes:
Magnify a portion of the Data Graph using the Magnify tool, and repeat this procedure.

To remove the slope line from the Data Graph, select the *Erase Object(s)* command from the *Tool* menu and follow instructions in the Tool Status box (refer to section *5.8.8 Erase Object(s)*).

Slope Applications:
Use the Slope tool to find the average slope between any two points on the graph. Longer slope lines tend to produce more accurate slope calculations.

The Slope tool can be used to compare actual data with ideal conditions by drawing a line with a known slope (to represent the ideal condition) beside a portion of a Data Plot.

Slope Limitations:
Slope calculations are based on logged points connected by the slope line. Points occur only at the exact time intervals used to record data.

The Slope tool cannot measure slopes when dx (change in X) is equal to zero (when the line is vertical).

The Slope tool can be accessed on the Profile worksheet Toolbar.

- **Slope Button:**

5.8.3 Peak Difference Tool

The Peak Difference tool displays the difference in value between the peak of the maximum Data Plot and the peak of the minimum Data Plot in any location of the Data Graph. This command is especially useful for measuring side-to-side heating differences in ovens.

To display the peak difference between Data Plots:

1) Select the *Peak Difference* tool from the *Profile* menu.

2) Position the mouse pointer on a corner of the area you want to analyze.

3) Press the left mouse button and drag the pointer diagonally to the opposite corner to form a Peak difference box. An outline of the box appears as you drag.

The peak difference is calculated as the maximum difference between the highest peak and the lowest peak within the rectangle.

> **To remove the peak difference rectangle and annotation from the Data Graph, select the *Erase Objects* command from the *Tools* menu and follow instructions in the Tool status box (See section *5.8.8 Erase Object(s)*).**

Figure 3-9: Peak Difference Tool

The Peak Difference tool can be accessed on the Profile worksheet Toolbar.

• **Peak Difference Button:**

5.8.4 Overlay Tool

The Overlay tool displays a second Data run profile for comparison with the currently displayed Data run.

To compare two Data Plots:

1) Click the *Overlay* tool from the *Tools* menu. A list box of data files uploaded into the opened workbook appears.

2) Select a data run file to overlay on the original by clicking it.

The data file will be inserted at the same process origin and automatically scaled to the same Y-axis with the Overlaid file name displayed in the Tool status box. The original Data Plot remains as solid lines while those added for comparison are dashed.

> **The dashed "Overlay" Data Plots are the same color as the original Data Plots.**
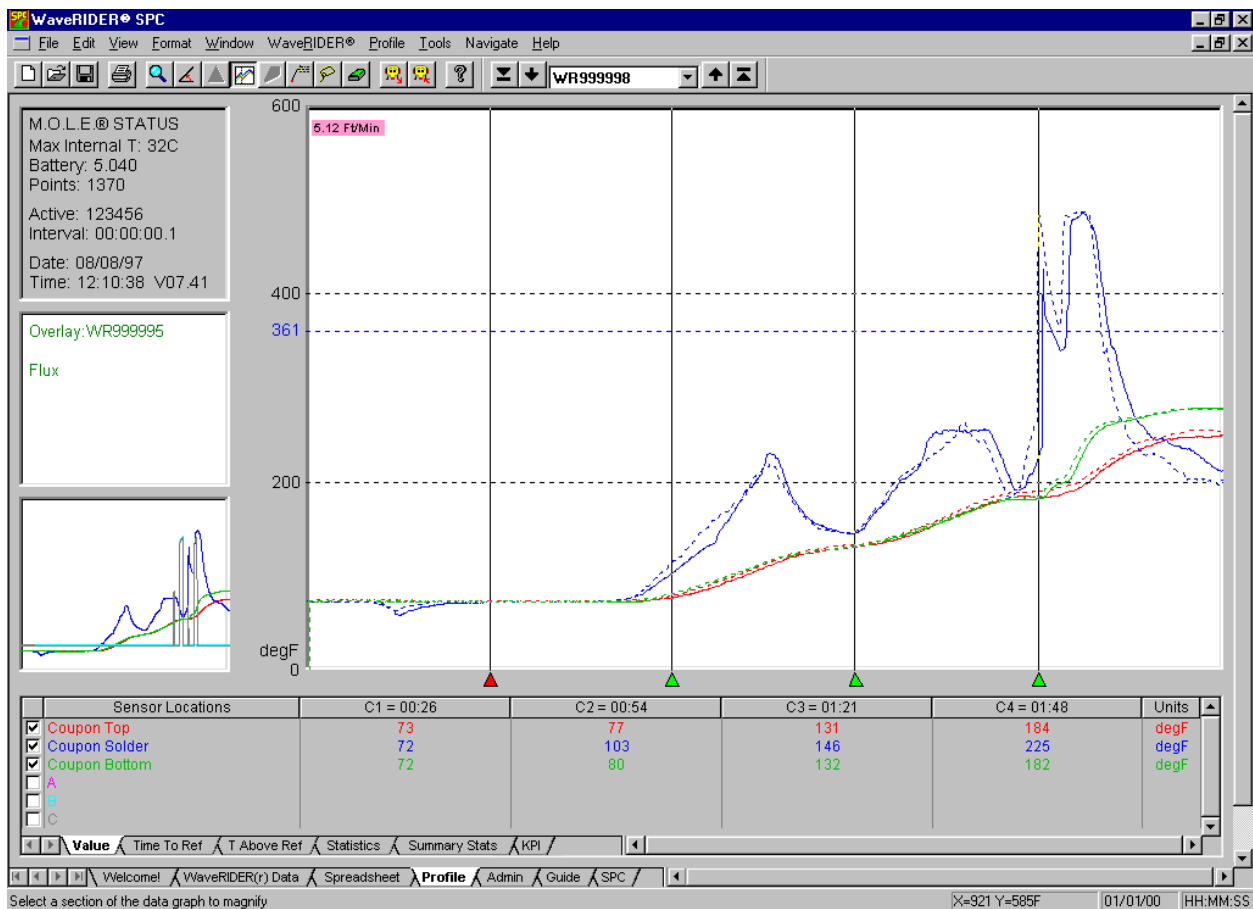
Figure 3-10: Overlay Tool

> **To remove the overlaid Data Graph from the original Data Graph select the Overlay tool again or press the right mouse button.**

Overlay Applications:

The Overlay and Magnify tools can be used together to overlay and compare ideal reference profiles and magnified portions of the two data files. They can have different but overlapping X-values (times, point numbers, logging intervals) or temperatures.

Overlay Limitations:

If the Data Plots are too numerous to clearly see the information of interest, they can be suppressed by removing the check mark from the desired channel in one or both files. This must be done to the overlaid profile prior to using the Overlay tool. Save that graph and use the Overlay tool again.

The Overlay tool can be accessed on the Profile worksheet Toolbar.

- **Overlay Button:**

5.8.5 3-D View

The 3-D tool draws a 3-dimensional representation of the temperature data. When the 3-D tool is selected a dialog box appears prompting the user to select a "Normal" or a "Reverse-Angle" view. A "Normal" view displays the Coupon Top sensor in back and Coupon Bottom sensor in front, and a "Reverse-Angle" view displays the Coupon Bottom sensor in the back and Coupon Top sensor in front.

The 3-D profile, shown below, is useful for comparing the general smoothness of the Data Plots for each sensor or showing uniform temperature across the coupon.
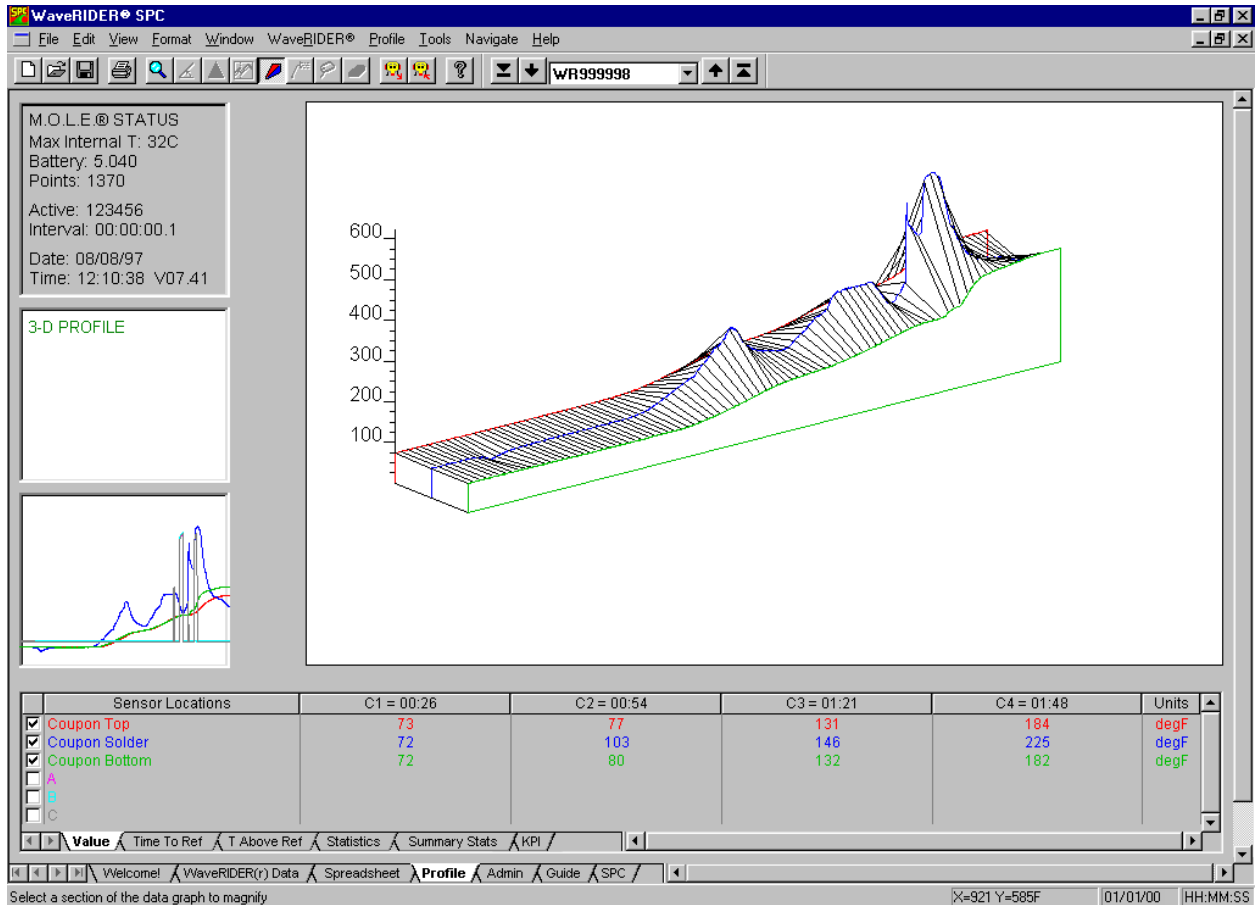

Figure 5- 44: Normal View
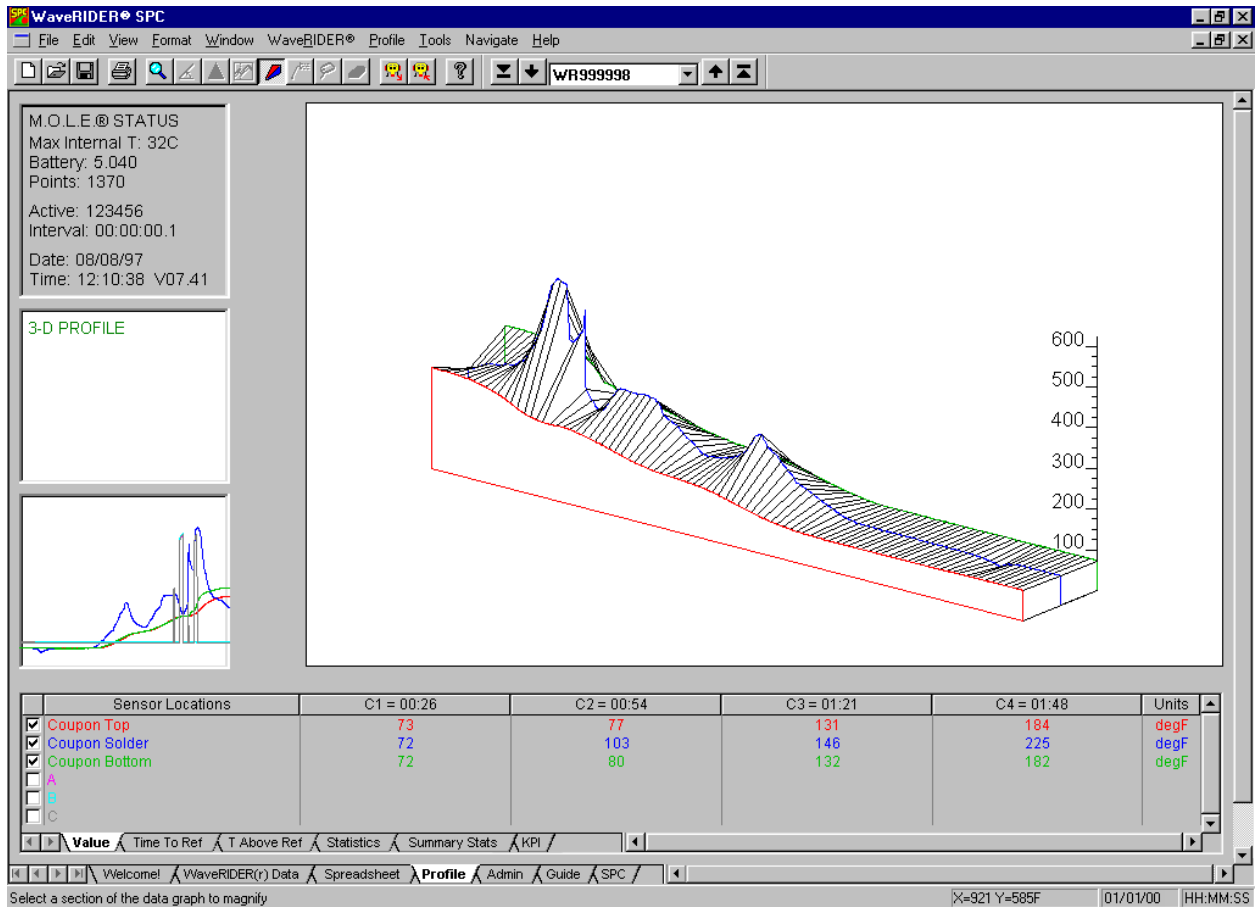
Figure 5- 45: Reverse-Angle View

To remove the 3-D profile, click the 3D tool, or click the right mouse button.

The 3-D tool can be accessed on the Profile worksheet Toolbar.

- **3-D Button:**

5.8.6 Measure Tool

The Measure tool is similar to the Slope tool except it measures the distance between any two points on the Profile worksheet Data Graph. This tool adds a line labeled with the distance values to the graph, and notes the change in X and change in Y (Delta X and Delta Y) instead of the slope.
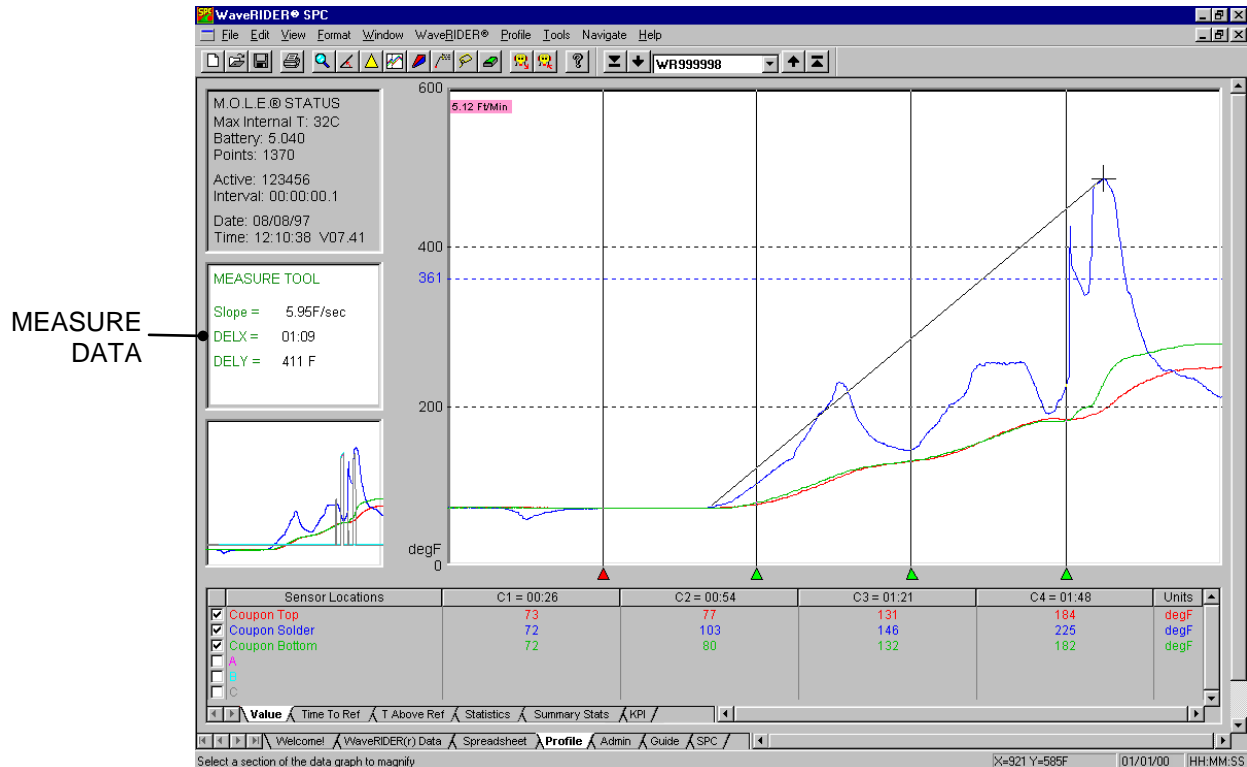
MEASURE
DATA

Figure 5- 46: Measure Tool

To find the distance between two points:

1) Select the *Measure* tool from the *Tools* menu.

2) Position the mouse pointer at a point on the curve.

3) Press and hold the left mouse button.

4) Drag the pointer to the end of the desired point on the curve.

5) Release the left mouse button when the pointer is at the desired location and a slope line labeled with the change in X and Y appears on the Data Graph.

To obtain more accurate distances, magnify a portion of the Data Graph using the Magnify tool and repeat this procedure.

To remove the annotated distance from the Data Graph, select the *Erase Objects* command from the *Tools* menu and follow instructions in the Tool status box (See section *5.8.8 Erase Object(s)*).

5.8.7 Notes Tool

The Notes tool adds a leader with text to any portion on the Data Graph to label special points of interest.

To add notes to the Data Graph:

1) Select the *Notes* tool from the *Tools* menu.

2) Position the mouse pointer at the desired location to start the note leader, click and drag the mouse pointer to the desired location for the note text and release the mouse button.

3) A dialog box will then appear allowing the user to enter a note by typing it in the text box. There also are options to customize the color, border and font size of the notes.

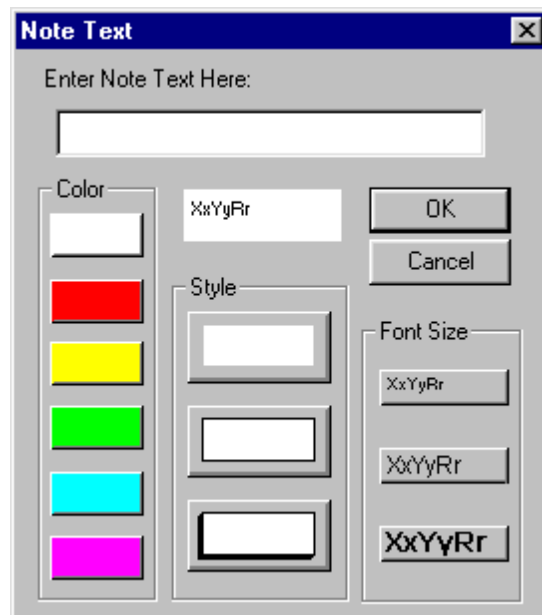*Figure 5- 47: Notes Dialog Box*

4) Click the *OK* command button or press the [*enter*] key to finish adding the note.

> **To remove notes from the Data Graph, select the *Erase Objects* command from the *Tools* menu and follow instructions in the Tool status box (See section *5.8.8 Erase Object(s)*).**

The Notes tool can be accessed on the Profile worksheet Toolbar.

- **Notes Button:**

5.8.8 Erase Object(s)

The Erase Object(s) command deletes objects and information that have been added to the Data Graph.

To erase object(s):

1) Select the *Erase Object(s)* command from the *Tools* menu.

2) Position the mouse pointer beside the object(s) to erase.

3) Press the left mouse button and drag diagonally to outline the object(s) to be deleted.

4) A message box asking, "*Do you wish to erase this object?*" appears for each object selected. (The object that the question is referring to will be surrounded by a red dashed box).

5) Click the *Yes* command button to continue erasing, or the *No* command button to cancel the operation.

If the Erase Objects command is selected and there are no object(s) to be deleted, click the right mouse button to escape from that command.

The Erase Object(s) command can be accessed on the Profile worksheet Toolbar.

- **Erase Object(s) Button:**

5.8.9 Erase All

The Erase All command deletes, in one operation, all the objects and information that have been added to the Data Graph.

This operation is not reversable, so use with CAUTION.

To erase all objects:

1) Select the *Erase All* command from the *Tools* menu.

2) A message box appears asking, "*Do you really want to erase all your objects*".

3) Click the *Yes* command button to continue erasing, or the *No* command button to cancel the operation.

If the Erase All command is selected and there are no object(s) to be deleted, the erase all command will simply redraw the screen.

The Erase All command can be accessed on the Toolbar of the Set & Verify worksheet.

Erase All Button:

5.9 Navigate Menu

When viewing a data run on the Profile worksheet, the Navigate menu allows the user to view other Profiles without having to select them from the Spreadsheet worksheet. It enables the user to view profiles that are one above or below the one currently being viewed, or jump to the first or last one uploaded into the open workbook.

Navigate Buttons

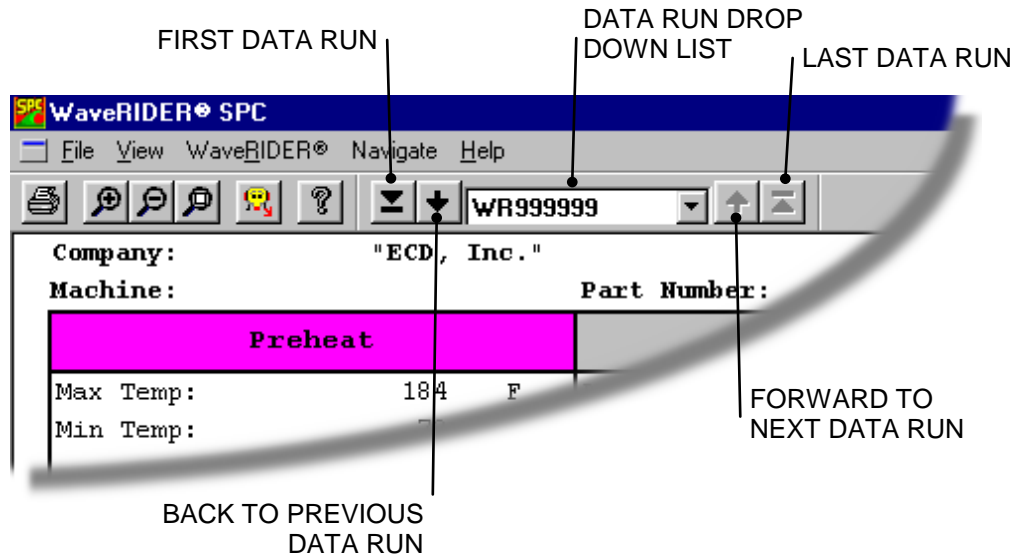The Navigate commands can be accessed on the WaveRIDER and Profile worksheet Toolbars.

Figure 5- 48: Navigate Tool Buttons

5.10 Help Menu

The Help menu commands are useful when information is needed quickly or when this Users guide is not available.

5.10.1 Help

The Help Index is a complete reference tool that can be used at any time. Select the *Help* command from the Help menu and Adobe Acrobat® Reader will automatically launch the users guide in a PDF document. You may now search for the help topic of your choice.

5.10.2 ECD on the Web

You can access more help by using ECD web commands. Let us help you by using the linked commands to the ECD Web site.

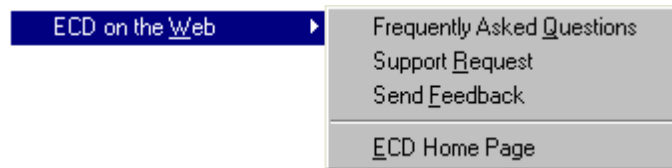*Figure 5- 49: ECD Web Sub-Menu*

5.10.3 About WaveRIDER

Select *About WaveRIDER* from the *Help* menu to display the software version, release date and company information.
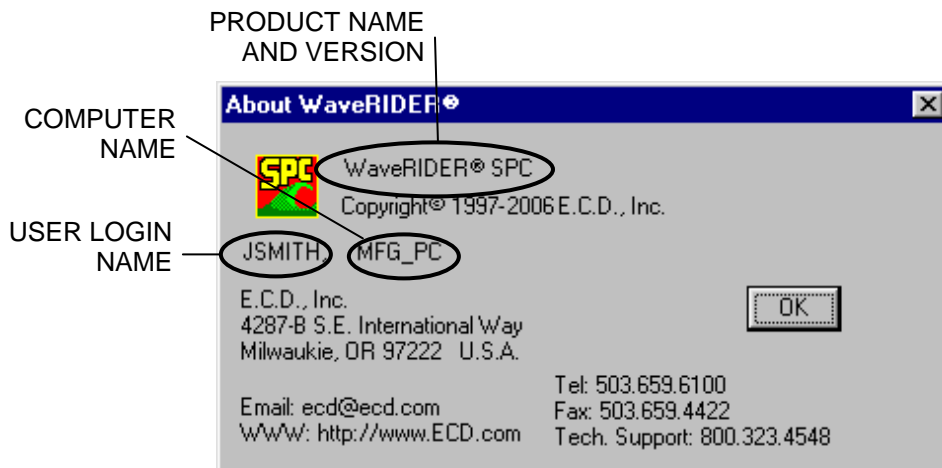

Figure 5- 50: About WaveRIDER Dialog Box

The About command can be accessed on all of the worksheet Toolbars.

- **About Button:**

6.0 Service and Calibration

General Service Information:

This section covers maintaining and troubleshooting the coupon thermocouples, software, wiring, and other parts of the system.

The following service instructions are for use by qualified personnel only. Refer to the summary and service safety summary prior to performing any service.

6.1 Service Troubleshooting

Check the appropriate section of the manual to be sure you're following the correct procedures.

Decide if the problem is with the RIDER, SuperM.O.L.E. Gold, or Software.

Once it has been determined what item is causing the problem, refer to the appropriate service section. Problems that are more likely or more easily corrected are listed first in each section. Start at the top of the list and work your way down. If the problem is still unresolved go to section *6.4 How to Get Additional Help*.

6.1.1 RIDER Troubleshooting Steps

Decide if the problem is with the Super M.O.L.E. Gold Hardware, communications or Software.

- If the problem occurs while attempting to log data, the Hardware may be faulty.

- If the problem occurs while attempting to communicate between SuperM.O.L.E. Gold and the PC, the Communications links may be faulty.

- If the problem occurs while attempting to use some other function of the WaveRIDER Software, the software may be faulty.

Incorrect or Inappropriate Readings:

Time, Speed or Contact Length measurements are dependent on good sensor contact with the solder wave. The most frequent causes of poor solder wave contact are:

1) Extremely turbulent solder wave.

   - Solder wave splash causes the wave to "miss" the sensor.

2) Extremely shallow or low solder wave.

   - The solder wave may be too low to reach the contacts.

   - The solder wave may be in contact less then 0.1 sec.

   - Raise wave, or lower RIDER.

3) Lack of solder flux.

   - Although not required, some flux does aid in duplicating the same conditions your product sees.

4) Too much flux or flux build-up over time.

   - Flux may insulate the sensor from the solder wave.

   - Clean the Pallet or sensor contacts (See section 3.5 Storing the RIDER).

5) Contact corrosion.

   - The flux may be too active and is corroding the contact material

6) Active acid fluxer can cause incorrect contact detection.

   - Start the RIDER after flux has been applied or run without flux

7) Fast conveyor speed readings can be caused by oven T/C's on the conveyor.

   - Replace coupon if suspected.

Temperature readings are taken from the three coupon sensors. Shorted or open T/Cs are the most common cause of errors. A shorted T/C will read near room temp or respond very slow relative to the other sensors. An open T/C will cause a sudden rise in the temperature graph printout and often ###°F or C values on the tables.
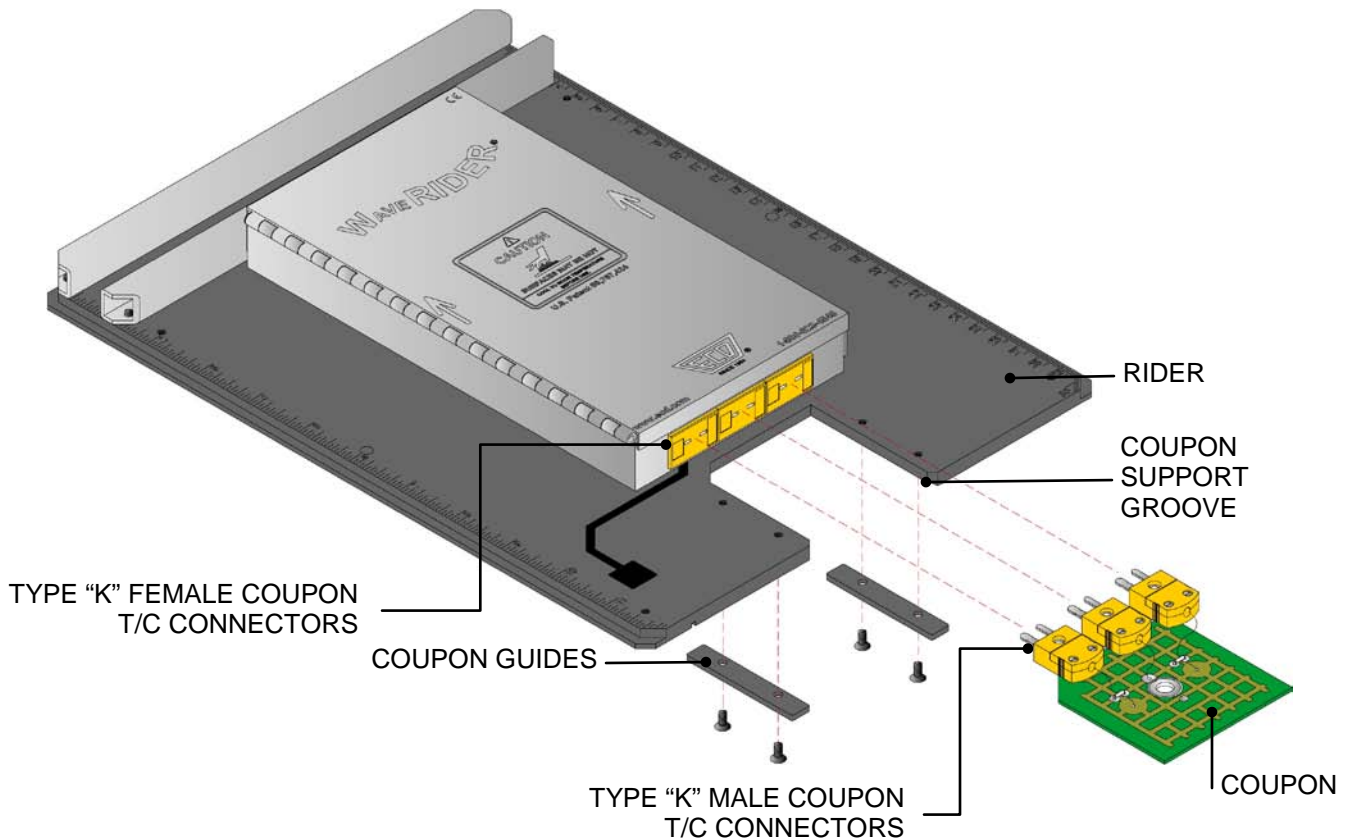
6.2 RIDER Coupon Replacement

To install a replacement RIDER coupon, the old or damaged coupon must first removed. Use the following steps to remove and replace the coupon:

1) Unplug the Male Type "K" thermocouple connectors from the female connectors.

2) Loosen the coupon guides by unscrewing the four black screws.

It is recommended to clean the accumilation of flux that may have built up in the coupon support groove.

3) Slide the replacement coupon assembly into the bottom coupon support grove.

4) Replace the coupon guides and align them with the coupon support holes.

5) Place the four screws in the holes and tighten them snugly.

6) Plug the three Type "K" male coupon thermocouple connectors into the three Type "K" female coupon thermocouple connectors.

Figure 5-51: Coupon Replacement

6.3 Checking the Coupon Thermocouples

Open thermocouples or loose connections may cause erratic readings. Visually check the thermocouples visually for breaks, crimps, or crushed insulation. With an ohmmeter or continuity indicator, check the thermocouples at the plugs. Tighten any loose or suspect connections. Replace the coupon if it still does not operate properly.

6.4 How to Get Additional Help

If you still have problems, let us help you. We offer many ways to service your problems. You can call our Sevice/Test technicians, visit our web site to view our FAQ section (Frequently asked Questions) or send us an e-mail explaining your problem in detail.

When calling our Service/Test technicians or sending us an e-mail, please include the following information:

- Product Description (i.e. WaveRIDER, Coupon)

- Software Version (i.e. 5.22)

Here is the information on how to contact ECD:
Telephone: (503) 659-6100
FAX: (503) 654-4422
Technical Support: (800) 323-4548
Email: ecd@ecd.com
Internet: http://www.ecd.com

APPENDIX A: Specifications

Electrical/Mechanical Spec:

Weight:	9" – 3.0 lbs (1352 grams)
	12" - 3.8 lbs (1633 grams)
	15" – 4.1 lbs (1787 grams)

Physical Dimensions: Length: 12" (30.5cm)
Height : 1.3" (3.3cm)
Width: 9" (22.9cm), 12" (30.5cm), 15" (38.1mm)
18" (45.7cm), Custom (more than 5.7", less than 18").

Power: Rechargeable Ni-Cad Power Pack
Charge Time: 14 hours
Expected Power Pack life: up to 400 charging cycles.
Number of runs per charge: 10 (Based on 9 minute runs)

Temperature Accuracy: T/C Sensor: (standard limits of error) ±4°F (2.2°C)
CJC Sensor: ±4.5°F (2.5°C) absolute
A/D System: ±0.3°F (0.17°C)
Conformity to IPTS-68*: ±0.1°F (0.06°C)
Channel to Channel: ±1.8°F (1°C)
Calibration points: 212°F (100°C) and 1832°F (1000°C)
±1.8°F (1°C)
Resolution:
    Printed: 1°F (1°C)
    Calculation: 0.1°F
Range: -200° - +2282°F (-129°C - +1250°C)

Time Accuracy: Time base: 1% of total seconds
Resolution: (Log rate) 0.1 seconds

Data Capacity: 9 minutes 6 seconds

Real-time
Clock/Calendar: ±1 minute/month at 25°C

Environmental

Temperature: Pallet - Short term 300°F (149°C)
    Long term 200°F (93°C)

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* **IPTS-68 (International Practical Temperature Scale of 1968)**

APPENDIX B: Statistical Process Control (SPC) Background Information

This appendix deals with the subset of SPC that is incorporated into WaveRIDER SPC. It does not address general SPC principals. A working knowledge of general statistical principals and SPC terms is assumed and is not addressed here. There are many good basic SPC books where this information may be obtained.

Wave Solder operators, engineers and production managers are expected to understand their wave soldering process so as to deliver quality products cost effectively. This is a continuous process.

First, the wave solder machine must be checked for consistency. A standard or typical set up should be routinely checked prior to any process set point determinations, or actual production run machine checks. Only after the machine has been determined to be operating correctly and not experiencing abnormal variation, should data from the wave solder machine be utilized. SPC is all about identifying common or normal variation from abnormal variation.

Second, the correct process set points must be determined for a particular product. Utilizing the ECD SuperM.O.L.E. Gold profiler, the correct set points for a particular product may be determined. These set points, if selected correctly and followed, should deliver the maximum throughput of quality product.

Third, the wave solder machine must consistently deliver the correctly determined set points. SPC will help identify common or normal variation from abnormal variation. Checking the wave solder machine using your ECD WaveRIDER with its SPC capability will help ensure that the reflow oven is consistently performing to it's set points and your expectations.

Fourth, repeat the above three steps. Continuous improvement is a never-ending cycle. Check the long-term variation of the wave solder machine by graphing typical set point samples. Using the SuperM.O.L.E. Gold profiler, recheck/adjust part number specific set points to maximize your quality throughput. Check the machine during a part number run to control the machine variation from that part number's actual ideal set points.

In the real world you may not want or be able to run your WaveRIDER through your wave solder machine continuously to collect process data. A more typical scenario is to check the machine by running the WaveRIDER through periodically: once per shift, once per day, once per week, or once after every maintenance cycle. In addition checking the wave solder machine at the start, middle or end of every part number run, at the start and end of every part number run or once during a part number run could be typical scenarios. Make sure you generate SPC charts based on data sets that had the same set points each time. Otherwise the charts will not be meaningful.

While SPC had its start in high volume repetitive operations, SPC is applicable to many other types of operations as well. However SPC can be difficult to apply to short runs. Short runs may be runs that take a short time to process, runs in which multiple samples are difficult to collect, and runs where samples are difficult to place into subgroups or runs where small quantities are run at a time.

There are several basic short run SPC techniques:

1) Nominals Charts

2) Individuals/Moving Range Charts

3) Moving Average/Moving Range Charts

4) Standardized Formula Charts

The Moving Average/Moving Range Chart technique is particularly well suited for situations where control information is desired as soon as possible and there is a relatively long time between sample collections. After considering the nature of wave solder operations and the wave solder machine sampling process, the Moving Average/Moving Range Chart technique was incorporated into WaveRIDER SPC.

Moving Average/Moving Range Chart Technique:

WaveRIDER SPC utilizes the standard Moving Average/Moving Range Charting technique with a subgroup size of 2-6 that is selected by the user. The following steps and figure illustrates the Moving Average/Moving Range calculations (using a group size of two) that are used to construct the SPC chart.

Steps for Creating a Moving Average Moving Range Control Chart

1) Select the key variable to monitor.

2) Select the moving average group size. (We will use two in our example.)

3) Obtain your first sample and record it as sample 1 (X1).

4) Obtain your second sample and record it as sample 2 (X2).

5) Determine the x-bar and R values.

> Moving Average formulas:
>
> $$\overline{X} = \frac{X_1 + X_2}{2} \qquad (Range)R = X_H - X_L$$

6) Plot this value on the chart as subgroup 1.

7) Carry forward sample 2 into subgroup 2's calculation. Obtain your third sample and record it as sample 3. The averages of sample 2 and sample 3 form subgroup 2.

8) Plot this value on the chart as subgroup 2.

9) Repeat for all the samples.

10) Calculate control limits using standard x-bar and R formulas for the appropriate sample sizes. WR SPC uses range-based calculations for LCL and UCL.

11) Continue monitoring the process.

SAMPLE #		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SAMPLE MEASUREMENTS		3	4	5	3	2	9	5	2	6	8	4	8	5	6	3	3
SUBGROUP VALUE	x̄		3.5	4.5	4	2.5	5.5	7	3.5	4	7	6	6	6.5	5.5	4.5	3
	R		1	1	2	1	7	4	3	4	2	4	4	3	1	3	0

Figure A-1: Moving Average/Moving Range Subgroup Size 2 Calculations Chart

Process Capability

A process capability index is a standard measure of how a process compares with its specification limits—how a process **is** performing relative to how it **is supposed to** perform. As opposed to the control chart, which shows detailed information about how the data compares with control limits, a capability index is a summary of how the data compares with the specification limits.
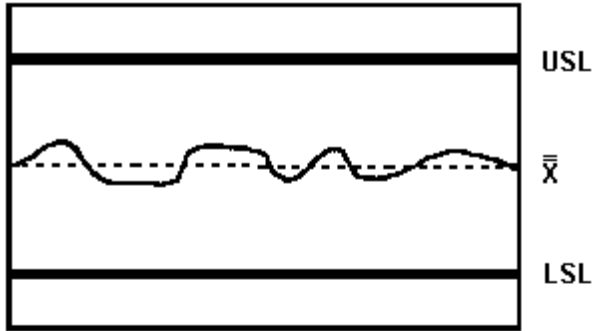
Two common capability indicators are Cp and Cpk. These values are shown in the Statistics Box on each SPC Worksheet.

Solder Wave	
Dwell Time: (A)	Sec
N:	8
Min:	2.3
Max:	2.6
X-2Bar:	2.5
Std-Dev:	0.09
Cp:	0.36
Cpk:	0.18

For both of the index values, the data used to determine them is dictated by the subgroup size (N) chosen by the user. In the case where N=1, individual data is used—for N>1, average data is used (x bar).

The figures below give a graphical representation of the concept of Cp and Cpk. Notice that in each graph, the same upper and lower specification limits (USL, LSL) are used. The values of Cp and Cpk will differ according to the data that is compared with those specifications.

Depending on the particular process being monitored, the desired value for Cp and Cpk may differ. In general, however, a Cp and Cpk of 1.33 or above is desired. This assures that the process is not only capable of meeting the required specification limits, but also has a built-in margin for error that may be needed in special circumstances. In addition to targeting a certain minimum Cp and Cpk, it is also desirable to have these two values equal one another. This indicates that the process is well-centered between the specification limits.
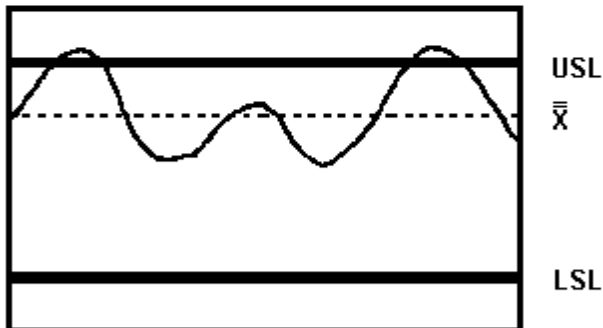
Cp ≥ 1.33: Data tightly distributed.

Cpk ≥ 1.33: Data well inside spec limits.
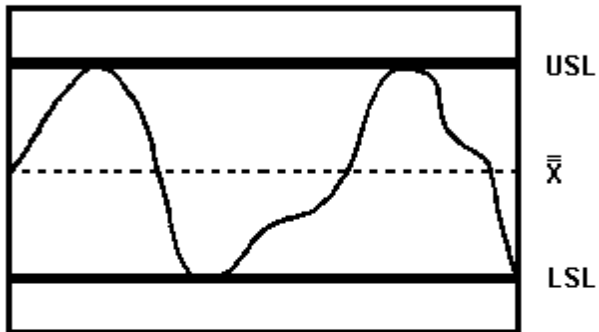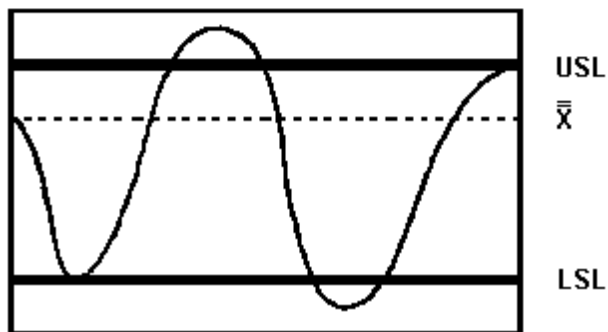
Cp = 1.00: Data fills entire spec range.

Cpk = 1.00: Data fills entire spec range.

Cp > 1.00: Data tightly distributed. If it were centered between the spec limits, no data would lie beyond those limits.

Cpk < 1.00: Some data is outside the spec limits.

Cp < 1.00: Data not tightly distributed. If it were centered between the spec limits, some data would still lie outside those limits.

Cpk < 1.00: Some data is outside the spec limits.

The equations used to calculate the index values are as follows:

$$Cp = \frac{USL - LSL}{6 * (Std.Dev.)}$$

$$Cpk = \frac{USL - \bar{\bar{x}}}{3 * (Std.Dev.)} \quad \text{OR} \quad Cpk = \frac{\bar{\bar{x}} - LSL}{3 * (Std.Dev.)}, \text{ whichever is less}$$

As can be interpreted from the above equations, Cp gives an indication of how narrow the data distribution is relative to the width of the specification limits. Essentially, it indicates how well the process would be able to stay within the specified limits if the data were perfectly centered between those limits.

Cpk compares the widest half of the data distribution to the appropriate specification limit. It indicates whether the process is capable of meeting the specification as indicated by the "worst half" of the measurements. Unlike Cp, the Cpk index measures process capability without assuming the data is well-centered.

The figures below give a graphical representation of the concept of Cp and Cpk. Notice that in each graph, the same upper and lower specification limits (USL, LSL) are used. The values of Cp and Cpk will differ according to the data that is compared with those specifications.

Depending on the particular process being monitored, the desired value for Cp and Cpk may differ. In general, however, a Cp and Cpk of 1.33 or above is desired. This assures that the process is not only capable of meeting the required specification limits, but also has a built-in margin for error that may be needed in special circumstances. In addition to targeting a certain minimum Cp and Cpk, it is also desirable to have these two values equal one another. This indicates that the process is well-centered between the specification limits.

APPENDIX C: Measurement Definitions

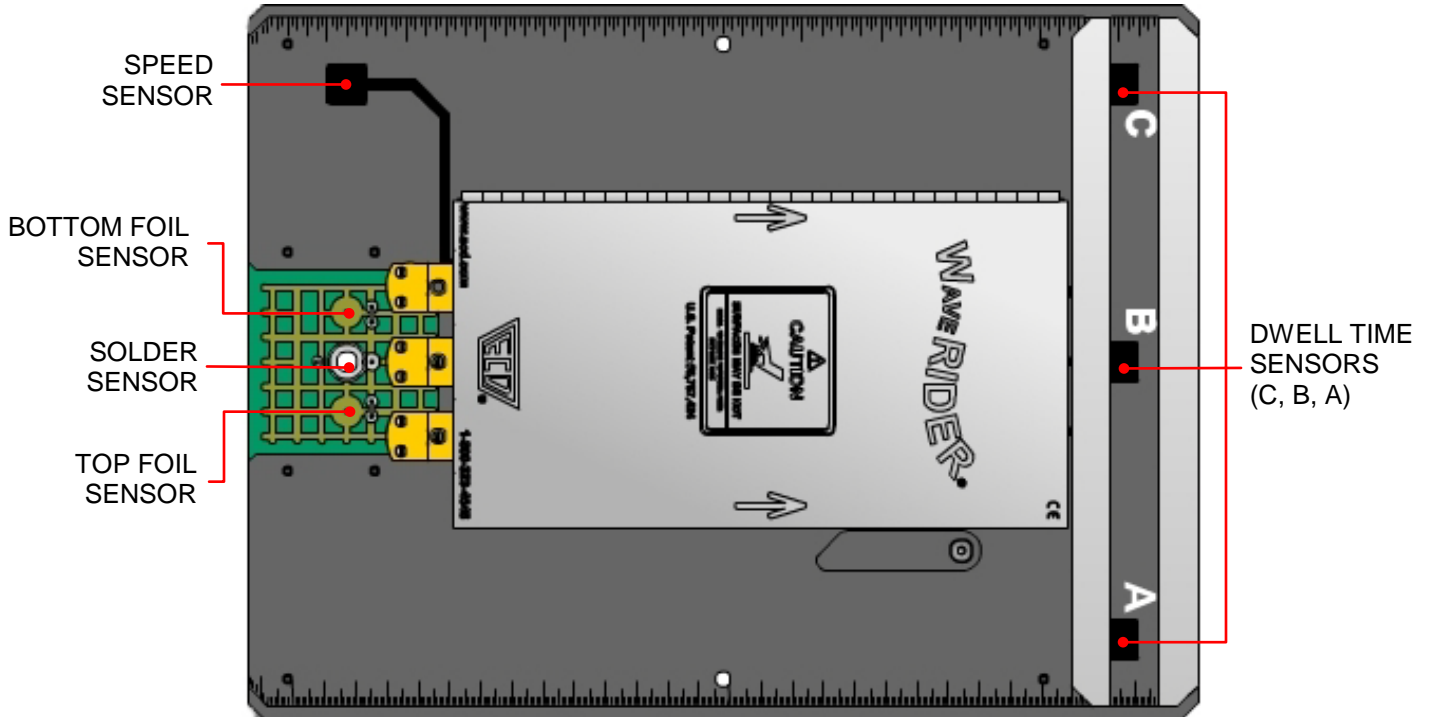This section defines how each solder machine parameter is measured and or calculated:

Figure C- 1: **Sensor Placements**

<u>PREHEAT</u>

<u>Preheat Max Temp:</u> The temperature of the Top Foil Thermocouple (Coupon Top) at the time when the Speed Sensor hits the first solder wave (chip wave or main wave). This records the change in temperature imposed by the preheat system on the top foil of a typical circuit board.

<u>Preheat Min Temperature:</u> The temperature of the Top Foil Thermocouple (T/C) at the first data point taken after the start button is pressed. This records the starting temperature of the top foil of the circuit board.

Preheat Max Slope: The largest temperature slope (positive or negative) seen on the Top Foil T/C between start and the Speed Sensor hitting the first wave (chip or main wave).

> **Slope is measured over a 1 second time interval using a "linear regression" technique (m = Slope).**
>
> $$m = \frac{n\sum(xy) - \sum x \sum y}{n\sum(x^2) - (\sum x)^2}$$

Conveyor (speed): The conveyor speed is found by dividing 9.75" (distance between C and Speed sensors) by the time measured between the C and Speed sensors hitting the main wave.

SOLDER WAVE

Delta T at Wave: The <u>maximum</u> overall temperature seen on the Top Foil T/C <u>after</u> the Speed Sensor hits the main wave **minus** the temperature of the Top Foil T/C <u>as</u> the Speed Sensor hits the main wave. This records the change in temperature imposed by the main wave on the top foil of a typical circuit board.

Contact Temperature: The maximum temperature seen on the Coupon Solder T/C after the Speed Sensor hits the solder wave to a user settable distance after the Speed Sensor disconnects from the main wave. This settable distance is typically the distance from the solder wave to the Hot air knife but may be less if it is seen that the hot air knife influences this temp prematurely. Range is from 0 to 30.5 cm (0 to12.0 in). The default is that this filter is off so the solder contact temp max is looked for to the end of the profile data.

Dwell Time (A, B, C): The time measured between the respective sensors entering and exiting the main wave. This records the total time each of the three sensors (A, B, C) spends in contact with the main wave.

Contact Length: The Dwell Time at A, B, and C times the measured Conveyor Speed. This records the total length of circuit board in contact with the main wave at any given instant while in the wave.

Immersion Depth: This is a function of Contact Length and is calculated based on a known basic wave shape. This records the height of a free flowing solder wave relative to the bottom of the WaveRIDER pallet.
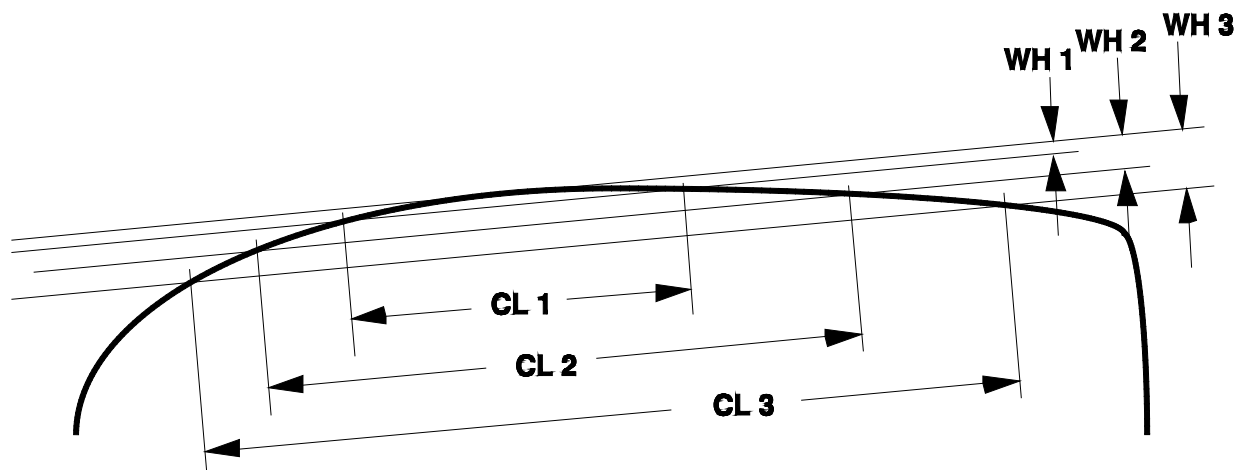
Figure C- 2: Wave Height

Parallelism: The Dwell Time at sensor C minus the Dwell Time at sensor A. This records the contact time difference between the left and right sides of the circuit board, which is a function of how parallel the bottom of the WaveRIDER pallet is to the crest of the wave.

CHIP WAVE

Delta T at Wave: The maximum overall temperature seen on the Top Foil T/C between the time the Speed Sensor hits the chip and main solder waves minus the Max Preheat Temp. This records the change in temperature imposed by the chip wave on the top foil of a typical circuit board.

Contact Temp: The maximum temperature seen by the Exposed T/C between the time the Speed Sensor hits the chip and main waves. This records the surface temperature of the chip wave.

Dwell Time (A, B, C); Contact Length; and Parallelism: These parameters are measured using the same techniques as those for the solder wave Dwell Times, except they are relative to the chip wave.

Chip Detection

Chip wave data is determined in the same manner as the solder wave. The presence of a chip wave is automatically detected when two solder contact points are detected on sensors A or B, or four solder contact points measured by sensor "C" / Speed Sensor. The solder contact time between the chip and solder wave for the C sensor must be greater than 1.0 seconds to be counted as separate wave contacts. If less than 1.0 seconds, the multiple solder contacts are considered "noise" or contact bounce and are counted as one wave contact rather than two.

In addition, as the distance between the chip and solder wave gets larger, the time between the C sensor leaving the solder wave and the Speed sensor hitting the chip wave must also be less the 1.0 seconds. If not, these two solder contacts will be seen as one wave for the same reasons stated above.

Figure C- 3 illustrates the interaction between the two waves and the WaveRIDER pallet sensors as described above.

Speed Sensor

Chip to Solder Wave Separation
Travel time between waves must be greater than 1.0 seconds.

C to Speed Sensor Separation
Travel time between C just exiting the solder wave and Speed sensor entering chip wave must be greater than 1.0 seconds.

Solder Wave
Contact Length

C Sensor just exits the Solder Wave
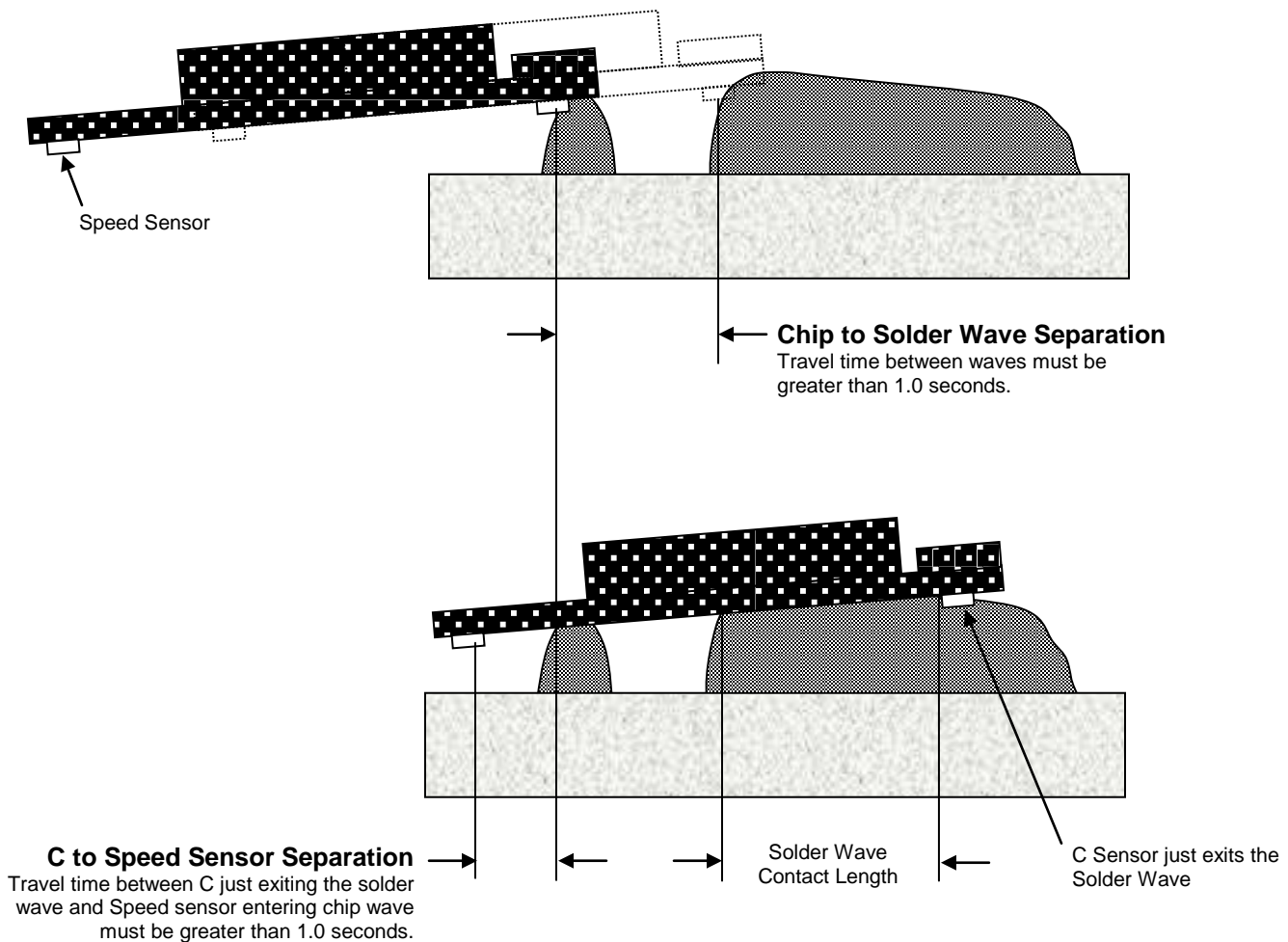
Figure C- 3: Chip/Solder Wave vs. WaveRIDER Pallet Sensors

The graph shown in *Figure C- 4* should be used to determine the maximum conveyor speed you may use to avoid violating the 1.0 second minimum travel time between sensors and waves. This is a function of the distance between the chip and solder waves and the average solder wave contact length.

Maxium Conveyor Speed vs Contact Length
Dropout Filter time = 1.0 Sec
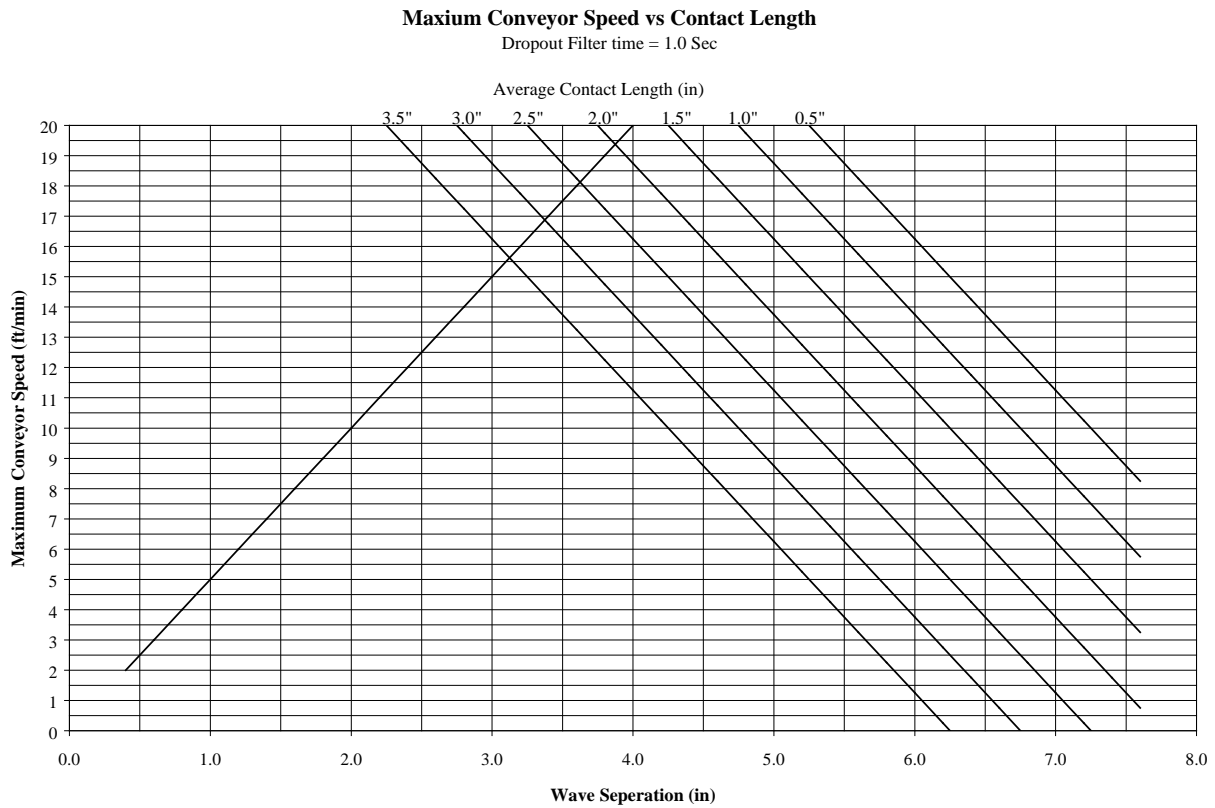
Figure C- 4: Dropout Time Graph

Locate the curve that represents your average contact length. Locate the Chip to Solder wave separation on the X-axis of the graph. Move up vertically until it intersects the contact length or the fixed curve. Look to the left to determine the maximum conveyor speed you may run.

COUPON TEMPERATURE STATISTICS

For all three coupon T/C's, the following is recorded:
(exception: solder sensor slopes are not calculated since they are normally very fast).

Min°: Lowest temperature seen throughout the data set.

Max°: Highest temperature seen throughout the data set.

Max (-) Slope: Greatest negative (falling) temperature change seen throughout the data set.

Max (+) Slope: Greatest positive (rising) temperature change seen throughout the data set.

Slope is measured over a 1 second time interval using a "linear regression" technique (m = Slope).

$$m = \frac{n\sum(xy) - \sum x \sum y}{n\sum(x^2) - (\sum x)^2}$$

Time > 361°F (183°C) = The total time spent above the typical solder melting point.

APPENDIX D: WR SPC Parameter Definitions

Value tab
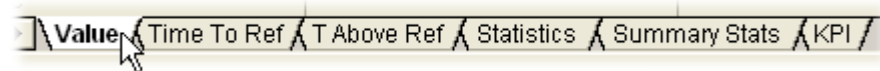
C1, **C2**, **C3**, **C4** indicate the point, time relative, time absolute, or distance (depending on the Units setting) on the X axis where the vertical cursors are set, respectively. The values below are the measured values for each channel at that position.

Time to Reference tab
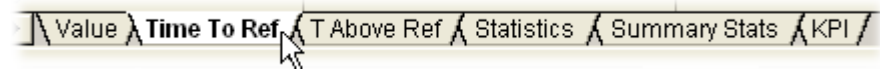
Low, **Medium**, and **Hi** are the temperatures set in the Temp Ref Lines dialog, if set. The values below these are the times in hours, minutes, and seconds (hh:mm:ss) that it takes for each channel to reach the respective reference value starting from the process origin.

Time Above Reference tab

Values shown in this tab are taken from the graph at it's present level of magnification. X-axis values outside of view are not included in the calculations. Y-axis values, however are included regardless of magnification level.

Low, **Medium**, and **Hi** are the temperatures set in the Temp Ref Lines dialog, if set. The values below these are the times in hours, minutes, and seconds (hh:mm:ss) that each channel spent at or above the reference value, if at all. All time above the reference values are accumulated in the total no matter where they occur.

Cure Factor%. The cure factor % is based on the time a sensor temperature was above a temperature reference line divided by the time you entered in the Times Above Temp (TAT) section of the Temp Ref Lines dialog box. This equation gets more complicated as you add more temperature reference lines. The graph illustrates the times used (shaded area) to sum the total curing time each temperature threshold contributes.

The following equation is used when all three temperature reference lines are used:

Cure Factor % = 100 * (HItime/HItat + (MEDtime – HItime) /MEDtat + (LOtime – MEDtime)/LOtat)

The same basic equation is used when there are only two (any two) temperature reference lines used:

Cure Factor % = 100 * (HItime/HItat + (MEDtime – HItime) /MEDtat)

or

Cure Factor % = 100 * (MEDtime/MEDtat + (LOtime – MEDtime) /LOtat)

or

Cure Factor % = 100 * (HItime/HItat + (LOtime – HItime) /LOtat)

Finally, if only one temperature reference line is used, the equation is simply:

Cure Factor % = 100 * time/tat (which ever temp ref line you are using)
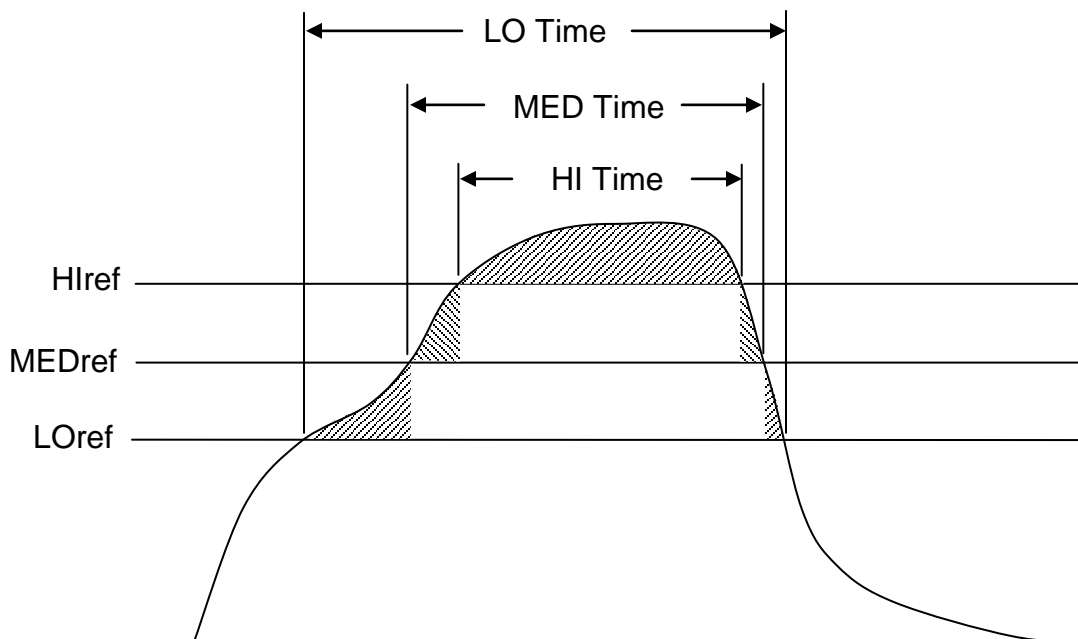
Statistics tab
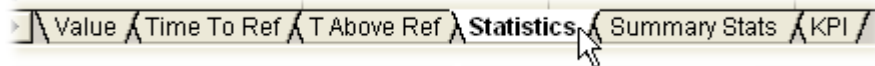
Values shown in this tab are taken from the graph at it's present level of magnification. X-axis values outside of view are not included in the calculations. Y-axis values, however are included regardless of magnification level.

Minimum is the lowest value measured. The values below are the minimum values for each channel.

Minimum X is the point in time where the minimum value occurred. The values below are the first point on the X-axis where the minimum value occurred for each channel.

Maximum is the highest value measured. The values below are the maximum values for each channel.

Maximum X is the point in time where the maximum value occurred. The values below are the first point on the X-axis where the maximum value occurred for each channel.

Average is based on the following equation:

$\Sigma x/n$

Where **n** is the number of data points and x is the value of any given data point. The values below are the average values for each channel.

Standard Deviation is based on the following equation:

$$\sqrt{(n \cdot \Sigma x^2 - (\Sigma x)^2)/n} \cdot$$

Where **n** is the number of data points and x is the value of any given data point. The values below are the standard deviation values for each channel. Small standard deviation means the data is used to calculate it is well centered around the average of that same data.

Summary Statistics tab
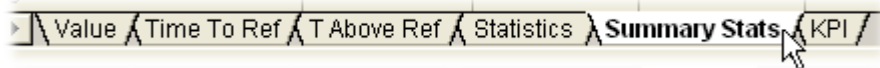
Values shown in this tab are taken from the intire graph regardless of its level of magnification.

Peak Temperature is the largest measured value. Values below are the largest value recorded for that channel. The higher the peak temperature, the greater the possibility for component damage.
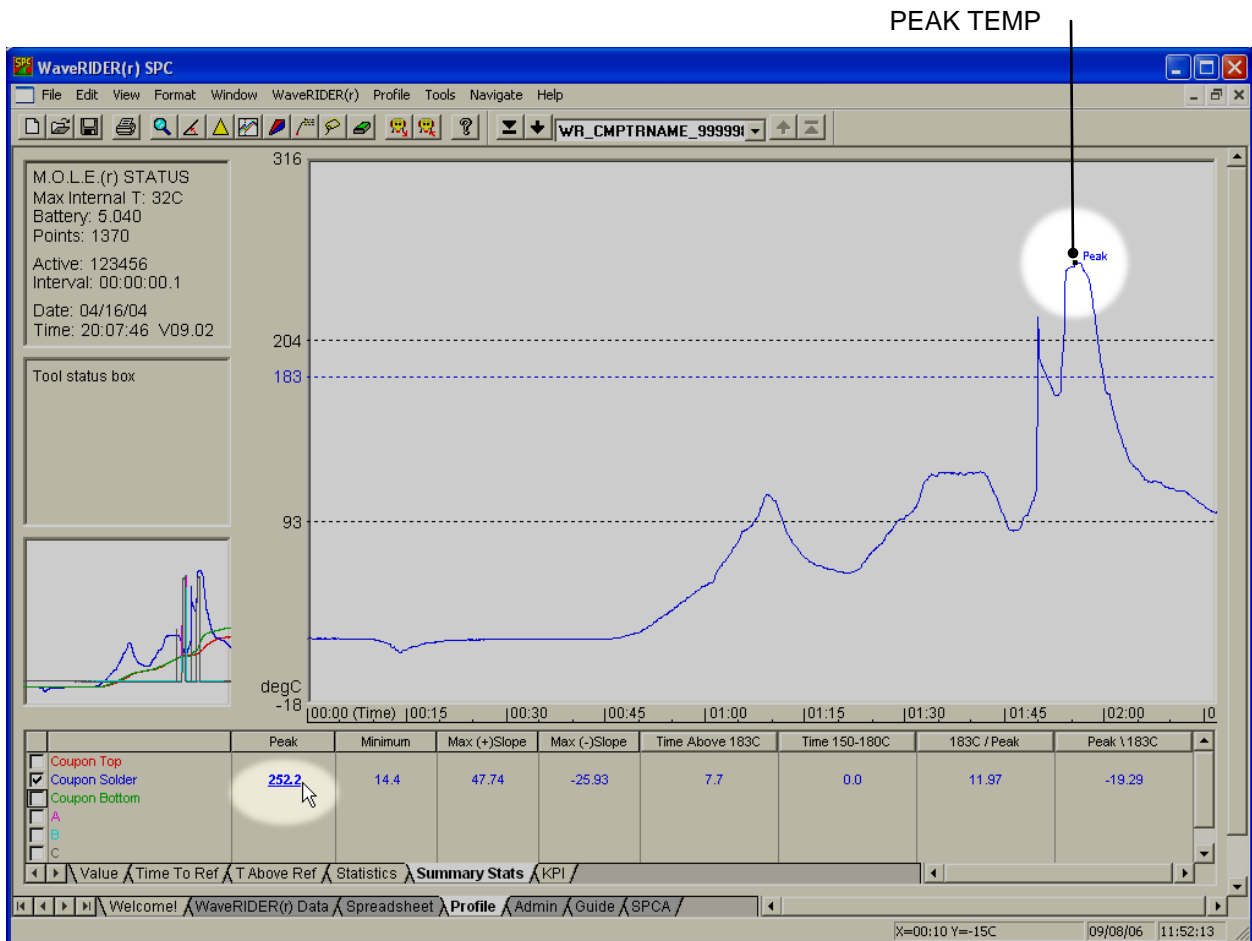
Figure D- 1: Peak Temp

Minimum Temperature is the smallest measured value. Values below are the smallest value recorded for that channel. Typically, these are the starting values, unless there is active cooling employed. It is best if starting temperature values are close to the same. This will allow a consistent starting point for other measurements.
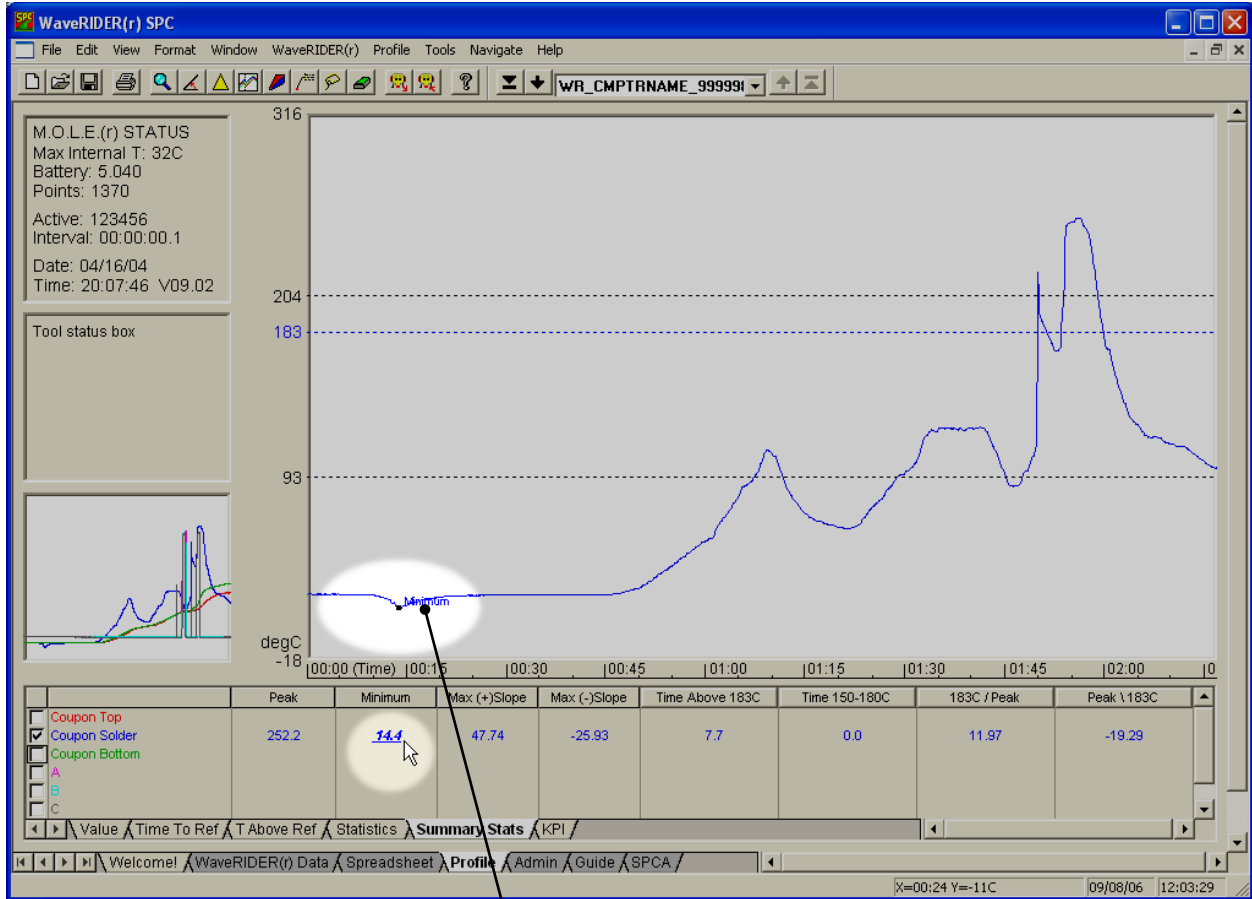
Figure D- 2: Minimum Temp

Maximum **(+) Slope** is the largest positive slope measured using a 2% of the total points in the Profile length (x-axis) differential. Thus, the equation for slope calculation is as follows:

Slope at point X = (Value at point (X + 10) – Value at point X) / (10 * Log interval in seconds)
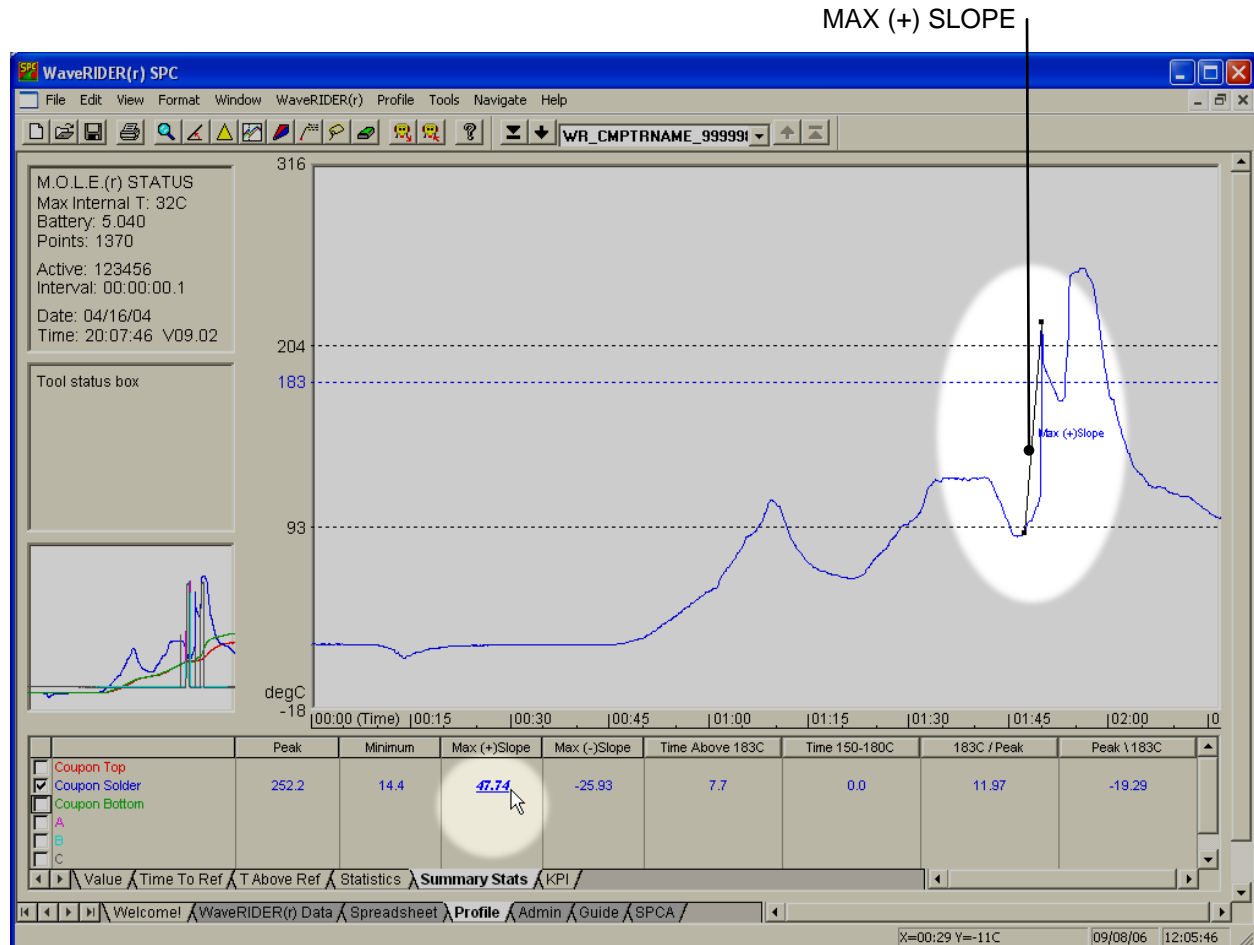
Figure D- 3: Max (+) Slope

The values below are the largest positive slope values calculated for each channel. The larger the slope, the faster the temperature is increasing (heating).

Maximum **(-) Slope** is the largest negative slope measured using a 2% of the total points in the Profile length (x-axis) differential. Thus, the equation for slope calculation is as follows:

Slope at point n = (Value at point (n + 10) – Value at point n) / (10 * Log interval in seconds)
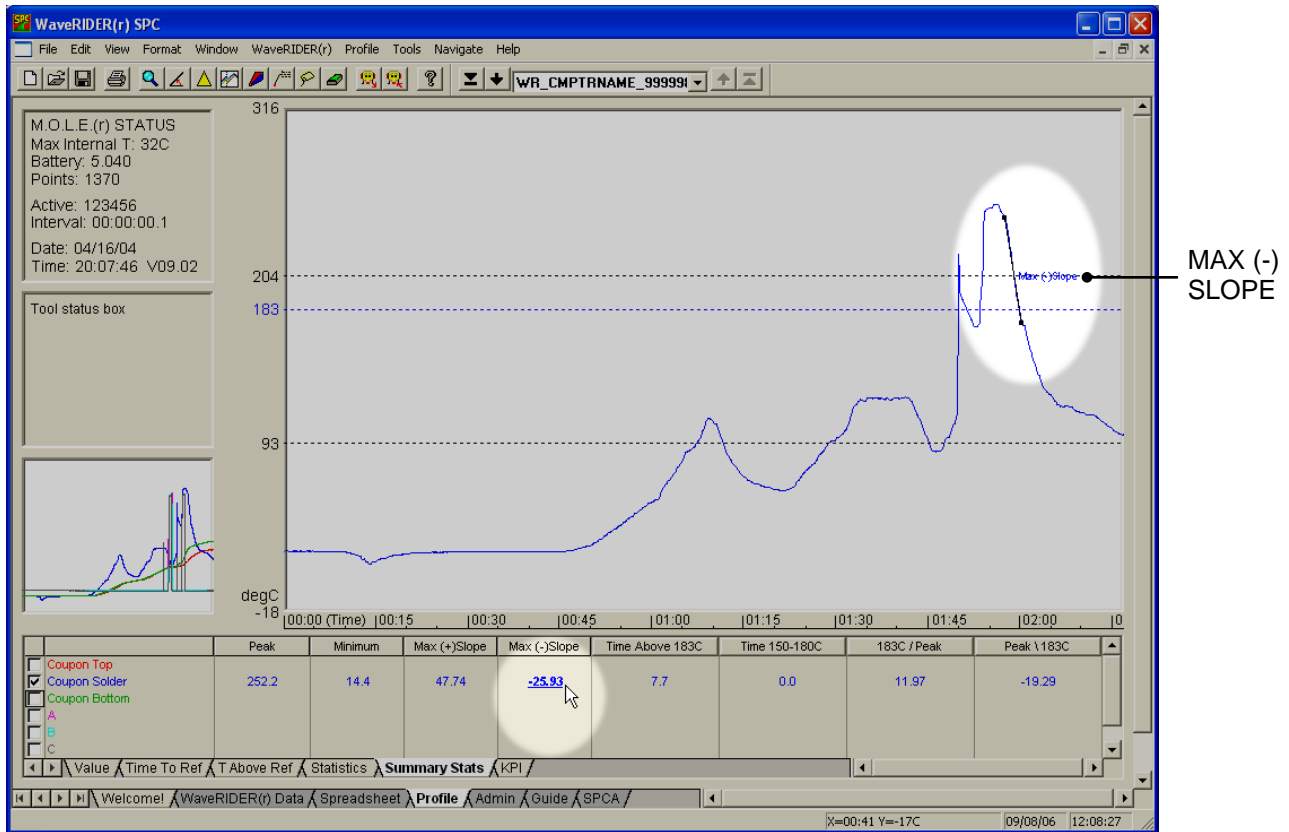
Figure D- 4: Max (-) Slope

The values below are the largest negative slope values calculated for each channel. The larger the slope, the faster the temperature is falling (cooling).

Time above Temperature is the total time spent at or above the selected temperature in seconds. This time above may occur anywhere along the x-axis and all will be accumulated in the total time. Values below are the total times spent at or above for each channel. The longer the time, the longer typical solder will be in its liquid state.
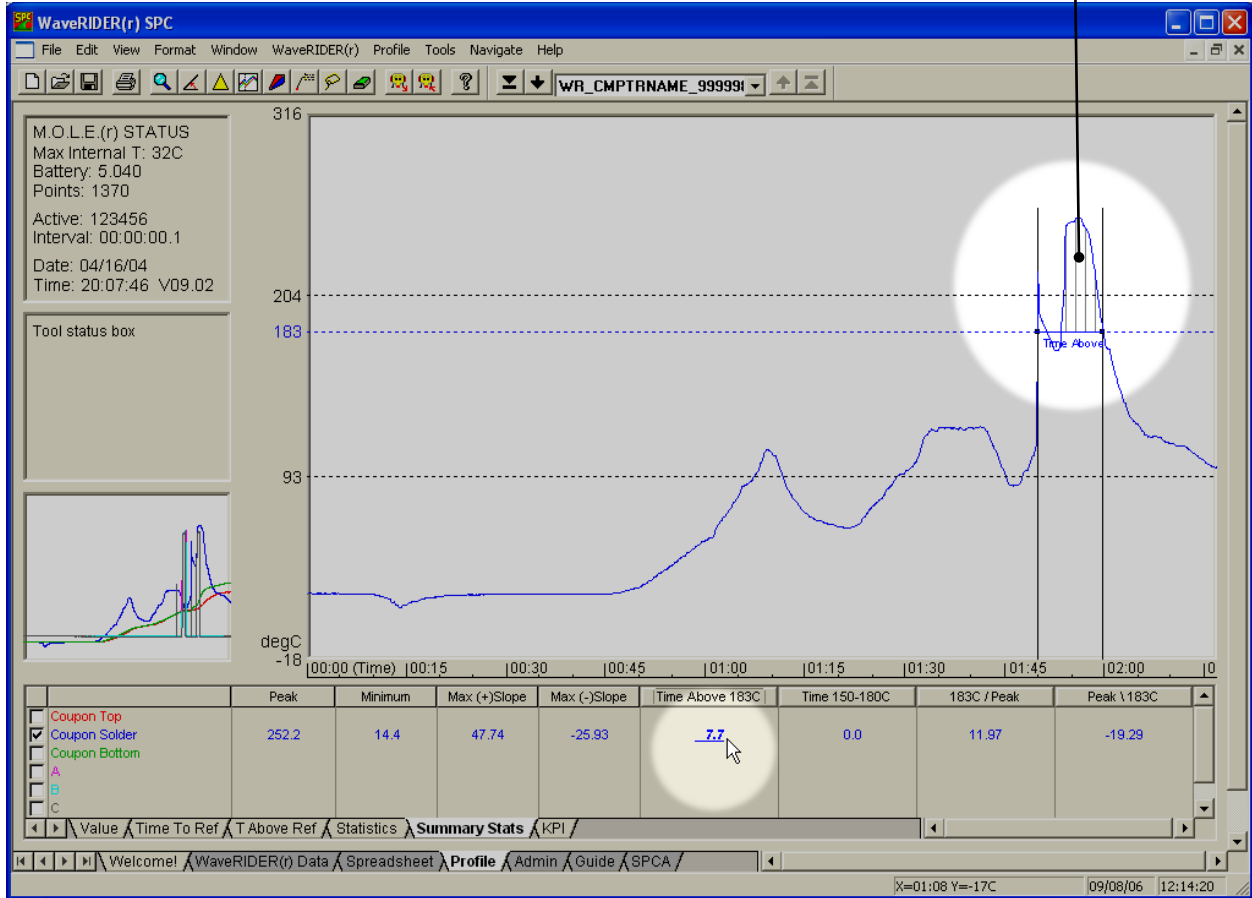
Figure D- 5: Time above 183C

Time between Temperatures is the time required for the temperature to rise from the begin temperature to the end temperature. The values below are the times in seconds measured for each channel. The larger this value, the longer it takes to heat the given temperature sense point.
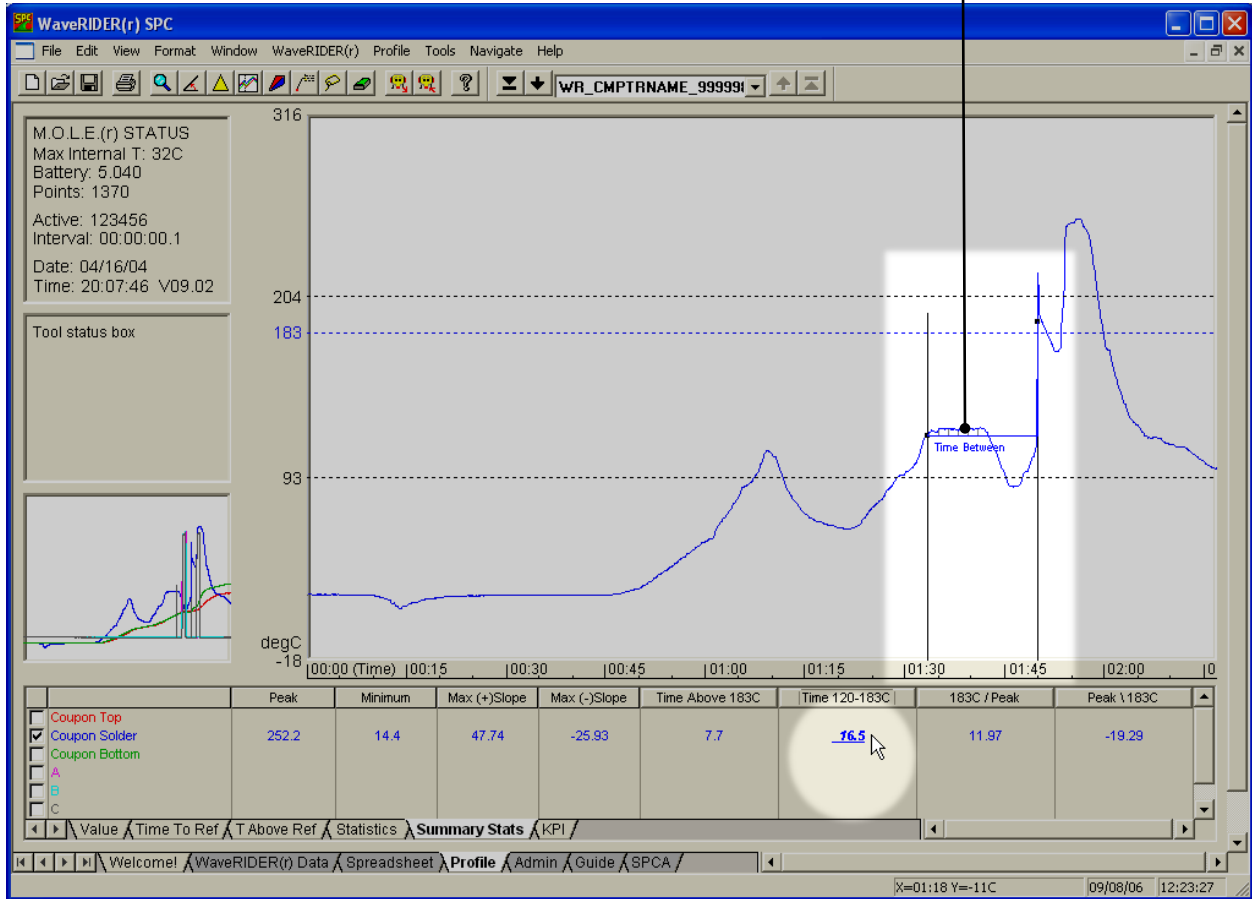
Figure B-1: Time 150C - 180C

Time above Temperature / Peak Slope is the Slope between the point where the profile rise above the Temperature and the Profiles Peak temperature.

TIME ABOVE TEMP / PEAK SLOPE
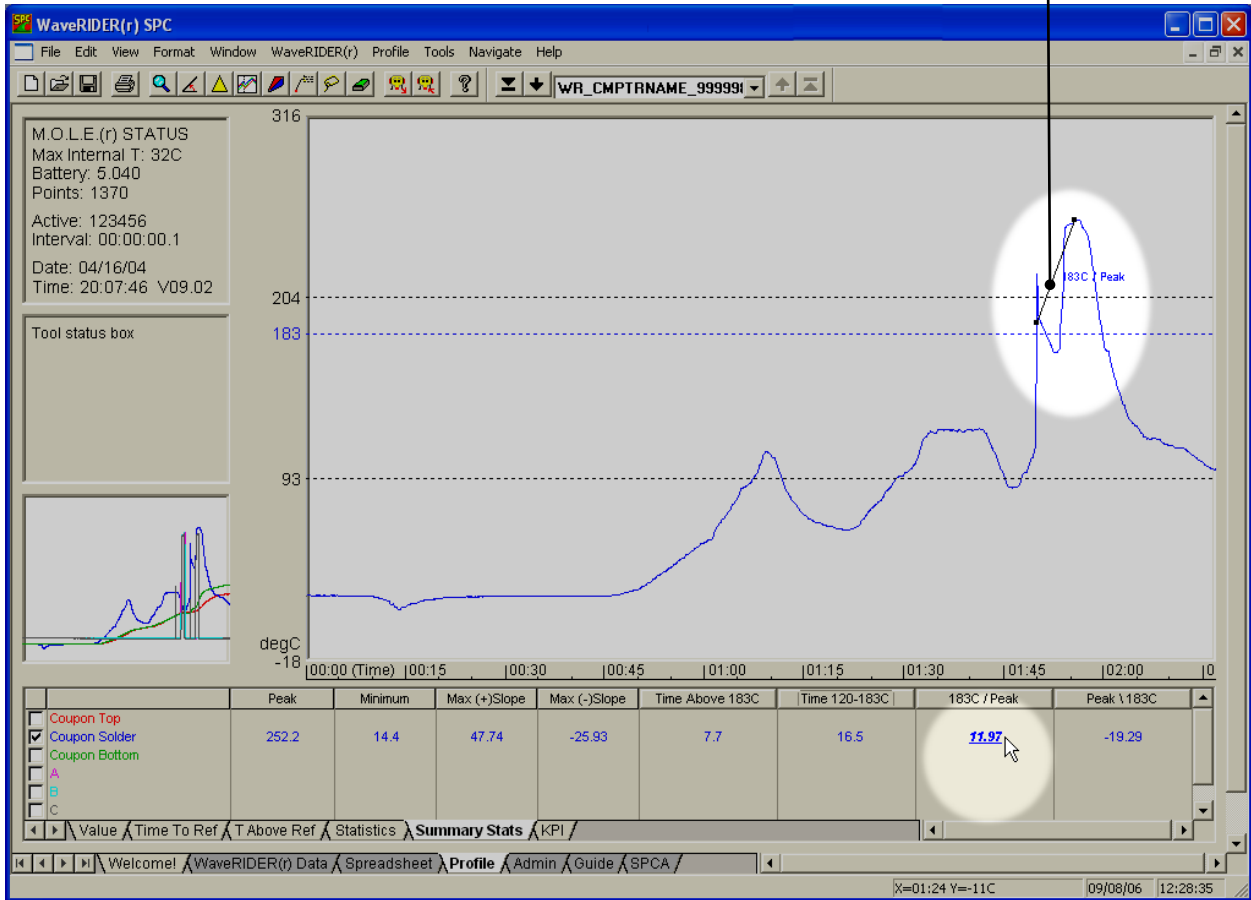
Figure B-2: Time Above Temp / Peak Slope

Peak Slope / Time above Temperature is the Slope between the point where the profile drops below the Temperature and the Profiles Peak temperature.
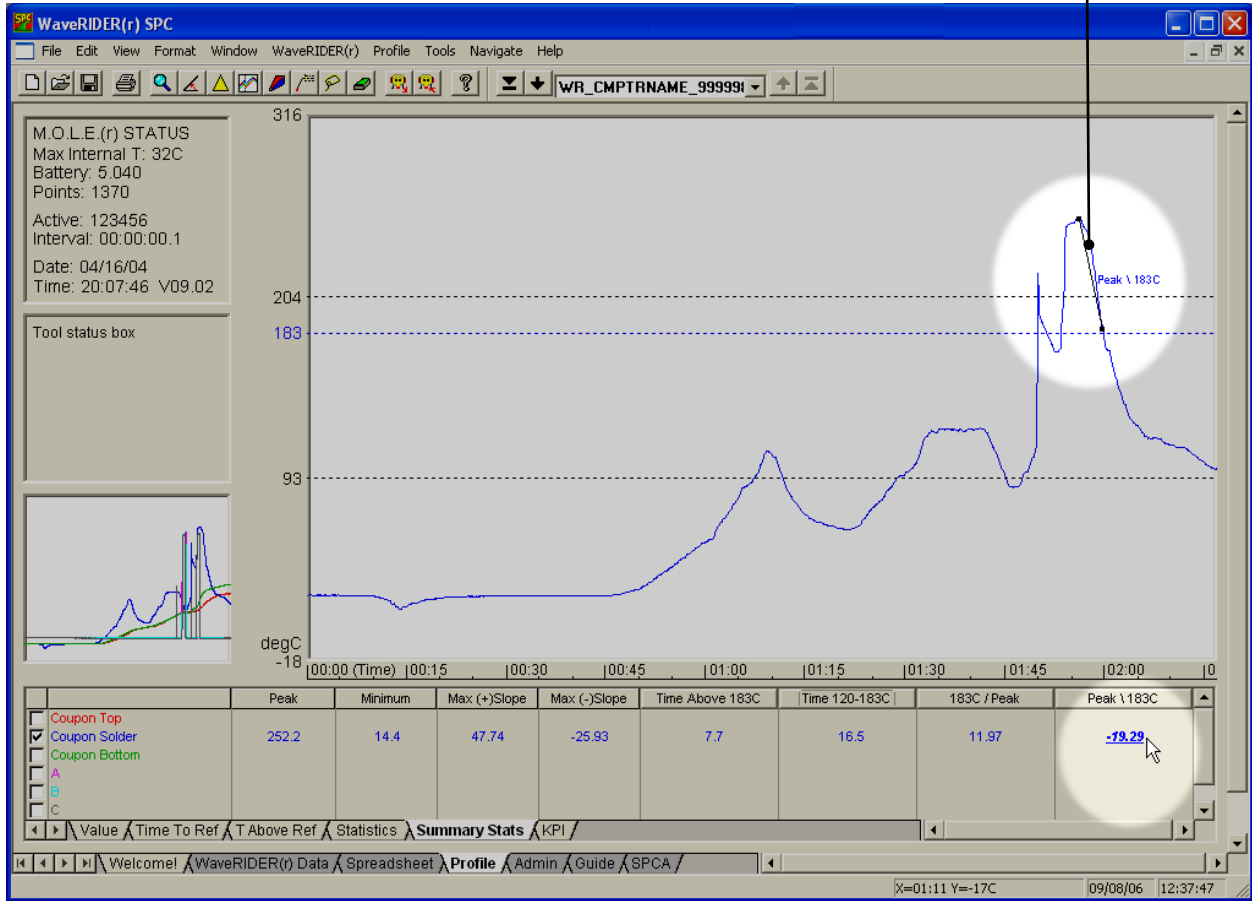
Figure B-3: Peak Slope / Time Above Temp

KPI tab
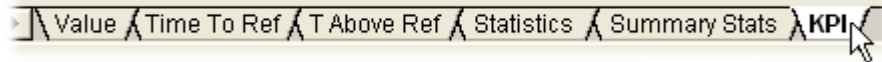
Values shown in this tab are set by the user.

● Temperature Parameters:

Peak Temperature is the largest measured value. Values below are the largest value recorded for that channel. The higher the peak temperature, the greater the possibility for component damage.

Min Temperature is the smallest measured value. Values below are the smallest value recorded for that channel. Typically, these are the starting values, unless there is active cooling employed. It is best if starting temperature values are close to the same. This will allow a consistent starting point for other measurements.

Max Slope (+) is the largest slope measured using the seconds specified in the user configured calculate slope value text box. This column then displays slopes in the positive direction.

Max Slope (-) is the largest slope measured using the seconds specified in the user configured calculate slope value text box. This column then displays slopes in the negative direction.

Max Slope (+ or -) is the largest slope measured using the seconds specified in the user configured calculate slope value text box. This column then displays the larges slope in the positive or negative direction depending on which is larger.

● X Cursor Parameter Data:

C1, **C2**, **C3**, **C4** indicate the point, time relative, time absolute, or distance (depending on the Units setting) on the X axis where the vertical cursors are set, respectively. The values below are the measured values for each channel at that position.

Slope between Cursor locations is the straight line slope between any two cursors.

● Time Parameter Data:

Time To Temperature is the time that it takes for each channel to reach the selected value in seconds or minutes.

Time above Temperature is the total time spent at or above the selected temperature in seconds or minutes.

Total (+/-): Total Time above temperature.
Rising (+): Time above during the rising portion of the temperature Profile.
Falling (-): Time above during the falling portion of the temperature Profile.

Time between Temperatures is the time required for the temperature to rise from the begin temperature to the end temperature in seconds or minutes.

Slope between Temperatures is the straight line slope measured between the beginning and ending temperatures.

● Display Values:

Range is the difference between the largest and smallest value recorded or calculated for each column of data. The smaller the range, the smaller the spread between the values collected from each channel.

Average is the calculation of the average value for each column displayed.

Standard Deviation is the calculation of the Standard Deviation for each column displayed.

APPENDIX E: WaveRIDER Accuracy and the Influencing Factors

There are two fundamental measurements the WaveRIDER measures: temperature and time. The accuracy, resolution and range the WaveRIDER is capable of is stated in the Specification section of the manual. The purpose of this paper is to show how these specifications affect the solder machine parameters presented on the WaveRIDER printout.

Time Specifications
Measurement time by the WaveRIDER is influenced more by the log rate rather then the overall accuracy of the timer. The WaveRIDER takes data at a log rate of 0.1sec. Thus every reading of time has a tolerance of ±0.1 second. The net effect on time dependent variables is best illustrated on the graphs below.

Dwell Times
The % effect that ±0.1 seconds has on the measured dwell times decreases as the dwell time increases. To determine the maximum error of dwell time measurements, locate the measured dwell time on the X axis of the graph and run vertically to the curve. Now run horizontally to the left and find the % error on the Y axis. Clearly the maximum % error that 0.1 seconds has on the measured value increases dramatically as your dwell times approach 0.1 seconds (100% error!), but practical dwell times run from 2 to 5 seconds or 5% to 2% error respectively.

Conveyor Speed
The % effect that ±0.1 seconds has on the measured conveyor speed increases with the actual conveyor speed. To determine the maximum error of conveyor speed measurements, locate the measured speed (ft/min) on the X axis of the graph and run vertically to the curve. Now run horizontally to the left and find the % error on the Y axis. This is the maximum % error of actual conveyor speed you could expect to see. Typical errors run at about 0.75% at 4ft/min.

> **Time measurement can be altered if there is one or more open T/C(s) on the coupon.**

Contact Lengths

Contact length is the product of conveyor speed and dwell time. Thus the % errors of both must be added to determine the total maximum % error for contact length. To determine the maximum error of contact length measurements, locate the measured dwell time on the X axis of the graph and run vertically to the curve that is closest to the measure of conveyor speed. Now run horizontally to the left and find the % error on the Y axis. As you can see from this graph, conveyor speed has little effect on error as the dwell times get much below 2 seconds. Typical errors range from 4% to 6% of the actual dwell time depending on the conveyor speed and the dwell time.

Temperature Specifications

Absolute temperature accuracy is dependent on four basic factors:

1) The accuracy of the thermocouple sensor (T/C)

2) The accuracy of the Cold Junction Compensation sensor (CJC)

3) The accuracy of the overall Analog to Digital system (A/D)

4) The conformity to the International Practical Temperature Scale (IPTS)

Other factors could be mentioned here but they are either too small to be concerned with or are "lumped" in with those mentioned above.

The maximum possible error for a given temperature reading is the sum of the errors listed above. For the Wave Rider this maximum would be:

T/C ± 4°F + CJC ± 4.5°F + A/D ± 0.3°F + IPTS ± 0.1°F = ±8.9°F

This may seem extreme but it is the theoretical maximum error (see Specification in the WaveRIDER manual). However, we calibrate each WaveRIDER to ±1.8°F (1°C) at 212°F (100°C) and 1832°F (1000°C). With conformity to IPTS at 0.1°F and A/D error at 0.3°F, the practical maximum error would be (when using a traceable voltage standards as the calibration source):

± 1.8°F + IPTS ± 0.1°F + A/D ± 0.3°F = ±2.2°F

This leaves only the T/C error to deal with. The WaveRIDER uses "Standard Limits of Error" T/Cs which have ±4°F tolerance. Practical use of these standard T/Cs shows that these tolerance limits are rarely approached. Tighter tolerance T/Cs can be used at extreme cost, with a tolerance no better then ±2°F. This small gain in accuracy is not worth the extra cost, considering the temperature range being measured by the WaveRIDER (<500°F typically).

Conveyor Speed Error % of Actual
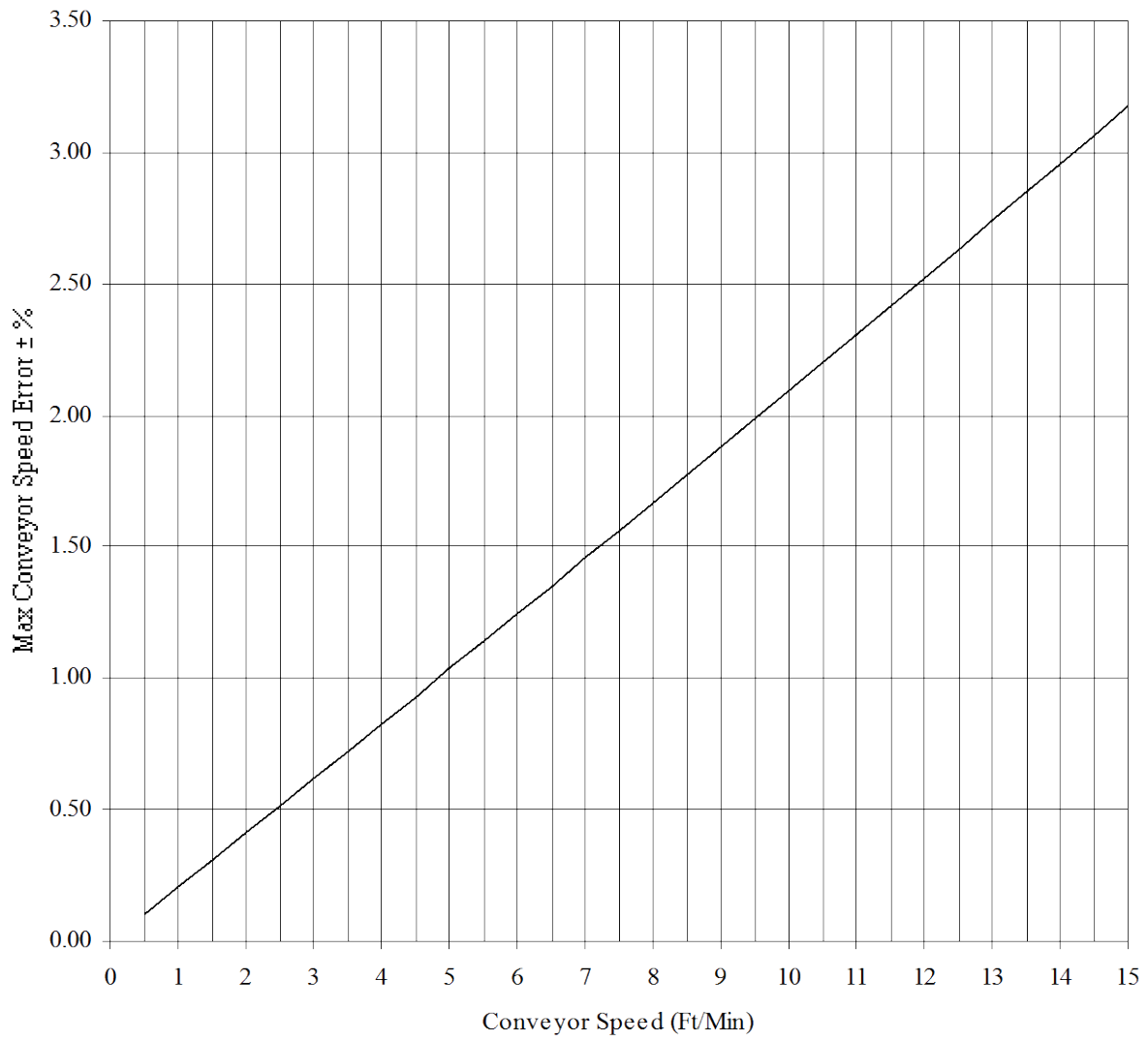
Figure C-5: Conveyor Speed Error
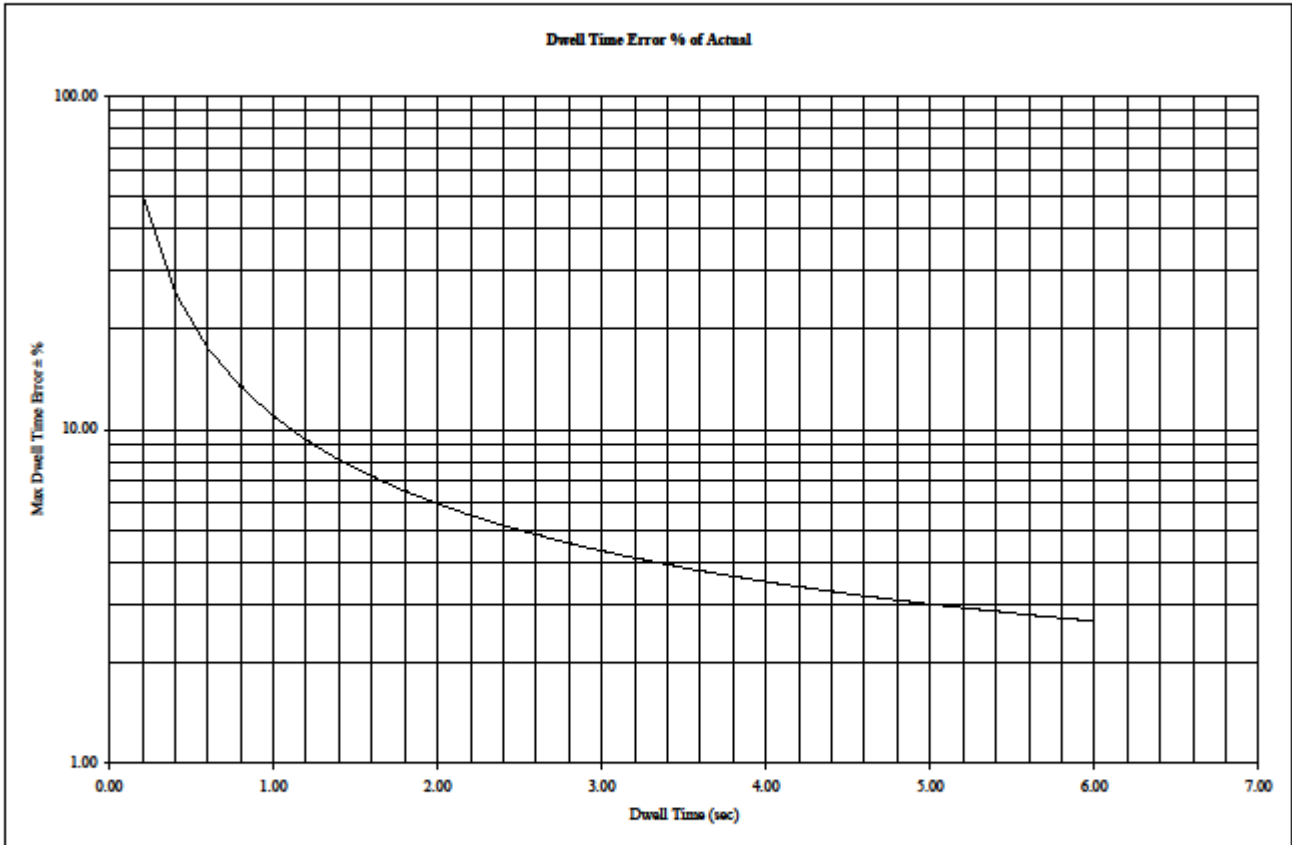
Figure C-6: Dwell Time Error

Contact Length Error % of Actual

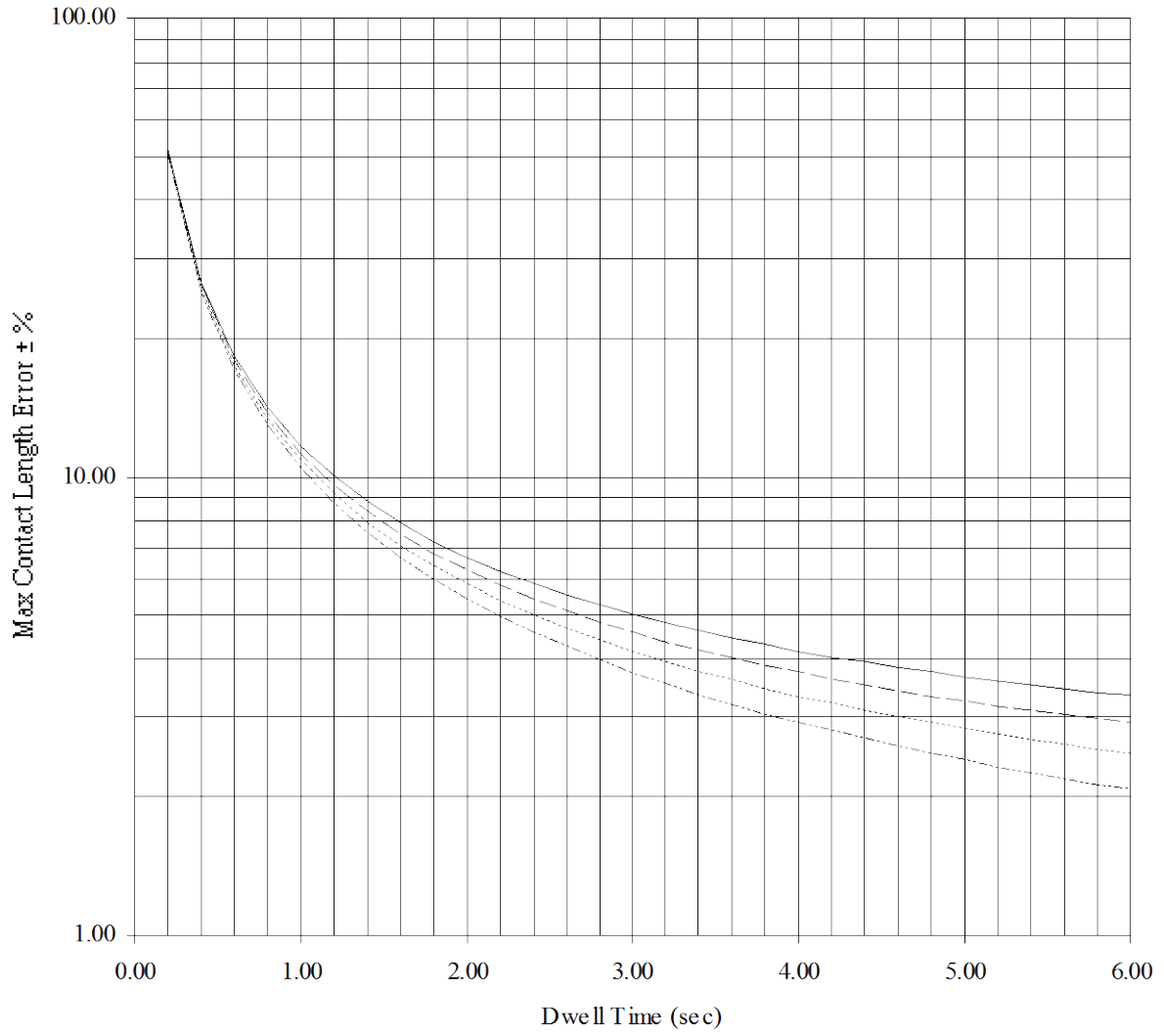*Figure C-7: Contact Length Error*

Solder Wave Variation

Solder wave variation happens. It is by nature a dynamic process caused by the pumping of a liquid. Through various channels, weirs, rudders, and nozzles, all designed to balance flow across the surface of the wave, liquid solder makes its way to the surface and finally breaks one way or the other depending on the wave shape. Lacking the presence of a printed circuit board, this wave looks even and more or less smooth on typical wave solder machines. However, some ripples and eddies are visible as the flow of solder moves toward the spill point. These ripples are everywhere and only some of the bigger ones are pointed out in the picture below.

Typical Ripples and Currents that appear on otherwise smooth looking waves
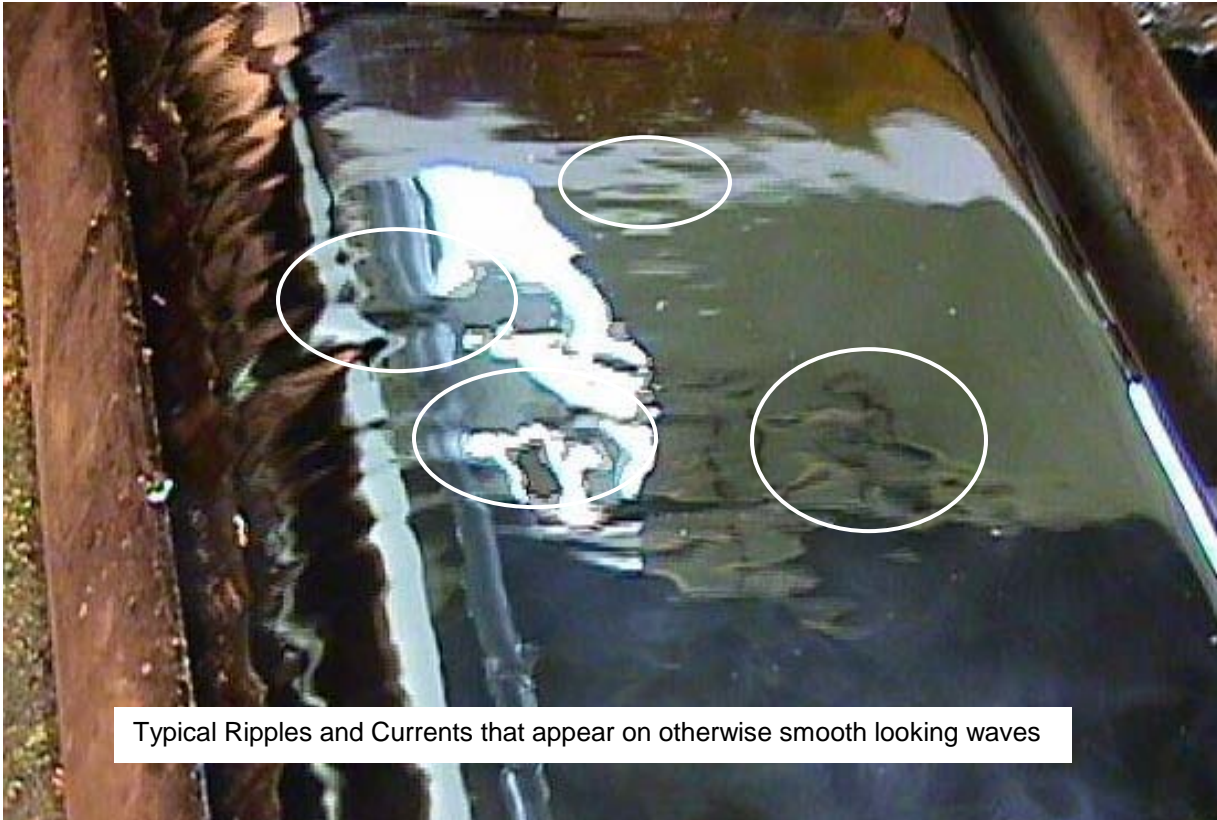
Figure C-8: Solder Wave Ripples

Currents running throughout the wave take on a whole new manifestation when they run into the underside of a printed circuit board. They will cause the crest of the wave to vary, much like ocean waves as run up a sandy beach. An ocean wave will never rush up the sand and stop in a perfectly straight line even though the beach may be very flat. Thus the crest of the solder wave, as it flows against the underside of a printed circuit board, will be very dynamic. You can view this using a tempered glass plate, such as the one called "Lev Cheek" by Hexacon Electric, as it runs slowly across the solder wave just like you would solder a printed circuit board. A typical solder wave using this glass plate is pictured below.
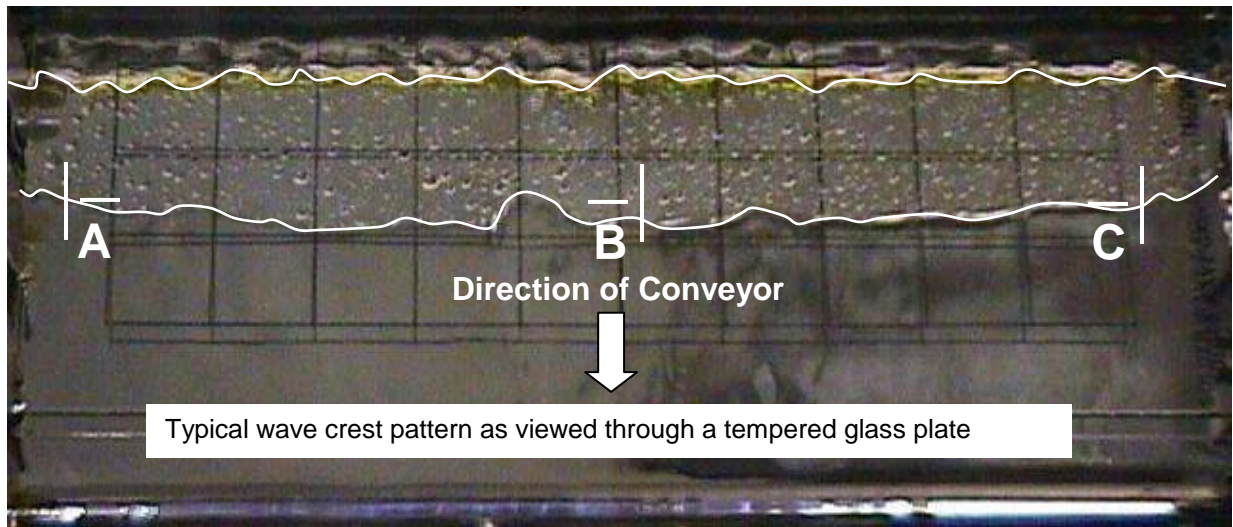
Figure C-9: Typical Wave Crest

The crest of the wave is highlighted to make is more visible. As you can see, the edge is very rough and is constantly changing shape as it progress across the board. It is also noticed that the sides of the wave tend to be narrower then the middle. Based on this snap-shot, one would expect this wave to read parallel with sensors "A" and "C" reading lower contact times then "B." This high in the middle observation is typical in many waves and is not because the glass bent down in the middle. It is most likely due to increased pumping action near the center of the wave, which may also be causing the increased ripple action near the center as seen in the first wave illustration. Also, with this typical wave dynamics one should expect successive measurements to have some variation. In the above illustration, at 4 ft/min conveyor speed, one can expect up to 0.8 seconds variation from sensor to sensor.

The real issue in making exact measurements from your solder wave is to determine what your solder process can tolerate, and not so much to make the solder processes perfect. Clearly some parameters are more important such as conveyor speed, solder temperature, and preheat slopes, but to expect a pumped liquid as dense as solder to behave with perfect geometry is asking a bit much from the machine manufacture. If your solder process is not producing good results, a measurement tool will quickly point out the problem. But the goal of measuring a good process over and over is to obtain data which can be used to determine how much variation is acceptable and help predict when a good process is going bad.

APPENDIX F: Pull-Down Menus & Toolbar Buttons

The dimmed menu commands are used in other worksheets.

Active menus for the Welcome & Guide Worksheets:
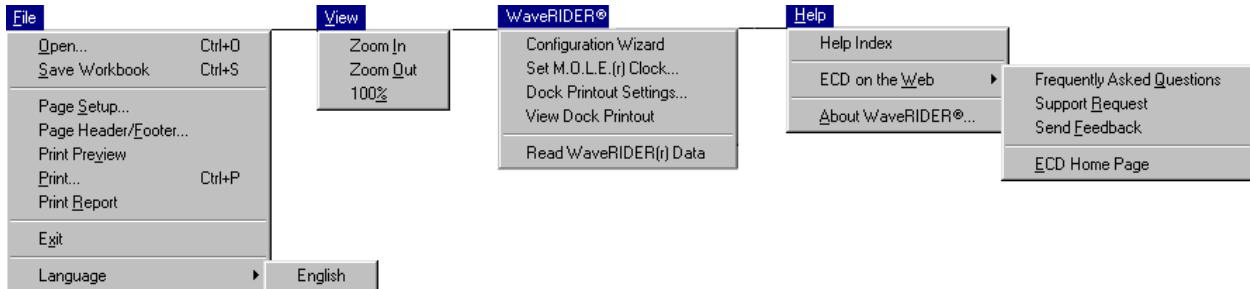
Active menus for the WaveRIDER Worksheet:
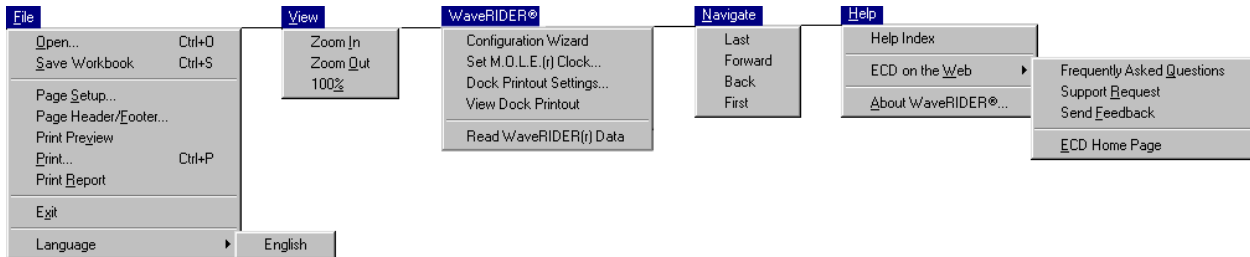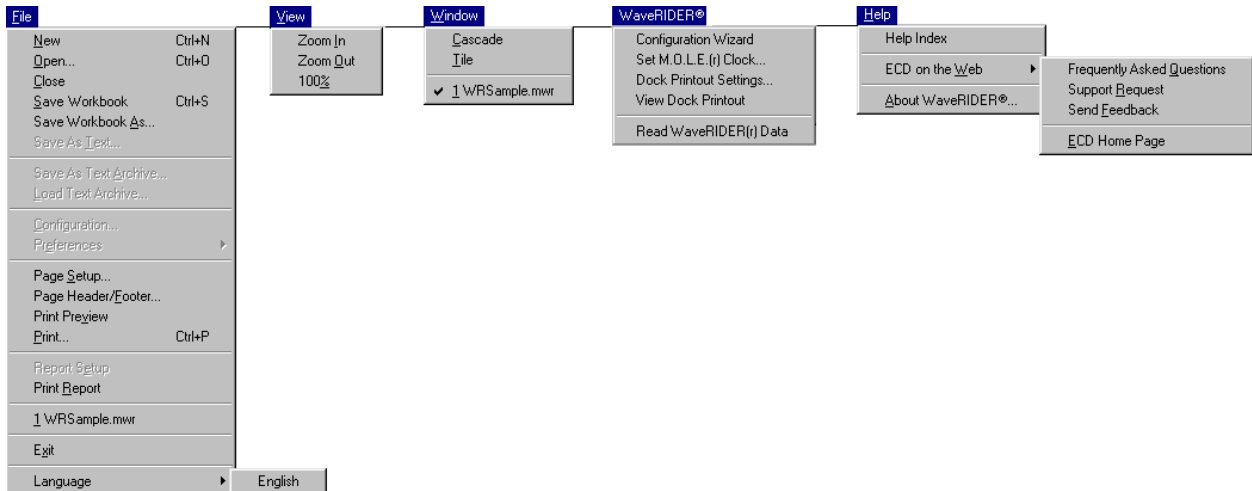

Active menus for the Spreadsheet Worksheet:
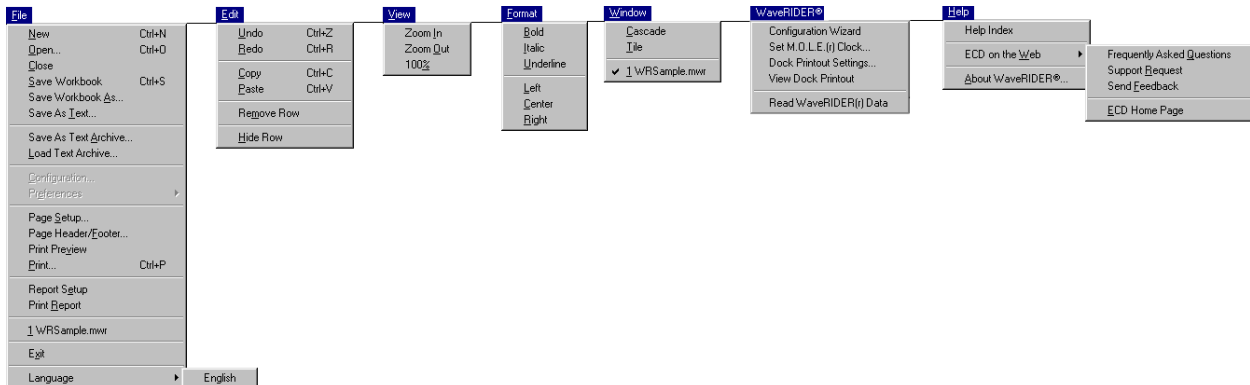
Active menus for the Profile Worksheet:

File
- New   Ctrl+N
- Open...   Ctrl+O
- Close
- Save Workbook   Ctrl+S
- Save Workbook As...
- Save As Text...
- Save As Text Archive...
- Load Text Archive...
- Configuration...
- Preferences
- Page Setup...
- Page Header/Footer...
- Print Preview
- Print...   Ctrl+P
- Report Setup
- Print Report
- 1 WRSample.mwr
- Exit
- Language   English

Edit
- Undo   Ctrl+Z
- Redo   Ctrl+R
- Copy   Ctrl+C
- Paste   Ctrl+V
- Remove Row
- Hide Row

Window
- Cascade
- Tile
- ✔ 1 WRSample.mwr

WaveRIDER®
- Configuration Wizard
- Set M.O.L.E.(r) Clock...
- Dock Printout Settings...
- View Dock Printout
- Read WaveRIDER(r) Data

Profile
- Part
- Process
- Scaling...
- Units...
- Temp Ref Lines...
- Profile Colors...

Tools
- Magnify
- Slope
- Peak Difference
- Overlay
- 3D View
- Measure
- Notes
- Erase Object(s)
- Erase All

Navigate
- Last
- Forward
- Back
- First

Help
- Help Index
- ECD on the Web ▶
- About WaveRIDER®...

  - Frequently Asked Questions
  - Support Request
  - Send Feedback
  - ECD Home Page

Active menus for the Administration Worksheet:

File
- New   Ctrl+N
- Open...   Ctrl+O
- Close
- Save Workbook   Ctrl+S
- Save Workbook As...
- Save As Text...
- Save As Text Archive...
- Load Text Archive...
- Configuration...
- Preferences
- Page Setup...
- Page Header/Footer...
- Print Preview
- Print...   Ctrl+P
- Report Setup
- Print Report
- 1 WRSample.mwr
- Exit
- Language   English

Edit
- Undo   Ctrl+Z
- Redo   Ctrl+R
- Copy   Ctrl+C
- Paste   Ctrl+V
- Remove Row
- Hide Row

Preferences
- Units...
- Passwords...
- File Tag Number...

View
- Zoom In
- Zoom Out
- 100%

Format
- Bold
- Italic
- Underline
- Left
- Center
- Right

Window
- Cascade
- Tile
- ✔ 1 WRSample.mwr

WaveRIDER®
- Configuration Wizard
- Set M.O.L.E.(r) Clock...
- Dock Printout Settings...
- View Dock Printout
- Read WaveRIDER(r) Data

Help
- Help Index
- ECD on the Web ▶
- About WaveRIDER®...

  - Frequently Asked Questions
  - Support Request
  - Send Feedback
  - ECD Home Page

Active menus for the SPC Worksheets:

File
- New   Ctrl+N
- Open...   Ctrl+O
- Close
- Save Workbook   Ctrl+S
- Save Workbook As...
- Save As Text...
- Save As Text Archive...
- Load Text Archive...
- Configuration...
- Preferences
- Page Setup...
- Page Header/Footer...
- Print Preview
- Print...   Ctrl+P
- Report Setup
- Print Report
- 1 WRSample.mwr
- Exit
- Language   English

View
- Zoom In
- Zoom Out
- 100%

Window
- Cascade
- Tile
- ✔ 1 WRSample.mwr

WaveRIDER®
- Configuration Wizard
- Set M.O.L.E.(r) Clock...
- Dock Printout Settings...
- View Dock Printout
- Read WaveRIDER(r) Data

Help
- Help Index
- ECD on the Web ▶
- About WaveRIDER®...

  - Frequently Asked Questions
  - Support Request
  - Send Feedback
  - ECD Home Page

Tool buttons:

3d View	Open
About	Overlay
Align Left	Peak Difference
Align Right	Prediction
Back (To Previous Data Run)	Print
Bold	Redo
Center	Read WaveRIDER Data
Copy	Save
Erase All	Slope
Erase Objects	Tolerance Band
First (Data Run)	Total Heat
Italic	Underline
Last (Data Run)	Undo
Magnify	WaveRIDER Settings
New	Zoom 100%
Next (Data Run Difference	Zoom In
Notes	Zoom Out

APPENDIX G: WaveRIDER Accessories

ITEM	PART NUMBER
Test Coupons:	
Test Coupon, Double sided, 2.5" (63 mm) wide (No-Lead)	E44-9283-64
Test Coupon, Double sided, 2.5" (63 mm) wide (No-Lead) (3 pk)	E44-9283-14
Manuals & Software:	
WaveRIDER Users Guide	A36-9283-00
Expert Guide to Wave Soldering	A36-9283-06
WaveRIDER SPC Software CD	Y50-9283-40
Miscellaneous:	
SuperM.O.L.E. Gold to PC Interface Cable	Y20-2848-04
USB/RS-232 Serial Adapter	Y23-7782-10
Extended warranty, 1 year. Includes 1 calibration	A10-0900-00