



Software User's Manual

For BridgeWorks

Resistance/Thermometry

DCC Bridge Measurement Software

NOTICE

The contents and information contained in this manual are proprietary to Guildline Instruments. They are to be used only as a guide to the operation and maintenance of the equipment with which this manual was issued and may not be duplicated or transmitted by any means, either in whole or in part, without the written permission of Guildline Instruments.

**SUM66XX-E-00
7 November, 2013**

TABLE OF CONTENTS

1. BRIDGEWORKS SOFTWARE	1-1
1.1. INSTALLATION AND SYSTEM CONFIGURATION	1-3
1.1.1. Indicators	1-6
1.1.2. Controls.....	1-6
1.1.3. Fields	1-7
1.1.4. Menu Bar	1-7
1.2. MAIN WINDOW.....	1-8
1.2.1. Using The Graph.....	1-8
1.2.2. Stop Button	1-9
1.2.3. Quick Control	1-9
1.2.4. Power Control	1-9
1.2.5. Units Control.....	1-9
1.2.6. Test/Advance Button	1-9
1.2.7. Mode Indicator.....	1-10
1.2.8. File Indicators	1-10
1.2.9. Numerical Indicators.....	1-10
1.2.10. Details Button	1-10
1.2.11. File Menu	1-10
1.2.12. Configuration Menu	1-11
1.2.13. Plugins Menu	1-12
1.2.14. View Menu.....	1-13
1.2.15. Maintenance Menu.....	1-14
1.2.16. Help Menu	1-14
1.3. RESCAN FOR BRIDGE WINDOW	1-16
1.4. ADMINISTRATIVE OPTIONS WINDOWS.....	1-16
1.4.1. Enter Passcode Window	1-16
1.4.2. Administrative Options Window	1-17
1.5. RESISTOR CONFIGURATION WINDOW	1-19
1.5.1. Model Field.....	1-19
1.5.2. Asset/ID Field	1-19
1.5.3. Serial Number	1-19
1.5.4. R (ohms) Field	1-20
1.5.5. Itest (mA) Field.....	1-20
1.5.6. Imax (mA) Field	1-20
1.5.7. Vtest (V) Field	1-20
1.5.8. Vmax (V) Field.....	1-20
1.5.9. Uncertainty (ppm) Field.....	1-20
1.5.10. Cal Date Field	1-20
1.5.11. Cal Due Field	1-20
1.5.12. Cal Temp (C) Field	1-20
1.5.13. Temp Coef (ohms/C) Field	1-21
1.5.14. New Button	1-21
1.5.15. Open Button	1-21
1.5.16. Save Button	1-21
1.5.17. Close Button.....	1-21
1.5.18. Creating a Resistor File	1-21

1.5.19.	Saving a Resistor File.....	1-22
1.5.20.	Loading a Resistor File	1-22
1.5.21.	Editing a Resistor File.....	1-22
1.5.22.	Resistor File Format.....	1-22
1.6.	PROBE CONFIGURATION WINDOW.....	1-23
1.6.1.	Creating a Probe File	1-23
1.6.2.	Setting Temperature Coefficients.....	1-23
1.6.3.	Saving a Probe File	1-24
1.6.4.	Loading a Probe File.....	1-24
1.6.5.	Editing a Probe File	1-24
1.6.6.	Probe File Format	1-24
1.7.	TEST CONFIGURATION WINDOW	1-26
1.7.1.	Scanner Setup	1-26
1.7.2.	Scanner Setup Load Button.....	1-26
1.7.3.	Scanner Setup Edit Button	1-27
1.7.4.	Scanner Setup Clear Button	1-27
1.7.5.	Test Setup Controls.....	1-27
1.7.6.	Suggest Button	1-27
1.7.7.	Test Setup Clear Button	1-27
1.7.8.	Rs and Rx Channel Controls	1-27
1.7.9.	Excitation/Ratio Control	1-27
1.7.10.	Ohms Mode Control.....	1-27
1.7.11.	Reference Control	1-28
1.7.12.	Reversal Rate Field	1-28
1.7.13.	Auto Reversal Rate Control	1-28
1.7.14.	Threshold Field	1-28
1.7.15.	Target Standard Deviation Field	1-28
1.7.16.	Sample Window Field.....	1-29
1.7.17.	Sample Limit Field.....	1-29
1.7.18.	Start of Process Delay Field.....	1-29
1.7.19.	Between Tests Delay Field.....	1-29
1.7.20.	Setting the Environment Button/Indicator.....	1-29
1.7.21.	6623A Ratio x Field.....	1-29
1.7.22.	Open Button	1-29
1.7.23.	Save Button.....	1-30
1.7.24.	Cancel Button.....	1-30
1.7.25.	Start Button	1-30
1.7.26.	Saving a Test Configuration.....	1-30
1.7.27.	Loading a Test Configuration.....	1-30
1.7.28.	Editing a Test Configuration	1-30
1.7.29.	Exiting the Test Configuration	1-30
1.7.30.	Test Configuration File Format	1-31
1.8.	ENVIRONMENT OPTIONS.....	1-31
1.8.1.	Location Field	1-32
1.8.2.	Name Field.....	1-32
1.8.3.	Pressure (kpa) Field	1-32
1.8.4.	Temperature (C) Field	1-32
1.8.5.	Humidity (%) Field	1-32
1.8.6.	OK Button.....	1-32
1.8.7.	Cancel Button	1-32

1.9.	DATA LOGGING	1-32
1.9.1.	Saving a Data File	1-32
1.9.2.	Saving Multiple Files	1-33
1.10.	TEST OVERVIEW WINDOW	1-34
1.10.1.	Graph	1-34
1.10.2.	Test Filename Indicator.....	1-35
1.10.3.	Test Date/Time Indicator	1-35
1.10.4.	Standard Resistor Indicator	1-35
1.10.5.	Resistor/Probe Indicator.....	1-35
1.10.6.	Test Value Indicator.....	1-35
1.10.7.	Power For Test Indicator.....	1-35
1.10.8.	Reversal Rate Indicator	1-35
1.10.9.	Temperature During Test Indicator.....	1-35
1.10.10.	Humidity During Test Indicator	1-35
1.10.11.	Pressure During Test Indicator.....	1-35
1.10.12.	Standard Deviation Indicator	1-36
1.10.13.	Expanded Uncertainty Indicator.....	1-36
1.10.14.	Done By Indicator.....	1-36
1.10.15.	Test Mean Indicator	1-36
1.10.16.	Notes Field.....	1-36
1.10.17.	File Menu	1-36
1.10.18.	Units Menu.....	1-38
1.10.19.	Viewing a Test	1-39
1.10.20.	Editing a Test Overview.....	1-39
1.10.21.	Saving a Test Overview	1-39
1.10.22.	Test File Format	1-40
1.11.	DATA MANAGER.....	1-41
1.11.1.	Total Samples Indicator	1-41
1.11.2.	Point On Graph Indicator.....	1-41
1.11.3.	Reversal Rate Indicator	1-41
1.11.4.	Values Indicator	1-41
1.11.5.	Start At Control.....	1-42
1.11.6.	Go To Control.....	1-42
1.11.7.	OK Button	1-42
1.11.8.	Cancel Button.....	1-42
1.12.	HISTORY CHART WINDOW	1-43
1.12.1.	Graph	1-43
1.12.2.	History Filename Indicator.....	1-43
1.12.3.	Last Entry Indicator.....	1-44
1.12.4.	Done By Indicator.....	1-44
1.12.5.	Company Indicator.....	1-44
1.12.6.	Resistor Asset/ID Indicator	1-44
1.12.7.	Standard Deviation Indicator	1-44
1.12.8.	Estimated Value Now Indicator	1-44
1.12.9.	Overall Mean Indicator	1-44
1.12.10.	Notes Indicator.....	1-44
1.12.11.	File Menu	1-44
1.12.12.	Resolution Menu	1-45
1.12.13.	Updating Resistor Files	1-45
1.12.14.	Displaying a History File	1-46
1.12.15.	Editing a History File	1-46

1.12.16.	Printing a History File	1-46
1.12.17.	History File Format	1-46
1.13.	HISTORY FILE EDITOR.....	1-47
1.13.1.	Date/Time Indicator	1-47
1.13.2.	Resistor (Rx) Field	1-47
1.13.3.	Done By Field	1-47
1.13.4.	Company Field	1-47
1.13.5.	Notes Field	1-48
1.13.6.	Test Values Indicator	1-48
1.13.7.	Add Button.....	1-48
1.13.8.	Delete Button	1-48
1.13.9.	Open Button	1-48
1.13.10.	Save Button	1-48
1.13.11.	Close Button.....	1-48
1.13.12.	Viewing a History File	1-49
1.13.13.	Saving a History File.....	1-49
1.13.14.	Editing a History File	1-49
1.14.	FILE MANAGER WINDOW.....	1-49
1.14.1.	Directory Button	1-50
1.14.2.	Print Button	1-50
1.14.3.	Open Button	1-50
1.14.4.	Close Button.....	1-50
2.	UTILITIES AND PLUGINS.....	2-1
2.1.	VERIFICATION UTILITY.....	2-1
2.1.1.	Start/Stop Button.....	2-2
2.1.2.	Preview Button	2-2
2.1.3.	Numbered Buttons (13 - 32)	2-2
2.1.4.	Channel Indicators	2-3
2.1.5.	6622A Serial Indicator	2-3
2.1.6.	6622A Variant Indicator/Button	2-3
2.1.7.	System Serial Indicator	2-3
2.1.8.	Report Button.....	2-3
2.1.9.	Close Button	2-3
2.1.10.	Rs Scanner Channel Indicator	2-3
2.1.11.	Rx Scanner Channel Indicator.....	2-4
2.1.12.	Samples Remaining Indicator.....	2-4
2.1.13.	Tests Remaining Indicator	2-4
2.1.14.	Current Value Indicator.....	2-4
2.1.15.	Next Sample In Indicator	2-4
2.1.16.	Saving Verification Report Data	2-4
2.1.17.	Loading/Viewing Verification Report Data	2-4
2.2.	VERIFICATION REPORT.....	2-5
2.2.1.	Print Button.....	2-5
2.2.2.	Close Button	2-5
2.2.3.	Value Indicators	2-5
2.2.4.	Closure Indicators	2-5
2.2.5.	Status Indicators.....	2-6
2.2.6.	Location Indicator.....	2-6

2.2.7.	Name Indicator	2-6
2.2.8.	Date/Time Indicator	2-6
2.2.9.	6622A Serial Indicator	2-6
2.2.10.	6622A Variant Indicator	2-6
2.2.11.	System Serial Indicator	2-6
2.3.	VERIFICATION PROCEDURE	2-6
2.4.	VERIFICATION PROCESS	2-8
2.5.	DECADE BOX UTILITY.....	2-10
2.5.1.	Start/Stop Button.....	2-11
2.5.2.	Go/Clear Button.....	2-11
2.5.3.	Zero Ohms Indicator	2-11
2.5.4.	From Control.....	2-11
2.5.5.	To Control.....	2-11
2.5.6.	Channel Control.....	2-11
2.5.7.	Decade Select Control	2-12
2.5.8.	Steps Control	2-12
2.5.9.	Accuracy Control	2-12
2.5.10.	Offset Control	2-12
2.5.11.	Crop Control	2-12
2.5.12.	Window Control.....	2-12
2.5.13.	Samples Control	2-12
2.5.14.	Rev Rate Control.....	2-12
2.5.15.	Serial Number Field	2-12
2.5.16.	Channel Controls.....	2-13
2.5.17.	Channel Indicators	2-13
2.5.18.	Open Button	2-13
2.5.19.	Save Button	2-13
2.5.20.	Report Button.....	2-13
2.5.21.	Close Button.....	2-13
2.5.22.	Rs Scanner Channel Indicator	2-14
2.5.23.	Rx Scanner Channel Indicator.....	2-14
2.5.24.	Samples Remaining Indicator.....	2-14
2.5.25.	Tests Remaining Indicator	2-14
2.5.26.	Current Value Indicator.....	2-14
2.5.27.	Next Sample In Indicator	2-14
2.5.28.	Tolerance Indicator	2-14
2.5.29.	Advance Test Control	2-14
2.5.30.	Saving Decade Box Report Data.....	2-14
2.5.31.	Loading/Viewing Decade Box Report Data	2-15
2.5.32.	Decade Box Test Prompt	2-16
2.6.	DECADE BOX SUMMARY REPORT	2-17
2.6.1.	Details Button	2-17
2.6.2.	Save Button.....	2-17
2.6.3.	Print Button.....	2-17
2.6.4.	Close Button	2-17
2.6.5.	Value Indicators	2-18
2.6.6.	Status Indicators.....	2-18
2.6.7.	Accuracy Indicators	2-18
2.6.8.	Offset Indicators	2-18
2.6.9.	Name Indicator	2-18

2.6.10.	Date/Time Indicator	2-18
2.6.11.	0 Ohms Value Indicator	2-18
2.6.12.	Location Indicator	2-18
2.6.13.	Decade Asset/ID Indicator	2-18
2.7.	DECADE BOX DETAIL REPORT	2-19
2.7.1.	Decade Select Button.....	2-19
2.7.2.	Print Button.....	2-19
2.7.3.	Close Button	2-20
2.7.4.	Value Indicators.....	2-20
2.7.5.	Standard Deviation (ppm) Indicators	2-20
2.7.6.	Reference Uncertainty (ppm) Indicators	2-20
2.7.7.	Coefficient Uncertainty (ppm) Indicators	2-20
2.7.8.	Expanded Uncertainty (ppm) Indicators	2-20
2.7.9.	Status Indicators.....	2-20
2.7.10.	Name Indicator.....	2-20
2.7.11.	Location Indicator	2-20
2.7.12.	Decade Serial Indicator	2-21
2.7.13.	Decade Model Indicator.....	2-21
2.7.14.	Reference Serial Indicator.....	2-21
2.7.15.	Reference Model Indicator.....	2-21
2.8.	DECADE BOX PROCEDURE.....	2-21
2.9.	DECADE BOX PROCESS	2-24
2.10.	TRANSFER STANDARD UTILITY	2-26
2.10.1.	Start/Stop Button.....	2-26
2.10.2.	Mode Switch	2-27
2.10.3.	Reversal Rate Control	2-27
2.10.4.	Samples Per Resistor Control.....	2-27
2.10.5.	Adapter Channels Control	2-27
2.10.6.	Reference Channel Control	2-27
2.10.7.	Serial Number Field	2-27
2.10.8.	Asset/ID Field	2-27
2.10.9.	Model Number Field.....	2-28
2.10.10.	Element Value Control.....	2-28
2.10.11.	Element/Element Button	2-28
2.10.12.	Element/Element Control	2-28
2.10.13.	Reference Value Indicator.....	2-28
2.10.14.	Reference Serial Indicator.....	2-28
2.10.15.	Load Ref. Button.....	2-28
2.10.16.	Series/Parallel Value Indicator.....	2-28
2.10.17.	Channel Control	2-28
2.10.18.	Go Button.....	2-28
2.10.19.	Report Button.....	2-28
2.10.20.	Close Button.....	2-29
2.10.21.	Rs Scanner Channel Indicator	2-29
2.10.22.	Rx Scanner Channel Indicator.....	2-29
2.10.23.	Samples Remaining Indicator.....	2-29
2.10.24.	Tests Remaining Indicator	2-29
2.10.25.	Current Value Indicator.....	2-29
2.10.26.	Next Sample In Indicator	2-29
2.10.27.	Saving Transfer Standard Report Data.....	2-29

2.10.28.	Loading/Viewing Transfer Standard Report Data	2-29
2.11.	TRANSFER STANDARD REPORT	2-31
2.11.1.	Save Button	2-31
2.11.2.	Print Button	2-31
2.11.3.	Close Button.....	2-31
2.11.4.	Value Indicators	2-31
2.11.5.	Standard Deviation (ppm) Indicators	2-32
2.11.6.	Reference Uncertainty (ppm) Indicators	2-32
2.11.7.	Coefficient Uncertainty (ppm) Indicators.....	2-32
2.11.8.	Expanded Uncertainty (ppm) Indicators	2-32
2.11.9.	Name Indicator.....	2-32
2.11.10.	Location Indicator	2-32
2.11.11.	Date Indicator.....	2-32
2.11.12.	Series/Parallel Value Indicator.....	2-32
2.11.13.	Delta Average Indicator	2-32
2.11.14.	Calculated Series Value (R1-R10) Indicator	2-33
2.11.15.	Calculated Parallel Value (R1-R10) Indicator	2-33
2.11.16.	Mean Resistor Value (R1-R10) Indicator	2-33
2.11.17.	Transfer Std. Serial Number Indicator	2-33
2.11.18.	Transfer Std. Asset/ID Number Indicator	2-33
2.11.19.	Transfer Std. Model Number Indicator	2-33
2.11.20.	Reference Serial Number Indicator	2-33
2.11.21.	Reference Model Number Indicator	2-33
2.11.22.	Calculated Series Value (all) Indicator	2-33
2.11.23.	Calculated Parallel Value (all) Indicator	2-33
2.11.24.	Mean Resistor Value (all) Indicator	2-34
2.12.	TRANSFER STANDARD PROCEDURE.....	2-34
2.13.	TRANSFER STANDARD PROCESS	2-35
2.14.	ITS-90 COEFFICIENT UTILITY	2-37
2.14.1.	Fixed Point Measurements Control	2-37
2.14.2.	Load Buttons	2-37
2.14.3.	Range Control	2-37
2.14.4.	Generate Button	2-38
2.14.5.	Coefficients Indicators	2-38
2.14.6.	Serial Number Control	2-38
2.14.7.	Model Number Control	2-38
2.14.8.	Cal Date Control	2-38
2.14.9.	New Button	2-38
2.14.10.	Open Button	2-38
2.14.11.	Save Button	2-38
2.14.12.	Report Button.....	2-38
2.14.13.	Close Button.....	2-38
2.15.	2.9. ITS-90 COEFFICIENT REPORT	2-39
2.15.1.	Print Button	2-39
2.15.2.	Close Button.....	2-39
2.15.3.	Fixed Point Measurements Indicators	2-39
2.15.4.	Coefficients Indicators	2-39
2.15.5.	Uncertainty Indicator	2-40
2.15.6.	Serial Number Indicator	2-40

2.15.7.	Model Number Indicator.....	2-40
2.15.8.	Cal Date Indicator	2-40
2.16.	BATCH PROCESS.....	2-41
2.16.1.	Start at: Control.....	2-41
2.16.2.	Go to: Control	2-41
2.16.3.	Save TXT Output Field.....	2-41
2.16.1.	Process Button	2-42
2.16.2.	Close Button.....	2-42
2.16.3.	Report Table/Field	2-42
2.17.	COEFFICIENT UTILITY	2-43
2.17.1.	Display Button	2-44
2.17.2.	Update Button	2-44
2.17.3.	Print Button.....	2-44
2.17.4.	Open Button.....	2-44
2.17.5.	Save Button.....	2-44
2.17.6.	Close Button.....	2-44
2.17.7.	Test Unit Serial Indicator	2-44
2.17.8.	Model Number Indicator.....	2-44
2.17.9.	Ratio Coefficient Values Indicator.....	2-44
2.17.10.	Ratio Coefficient Uncertainties Indicator.....	2-45
2.17.11.	Cal Date Indicator	2-45
2.17.12.	Date Modified Indicator.....	2-45
2.17.13.	Date Indicator.....	2-45
2.17.14.	Calibration Restoration Procedure	2-45
2.18.	SCANNER EXERCISE UTILITY	2-46
2.18.1.	Start/Stop Button.....	2-46
2.18.2.	Numbered Checkboxes (Ch 1 – Ch 32).....	2-46
2.18.3.	Select All Button.....	2-46
2.18.4.	Clear All Button	2-46
2.18.5.	Switch Delay Button	2-47
2.18.6.	Iterations Indicator	2-47
2.18.7.	Close Button.....	2-47
2.18.8.	Scanner Exercise Procedure	2-47
3.	USER NOTES.....	3-1
3.1.	MEASUREMENT OPERATION GUIDE	3-1
3.1.1.	Resistance Measurement Normal Mode - $1 \Omega \leq R_s \leq 10 \text{ k}\Omega$	3-2
3.1.2.	Resistance Measurement - Low Ohms Mode - $R_x \leq 0.1 \Omega$	3-6
3.1.3.	Resistance Measurement - High Ohms Mode - $100 \text{ k}\Omega \leq R_s \leq 10 \text{ M}\Omega$; $R_x \leq 100 \text{ M}\Omega$	3-11
3.1.4.	Thermometry Measurement $1 \Omega \leq R_s \leq 10 \text{ k}\Omega$	3-14
3.2.	DATA STORAGE	3-18
3.3.	TROUBLESHOOTING BRIDGEWORKS	3-18
3.3.1.	Error Messages	3-19
3.3.2.	Warnings.....	3-22
3.3.3.	Passcode Removal	3-24
3.4.	KEY NAVIGATION	3-25

3.5.	USING BRIDGEWORKS DEMO PROGRAM	3-26
3.5.1.	On Other Computers	3-26
3.5.2.	On the System Computer	3-26
3.6.	EXPORTING DATA.....	3-27
3.6.1.	Exporting to Excel	3-27
3.6.2.	Exporting Webpage	3-29
4.	APPENDIX.....	4-1
4.1.	SUMMARY OF RECOMMENDED TEST SETUPS	4-1
4.2.	FORMULAS	4-5
4.2.1.	Standard Deviation	4-5
4.2.2.	Uncertainty.....	4-5
4.2.3.	Interchange Error	4-5
4.2.4.	Closure Error	4-5
4.3.	AUTO REVERSAL RATE	4-6
5.	GLOSSARY	5-1
6.	INDEX.....	6-1

LIST OF TABLES

TABLE 2-2 : VERIFICATION TEST SCHEDULE	2-8
TABLE 2-5 : DECADE BOX TEST SCHEDULE	2-24
TABLE 2-6 : TRANSFER STANDARD TEST SCHEDULE	2-36
TABLE 4-1 : RECOMMENDED NORMAL MODE TEST SETUP	4-1
TABLE 4-2 : RECOMMENDED 100V HIGH OHMS MODE TEST SETUP	4-2
TABLE 4-3 : RECOMMENDED 1000V HIGH OHMS MODE TEST SETUP	4-2
TABLE 4-4 : RECOMMENDED LOW OHMS MODE TEST SETUP (6623A-300)	4-3
TABLE 4-5 : RECOMMENDED TEMPERATURE MODE TEST SETUP	4-4

1. BRIDGEWORKS SOFTWARE

The BridgeWorks Data Acquisition Software is the accompanying control software for your Guildline Resistance Measurement System. Using your system with the computer will increase the functionality of the instrument greatly with respect to operating its components as stand-alone units. Before using your bridge with the computer, you should ensure that the operation of this software package is well understood. This software was designed with an interface that blends the most common features of a traditional front panel coupled with the familiarity of the WindowsTM interface. The control of your Guildline Resistance Measurement System through this software will enable you to automate your measurement process, acquire your data, and analyze the results. This document pertains to BridgeWorks version 3.0 and higher.

Section 1 in this manual has been written in a fashion that breaks down each window and its associated controls/indicators on an as needed basis. This means that this manual describes each window in terms of their processes that you, as a user, would be able to execute. All the controls/indicators are explained as they are called upon in the processes in which they are used. This section describes only the software and its functionality. It is best for any inquiry about a certain point of the software to at least read the entire of sub-section in regards to the window that has the point in question. The utilities provided with BridgeWorks are described in detail in section 2.

Section 2, like Section 1, in this manual has been written in a fashion that breaks down each window and its associated controls/indicators of the utilities provided with BridgeWorks on an as needed basis. These utilities are predefined test setup procedures to perform calibration or verification. These routines are set up in a manner that simplifies the preparation of a given measurement in comparison to the usual means of entering the data. Furthermore, these utilities will present some options not available through the standard BridgeWorks measurement process. This section of the manual describes each window in terms of their processes that you, as a user, would be able to execute. All the controls/indicators are explained as they are called upon in the processes in which they are used. This section describes only the software and its functionality. It is best for any inquiry about a certain point of the software to at least read the entire of sub-section in regards to the window that has the point in question.

Section 3 is the User Notes to the BridgeWorks software. This section includes a measurement operation guide (section 3.1) which has been written in the approach that the basic functionality of the software is not addressed. It is understood to be a complete set of example setups in which to base your own measurements upon, focusing on both the hardware and the software. These examples are written in a step by step procedure. When using this section, you may wish to refer to the recommended setup tables in the Appendix (section 4.1) for a specific setup to obtain optimum values. For further assistance, you may also wish to go to the pertinent sub-section

describing how to execute normal, high, and low ohms tests. This section also contains information that is not required for the use of BridgeWorks, but is suggested information to help you improve the functionality and reliability. Included in the section are notes on the method for data storage/backup with the supplied configuration, as well as information on how to troubleshoot/prevent problems with your software and the computer in which it is installed. There is also a subsection on key navigation through BridgeWorks to help you move within the program more efficiently or in the event a pointing device is not available.

Section 4 is the appendix for quick reference to specific tables and other data.

For the best benefit out of this document, one should read it in the order it is presented. As the latter sections will, in many cases, assume that you have read and understood the information presented in the earlier sections.

Another literature resource that exists is the Operators Manual, which addresses the front panel usage and hardware aspects of your resistance bridge.

1.1. INSTALLATION AND SYSTEM CONFIGURATION

System Requirements

In order to run BridgeWorks, the software must be installed on a system that meets the system requirements stated below:

Software

- Microsoft™ Windows™ XP Service Pack 3 or newer Operating System.
- National Instruments™ driver software for Windows™ (supplied on BridgeWorks CD).
- Microsoft™ Excel™ XP or newer (recommended).
- Microsoft™ Internet Explorer™ 7.0 or newer (recommended).
- Seagate™ Crystal Reports™ 8.5 or newer (recommended).

Hardware (supplied with system)

- Minimum 50 Megabytes of free harddrive space for the program files.
- A SVGA graphics card and monitor.
- Mouse supported by Windows™.
- National Instruments™ GPIB interface.
- Printer supported by Windows™ (recommended).
- CD-ROM for installation purposes only (recommended).

Installation

BridgeWorks is supplied on a CD-ROM. For your convenience, the CD-ROM will automatically start up the BridgeWorks setup program after it has been placed in your CD-ROM drive. For those who do not have Windows™ autoplay extender enabled, simply run the setup executable from the CD-ROM through "Windows Explorer". The setup program will ask you if you wish to install and verify the install directory. Click on "Finish" and the setup will decompress all the files as well as create the appropriate directory structure. This setup will also update itself to the "Add/Remove Programs" list in your "Control Panel" for easy uninstallation. To run BridgeWorks, there will be a shortcut created in your "Start Menu". This is found by clicking on "Start", then pointing to the sequence of sub-menus "Programs...BridgeWorks".

NOTE: You will in many cases need to run the installation as an Administrator to successfully complete the install.

Also note that it may be desirable to install the Training Demo software on a computer that does not actually control the hardware. The demo version will at no time attempt to communicate over a GPIB bus and therefore it is also not a system requirement. The demo version only

simulates the hardware operation as if there was a system present, but maintains all other functionality. The BridgeWorks Demo can be beneficial on other computers for training purposes and offline data processing/viewing.

All of the files for the BridgeWorks program, as well as the help file and digital copies of the manuals, are installed together in the BridgeWorks directory structure which is located at "C:\Program Files\BridgeWorks" for the program and help file. These items all contain links in the "Start Menu" located in "Start...Programs... BridgeWorks...".

All of the files for the BridgeWorks Demo program as well as the training seminar are installed together in the BridgeDemo directory structure which is located at "C:\Program Files\BridgeDemo" for the program and training seminar file. These items also all contain links in the "Start Menu" located in "Start...Programs... BridgeWorks Demo...".

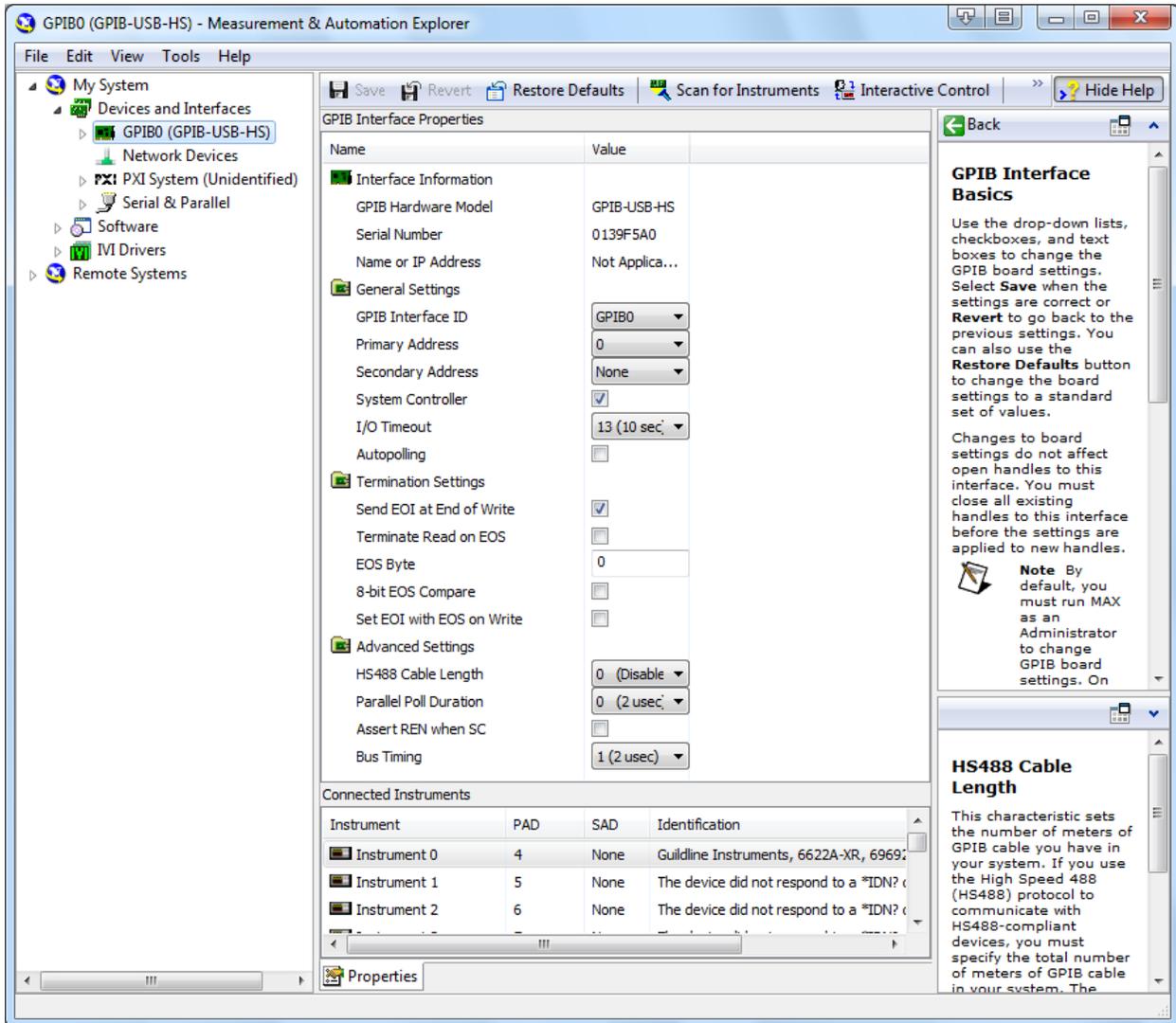
Upgrading From BridgeWorks v2.x

You do **NOT** need to uninstall BridgeWorks v2.x to install BridgeWorks 3. Furthermore, BridgeWorks 3 is also **NOT** installed over your older BridgeWorks 2.x installation. This allows you to keep your older version active and running in parallel until you have confidently migrated your test and data over. All data files from the 2.x versions of BridgeWorks will work in BridgeWorks 3 with the exception that in some cases there is less data available in the BridgeWorks 2.x files, some report fields will remain blank in these cases.

GPIB Driver Setup

When installing the National Instruments[™] driver software for Windows[™] you may encounter a prompt that instructs you to close the autorun program to complete the installation. This prompt will only appear if you already have a version of the driver database installed. If your version of the driver database is older than the supplied drivers on the BridgeWorks CD then it is recommended that you do close the autorun and continue the installation of the drivers. If your drivers are a more recent or the same version you should cancel the driver installation process at this point. Note that installation of the drivers will usually require a reboot of the system.

Once the GPIB drivers are installed you will need to configure the GPIB settings. This is done through National Instruments Measurement and Automation Explorer (NI MAX). The NI MAX should be run with administrator privileges to configure the GPIB settings. The settings that are most important are the Bus Timing **MUST** be set to 2usec, and the AutoPolling should be disabled. (see next page). Failing to use these setting can result in erratic behavior of the system, primarily the 6664 scanners. These settings are retained by the system and should only need to be set once.



GENERAL

Throughout the various windows in BridgeWorks, you will see different indicators and controls. These are used to display and retrieve information for you, as well as to control some of the features in BridgeWorks. In some windows throughout BridgeWorks, you will also find menu bars that offer pertinent commands for that area of the program.

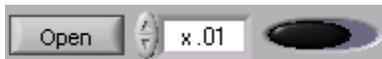
Warning: It is strongly advised that you do not attempt to change any parameters manually while under software control. If manual intervention is viewed as necessary, it should only occur while the software is either closed or displaying an error message. During software control, the front panel controls may appear to be inactive, due to the frequency of communication by the software. For manual control of the bridge, refer to the Operator Manual.

1.1.1. Indicators



Indicators are how BridgeWorks displays information to you. The more common indicators are message indicators (text), numeric displays and graphs. Indicator data cannot be changed directly by you. BridgeWorks updates them, as new information is available.

1.1.2. Controls



Controls are how you can input your information and choices into BridgeWorks. The most common controls are buttons, switches and numeric entry fields. These controls are, in most cases, set to default values and can be changed, as well as loaded with saved values to be edited or just viewed. Controls are activated by clicking on them, and you will see a visual representation of the action of that control or the edit cursor field will be activated. The displayed text for each control represents the applicable state that will be achieved when it is activated by the user. Data can be entered in numeric entry fields by either directly entering data in the field or by clicking on the associated index arrows. The index arrow pointing up will increase the value displayed in the field, while the index arrow pointing down will decrease the value displayed in the field.

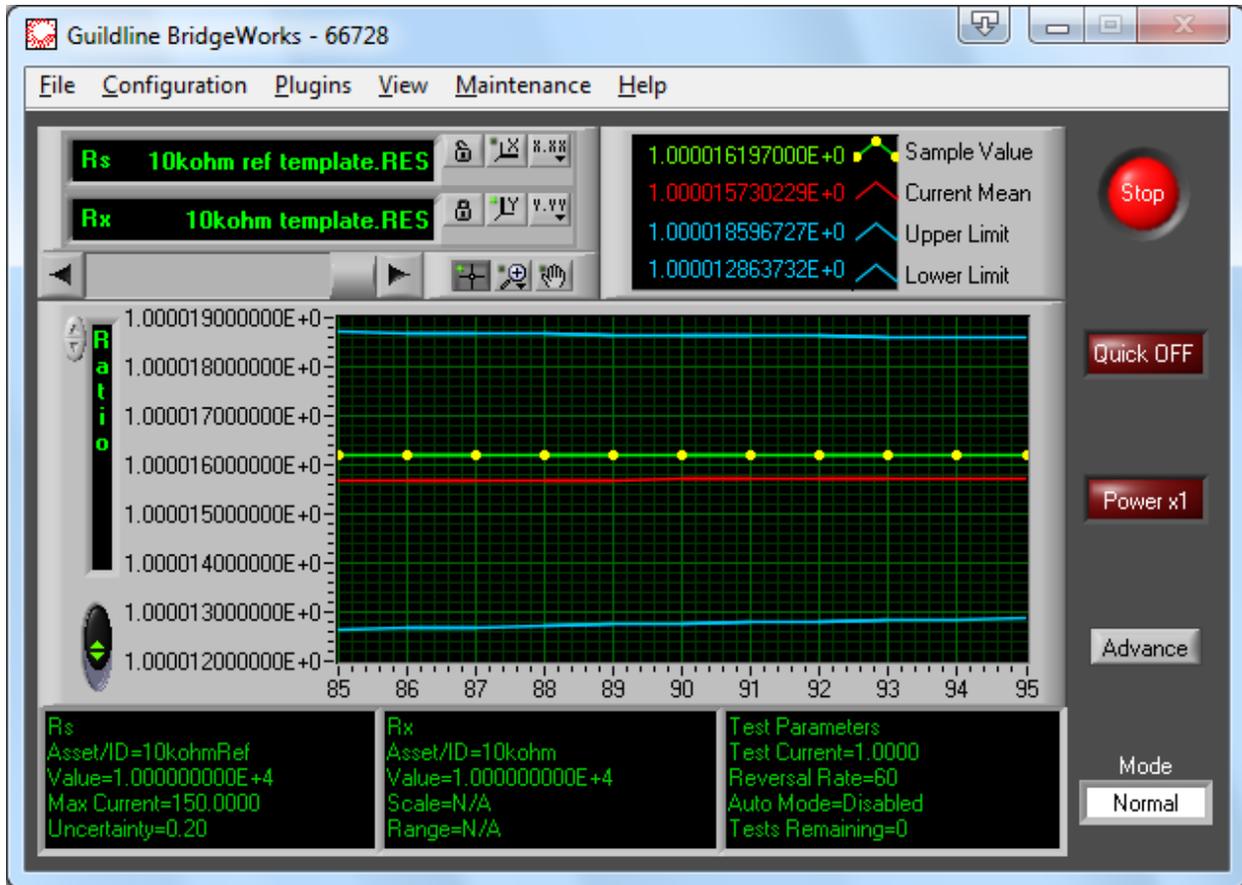
1.1.3. Fields

Fields are actually a type of control that requires a value or text entry through the keyboard. Being a type of control, they will also in many cases be set to preset values and can be loaded with saved values, as well as edited directly. This type of control is the most predominant type in all of the configuration windows. To edit the contents of a field, click with your mouse pointer inside the field and an editing cursor will appear. Enter in the desired information and then click outside the field to keep the contents in the field.

1.1.4. Menu Bar

The other main way you have to navigate through BridgeWorks is the menu bar. The menu bar has a series of commands within it that are relevant to that window. These commands usually consist of file management functions and program options rather than control of an actual measurement. Some of the more common menu items also can be accessed by controls in the window or through quick key combinations known as hotkeys. All menu items can also be accessed by pressing the Alt key and using the arrow keys to navigate through, or by using the mouse.

1.2. MAIN WINDOW



In the main window, there is a series of indicators and controls to setup and observe the measurement process. There is also a menu bar that you will need to use to access many of the functions and features of BridgeWorks.

1.2.1. Using The Graph

The graph on the main panel has many features available for you to view your incoming data as you so choose. The incoming data that is displayed are the four numerical indicators described in section 1.2.9 for all test sample points from the start of the logged test, including the logging delay, to the current sample. The main functions being that you can scroll back to view older samples at any time during the test using the scrollbar located above the graph, and you can modify the x and y scales by the control buttons above the scrollbar. The x.xx and y.yy is a control for you to change the format and precision of each respective axis. The two buttons with x and y axis icons will enable/disable the auto-scaling feature of the graph for each respective axis. Auto scaling is a function that optimizes the scale of graph to display all the points, but maximizing the fixed amount of viewing space. This feature is enabled on the y-axis by default, therefore displaying the changes at the smallest possible scale that will still show all the

information on the graph. There is also the zoom button, which will change your mouse pointer to a magnifying glass to show that the feature is active. You can either click on a central point for the zoom or highlight an area to zoom into. Lastly, by clicking on the hand, you can arbitrarily drag the graph to the position you want. While in this mode, your mouse pointer is in the shape of a hand. To return to normal from any of these states, just click on the crosshair button, for the default view mode. Clicking on the extremes of the x and y axis numbers will highlight the selected number to allow you to change the scale.

1.2.2. Stop Button

The "Stop" button located to the upper right is used to end a measurement in progress. When you start a measurement, you will notice that the "Stop" button will turn red. It will remain red until the test has stopped. If you need to end a measurement early, you can click on this control and the test will stop. The button will return to black when the test has successfully stopped.

1.2.3. Quick Control

The "Quick" control will allow you to toggle the quick mode of operation within the bridge. This mode is primarily used when there are large changes in resistance values to be measured. Selecting this will also reduce your resolution to a maximum of 7 digits. This control is only available while not running an auto reversal rate function, as the auto reversal rate optimizes this feature as well.

1.2.4. Power Control

The "Power" control allows you to step up your current or voltage to a value that is the square root of 2 times your configured value which doubles the power dissipated in the resistance devices under test. You can also toggle back to your original value as set up in your test configuration.

1.2.5. Units Control

The "Units" control sets the units in which you wish to view the incoming data. Changing the units will not affect the data being stored. All data is stored in ratio.

NOTE: It is best that this selection should be made before the start of a measurement. This selection can be changed during the test. However, already recorded data is not automatically changed to the new units. They continue to be displayed with the same numerical value.

1.2.6. Test/Advance Button

The "Test" button opens up the Test Configuration window the same as the menu item Configuration...Test. This is provided for speed and simplicity in setting up your measurements. While a test sequence is in operation the "Test" button changes to "Advance". The "Advance" button will index the test sequence to the next test.

1.2.7. Mode Indicator

The "Mode" indicator displays whether you have set BridgeWorks to normal, high, or low ohm measurements. High ohm mode is used when measuring with an R_s of 100k and greater, and Low ohm mode is used when a high current range extender is required.

1.2.8. File Indicators

At the top left of the main window, there are two indicators displaying which two device files are being used for the test. They are especially useful when in multi-test situations, where you can see which test is currently running.

1.2.9. Numerical Indicators

Above the graph there are four indicators displaying numerical values. These numbers are "Sample Value" (current test sample point reading), "Current Mean" (calculated mean of all test sample points), as well as the "Upper Limit" and "Lower Limit" (the current calculated mean +/- one current calculated standard deviation). Directly beside the current numbers there is a legend that shows the plot line colour/style which corresponds to the displayed value. Clicking on these plot lines will bring up a drop menu allowing you to modify the plot's appearance.

1.2.10. Details Button

Clicking the black oval "Details" button located at the bottom left of the graph will toggle the front panel to the split screen mode. In the split screen mode, the graph will become smaller to allow for text fields that display your current test's configuration information.

1.2.11. File Menu

The menu functions located in the File menu are some of the program's basic functions such as file management, printing and some program setup utilities.

File...Rescan For Bridge

This function, when selected, will open a GPIB scanning utility that will query all 32 possible addresses for your Guildline Resistance Bridge.

File...Import data Buffer

The import data buffer function allows you to download the last measurement manually run on the 6622A bridge into the the BridgeWorks software so that it can be stored on the computer.

File...Save Data As (hotkey Ctrl+S)

This command will open a standard windows file dialog prompting you for a name in which to save the current test data. Once given a filename, you can then click on OK to complete that task.

File...Config File Update

This command will open a standard windows file dialog prompting you for a name in which to save the updated value for the Rx device configuration file based on the displayed mean of the current measurement displayed in the main window. Once given a filename, you can then click on OK to complete that task. This function is disabled when the Administrative Options "Config File Save Lockout" feature is enabled.

File...Administrative Options

The administrative options allow you to set the passcode, uncertainty mode and block out the ability to overwrite configuration files. You are required to know the existing passcode to access the Administrative Options window.

File...Print Window (hotkey Ctrl+P)

This menu item will print the contents of the main window through your windows default printer.

File...Page Setup

This will call up your Windows printer configuration editor so that you can prepare your printer for any documents you will need to print out of BridgeWorks.

File...Quit (hotkey Ctrl+Q)

This item, when selected, will quit the BridgeWorks program.

1.2.12. Configuration Menu

The Configuration menu contains links to all the configuration windows used in creating device files and the test setup.

Configuration...Resistor

This menu item opens the Resistor Configuration window for you to create and edit "*.RES" or resistor files. One of these files is required on the Rs channel for all measurements and a second file will be needed on the Rx channel.

Configuration...Probe

This menu item opens the Probe Configuration window for you to create and edit "*.PRB" or probe files. One of these files is required on the Rx channel for all temperature measurements.

Configuration...Test

This menu item opens the Test Configuration window for you to create and edit "*.SEQ" or test sequence files. From this window, you also initiate the actual test. You start the test by clicking on "OK". If you do not wish to start the test, then remember to click on "Cancel".

Configuration...Environment

Clicking on this option brings up a window where you can log the test variables external to the direct system. These items include pressure, room temperature and humidity in separate fields. You also have a place to log your name as the test operator and the company/lab name. The information entered here will be logged with all data files.

Configuration...Decade Box

The decade box utility is designed to speed up the verification of decade. The duration of this utility can range from approximately 5 minutes to 4 hours, depending upon the values, accuracy and the amount of ranges measured. In most cases the utility is approximately 1 hour long.

Configuration...Transfer Standard

The Transfer Standard utility is designed for Hamon type resistance transfer standards through the use of a scanner and an adapter. The duration of this utility can range from approximately 15 minutes to several hours, depending on the sample depth and reversal rates chosen. In most cases, the utility is approximately 1 hour long.

Configuration...ITS-90 Cal

ITS-90 Cal is a utility which is designed to calibrate a SPRT to the International Temperature Scale of 1990. The utility allows the importing of resistance test data at the temperature fixed points required to calculate the coefficients for the ITS-90 temperature fit of SPRT's and PRT's.

1.2.13. Plugins Menu

The Plugins menu contains links to the installed plugins. These plugins are modular expansions to the BridgeWorks software and offer automation of higher level processes as well as dedicated test routines. These plugins can be added to and therefore the items listed in the menu can vary, however the BridgeWorks package does come with the base plugins listed below

Plugins...Verification

The Verification utility is a full procedure to verify the entire range of the 6622A bridge and ratio modes. This routine uses the interchange of each 1:1 tests and 100:1 closures to remove the dependency on the actual values of the resistors. This is a very in depth test and report and will require the use of external resistors. These resistors should be from your standard and working sets. To run this utility, you must load your resistor files to their associated scanner channel. You should review your hardware, to verify that it is the same as displayed by the utility. When you have completed this, click on "Start" to initiate the test. On completion, the verification test utility will generate a report so you can review the data. The duration of this utility varies based on the 6622A variant and can be approximately 14 to 28 hours.

Plugins...Batch Process

The batch process is a useful tool that allow you to process a large amount of test data within a directory and provides a summary which is displayed as well as saved is in a tab delimited text file for easy importing into common spreadsheet tools such as Microsoft Excel.

1.2.14. View Menu

The View menu has all the features in it that are used to display test information. Most of these items are used with sample data.

View...Test Overview

The Test Overview window will appear when you select this item. Inside the Test Overview is where you will be able to view your test, along with the post-test analysis completed by BridgeWorks.

View...History Chart

Selecting this function will bring up a window quite similar to the Test Overview window. This window is called the History Chart. In here, you will be able to group data from multiple tests for your analysis.

View...File Manager

The File Manager is an organizational tool allowing you to view, with more detail data files in a chosen directory. This is done by selecting the "Directory" button in the File Manager window and then the "Select Cur Dir" button in the following windows file dialog at the chosen directory. The details shown within the file are filename, Rs control number, Rx control number and date stamp. From this window you can open the file in the associated viewer. You can also print out the listing that is being displayed.

View...Resolution...(5-12 Digits)

This will open a sub-menu that has resolution selection options of anything from 5 to 12 digits. Selecting one of these options will change the displayed data's resolution to the chosen option and place a menu marker beside the menu item to point out the current selection. The default resolution is 12 digits.

NOTE:

While in "Quick" mode of measurement, the maximum resolution is 0.1 ppm.

1.2.15. Maintenance Menu

The Maintenance menu has all the features in it that are used to set-up and maintain your 6625 system.

Maintenance...Scanner Exercise

The Test Overview window will appear when you select this item. Inside the Test Overview is where you will be able to view your test, along with the post test analysis completed by BridgeWorks.

Maintenance...Coefficients

The Coefficient Utility that allows you to display, modify and print out the calibration coefficients stored in your bridge. This utility should only be used in the event of the bridge being re-calibrated, to restore your old calibration from a non-volatile memory failure, or as part of a test. Misuse of this utility can remove the calibration from your bridge. This function is by default locked under the Administrative Options.

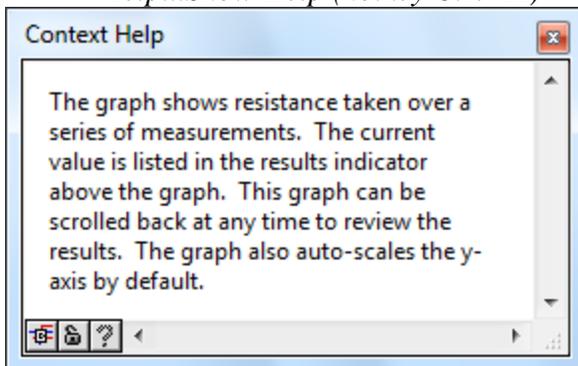
Maintenance...System Setup

The System Setup is a window is where you can define all the equipment parameters 6625 Resistance Measurement System.

1.2.16. Help Menu

In the Help menu you will find three selections that will assist you. They include information such as the operation of BridgeWorks, and contact information for Guildline Support. This function will open a small window that will display a quick description of the control or indicator your mouse pointer is hovering over. This window will update itself as you hover over other controls and indicators throughout all of the windows in BridgeWorks. This window will remain on top of all others until you click on the close button.

Help...Show Help (hotkey Ctrl+H)



This function will open a small window that will display a quick description of the control or indicator your mouse pointer is hovering over. This window will update itself as you hover over

other controls and indicators throughout all of the windows in BridgeWorks. This window will remain on top of all others until you click on the close button.

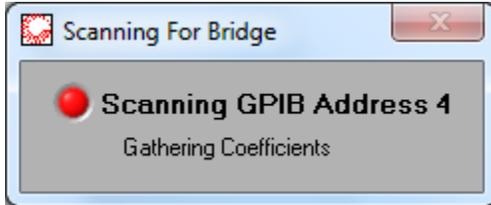
Help...Help

This menu selection will open up the windows help file, which is your on-line reference guide. The help file can be navigated through hyperlinks and the search engine.

Help...About

Selecting this item will open a window that displays the program version number and how to contact Guildline Instruments. If you have an active connection to the internet, you can click on the web address shown in the window to automatically open Internet Explorer and load our home page. Here you can access even more information about Guildline and our products.

1.3. RESCAN FOR BRIDGE WINDOW

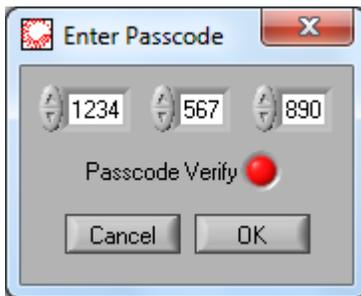


This function, when selected, will open a GPIB scanning utility that will query all 32 possible addresses for a Guildline bridge. The address of the model and address that is found will be saved in the Bridge.ini file, so that BridgeWorks will check that address first at startup. Run this function:

- 1) If BridgeWorks indicates upon startup that a bridge has not been found.
- 2) If the GPIB cables have been disconnected at any time, particularly as if bridge has been replaced.
- 3) If the bridge has been turned on after BridgeWorks was opened.
- 4) If a communication error has been reported.

1.4. ADMINISTRATIVE OPTIONS WINDOWS

1.4.1. Enter Passcode Window



The Enter Passcode window allows you to enter the present passcode to access the Administrative Options window. Be certain to remember your passcode, as you cannot enter the Administrative Options window without a passcode once it has been set for the first time. Until you select a passcode for the first time, the Enter Passcode window will be automatically bypassed when you click on the “Administrative Options” File menu item, so that the Administrative Options window appears immediately.

1.4.1.1. Passcode Fields

The "Passcode" fields are where you can type in the present supervisor passcode for accessing the Administrative Options. The passcode consists of one four-digit field and two succeeding three-digit fields. The number in the four-digit field can be any number between 1 and 9999. The

numbers in the three-digit fields can be any number between 1 and 999. Unless you change it, BridgeWorks will automatically display the original default passcode containing 1 in each field, which is not necessarily the actual present passcode.

1.4.1.2. Pass Code Verify

The Pass Code Verify feature is not a presently enabled feature of BridgeWorks.

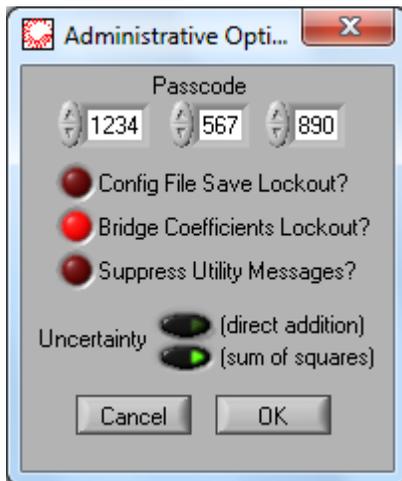
1.4.1.3. OK Button

Clicking the "OK" button will exit the Enter Passcode window. If the passcode has been correctly entered, then the Administrative Options window will be displayed. If the passcode has not been correctly entered, then you will be returned to the main window.

1.4.1.4. Cancel Button

Clicking the "Cancel" button will exit the Enter Passcode window and return you to the main window.

1.4.2. Administrative Options Window



The Administrative Options window allows you to set the passcode, choose the uncertainty calculation method, and block out the ability to overwrite configuration files. This provides the ability for supervisory control over your measurement process and devices. Be certain to remember your passcode, as you cannot enter this window without a passcode once it has been set for the first time.

1.4.2.1. Passcode Fields

The "Passcode" fields are where you can type in the new supervisor passcode for accessing the Administrative Options. The passcode consists of one four-digit field and two succeeding three-digit fields. The number in the four-digit field can be any number between 1 and 9999. The

numbers in the three-digit fields can be any number between 1 and 999. Unless you change it, the present passcode is displayed. When BridgeWorks is first installed, there is no passcode, although the default proposed passcode of 1, 1, and 1 will be displayed.

1.4.2.2. Config File Save Lockout Control

The "Config File Save Lockout" control is a checkbox that enables/disable the ability for the user to overwrite configuration files in BridgeWorks. This includes all resistor and test setup files. Having the checkbox "checked" enables the feature. When BridgeWorks is first installed, the checkbox is not "checked", indicating that the feature is not enabled.

1.4.2.3. Bridge Coefficients Lockout Control

The "Bridge Coefficients Lockout" control is a checkbox that enables/disable the ability of the user to view and modify the 6622A DCC Bridge coefficients BridgeWorks. Having the checkbox "checked" enables the feature. When BridgeWorks is first installed, the checkbox is "checked", indicating that the feature is enabled.

1.4.2.4. Suppress Utility Messages Control

The "Suppress Utility Messages" control is a checkbox that enables/disable the warning messages received at the beginning of the software utilities.

1.4.2.5. Uncertainty Type Control

The "Uncertainty Type" control is a set of selection switches that toggle a system wide choice between the direct addition and the sum of squares method for uncertainty calculation. This will affect ALL uncertainty calculations within BridgeWorks. The default setting for this on initial installation is the sum of square method.

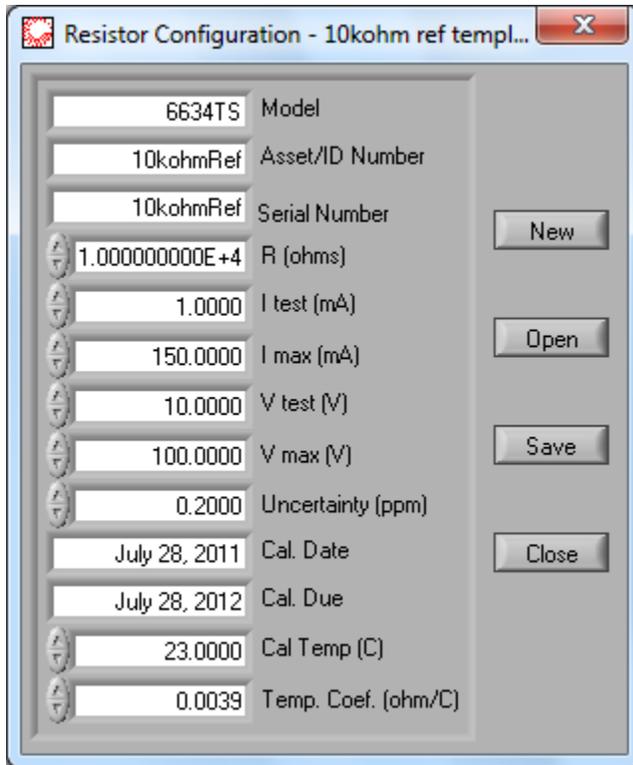
1.4.2.6. OK Button

Clicking the "OK" button will exit the Administrative Options window and update the information. Until the "OK" button has been clicked for the first time since BridgeWorks was installed, there is no passcode required to enter this menu. After the first time that the "OK" button is clicked, the passcode will be the default containing 1 in each field, unless you have entered a new passcode in the "Passcode" fields. It is recommended that a passcode that is not the default be chosen.

1.4.2.7. Cancel Button

Clicking the "Cancel" button will exit the Administrative Options window without updating the information.

1.5. RESISTOR CONFIGURATION WINDOW



The Resistor Configuration window is where you can create and edit "*.RES" or resistor files that are used by BridgeWorks. These files are profiles of your resistors for usage within BridgeWorks. These profiles contain the resistance value, the test and maximum excitation values, as well as control numbers and calibration information.

1.5.1. Model Field

The "Model" field is where you can type in the model type for the resistor you are describing.

1.5.2. Asset/ID Field

The "Asset/ID" field is where you can type in the asset or identification number for the resistor you are describing.

1.5.3. Serial Number

The "Serial Number" field is where you can type in the serial number for the type of resistor you are describing.

1.5.4. R (ohms) Field

The "R (ohms)" field is where you can type in the actual value for the resistor you are describing. When you first enter a value in this field the usual and maximum excitation values are automatically suggested.

1.5.5. Itest (mA) Field

The "Itest (mA)" field is where you can type in the excitation current for the resistor you are describing. This field is where the suggested value (based on 10mW) is stored for when this resistor is used in either Normal or Low ohms tests.

1.5.6. Imax (mA) Field

The "Imax (mA)" field is where you can type in the maximum current for the resistor you are describing. This field is where the maximum value to run a test is stored for when this resistor is used in a test sequence for either Normal or Low ohms tests. If the system detects that the resistor will be excited beyond this value, then the test is automatically stopped.

1.5.7. Vtest (V) Field

The "Vtest (V)" field is where you can type in the excitation voltage for the resistor you are describing. This field is where the suggested value (based on 10 mW) to run a test is stored for when this resistor is used in a test sequence for High ohms tests.

1.5.8. Vmax (V) Field

The "Vmax (V)" field is where you can type in the maximum voltage for the resistor you are describing. This field is where the maximum value to run a test is stored for when this resistor is used in a test sequence for High ohms tests. If the system detects that the resistor will be excited beyond this value, then the test is automatically stopped.

1.5.9. Uncertainty (ppm) Field

The "Uncertainty (ppm)" field is where you can type in the known uncertainty for the resistor you are describing. This uncertainty will be used for measurements where this resistor is the reference.

1.5.10. Cal Date Field

The "Cal Date" field is where you can log the date that the resistor was calibrated.

1.5.11. Cal Due Field

The "Cal Due" field is where you can log the date that the resistor is due to be calibrated.

1.5.12. Cal Temp (C) Field

The "Cal Temp (C)" field is where you can log the temperature that the resistor was calibrated at.

1.5.13. Temp Coef (ohms/C) Field

The "Temp Coef (ohm/C)" field is where you can log the temperature coefficient for that resistor.

1.5.14. New Button

The "New" button will clear all fields to allow the creation of a new resistor profile.

1.5.15. Open Button

The "Open" button allows you to open an existing resistor configuration file to be edited. Clicking on this button will open a file dialog box prompting for a resistor configuration file "*.RES" to open for editing.

1.5.16. Save Button

The "Save" button allows you to save the edited or created resistor configuration to a file. Clicking on this button will open a file dialog box prompting for a resistor configuration file "*.RES" name to save the data under. This function will not allow overwriting an existing file when the Administrative Options "Config File Save Lockout" feature is enabled.

1.5.17. Close Button

Clicking the "Close" button will exit the Resistor Configuration window.

1.5.18. Creating a Resistor File

Upon opening the Resistor Configuration window or after pressing the "New" button, there are several fields to be filled in. The "Asset/ID Number" field will help you keep track of specific resistors, while the "Serial Number", "Model Number", "Cal. Date", and "Cal. Due" provide supplementary information. "Cal. Temp. (C)" and "Temp. Coef. (Ohm/C)" can also be filled in for your future reference. The "R(ohms)" field is where you enter the known or approximate value of the resistor. When this field has been entered for the first time, the "I max (mA)", "I test (mA)", "V max (V)", and "V test (V)" fields will automatically be set to recommended values. The automatic settings for "I test (mA)" and "V test (V)" are equivalent to 10 mW of applied power, which is compatible with the recommended excitation for most resistor manufacturers. Selecting the corresponding field and typing in your own value can change all these values. The "I max (mA)" field is the maximum current you wish to allow through the resistor, if it is connected to the Rs side of the bridge. The "I test (mA)" sets the test current for the resistor, if it is placed on the Rx side of the bridge. The "V max (V)" field is the maximum voltage you wish to apply to the resistor, if it is connected to the Rs side of the bridge. The "V test (V)" sets the test voltage for the resistor, if it is placed on the Rx side of the bridge. The BridgeWorks software and the bridge will report an invalid test setup, if the necessary current required to find a rough null will exceed the value in the "I max (mA)" or "V max (V)" fields, based on the ratio between Rs and Rx. The defaults for "I max (mA)" and "V max (V)" in this window are based on using nominal values for Rs and Rx, and, thus, may have to be adjusted by the user. Always use caution when setting these values, as using wrong values will result in bad data or even failed tests. Lastly, there is the "Uncertainty (ppm)" field, where you can state any known inaccuracy of

the resistor's value. Once you have all the information in place, you must save the resistor file so that it can be used during the test.

1.5.19. Saving a Resistor File

To save the resistor configuration that is currently being displayed, you click on the "Save" button. This will call up a Windows file dialog prompting you for a file name for your resistor configuration. Type out the name you wish to call the configuration and click on "Save". The file extension ".RES" will automatically be added to your saved Resistor Configuration.

1.5.20. Loading a Resistor File

To load a resistor configuration that has previously been saved, click on the "Open" button in the Resistor Configuration window. A standard Windows file dialog will prompt you to select a file with ".RES" extension. You then find and select the file of choice, highlight it and then click on "Open".

1.5.21. Editing a Resistor File

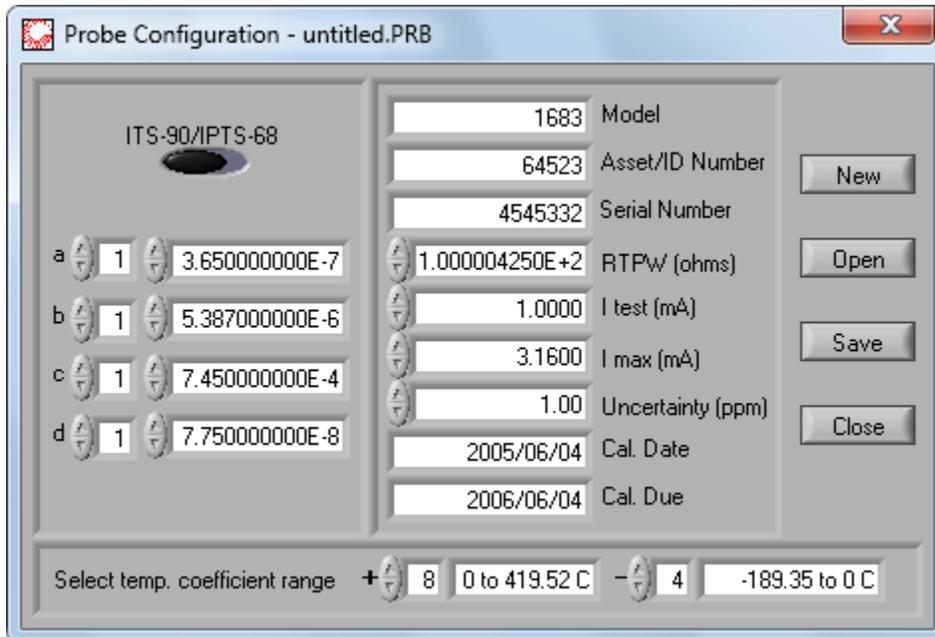
To edit an existing resistor file, you need to open the file into the Resistor Configuration window. While the configuration is in the window, you can change the fields to reflect the desired resistor configuration. When this is complete, you merely save the new resistor configuration using the same name to overwrite the old file or a new name to keep both resistor configurations. You can then click on "Close" to close the Resistor Configuration window.

1.5.22. Resistor File Format

The resistor file consists of these fourteen lines. The first acting as a header and the other thirteen are read in as a configuration file. This file is stored as standard ASCII text and can be opened by any text editor. It is possible, but not recommended, for you to edit these files outside the BridgeWorks program.

```
[Resistor]
R=1.0000000E+0
Serial=56375
Manufacturer=Guildline
Asset=38733
Itest=9.9000000E+1
Imax=1.5000000E+2
ppm=0.0000000E+0
Date=1999/06/23
Due=2000/06/23
Vtest=9.4868330E-2
Vmax=1.0000000E-1
caltemp=2.3000000E+1
coef=3.1600000E-4
```

1.6. PROBE CONFIGURATION WINDOW



The Probe Configuration window is where you can create and edit “*.PRB” or probe files that are used by BridgeWorks. These files serve as a profile for BridgeWorks from which to make measurements using that probe.

1.6.1. Creating a Probe File

In the Probe Configuration window there are many fields to be filled in. The “Serial Number”, “Asset/ID Number”, and “Model Number” fields will help you keep track of specific probes, along with the “Cal. Date” and “Cal. Due”. The “RTPW(ohms)” field is where you enter the known triple-point of water resistance of the probe. When this field has been entered for the first time the “Imax(mA)” and “Itest(mA)” fields will automatically be set to recommended values. These values can all be changed by selecting the corresponding field and typing in your own value. The “Imax(mA)” field is the maximum current you wish to allow through the probe. The “Itest(mA)” sets the test current for the probe. Always use caution when setting these values, as using wrong values will result in bad data or even failed tests. And lastly there is the “Uncertainty(ppm)” field where you can state any known inaccuracy of the probe's value. Once you have all the information in place you must save the probe file so that it can be used during the test.

1.6.2. Setting Temperature Coefficients

Unlike resistor files, probes files also have coefficients that are used to mathematically to convert the probe resistance to temperature. There are two standardized sets of coefficients that BridgeWorks will accept. They are the ITS-90 scale and the IPTS-68

scale for temperature conversion. You can enter the desired coefficient set by selecting the ITS-90/IPTS-68 switch. You will notice that the fields will change to suit each scale.

You can in fact enter both sets of coefficients for any probe then merely select your scale of choice for the test. If you choose to use the IPTS-68 scale you must fill in at least those four coefficients for proper calculations. If the ITS-90 scale is the scale you will use you need only to enter the coefficients that exist within the test's operating temperature range for the ITS-90 scale. However you can store all the coefficients for that probe in one file and merely select the ITS-90 range you wish to use before you start the test. You can select this range with the given controls for the positive and negative ranges at the bottom of the Probe Configuration window.

1.6.3. Saving a Probe File

To save the probe configuration that is currently being displayed you click on the “Save” button. This will call up a Windows file dialog prompting you for a file name for your probe configuration. Type out the name you wish to call the configuration and click on save. The file extension “.PRB” will automatically be added your saved Probe Configuration.

1.6.4. Loading a Probe File

To load a probe configuration that has previously been saved, click on the “Open” button in the Probe Configuration window. A standard Windows file dialog will prompt you to select a file with “.PRB” extension. You then find and select the file of choice, highlight it, and then click on open.

1.6.5. Editing a Probe File

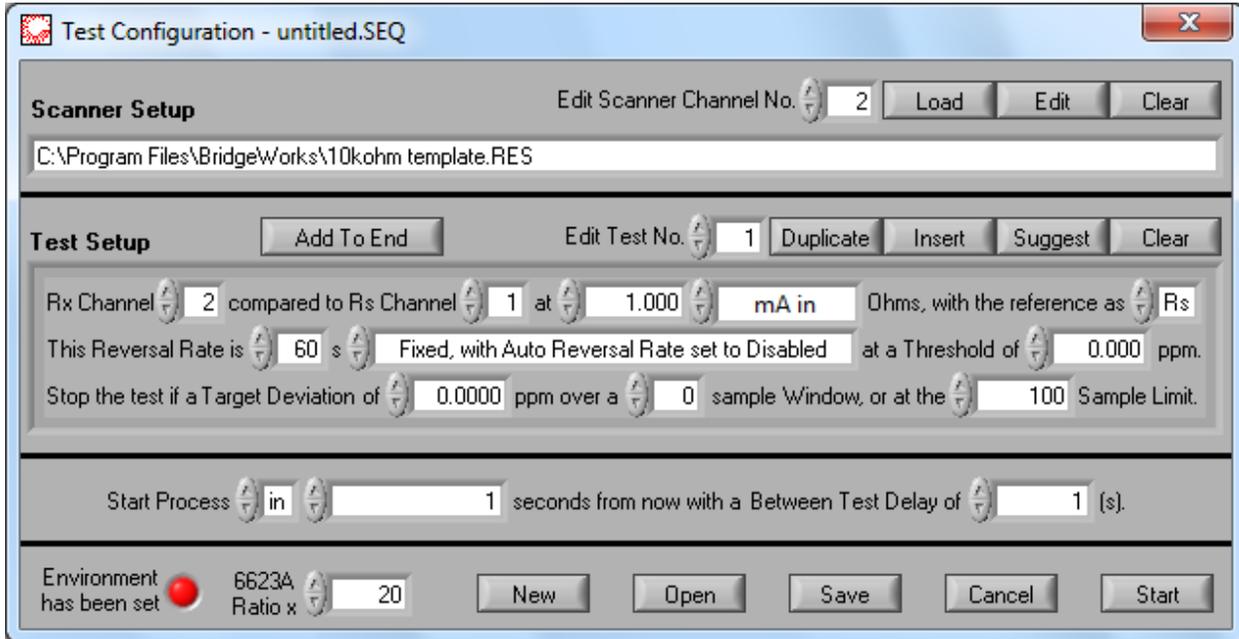
To edit an existing probe file you need to open the file into the Probe Configuration window. While the configuration is in the window you can change the fields to reflect the desired probe configuration. When this is complete you merely save the new probe configuration using the same name to overwrite the old file or a new name to keep both probe configurations. You can then click on “Close” to close the Probe Configuration window.

1.6.6. Probe File Format

The probe file consists of these forty-three lines. The first acting as a header and the other forty-two are read in as a configuration file. This file is stored as standard ASCII text and can be opened by any text editor. It is possible but not recommended that you edit these files outside the BridgeWorks program.

```
[Probe]
R=1.0000000E+2
Itest=4.9500000E-1
Imax=1.0000000E+0
Serial=84785
ppm=5.0000000E+0
Posrange=7
Negrange=1
Scale=FALSE
a1=4.8539000E-7
a2=0.0000000E+0
a3=0.0000000E+0
a4=0.0000000E+0
a5=0.0000000E+0
a6=0.0000000E+0
a7=0.0000000E+0
a8=0.0000000E+0
a9=0.0000000E+0
a10=0.0000000E+0
a11=0.0000000E+0
b1=7.8652800E-7
b2=0.0000000E+0
b3=0.0000000E+0
b4=0.0000000E+0
b5=0.0000000E+0
b6=0.0000000E+0
b7=0.0000000E+0
b8=0.0000000E+0
b9=0.0000000E+0
c1=5.2165000E-8
c2=0.0000000E+0
c3=0.0000000E+0
c4=0.0000000E+0
c5=0.0000000E+0
c6=0.0000000E+0
c7=0.0000000E+0
d=7.5928400E-12
A=0.0000000E+0
B=0.0000000E+0
sB4=0.0000000E+0
E4=0.0000000E+0
Date=03/21/1999
Due=09/21/1999
```

1.7. TEST CONFIGURATION WINDOW



In the Test Configuration window, you will be able to select which resistor files you will use for your test(s). You can also control, from this panel, the number of tests taken and their order, as well as the number of samples within those tests. The controls for the Auto Reversal Rate feature can also be accessed on this panel. When working in this window, use caution, as clicking on "Start" will execute the test configuration as displayed. Be sure to click on "Cancel", if you do not wish to execute the test and wish to close this window instead.

1.7.1. Scanner Setup

In the top portion of the Test Configuration window there is the scanner setup. The "Scanner Setup" field displays the path to the resistor file loaded on the displayed scanner channel. You can change the displayed scanner channel by indexing the "Edit Scanner Channel No." control.

1.7.2. Scanner Setup Load Button

Clicking on the "Load" button will bring up the Select Resistor/Probe File window to allow you to search for the resistor or probe file that will be loaded for the applicable scanner channel. The resistor/probe file name and its directory location will be displayed in the text message indicator in the "Scanner Setup" field. You can then select any channel combination(s) of the scanner channels to access the resistor(s)/probe(s) for your chosen test configuration(s) to be set into a test sequence, by first selecting the channel number and then loading in the resistor/probe file.

1.7.3. Scanner Setup Edit Button

The "Edit" button will call up the "Resistor Configuration" or "Probe Configuration" window with the selected resistor's information. This will be a blank template, if no resistor file has been previously selected. This will allow you to edit an existing file or create a new one without having to exit from the Test Configuration window. When you have completed your editing, closing the window will update any file already loaded into your test configuration. The "Resistor Configuration" window can also be accessed through the "Configuration" menu.

1.7.4. Scanner Setup Clear Button

Clicking on the "Clear" button will clear the displayed scanner channel of a resistor/probe configuration.

1.7.5. Test Setup Controls

The Test Setup is where you get to choose which channel of the scanner(s) will be selected for each test as well as all the test's parameters. This means that the resistors and/or probes that you have assigned to a scanner channel now can be accessed in any order you desire. You simply enter into all the fields within the "Test Setup" control the parameters that you desire for your test. You can index through each test using the "Edit Test No." control.

1.7.6. Suggest Button

The "Suggest" button will fill in the test being displayed with the recommended test setup for the 6625 Rs and Rx value chosen. This will only affect the displayed test in the sequence and not the rest of the tests in the sequence.

1.7.7. Test Setup Clear Button

Clicking on the "Clear" button will clear the displayed test configuration.

1.7.8. Rs and Rx Channel Controls

The channel control allows you to set scanner channels used for both your reference and your test unit to be connected to Rs and Rx channel of the bridge. This is normally set to Rs but is to be set to Rx where reverse ratio measurements are used.

1.7.9. Excitation/Ratio Control

The "Excitation/Ratio" control allows you to set either the excitation current/voltage or extender ratio for the test setup. This parameter changes based on the measurement mode chosen by the "Ohms Mode" control and is displayed in the "Ohms Mode" control.

1.7.10. Ohms Mode Control

The "Ohms Mode" control allows you to set BridgeWorks up to use a range extender for "Low Ohms" current measurements, or voltage for "High Ohms" measurements, as well as the default, which is current for "Normal" measurements. Refer to section 4.1 for the summary of recommended test setups which describe the setup requirements for these four modes. If "A in

Low” or “mA in Normal” is selected, then the test current is entered into the “Excitation/Ratio” control. If “V in High” is selected, then the test voltage is entered. Lastly if the “x Ratio in Low” is selected this represent the ratio used in older Guildline Range extenders.

1.7.11. Reference Control

The “Reference” control will let you specify whether the reference (known) resistance value is on the Rs or Rx side of the bridge for the test. Using this control can help you achieve the best specifications out of the system by maintaining the optimum measurement range of the 6622A.

1.7.12. Reversal Rate Field

The baseline reversal rate is set by the Reversal Rate control. The reversal rate control has three functions on the Test Setup window. That function is determined by the Reversal Rate control. When the control by default is set to “Fixed, with Auto Reversal Rate set to Disabled”, the reversal rate entered is the reversal rate for the test. When it is set to “Maximum, with Auto Reversal Rate set to Stabilize”, the entered value is the upper limit of the variable reversal rate. When it is set to “Minimum, with Auto Reversal Rate set to Track”, the entered value is the lower limit of the variable reversal rate. Refer to Section 4.1 for recommended reversal rates.

1.7.13. Auto Reversal Rate Control

Auto Reversal Rate is a feature in BridgeWorks that optimizes the reversal rate based upon your criteria for drift and accuracy. The Auto Reversal Rate obtains the criteria needed for this decision process from a combination of user set "Threshold" control, the deviation of the three most recent values, and measurement mode type (Track or Stabilize). This is a real time process during the measurement cycle that dynamically updates the reversal rate to accommodate for any changes encountered (flowchart shown in section 4.3).

1.7.14. Threshold Field

The “Threshold” control is where you can establish the guideline that the Auto Reversal Rate will follow. The threshold is defined as "the magnitude of standard deviation that the Auto Reversal Rate will choose to increase or decrease the reversal rate". While taking a resistance measurement, this can be thought of as the ceiling for how much noise or drift (in ppm) that you will allow before BridgeWorks will slow down the reversal rate to gain more stable readings.

1.7.15. Target Standard Deviation Field

The “Target Standard Deviation” control is where you define an acceptable amount of deviation to satisfy your criteria and carry on to the next test. If this field is left at zero, then BridgeWorks does not enable deviation as an end of test criteria. If the desired test criteria are not met, then the test will exit when the sample limit has been reached as defined in the “No. Of Samples” control.

1.7.16. Sample Window Field

"Sample Window" is a control that lets you vary the sample size of the standard deviation calculation. This allows you to specify how many readings that you require for a given standard deviation. If this field or the deviation field is left at zero, then BridgeWorks does not enable deviation as an end of test criteria. When deviation is used as an end of test criteria, the test will continue until the standard deviation of the last "Sample Window" sample size falls within the deviation limit or until the "No. of Samples" has been reached.

1.7.17. Sample Limit Field

The "No. of Samples" control allows you to select how many samples you wish to log for the test(s) you execute. BridgeWorks will use this number to know when to stop the current test and carry out the next test, if there is more than one test in the sequence.

1.7.18. Start of Process Delay Field

The start of process delay can be specified in two manners; the specific time and date, or length of time from now (in seconds). To choose the method of entering in your startup delay, use the "in/at" control and then enter the corresponding information.

1.7.19. Between Tests Delay Field

The "Between Test Delay" control is for you to specify how much time, in seconds, you wish to pause between tests in your sequence.

1.7.20. Setting the Environment Button/Indicator

The "Test Environment" window settings allow you to log the conditions under which the test is being executed. Here you enter in the values for test area Temperature, Humidity and Pressure, as well as the "Location" of the company/lab name and the name of the test conductor, in the respective fields. To set the environment, click on the indicator for the environment on the Test Configuration window. This will be "Click to set Environment" if you have not yet set the environment, or "Environment Set" if you have. This action will bring up the window with the fields to edit these settings. Click on "OK" to accept the changes, and the window will close and update the new information. Click on Cancel to not accept the changes. The indicator will also display that the environment log has been set by displaying "Environment Set". The "Test Environment" window can also be accessed through the "configuration" menu.

1.7.21. 6623A Ratio x Field

The "6623A Ratio x" field allows you to enter in the range extender ratio you have configured your shunt connections to. This will be either 20, 200, or 2000 typically.

1.7.22. Open Button

The "Open" button allows you to open an existing test sequence file to be edited or executed. Clicking on this button will open a file dialog box prompting for a test sequence file "*.SEQ" to open for editing.

1.7.23. Save Button

The “Save” button allows you to save the edited or created test sequence to a file. Clicking on this button will open a file dialog box prompting for a test sequence file "*.SEQ" name to save the data under. This function will not allow overwriting an existing file when the Administrative Options "Config File Save Lockout" feature is enabled.

1.7.24. Cancel Button

Clicking the "Cancel" button will exit the Test Sequence window without executing the test(s).

1.7.25. Start Button

Clicking the "Start" button will prompt you to select the directory that the test results will be saved in. Pressing “Cancel” will return you to the Test Configuration window. Pressing “OK” will open another window allowing you to create a new directory for the file storage. Pressing “Cancel” in this window will return you to the Test Configuration window. Pressing “Save” in this window will exit the Test Sequence window and execute the test(s).

1.7.26. Saving a Test Configuration

To save the test configuration that is currently being displayed, you click on the "Save" button. This will call up a Windows file dialog prompting you for a file name for your test configuration. Type out the name you wish to call the configuration and click on save. The file extension ".SEQ" will automatically be added your saved Test Configuration.

1.7.27. Loading a Test Configuration

To load a test configuration that has previously been saved, click on the "Open" button in the Test Configuration window. A standard Windows file dialog will prompt you to select a file with ".SEQ" extension. You then find and select the file of choice, highlight it and then click on "Open".

1.7.28. Editing a Test Configuration

To edit an existing test configuration, you need to open the file in the Test Configuration window. While the configuration is in the window, you can change the fields to reflect the desired test configuration. When this is complete, you merely save the new test configuration using the same name to overwrite the old file or a new name to keep both test configurations.

1.7.29. Exiting the Test Configuration

You must take special care as to how you exit the "Test Configuration" window. Before leaving this window, you must be certain whether you wish to initiate the test on exit or not. You can then click on "Start" to close the window, create a directory to save the test data in and execute the test, or click on "Cancel" to close the window and not start the test.

1.8.1. Location Field

In the "Location" field, the program operator should enter his or her company or lab name to have this displayed on the measurements logged using BridgeWorks. The entry of this field is stored in the initialization file of BridgeWorks as the default.

1.8.2. Name Field

In the "Name" field, the program operator should enter his or her name to have this displayed on the measurements logged using BridgeWorks.

1.8.3. Pressure (kpa) Field

In the "Pressure (kpa)" field, the program operator should enter the pressure of the test environment to have this displayed on the measurements logged using BridgeWorks.

1.8.4. Temperature (C) Field

In the "Temperature (C)" field, the program operator should enter the temperature of the test environment to have this displayed on the measurements logged using BridgeWorks.

1.8.5. Humidity (%) Field

In the "Humidity (%)" field, the program operator should enter the humidity of the test environment to have this displayed on the measurements logged using BridgeWorks.

1.8.6. OK Button

Clicking the "OK" button will exit the Environment Options window and update the information.

1.8.7. Cancel Button

Clicking the "Cancel" button will exit the Environment Options window without updating the information.

1.9. DATA LOGGING

As with any data acquisition software, the primary purpose is to retrieve and store data. While configured to take multiple measurements, BridgeWorks will automatically save to a self-generated filename, so that it can proceed to the next test in the sequence.

1.9.1. Saving a Data File

To save the data file that is currently being displayed on the main window, you can go to the menu bar and select "File...Save Data As" or use hotkey "Ctrl+S". You will then see a Windows file dialog prompting you to save the information in a *.TST file. This file can then be recalled by the Test Overview window for review. If you have chosen to save a file that has the same name and path as another file, you will get a warning message. In this message, you are given the choice to cancel the saving operation or replace the other file with the one you are trying to save.

1.9.2. Saving Multiple Files

Saving multiple files is used when there is a scanner enabled on either one or both of the channels. Outside of selecting the directory to store the files, there is nothing you need to do as the user to set up the files that are saved. BridgeWorks will use the file names of the units under test on the Rx and Rs channels.

As an example:

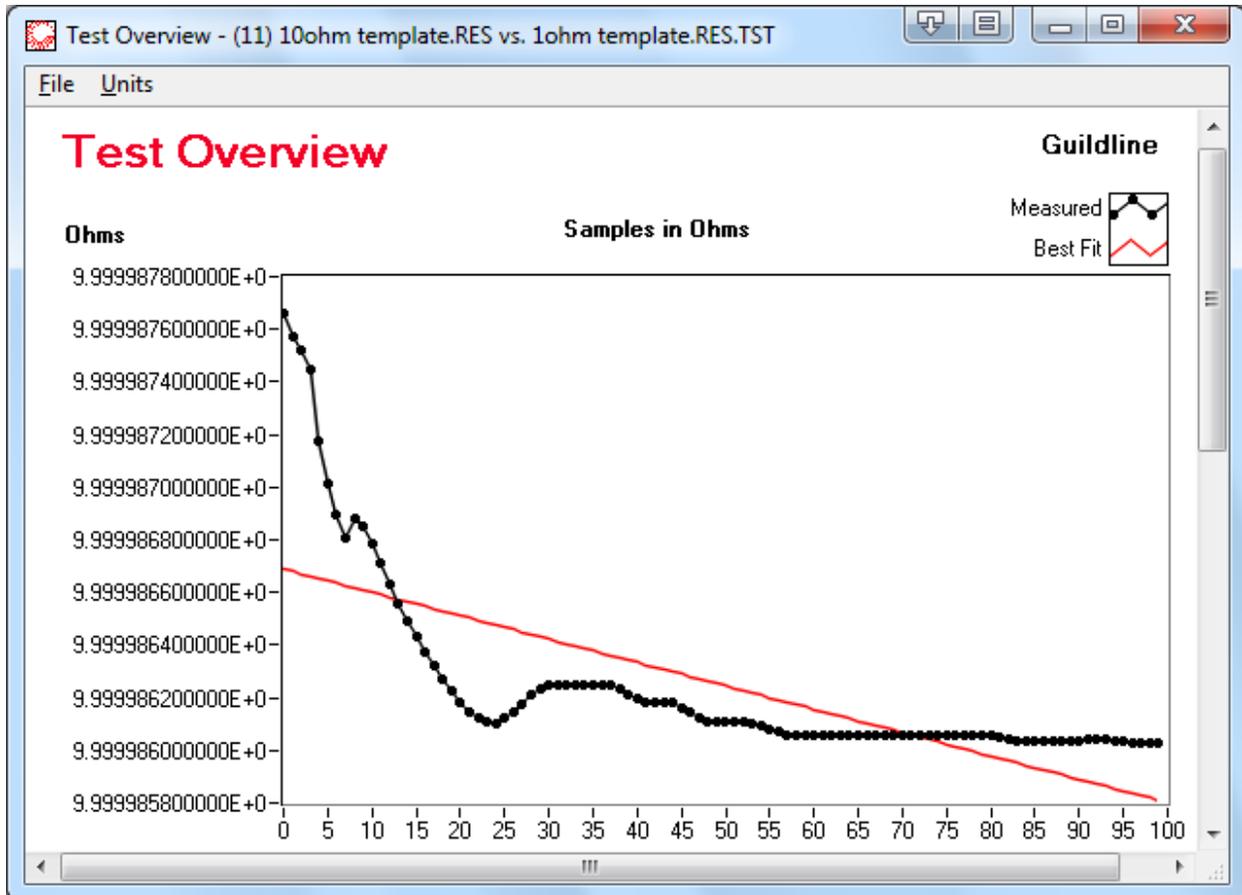
(#)measured.RES vs. standard.RES.TST

The format, as can be seen above, (indexed number)(Rx channel) vs. (Rs channel).TST, is used to automatically generate the test filename. Knowing this will be important for you to keep track of your data along with choosing an adequate directory name.

The other cases in which the data is automatically logged for you is in the plugin Utilities. The format is as follows...

For Verification: The data is stored in a directory entitled "verification_YYYY-MM-DD". These data files will be entitled in sequence from "test1.TST" - "test18.TST".

1.10. TEST OVERVIEW WINDOW



The Test Overview window is where you can open and edit saved test data. This window will complete a data analysis of the opened test file and display a graph with the best-fit curve; as well as mean, standard deviation and uncertainty calculations. These are all displayed in a clean, organized report format, which can be printed out.

1.10.1. Graph

The graph displays all the points used for calculations within a given test. The graph displays sample values on the vertical axis with respect to an incrementing sample number on the horizontal axis. The incrementing sample number always starts with 0. The sample value axis can adjust its resolution (from 5 to 12 digits) and units (resistance or ohms) and (Kelvin, Celsius, of Fahrenheit as well for probe measurements). The scale ranges of this graph are auto selected to display all the points used at the best resolution. The dimension of the sample values is determined by the units menu. Refer to section 1.9.18. Along with all the points being displayed there is a best fit line plot to help graphically represent any measurement drift. The points displayed here can be adjusted with the “Crop” tool found in the “Data Manager”.

1.10.2. Test Filename Indicator

The "Test Filename" indicator displays the filename of the test that is being displayed.

1.10.3. Test Date/Time Indicator

The "Test Date/Time" indicator displays the time that the displayed test was executed.

1.10.4. Standard Resistor Indicator

The "Standard Resistor (Rs)" indicator displays the control number of the standard resistor used for the displayed test.

1.10.5. Resistor/Probe Indicator

The "Resistor/Probe (Rx)" indicator displays the control number of the resistor tested in the displayed test.

1.10.6. Test Value Indicator

The "Test Value" indicator displays the test current or voltage (whichever is appropriate) used for the resistor under test in the displayed test.

1.10.7. Power For Test Indicator

The "Power For Test (mW)" indicator displays the power dissipated in the resistor under test for the displayed test in mW.

1.10.8. Reversal Rate Indicator

The "Reversal Rate (s)" indicator displays the reversal rate used in the displayed test in seconds (s).

1.10.9. Temperature During Test Indicator

The "Temperature During Test(C)" indicator displays the temperature of the test environment entered in the Environment Options during the time the test being displayed was taken in °C.

1.10.10. Humidity During Test Indicator

The "Humidity During Test (%)" indicator displays the relative humidity of the test environment entered in the Environment Options during the time the test being displayed was taken as a percentage (%).

1.10.11. Pressure During Test Indicator

The "Pressure During Test (kpa)" indicator displays the barometric pressure of the test environment entered in the Environment Options during the time the test being displayed was taken in kpa.

1.10.12. Standard Deviation Indicator

The "Standard Deviation (ppm)" indicator displays one standard deviation of the samples for the test being displayed in ppm. See Section 4.2.1 for more standard deviation calculation formula.

1.10.13. Expanded Uncertainty Indicator

The "Expanded Uncertainty (ppm)" indicator displays the calculated uncertainty of the samples for the test being displayed in ppm. See Section 4.2.2 for more uncertainty calculation formula. Data is displayed in this indicator only if ohms or a temperature unit has been selected. Refer to section 1.9.18.

1.10.14. Done By Indicator

The "Done By" indicator displays the name of the system operator logged in the Environment Options during the time the test being displayed was taken.

1.10.15. Test Mean Indicator

The "Test Mean" indicator displays the calculated average of the samples for test being displayed. The dimension of the test mean is determined by the units menu. Refer to section 1.9.18.

1.10.16. Notes Field

The "Notes" field displays and allows you to edit the notes you would like to store with the displayed test. In this field the typed text will auto wrap to the next line as you reach the end of a line. This means that you do not have to hit enter to go to the next line. The "Enter" and the Tab" functions are not valid in this window.

1.10.17. File Menu

The menu functions located in the File menu are the Test Overview's functions such as data file management, editing, and printing options.

File...Open (hotkey Ctrl+O)

This command will open a standard windows file dialog prompting you for a name of the data file you wish to open. Once given a filename, you can then click on OK to complete that task.

File...Save (hotkey Ctrl+S)

This command will open a standard windows file dialog prompting you for a name in which to save the current test data. Once given a filename, you can then click on OK to complete that task.

File...Data Manager

This command will open the Data Manager Log window that displays the test sample data in tabular format that allows you to select the range of data in the displayed test that you would like to focus on. Refer to section 1.10.

File...Restore

This command will restore modified test data being displayed to that in the originally saved file.

File...Open In Excel

This command will open the file you are currently viewing in Microsoft™ Excel so that you can apply your own mathematical processes to the stored data.

File...Print Window (hotkey Ctrl+P)

This menu item will print the contents of the Test Overview window through your Windows default printer.

File...Printer Setup

This will call up your Windows printer configuration editor so that you can prepare your printer for any documents you will need to print out of BridgeWorks.

File...Close (hotkey Ctrl+W)

This command will close the Test Overview window.

1.10.18.Units Menu

The menu functions located in the Units menu are the Test Overview's data display options; such as units and resolution. These items are also marked within the menu to show which option is currently in use.

Units...Ratio

This will configure the Test Overview Window to display all data in ratio. Ohms is the default unit.

Units...Ohms

This will configure the Test Overview Window to display all data in ohms. Ohms is the default unit.

Units...Celsius

This will configure the Test Overview Window to display all data in Celsius. A probe profile must also be loaded to display this unit. (only available in BridgeWorks-T and BridgeWorks-C)

Units...Kelvin

This will configure the Test Overview Window to display all data in Kelvin. A probe profile must also be loaded to display this unit. (only available in BridgeWorks-T and BridgeWorks-C)

Units...Fahrenheit

This will configure the Test Overview Window to display all data in Fahrenheit. A probe profile must also be loaded to display this unit. (only available in BridgeWorks-T and BridgeWorks-C)

Units...Invert

This will show the calculated ratio inversion of the displayed data. The default is the non-inverted or U.U.T with respect to Reference Standard being displayed.

NOTE: Tests that were conducted as an inverted ratio are stored with the data already adjusted to accommodate the reverse/reciprocal configuration. There is no need to use this function to adjust the stored results for these tests. It can, however, let you see the actual measurement taken from the hardware perspective.

Units...Probe File Load

This will open a file dialog for you to select a probe profile to use with the data in the Test Overview. This will enable the conversion to temperature with the appropriate scale.

Units...Resolution...(5 – 12 digits)

This will open a sub-menu that has resolution selection options of 5 to 12 digits. Selecting one of these options will change the displayed data's resolution to the chosen option and place a menu marker beside the menu item to point out the current selection. The default resolution is 12 digits.

1.10.19.Viewing a Test

To open a previously made test file to be viewed, select "File...Open" from the menu bar or use hotkey "Ctrl+O". This will bring up a standard Windows file dialog that is looking for "*.TST" files. Highlight the file of choice and click on "Open".

1.10.20.Editing a Test Overview

When test files are initially created, there is no opportunity to add your own notes, or to modify the sample set. For this reason, you can edit and then resave a currently loaded test file from the viewer. While in the viewer, you can alter the "Notes" field to place any additional information that is not represented in the given information by the viewer. You can also save the data after it has been cropped to have only the desired data remaining in the file. This is especially key when establishing what data you wish to have entered into a history file. It is recommended the when you edit a test data file that you save to another filename, rather than overwriting your original data so that you can always return to the original source information, in the future.

1.10.21.Saving a Test Overview

In the Test Overview you can save the file by selecting "File...Save" or by using hotkey "Ctrl+S".

In the file dialog that comes from selecting the save function, you can choose a new name for the file or use the same name to overwrite the updated file. If you choose to overwrite or your new name already exists, you will get a warning message asking if you wish to replace the older file or cancel the operation. Click on "Replace", if you are sure that you do not need the older copy.

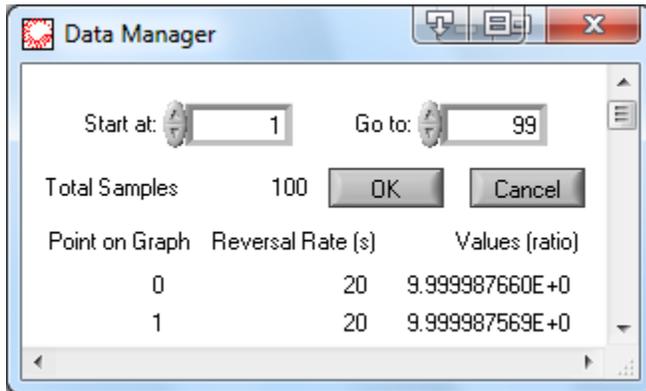
NOTE: It is only possible to replace a file if you have first disabled that “Config File Save Lockout” feature in the Administrative Options. Refer to section 1.4.2.

1.10.22. Test File Format

The test file consists of a minimum of sixteen lines. The first fourteen are read in as a configuration file, and all other lines are the stored data and reversal rate information. This file is stored as standard ASCII text and can be opened by any text editor. It is possible, but not recommended, that you edit these files outside the BridgeWorks program.

```
Bridge=0.176
Rs=25.000000000
Rx=25.550462000
uncertainty=0.050000000
STDAAsset=60538A
TSTAsset=
Time=1999/03/03,14:26:19
Itest=0.9900
Power=0.0250
Humidity=
Pressure=
Temp=
Name=
Place=
Notes=
39.993714300 39.993742115 39.993745344 39.993757513 ... 39.993815626
30.000000000 30.000000000 30.000000000 30.000000000 ... 30.000000000
```

1.11. DATA MANAGER



In BridgeWorks, data is not stored based on a timeline. Instead, samples are based on an incrementing sample number. This is because using the automatic reversal rate makes the measurement time also a variable value. For those instances where the timeframe is necessary information, the reversal rate for each measurement is logged. This log can be accessed from the Test Overview Window's file menu bar by selecting "File...Data Manager". The Data Manager will pop up in a scroll window displaying the total number of samples and each sample's reversal rate and value. Also within the Data Manager is a crop tool. The crop tool is a utility allowing you to remove unwanted extra data from the test data file that you are viewing. To use the crop tool, select the desired range to focus on with a "Start at" and a "Go to" field. Click on the "OK" button and your data will be updated. The crop tool does not permanently affect your saved data. To keep the changes made by the crop tool, you must resave your data.

1.11.1. Total Samples Indicator

The "Total Samples" indicator displays the total number of samples within the displayed data.

1.11.2. Point On Graph Indicator

The "Point On Graph" indicator displays the sample number of each point within the displayed data, always beginning at 0.

1.11.3. Reversal Rate Indicator

The "Reversal Rate" indicator displays the reversal rate used at each point within the displayed data in seconds.

1.11.4. Values Indicator

The "Total Samples" indicator displays the sample value of each point within the displayed data as the Rx:Rs ratio.

1.11.5. Start At Control

The "Start at" field allows you to select where you would like the crop window to begin. This means that all data before the entered sample number will be removed from the display, as well as the calculations. The new sample range will be automatically renumbered to start at 0.

1.11.6. Go To Control

The "Go to" field allows you to select where you would like the crop window to end. This means that all data after the entered sample number will be removed from the display, as well as the calculations. If the selected sample number is greater than the present maximum sample number, the new maximum sample number will be the same as the present maximum sample number.

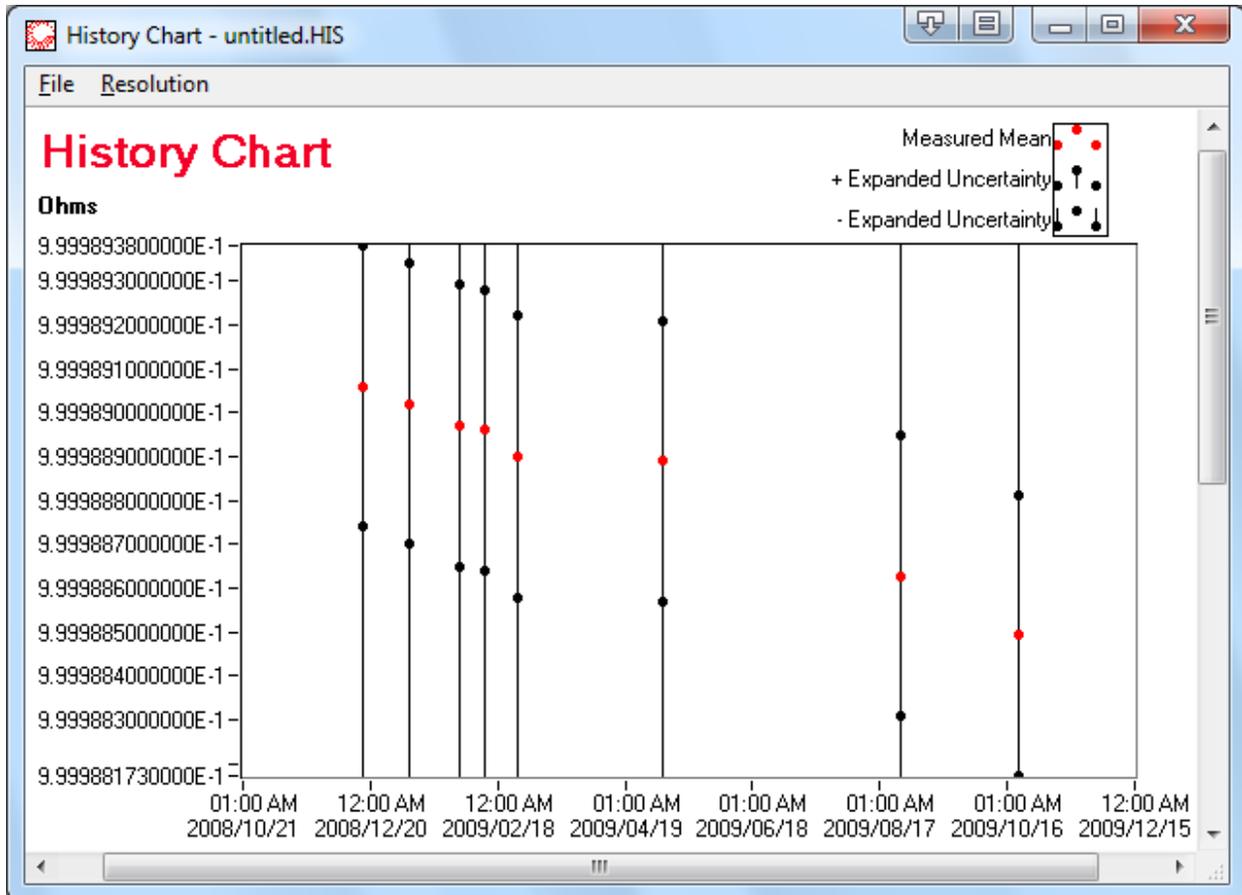
1.11.7. OK Button

Clicking the "OK" button will exit the Crop Tool window and crop the data as selected.

1.11.8. Cancel Button

Clicking the "Cancel" button will exit the Crop Tool window without cropping the data.

1.12. HISTORY CHART WINDOW



The History Chart window is similar to the Test Overview window, except that the viewer is made to open and create "*.HIS" history files. History files are cumulated test "*.TST" file data grouped into one file for the purpose of analyzing many measurements on the same resistor.

1.12.1. Graph

The graph displays all the points used for calculations within a given trend analysis. The graph displays sample values with respect to time. The sample value axis can adjust its resolution (5 to 12 digits). The scale ranges of this graph are auto selected to display all the points used at the best resolution. Along with all the points being displayed, there is a secondary set of points showing the uncertainty of each point as the points represented here are calibration or measurement average points.

1.12.2. History Filename Indicator

The "History Filename" indicator displays the filename of the trend analysis that is being displayed.

1.12.3. Last Entry Indicator

The "Last Entry" indicator displays the time that the trend analysis was last updated.

1.12.4. Done By Indicator

The "Done By" indicator displays the name of the system operator logged in the History File Editor.

1.12.5. Company Indicator

The "Company" indicator displays the name of the company logged in the History File Editor.

1.12.6. Resistor Asset/ID Indicator

The "Resistor Asset/ID" indicator displays the control number of the resistor used for the trend analysis.

1.12.7. Standard Deviation Indicator

The "Standard Deviation" indicator displays one standard deviation of the of the samples for the trend analysis being displayed. See Section 4.2.1 for more standard deviation calculation formula.

1.12.8. Estimated Value Now Indicator

The "Estimated Value Now" indicator displays the calculated value based on the current system time and date. This value is derived from extrapolating the linear regression of all entered points on the History chart graph.

1.12.9. Overall Mean Indicator

The "Overall Mean" indicator displays the calculated average of the of the samples for the trend analysis being displayed.

1.12.10. Notes Indicator

The "Notes" indicator displays the notes stored with the displayed trend analysis. The contents of this indicator can be edited in the History File Editor.

1.12.11. File Menu

The menu functions located in the File menu are the History Chart's functions such as data file management, editing, and printing options.

File...Edit (hotkey Ctrl+E)

This command will open the History Chart Editor window to allow you to edit or create history files for trend analysis.

File...Display (hotkey Ctrl+D)

This command will open a standard windows file dialog prompting you for a name of the history file you wish to display. Once given a filename, you can then click on OK to complete that task.

File...Config File Update

This command will open a standard windows file dialog prompting you for the name of the resistor file you wish to update with the value displayed in "Expected Value Now" field.

File...Open In Excel

This command will open the file you are currently viewing in Microsoft™ Excel so that you can apply your own mathematical processes to the stored data.

File...Print Window (hotkey Ctrl+P)

This menu item will print the contents of the main window through your windows default printer.

File...Printer Setup

This will call up your Windows printer configuration editor so that you can prepare your printer for any documents you will need to print out of BridgeWorks.

File...Close (hotkey Ctrl+W)

This command will close the History Chart Window.

1.12.12.Resolution Menu

The menu functions located in the Units menu are the Test Overview's data display options; such as units and resolution. These items are also marked within the menu to show which option is currently in use.

Resolution...(5 – 12 digits)

This will open a sub-menu that has resolution selection options of 5 to 12 digits. Selecting one of these options will change the displayed data's resolution to the chosen option and place a menu marker beside the menu item to point out the current selection.

1.12.13.Updating Resistor Files

Through the History Window, you can update you resistor's configuration file to use the "Expected Value Now" as the value for that device. To do this, you go to the file menu and select "Config File Update". You will then be prompted to select the .RES file in which you wish to modify.

NOTE: It is only possible to replace a file if you have first disabled that “Config File Save Lockout” feature in the Administrative Options. Refer to section 1.4.2.2.

1.12.14. Displaying a History File

To open a previously made history file to be viewed, select "File...Display" from the menu bar or use hotkey "Ctrl+D". This will bring up a standard Windows file dialog that is looking for "*.HIS" files. Highlight the file of choice and click on "Open".

1.12.15. Editing a History File

History files are created from concatenated data of more than one test. This meaning that it can be a more complex process to edit a history file. To edit or create a History Chart file you select "File...Editor" from the menu bar or use hotkey "Ctrl+E". A file editing window will appear where you can add/remove any stored point in the history of the resistor using test files to generate values or manually entering in the values. Through this window you can also enter your name, as the file's creator, the company name, and extra notes. It is recommended the when you edit a history file that you use great caution as the data is intended for use to estimate your resistor's value between calibrations by plotting their long term drift.

1.12.16. Printing a History File

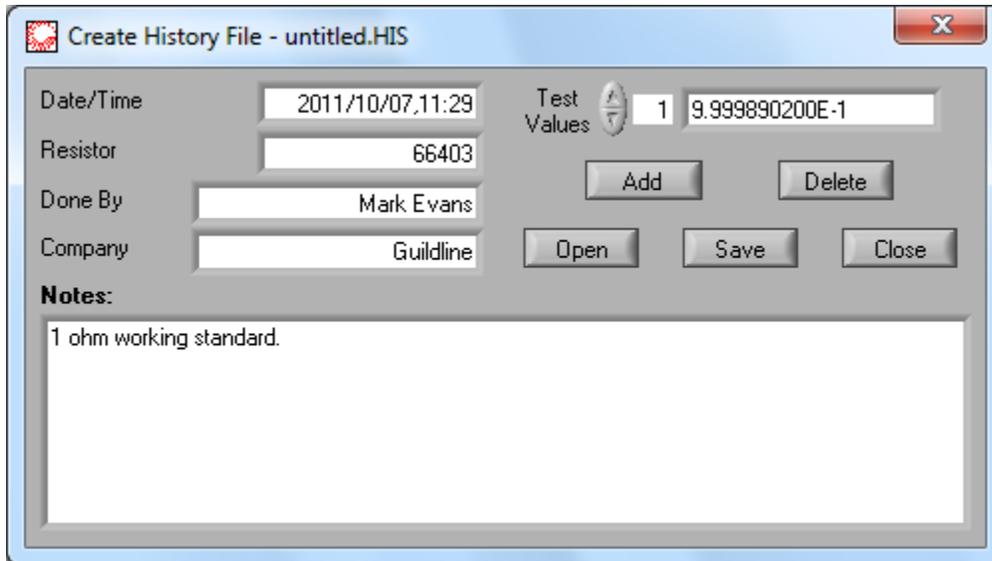
To print the information currently being displayed to you, go to "File...Print Window" or use hotkey "Ctrl+P". This function will print out a one-page document that will have the same layout as the contents of the display window.

1.12.17. History File Format

The history file consists of eight lines. The first five are read in as a configuration file and all other lines are the stored data. The sixth line is a time-zone-independent number of seconds that have elapsed since 12:00 a.m., Friday, January 1, 1904, Universal Time. The seventh line is the mean value in ohms. The eighth line is the uncertainty in ppm. This file is stored as standard ASCII text and can be opened by any text editor. It is possible, but not recommended, that you edit these files outside the BridgeWorks.

```
TSTAsset=  
Time=3/9/99,9:21 AM  
Name= John Doe  
Place= Guildline Calibration Services  
Notes=  
3003329503 3003322681 ... 3003340606  
999.837404403 999.849730807 ... 999.852198273  
0.002581 0.056895 ... 0.013972
```

1.13. HISTORY FILE EDITOR



The History File Editor is an interface to allow you to change the values which are used in your trend analysis. To open the History File Editor, go to the History Chart menu bar, and select "File...Editor" or hotkey "Ctrl+E". In the History File Editor, you can enter your name, as the file's creator, the company name, as well as your own notes. From this window, you add or delete history data either from a test data file or through direct entry. The date and resistor control number fields are updated by the editor to date stamp the last time the file was modified and to track the control number of the resistor's history. There is also a full list of all data points in the history file available for review.

1.13.1. Date/Time Indicator

The "Date/Time" indicator is where the current date and time are shown. This date and time are stamped into any saved history file to state when it was last modified.

1.13.2. Resistor (Rx) Field

The "Resistor (Rx)" field is where the control number of the resistor that is being traced in the history file can be entered. It is usually loaded from the data files used to create the history file.

1.13.3. Done By Field

In the "Done By" field, you are to enter the name of the history file's creator or modifier to be logged with the stored data.

1.13.4. Company Field

In the "Company" field, you are to enter the company name to be logged with the history file.

1.13.5. Notes Field

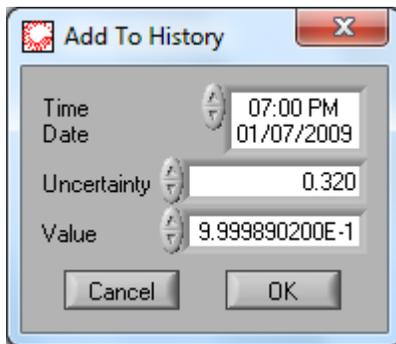
The "Notes" field is where you may enter any other notes you wish to have stored with the history data.

1.13.6. Test Values Indicator

The "Test Values" indicator displays all the points that will be used in the history file displayed in the editor.

1.13.7. Add Button

The "Add" button allows you to add new points to a history file. Selecting this button will bring up a prompt to choose between entering a point directly or sourcing the point from a test file. The manually entered selection provides you with a Date, Value, and an Uncertainty field to enter all the information necessary to a historical data point. Choosing the file option will open the "Test Overview" window allowing you to open a data file "*.TST" to and pick the sample set in which extract this information from. (see below for Add Entry").



1.13.8. Delete Button

The "Delete" button allows you to delete the displayed point in the "Test Values" indicator.

1.13.9. Open Button

The "Open" button allows you to open an existing history file to be edited in this editor. Clicking on this button will open a file dialog box prompting for a history file "*.HIS" to open for editing.

1.13.10. Save Button

The "Save" button allows you to save the edited or created history to a file. Clicking on this button will open a file dialog box prompting for a history file "*.HIS" name to save the data under.

1.13.11. Close Button

Clicking the "Close" button will exit the History File Editor.

1.13.12. Viewing a History File

To open a previously made history file to be edited, click on the "Open" button. This will bring up a standard Windows file dialog that is looking for "*.HIS" files. Highlight the file of choice and click on "Open".

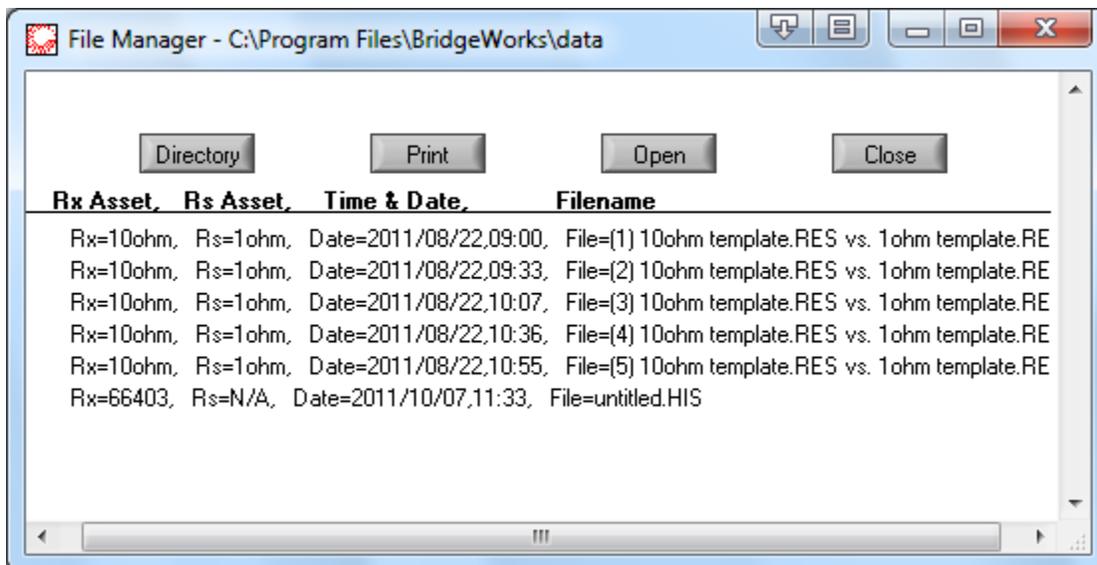
1.13.13. Saving a History File

In the History File Editor you can save the file by clicking on the "Save" button. In the file dialog that comes from selecting the save function, you can choose a new name for the file or use the same name to overwrite the updated file. If you choose to overwrite or your new name already exists, you will get a warning message asking if you wish to replace the older file or cancel the operation. Click on replace if you are sure that you do not need the older copy.

1.13.14. Editing a History File

You edit or create a history file by adding or removing historical points in the history trend as well as change or add notes to the "Notes" field. If you wish to add points, you click on the "Add" button and choose the method in which to enter the data. You can add historical points either by a test data file or directly entering the data. Adding the first point will also fill in the Resistor (Rx) field. All subsequent points will have the control number compared to the current number, and you will be warned if you attempt to enter data for a resistor of a different control number. If you need to delete a point, then you can use the "Delete" button to remove the displayed point in the "Test Values" indicator. When all editing is complete you will need to save the changes, by selecting the "Save" button.

1.14. FILE MANAGER WINDOW



The File Manager is an organizational tool allowing you to view, with more detail data files in a chosen directory. The details shown within the file are the Rx Asset control number, Rs Asset control number, Time & Date stamp and filename,. From this window, you can open the file in the associated viewer. You can also print out the listing that is being displayed.

1.14.1. Directory Button

Clicking the "Directory" button bring up a windows file dialog box prompting you to select a directory that you wish to preview. When you have found the desired directory, click on the "Select Cur Dir" button.

1.14.2. Print Button

Clicking the "Print" button will print the displayed information in the File Manager Window.

1.14.3. Open Button

Clicking the "Open" button will load the selected file into associated BridgeWorks viewer so that you can see more details or edit the stored data.

1.14.4. Close Button

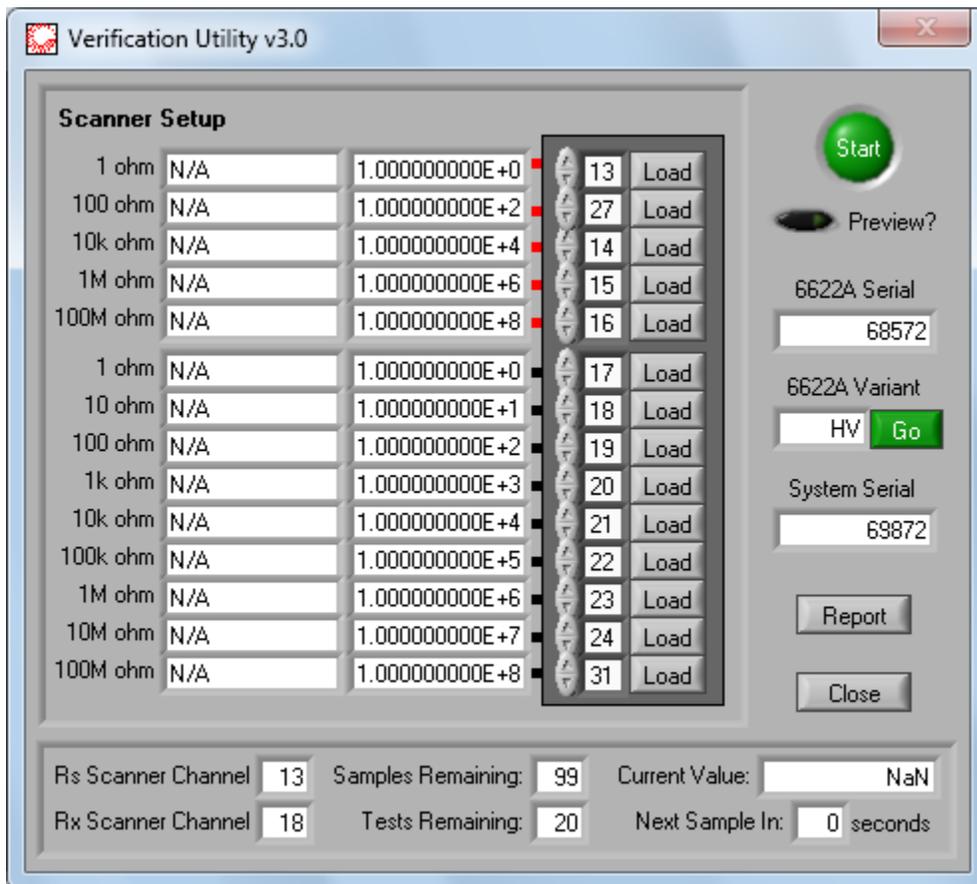
Clicking the "Close" button will exit the File Manager.

2. UTILITIES AND PLUGINS

Within BridgeWorks there have been placed some predefined test setup procedures to be used as calibration/verification utilities. These routines are set up in a manner that simplifies the preparation of a given measurement in comparison to the usual means of entering the data. Furthermore, these utilities will present some options not available through the standard BridgeWorks measurement process that uses the Test Configuration window.

BridgeWorks also has a system within it that allows for expandability which is known as a Plug-in. What these “Plug-ins” are is an extension to the application allowing you to expand the software by adding new utilities and data processing wizards. Several of the utilities in BridgeWorks are Plug-ins which have already been developed and are described within this section. Custom plugins can be also made, contact Guildline for more details.

2.1. VERIFICATION UTILITY



The Verification Utility window is a more simplified approach to verifying the performance of your model 6622A Resistance Measurement Bridge, than using a series of measurements in the Test Configuration window. This utility removes a lot of the configuration and post-process manual work involved in proving your systems performance over the full operating range. The utility can be accessed by selecting the "Verification" item of the Plugins menu. For this utility, you will need both scanners configured in the factory default settings. At the launch of the utility, a prompt will remind you of the specific hardware configuration required to execute this test process. The prompt must be acknowledged by the user by clicking the "OK" button to continue. Then you can load your resistor files to their associated scanner channel (13 through 32). You should review your hardware to verify that it is the same as displayed by the utility. When you have completed this, click on "Start" to have the utility automatically configure and run your test. Bearing in mind that this sequence of tests will take a considerable amount of time (approximately 14 to 28 hours depending on the bridge variant), it is intended for use when the system needs to be proven. Such instances are a lab audit of an annual full systems check. While in operation, the status area at the bottom will gauge your progress. Upon completion, the Verification Utility will generate a report so you can review the data. At any time, you can stop the test by clicking on the "Stop" button.

NOTE: All the tests in this utility are pre-configured for power in accordance with the recommended test configurations.

2.1.1. Start/Stop Button

Clicking the green "Start" button will execute the tests and toggle the button to be a red "Stop" button. Clicking the "Stop" button will terminate the test process and toggle it back to a "Start" button. When the test is completed, the "Stop" button will automatically toggle back to a "Start" button.

2.1.2. Preview Button

Clicking the "Preview" button will set the utility into an accelerated test mode where the reversal rate and the sample counts are both 10 times smaller than the normal/recommended setup. Clicking on "Start" in this accelerated mode will operate the system and confirm your test setup and connections have no catastrophic failures. The system will not achieve full accuracy in this mode.

2.1.3. Numbered Buttons (13 - 32)

Clicking a button with the number 13 through 32 on it will bring up the Select Resistor File window to allow you to search for the resistor file that will be loaded for the scanner channel of the same number as labeled on the button. It is possible to change the resistor file loaded to a scanner channel before the start of the test. These channels are in a predefined setup starting from the first available channel after the channels typically reserved for the SR1010 adapter (channel 13) to channel 32. These channel selections are also set to the factory default for the optionally installed 6634 and 6634TS resistance standards. Only the resistance values and

control numbers in the resistor profiles are loaded in this utility. The test currents and voltages, along with sample depth and reversal rates, are predefined based on the resistances measured.

WARNING: If the “Cancel” button in the Select Resistor File window is clicked, then 0 ohms will be loaded to the selected scanner channel number, if no resistor file was previously loaded to it.

2.1.4. Channel Indicators

The "Channel" indicators are a series of thirteen pairs of indicators. Each pair of indicators is labeled for the standard resistor to which they are associated. For each standard resistor you load using the corresponding "Channel" control, the resistor's value and control number is displayed in these indicators.

WARNING: Ensure that the resistor files are loaded in that are compatible with the nominal resistance indicated by the label, as a test error may otherwise occur.

2.1.5. 6622A Serial Indicator

The "Bridge Serial" indicator is where the serial number of the bridge that was scanned in at the program's startup is displayed.

2.1.6. 6622A Variant Indicator/Button

The "6622A Variant" indicator is where the 6622A variant is displayed. Clicking on the button beside this indicator will query the bridge to determine the variant.

2.1.7. System Serial Indicator

The "System Serial" indicator is where the serial number of the 6625 system that was entered in the Verification Utility is displayed.

2.1.8. Report Button

Clicking the "Report" button will call a prompt that will guide you to selecting what report you wish to view, either current or from stored report data.

2.1.9. Close Button

Clicking the "Close" button will prompt you to save your current data and then exit the Verification Utility after you have responded to the prompt.

2.1.10. Rs Scanner Channel Indicator

The "Rs Scanner Channel" indicator displays the currently selected Rs scanner channel by BridgeWorks for the current test in the verification process.

2.1.11. Rx Scanner Channel Indicator

The "Rx Scanner Channel" indicator displays the currently selected Rx scanner channel by BridgeWorks for the current test in the verification process.

2.1.12. Samples Remaining Indicator

The "Samples Remaining" indicator displays the number of samples remaining for the current test in the verification process, not including the present sample.

2.1.13. Tests Remaining Indicator

The "Tests Remaining" indicator displays the number of tests remaining in the current verification process, not including the present test.

2.1.14. Current Value Indicator

The "Current Value" indicator displays the last Rx:Rs ratio sample value read in by BridgeWorks for the current test in the verification process.

2.1.15. Next Sample In Indicator

The "Next Sample In" indicator displays the amount of time in seconds before the next sample is expected for the current test in the verification process. Note that this is an estimation made by BridgeWorks, and will differ greatly from the model 6622A during the rough null stage (first few samples) of any test. For the remainder of that test, it is a good estimate.

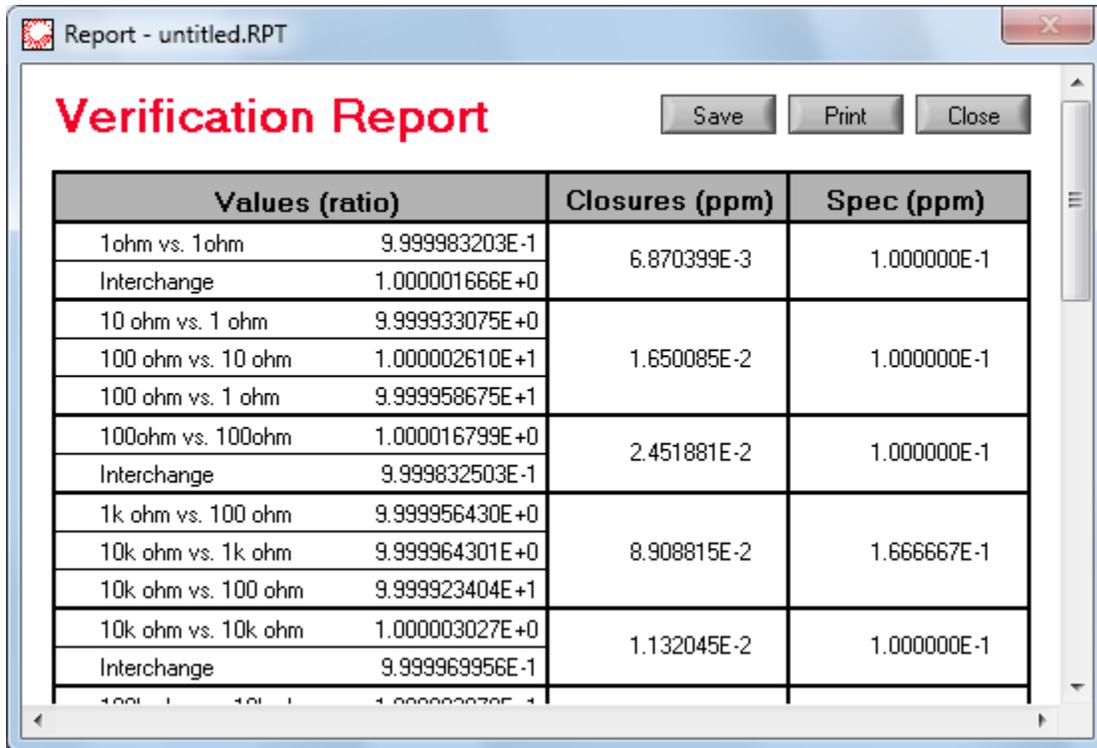
2.1.16. Saving Verification Report Data

Upon exiting the Verification window you will be prompted to save the data currently stored in memory from the utility. At this time you can select "No" to discard the data or "Yes" where you will then be given a windows file dialog prompting you for the name you wish to save the data under. The file extension ".RPT" will automatically be added to your saved Verification file.

2.1.17. Loading/Viewing Verification Report Data

To load or view a Verification Report, click on the "Report" button in the Verification Utility window. You will then be asked to select between viewing the current data or from a saved report file. If you choose current data, then the information that is currently available from the last run test will be loaded. If you choose to load a file, then a standard Windows file dialog will prompt you to select a file with the ".RPT" extension. You then find and select the file of choice, highlight it and then click on "Open" to view it. Refer to section 2.6 for the Verification Report itself.

2.2. VERIFICATION REPORT



Values (ratio)		Closures (ppm)	Spec (ppm)
1ohm vs. 1ohm	9.999983203E-1	6.870399E-3	1.000000E-1
Interchange	1.000001666E+0		
10 ohm vs. 1 ohm	9.999933075E+0		
100 ohm vs. 10 ohm	1.000002610E+1	1.650085E-2	1.000000E-1
100 ohm vs. 1 ohm	9.999958675E+1		
100ohm vs. 100ohm	1.000016799E+0	2.451881E-2	1.000000E-1
Interchange	9.999832503E-1		
1k ohm vs. 100 ohm	9.999956430E+0		
10k ohm vs. 1k ohm	9.999964301E+0	8.908815E-2	1.666667E-1
10k ohm vs. 100 ohm	9.999923404E+1		
10k ohm vs. 10k ohm	1.000003027E+0	1.132045E-2	1.000000E-1
Interchange	9.999969956E-1		

The Verification Report window displays the current or a saved Verification results in an easy to follow printable report. The report is accessed through the "Report" button on the Verification Utility window.

2.2.1. Print Button

Clicking the "Print" button will print the report as shown.

2.2.2. Close Button

Clicking the "Close" button will exit the report window and return you to the Verification Utility window.

2.2.3. Value Indicators

The "Value" indicators are in the left column of the Verification Report table. These indicators display measured ratios for each of the indicated tests conducted in the Verification Utility.

2.2.4. Closure Indicators

The "Closure" indicators are in the center column of the Verification Report table. These indicators display interchange, range extender, and ladder up closure errors calculated by the Verification Utility.

2.2.5. Status Indicators

The "Status" indicators are in the right column of the Verification Report table. These indicators display the pass or failure status of each ladder up and interchange closure test conducted by the Verification Utility.

2.2.6. Location Indicator

The "Location" indicator is where the company/lab name that was entered into the Environment Options is displayed.

2.2.7. Name Indicator

The "Name" indicator is where the test technician's name that was entered into the Environment Options is displayed.

2.2.8. Date/Time Indicator

The "Date/Time" indicator is where the test date and time are shown. This date and time are stamped at test completion into the saved Verification file.

2.2.9. 6622A Serial Indicator

The "Bridge Serial" indicator is where the serial number of the bridge that was scanned in at the program's startup is displayed.

2.2.10. 6622A Variant Indicator

The "6622A Variant" indicator is where the 6622A variant is displayed.

2.2.11. System Serial Indicator

The "System Serial" indicator is where the serial number of the 6625 system that was entered in the Verification Utility is displayed.

2.3. VERIFICATION PROCEDURE

The following steps outline the general procedure for executing a system "Verification".

Connect the IEEE-488.2 interface connector of the model 6625 to an IBM-PC compatible computer running WindowsTM and run the BridgeWorks software.

- Step 1)** Connect the required set of resistors' leads on the four wire terminals to the pre-configured scanner channels, where C₁P₁ identifies one current potential pair and C₂P₂ the other pair.
- Step 2)** Open the "Verification" utility from the "Plugins" menu of the main window.
- Step 3)** Fill in the System Serial number fields with the serial number of the 6625 system.

- Step 4)** Click on the “Go” button beside the 6622A Variant indicator to acquire the bridge variant.
- Step 5)** Now click on each of the buttons that are labeled by a number (scanner channel). After each button, you will be greeted with a Windows file dialog that asks you to locate the resistor file required for the selected scanner channel. The prompt will read Open (resistor value) File, such as "Open 10k ohm File".
- Step 6)** Upon completion of loading all the resistor files, recheck to see that the configuration matches that as described for this utility, both in hardware and in loaded data.
- Step 7)** Set the utility into “Preview” mode by clicking on the “Preview” button.
- Step 8)** Click on “Start” to run the preview. This process will take less than ½ hour.
- Step 9)** If no errors are returned click on the “Preview” button again to return the utility to normal. If there were errors, correct the problem and confirm by re-running the preview.
- Step 10)** Click on the green "Start" button and the Verification will begin.
- Step 11)** This test will run completely automated using the Scanner 1 and Scanner 2 scanners. The status indicators will display the progress of the verification process. This whole process will take approximately 14 to 28 hours depending on the bridge variant.
- Step 12)** Upon completion of the Verification, click on the "Report" button to see the results. A prompt will follow asking if you wish to load a saved file or view the current results. You need to select current to see the test you have just completed.
- Step 13)** Use the "Print" button if you desire a hard copy report.
- Step 14)** Close the report window using the "Close" button. This will return you to the utility window.
- Step 15)** Now exit the utility using its “Close” button. Upon clicking on "Close" in the utility, you will be greeted with a prompt asking if you wish to save the data. It is recommended that you do so by selecting "Yes" and typing a filename in the file dialog that follows. Then click on "Save" in the file dialog.
- Step 16)** You will now be back at the main window. If you selected "No" when asked to save, you will go straight back to the main window and will no longer have the opportunity to save the "Verification" data.

Note: If the data on the report, or the during the actual measurement process, a problem is detected then you can re-run the closure for the affected area. This can be done only on a per closure basis during the SAME Verification session. Simply click on the “Start” button as if to re-launch the whole process again. This will open a prompt allowing you to “Update” or start a “New” test. Selecting “Update” will give you an options window to choose the test closure you wish to re-run. Once you have exited the utility the ability to “patch” measurements is reset.

2.4. VERIFICATION PROCESS

The table below contains the predetermined test schedule for the complete verification of your 6622A DCC Resistance Measurement Bridge. All tests are based on a sample depth of 150 readings, with only the last 35 readings (115-149) used for the calculations. This allows proper settling time to acquire the quality of measurement as specified for the 6622A. Test files are automatically created for each of the measurements in Table 2-2 upon each of their completion. The full sample depth is recorded in each test file. A directory named verification-(date code), where the date code indicates the date when the first measurement was started, is automatically created in the chosen directory to store these test files when the first measurement is started.

Meas. No.	R _x Resistor	R _s Resistor	Excitation Current	Reversal Rate	Meas. Mode	Closure Method
<i>Tests 1 – 12 for all 6622A bridges.</i>						
1	1 Ω	1 Ω	100 mA	20 s	Normal	Interchange
2	1 Ω	1 Ω	100 mA	20 s	Normal	
3	100 Ω	100 Ω	10 mA	20 s	Normal	Interchange
4	100 Ω	100 Ω	10 mA	20 s	Normal	
5	10 kΩ	10 kΩ	1 mA	60 s	Normal	Interchange
6	10 kΩ	10 kΩ	1 mA	60 s	Normal	
7	10 Ω	1 Ω	10 mA	20 s	Normal	Ladder
8	100 Ω	10 Ω	1.0 mA	20 s	Normal	
9	100 Ω	1 Ω	1.0 mA	20 s	Normal	
10	1 kΩ	100 Ω	1.0 mA	40 s	Normal	Ladder
11	10 kΩ	1 kΩ	0.1 mA	60 s	Normal	
12	10 kΩ	100 Ω	0.10 mA	90 s	Normal	
<i>Additional tests 13 – 20 for 6622A-XR, 6622A-XPR, and 6622A-HV</i>						
13	1 MΩ	1 MΩ	100 V	90 s	High Ohms	Interchange
14	1 MΩ	1 MΩ	100 V	90 s	High Ohms	
15	100 kΩ	10 kΩ	0.10 mA	90 s	Normal	Ladder
16	1 MΩ	100 kΩ	10 V	90 s	High Ohms	
17	1 MΩ	10 kΩ	10 V	90 s	High Ohms	
18	10 MΩ	1 MΩ	100 V	90 s	High Ohms	Ladder
19	100 MΩ	10 MΩ	100 V	120 s	High Ohms	
20	100 MΩ	1 MΩ	100 V	120 s	High Ohms	
<i>Additional tests 21 and 22 for 6622A-HV only</i>						
21	100 MΩ	100 MΩ	1000 V	150 s	High Ohms	Interchange
22	100 MΩ	100 MΩ	1000 V	150 s	High Ohms	

Table 2-1 : Verification Test Schedule

For each resistor pair, the software will calculate and report the interchange closure error. For example, if the Rx:Rs ratio of the first measurement is R_a and the Rx:Rs ratio of the second measurement, where the two resistors are exchanged with one another, is R_b , then the interchange closure error e_i in ppm of the nominal ratio is:

$$e_i = (1/2) \times |R_a \times R_b - 1| \times 10^6$$

The maximum allowable interchange closure errors (ppm) for the following resistor pairs are:

Resistor	Resistor	Interchange Closure Error					
		-B	-XP	-XPS	-XR	-XPR	-HV
1 Ω	1 Ω	0.1	0.05	0.02	0.1	0.05	0.04
100 Ω	100 Ω	0.1	0.05	0.02	0.1	0.05	0.04
10 k Ω	10 k Ω	0.1	0.05	0.05	0.1	0.05	0.05
1 M Ω	1 M Ω				0.6	0.4	0.4
100 M Ω	100 M Ω						3.5

For the 100:1 ladder up closure error e_i , the 100:1 ratio must agree to within the specification of the nominal ratio for either directly measuring the 100:1 ratio, or calculating the ratio from the product of the 100:10 ratio and the 10:1 ratio, in ppm as follows:

$$e_i = (1/3) \times |R_a - R_b \times R_c| / 100 \times 10^6$$

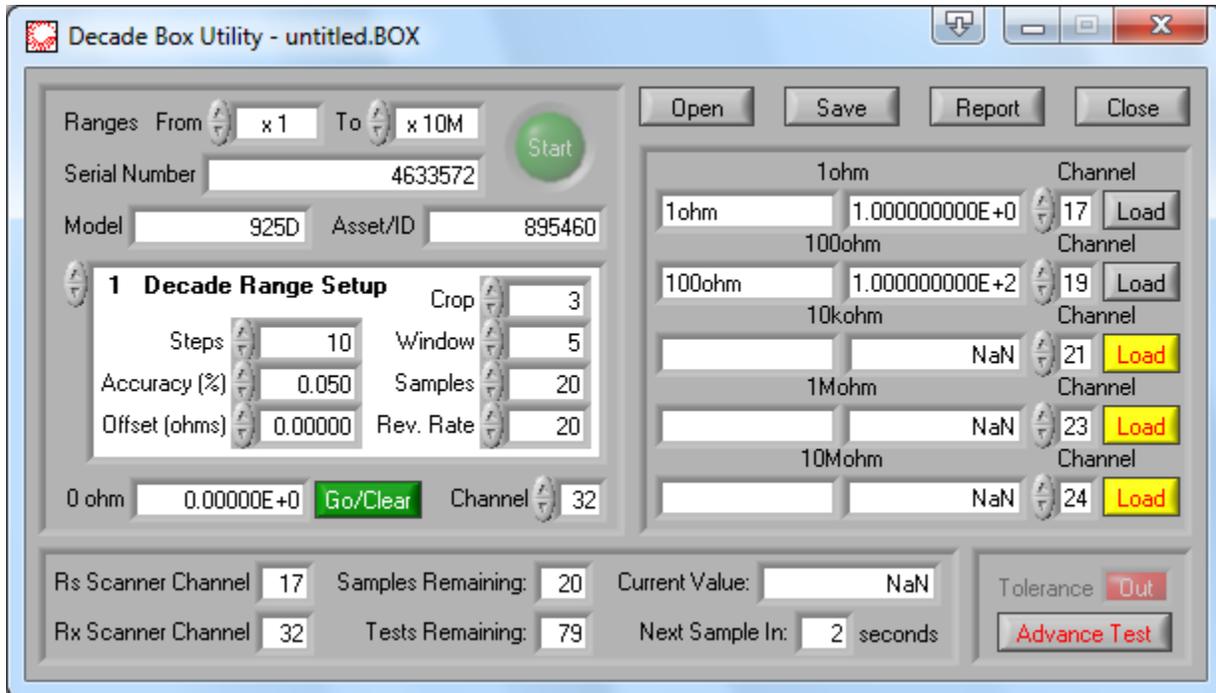
Where:

- R_a is the 100:1 ratio
- R_b is the 100:10 ratio
- R_c is the 10:1 ratio

The maximum allowable ladder up closure errors (ppm) for the following resistor sets are:

Resistor	Resistor	Resistor	Interchange Closure Error					
			-B	-XP	-XPS	-XR	-XPR	-HV
1 Ω	10 Ω	100 Ω	0.100	0.067	0.053	0.100	0.067	0.060
100 Ω	1 k Ω	10 k Ω	0.167	0.133	0.120	0.167	0.133	0.127
10 k Ω	100 k Ω	1 M Ω				1.233	1.150	1.150
1 M Ω	10 M Ω	100 M Ω				5.600	4.200	3.533

2.5. DECADE BOX UTILITY



The Decade Box Utility will verify that up to an 8 dial decade box is accurate from 0.001% to 11%. The decade box utility will calibrate all the decades in the range from 0.01 ohm to 100M ohm. There is also a zero ohms offset measurement in the test utility. At the launch of the utility, a prompt will remind you of the specific hardware configuration required to execute this test process. The prompt must be acknowledged by the user by clicking the "OK" button to continue.

Within this utility the test parameters and test pass criteria are set on a per decade range basis. This test profile can be optionally saved for future use by pressing the "Save" button and creating a decade profile file.

While in operation, a window prompt with an illustrated knob will open and prompt which decade step is presently being tested. For each resistance test, if defined window of consecutive samples are within the selected accuracy for the applicable decade, the test will automatically proceed to the next measurement, rather than waiting for the completion of the maximum limit of samples. If all the maximum limit of samples are performed, the reported resistance is the average of the last window of samples. You can stop the test at any time while it is in progress by pressing the round "Stop" button.

With the completion of the test, there is a more summary report showing pass or fail for each given decade range based on the given tolerances, which can be printed out. This is selected by

pressing the “Report” button. This Report can further be broken down by selecting its “Details” view. You can exit the Decade Box Utility at any time by pressing the "Close" button. When exiting the Decade Box Utility, you will be prompted to save this report.

Note: The measured zero ohms offset is subtracted from all measurements on the report.

2.5.1. Start/Stop Button

Clicking the round green "Start" button will execute the test(s) and toggle the button to be a round red "Stop" button. You will first be prompted to perform the zero ohms measurement. If you press the “Skip” button, this indicates that you do not wish to perform this measurement and you will be prompted to the first step change. Clicking “Cancel” will return you back to the Decade Box window allowing you to initiate the zero ohms measurement. Clicking the "Stop" button will terminate the test process and toggle it back to a "Start" button. When the test is completed, the "Stop" button will automatically toggle back to a "Start" button.

2.5.2. Go/Clear Button

Clicking the rectangular green "Go/Clear" button when there the zero ohms field is at a nominal exact zero will execute the zero ohms test and toggle the button to be a rectangular red "Stop" button. Clicking the "Stop" button will terminate the zero ohms test and toggle it back to a "Go/Clear" button. When the test is completed, the "Stop" button will automatically toggle back to a "Go/Clear" button. Clicking on the “Go/Clear” button with the zero ohms field at a value other than nominal will return the field to nominal to reset/clear the test. The zero ohms test is a test that is used to account for the contact resistance added to each measurement in the decade box. This test is not required for direct reading decade boxes. Otherwise, this test should be executed first. This test can be used to measure the 10mΩ value in an ESI 925D to determine the offset.

2.5.3. Zero Ohms Indicator

The "0 ohm" indicator displays the measured zero ohms value which is used to subtract the contact resistance from the readings taken from the decade box under test.

2.5.4. From Control

The "From" control allows you to select the lower limit of the decade ranges of your decade box test. The lower limit must be set before entering the decade specifications.

2.5.5. To Control

The "To" control allows you to select the upper limit of the decade ranges of your decade box test. The upper limit must be set before entering the decade attributes.

2.5.6. Channel Control

The "Channel" control allows you to select the channel that your decade box will be connected to for the test. You may use any free channel above channel 12.

2.5.7. Decade Select Control

The "Decade Select" control is an index selecting the decade you wish to modify/view the attributes of. These attributes consist of Steps, Accuracy, and Offset.

2.5.8. Steps Control

The "Steps" control allows you to set how many steps are in the chosen decade range.

2.5.9. Accuracy Control

The "Accuracy (%)" control allows you to establish the accuracy requirements for the chosen decade range as a percentage. The range is 0.001 to 11.000 in 0.001 steps.

2.5.10. Offset Control

The "Offset (ohms)" control allows you to set the offset allowance adjustment for the chosen decade range in ohms. The range is 1.0000 to 0.00001 in 0.00001 steps.

2.5.11. Crop Control

The "Crop" control allows you to set the number of readings arbitrarily taken before the criteria rules specified are calculated and applied. It is recommended for most applications to use a crop of 5 to 10 samples.

2.5.12. Window Control

The "Window" control allows you to set the number of readings that the criteria rules specified are calculated and applied to. It is recommended to use a 5 to 10 sample window for most applications.

2.5.13. Samples Control

The "Samples" control allows you to set the maximum number of readings to be taken before indexing to the next test regardless of the criteria rules specified. The minimum allowable setting is (**Crop Control Number + Window Control Number**). To allow the utility to run in a virtual free running operation set this parameter to 999 samples. This is beneficial when you are adjusting trim able decade boxes such as the ESI925D where the test time is not easily estimatable.

2.5.14. Rev Rate Control

The "Rev Rate" control allows you to set the reversal rate used for the chosen decade range in seconds. For most decade boxes a 10 second reversal rate at 1k/step and below, as well as 20 second reversal rate for 10k/step and above will obtain sufficient accuracy and uncertainty for calibration.

2.5.15. Serial Number Field

The "Serial Number" field is where the serial number can be logged for the decade box under test

2.5.16. Channel Controls

The "Channel" controls are a series of five index controls along with an associated "Load" button. These controls are used to load the resistance standard profiles to calibrate your decade box against, as well as select the scanner channel to which they are connected. The "Load" button will flash for all the required resistors to execute the decade box test until they are loaded.

These channels can be any channel starting from the first available channel after the SR1010 Adapter (channel 13) to channel 32. These channel selections default to the factory default for the optionally installed 6634 and 6634TS resistance devices. Only the resistance values and control numbers in the resistor profiles are loaded in this utility. The 1 ohm "Load" button will not flash, if it is only required to conduct the zero ohms measurement, as this is an optional test. However, if you attempt to conduct a zero ohms test without the 1 ohm resistor loaded, the software will prompt you to select a 1 ohm resistor. The test currents and voltages, along with sample depth and reversal rates, are predefined based on the decade range measured.

2.5.17. Channel Indicators

The "Channel" indicators are a series of five pairs of indicators. Each pair of indicators is labeled for the standard resistor to which they are associated. For each standard resistor you load using the corresponding "Channel" control, the resistor's value and control number is displayed in these indicators.

2.5.18. Open Button

Clicking the "Open" button will call a prompt that will guide you to selecting what decade box profile you wish to load. This is a configuration file that stores all the information about a decade box required to run a calibration test, except the control number. With the profile loaded, you only need to enter the control number and then the test is ready to be executed once the channels are set up.

2.5.19. Save Button

Clicking the "Save" button will call a prompt asking you to select what name you wish to save your decade box profile under. This is a configuration file that stores all the information about a decade box required to run a calibration test, except the control number. Using these profiles on a model or specification requirement basis will save setup up time for these tests.

2.5.20. Report Button

Clicking the "Report" button will call a prompt that will guide you to selecting what report you wish to view, either current or from stored report data.

2.5.21. Close Button

Clicking the "Close" button will prompt you to save your current data and then exit the Decade Box Utility after you have responded to the prompt.

2.5.22. Rs Scanner Channel Indicator

The "Rs Scanner Channel" indicator displays the currently selected Rs scanner channel by BridgeWorks for the current test in the decade box calibration process.

2.5.23. Rx Scanner Channel Indicator

The "Rx Scanner Channel" indicator displays the currently selected Rx scanner channel by BridgeWorks for the current test in the decade box calibration process.

2.5.24. Samples Remaining Indicator

The "Samples Remaining" indicator displays the number of samples remaining for the current test in the decade box calibration process, not including the present sample.

2.5.25. Tests Remaining Indicator

The "Tests Remaining" indicator displays the number of tests remaining in the current decade box calibration process, not including the present test.

2.5.26. Current Value Indicator

The "Current Value" indicator displays the last **ohms** value read in by BridgeWorks for the current test in the decade box calibration process.

2.5.27. Next Sample In Indicator

The "Next Sample In" indicator displays the amount of time in seconds before the next sample is expected for the current test in the decade box calibration process. Note that this is an estimation made by BridgeWorks, and will differ greatly from the bridge during the rough null stage (first few samples) of any test. For the remainder of that test, it is a good estimate.

2.5.28. Tolerance Indicator

The "Tolerance" indicator displays if the current reading is "In" or "Out" of the specified tolerance. This is primarily used for trim able decade box calibrations such as the ESI925D where manual adjustment is required.

2.5.29. Advance Test Control

The "Advance Test" control allows you to manually jump to the next step in the decade box test. This also is primarily used for trim able decade box calibrations such as the ESI925D where manual adjustment is required and therefore an indefinite sample count is needed.

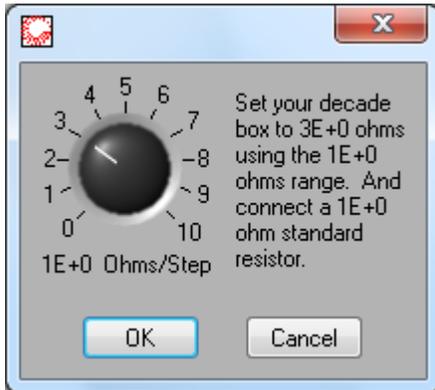
2.5.30. Saving Decade Box Report Data

Upon exiting the Decade Box Utility window, you will be prompted to save the data currently stored in memory from the utility. At this time you can select "No" to discard the data or "Yes" where you will then be given a windows file dialog prompting you for the name you wish to save the data under. The file extension ".DEC" will automatically be added your saved Decade Box file.

2.5.31. Loading/Viewing Decade Box Report Data

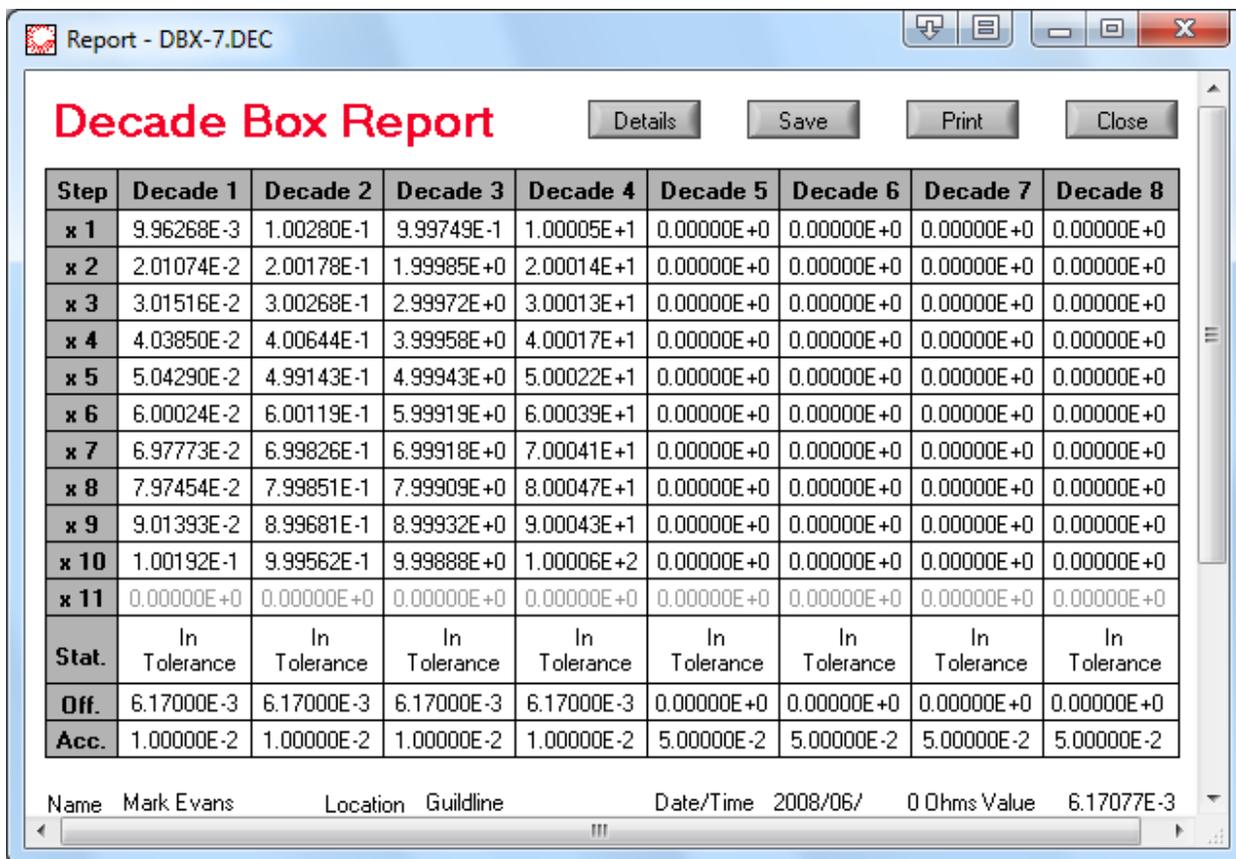
To load or view a decade Box Report, click on the "Report" button in the Decade Box Utility window. You will then be asked to select between viewing the current data or from a saved report file. If you choose current data, then the information that is currently available from the last run test will be loaded. If you choose to load a file, then a standard Windows file dialog will prompt you to select a file with ".DEC" extension. You then find and select the file of choice, highlight it and then click on "Open" to view it. Refer to section 2.18 for the Decade Box Report itself.

2.5.32. Decade Box Test Prompt



When testing a decade box you will be prompted throughout the process to adjust the dial settings on the decade box. You should execute the change before clicking on the “OK” button which will initiate the next step test. Clicking on “Cancel” will stop the entire decade box test.

2.6. DECADE BOX SUMMARY REPORT



Report - DBX-7.DEC

Decade Box Report [Details] [Save] [Print] [Close]

Step	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5	Decade 6	Decade 7	Decade 8
x 1	9.96268E-3	1.00280E-1	9.99749E-1	1.00005E+1	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 2	2.01074E-2	2.00178E-1	1.99985E+0	2.00014E+1	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 3	3.01516E-2	3.00268E-1	2.99972E+0	3.00013E+1	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 4	4.03850E-2	4.00644E-1	3.99958E+0	4.00017E+1	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 5	5.04290E-2	4.99143E-1	4.99943E+0	5.00022E+1	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 6	6.00024E-2	6.00119E-1	5.99919E+0	6.00039E+1	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 7	6.97773E-2	6.99826E-1	6.99918E+0	7.00041E+1	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 8	7.97454E-2	7.99851E-1	7.99909E+0	8.00047E+1	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 9	9.01393E-2	8.99681E-1	8.99932E+0	9.00043E+1	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 10	1.00192E-1	9.99562E-1	9.99888E+0	1.00006E+2	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
x 11	0.00000E+0							
Stat.	In Tolerance							
Off.	6.17000E-3	6.17000E-3	6.17000E-3	6.17000E-3	0.00000E+0	0.00000E+0	0.00000E+0	0.00000E+0
Acc.	1.00000E-2	1.00000E-2	1.00000E-2	1.00000E-2	5.00000E-2	5.00000E-2	5.00000E-2	5.00000E-2

Name Mark Evans Location Guildline Date/Time 2008/06/ 0 Ohms Value 6.17077E-3

The Decade Box Summary Report displays the current or a saved Decade Box results in an easy to follow printable report. The report is accessed through the "Report" button on the Decade Box Utility window.

2.6.1. Details Button

Clicking the "Details" button will open an expanded information report breaking down each decade step's value, tolerance criteria status, and uncertainty calculation.

2.6.2. Save Button

Clicking the "Save" button will save the displayed report to a file.

2.6.3. Print Button

Clicking the "Print" button will print the report as shown.

2.6.4. Close Button

Clicking the "Close" button will exit the report window and return you to the Decade Box Utility.

2.6.5. Value Indicators

The "Value" indicators are in a table organized by decade and step. These indicators display measured resistances from each of the tests conducted in the Decade Box utility.

2.6.6. Status Indicators

The "Status" indicators display the status of each decade range measured in the Decade Box utility. The status will always fail a decade range if any element is measured to be outside of the entered specification in the Decade Box Utility.

2.6.7. Accuracy Indicators

The "Accuracy" indicators display the user specified accuracy criteria for the associated decade range.

2.6.8. Offset Indicators

The "Offset" indicators display the user specified offset criteria for the associated decade range.

2.6.9. Name Indicator

The "Name" indicator is where the test technician's name that was entered into the Environment Options is displayed.

2.6.10. Date/Time Indicator

The "Date/Time" indicator is where the test date and time are shown. This date and time are stamped at test completion into the saved Decade Box file.

2.6.11. 0 Ohms Value Indicator

The "0 Ohms Value" indicator is where the measured zero ohms value is shown in ohms. This value has been subtracted from each point in the values table to remove the zero ohms offset.

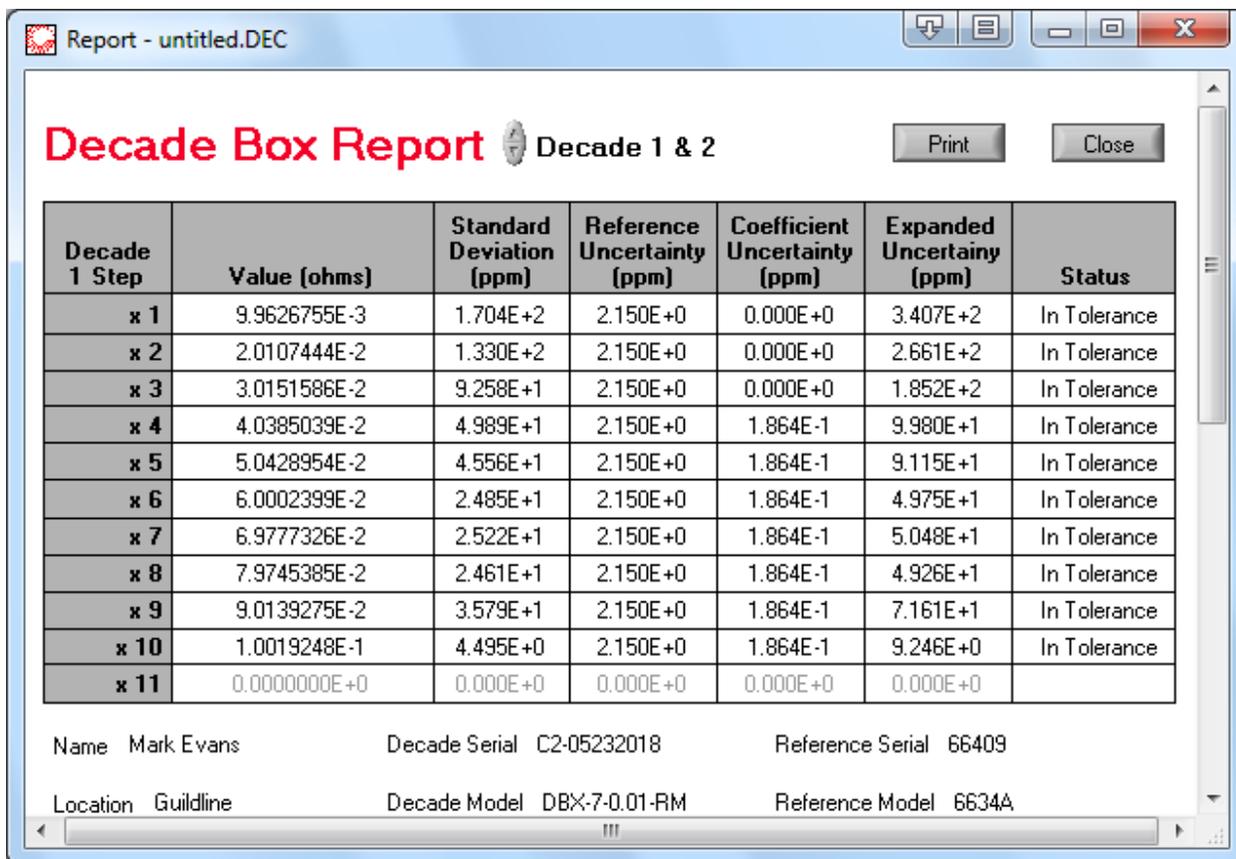
2.6.12. Location Indicator

The "Location" indicator is where the company/lab name that was entered into the Environment Options is displayed.

2.6.13. Decade Asset/ID Indicator

The "Decade Asset/ID" indicator is where the control number of the measured decade box that was entered in the Decade Box utility is displayed.

2.7. DECADE BOX DETAIL REPORT



Decade 1 Step	Value (ohms)	Standard Deviation (ppm)	Reference Uncertainty (ppm)	Coefficient Uncertainty (ppm)	Expanded Uncertainty (ppm)	Status
x 1	9.9626755E-3	1.704E+2	2.150E+0	0.000E+0	3.407E+2	In Tolerance
x 2	2.0107444E-2	1.330E+2	2.150E+0	0.000E+0	2.661E+2	In Tolerance
x 3	3.0151586E-2	9.258E+1	2.150E+0	0.000E+0	1.852E+2	In Tolerance
x 4	4.0385039E-2	4.989E+1	2.150E+0	1.864E-1	9.980E+1	In Tolerance
x 5	5.0428954E-2	4.556E+1	2.150E+0	1.864E-1	9.115E+1	In Tolerance
x 6	6.0002399E-2	2.485E+1	2.150E+0	1.864E-1	4.975E+1	In Tolerance
x 7	6.9777326E-2	2.522E+1	2.150E+0	1.864E-1	5.048E+1	In Tolerance
x 8	7.9745385E-2	2.461E+1	2.150E+0	1.864E-1	4.926E+1	In Tolerance
x 9	9.0139275E-2	3.579E+1	2.150E+0	1.864E-1	7.161E+1	In Tolerance
x 10	1.0019248E-1	4.495E+0	2.150E+0	1.864E-1	9.246E+0	In Tolerance
x 11	0.0000000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	

Name Mark Evans Decade Serial C2-05232018 Reference Serial 66409
 Location Guildline Decade Model DBX-7-0.01-RM Reference Model 6634A

The Decade Box Detail Report displays the expanded information of the current or a saved Decade Box results in an easy to follow printable report. This report has 4 pages containing two decades each. The report is accessed through the "Details" button on the Decade Box Summary Report window.

2.7.1. Decade Select Button

The "Decade Select" control indexes through the ranges displayed in the window. The window will display two decades at a time which is that same as how the report is printed (two decades per page). Thus meaning the selections are "Decade 1 & 2", "Decade 3 & 4", "Decade 5 & 6", and "Decade 7 & 8".

2.7.2. Print Button

Clicking the "Print" button will print the all 4 pages of the Decade Box Detail Report regardless of the page currently being displayed.

2.7.3. Close Button

Clicking the "Close" button will exit the report window and return you to the Decade Box Utility.

2.7.4. Value Indicators

The "Value" indicators are in a table organized by decade and step. These indicators display measured resistances from each of the tests conducted in the Decade Box utility.

2.7.5. Standard Deviation (ppm) Indicators

The "Standard Deviation (ppm)" indicators are in a table organized by decade and step. These indicators display measured standard deviation from each of the tests conducted in the Decade Box utility.

2.7.6. Reference Uncertainty (ppm) Indicators

The "Reference Uncertainty (ppm)" indicators are in a table organized by decade and step. These indicators display uncertainty from the reference standard contributed for each of the tests conducted in the Decade Box utility. For more information on how these values are calculated.

2.7.7. Coefficient Uncertainty (ppm) Indicators

The "Coefficient Uncertainty (ppm)" indicators are in a table organized by decade and step. These indicators display uncertainty from the bridge coefficient contributed for each of the tests conducted in the Decade Box utility.

2.7.8. Expanded Uncertainty (ppm) Indicators

The "Expanded Uncertainty (ppm)" indicators are in a table organized by decade and step. These indicators display calculated expanded uncertainty for each of the tests conducted in the Decade Box utility.

2.7.9. Status Indicators

The "Status" indicators display the status of each decade range measured in the Decade Box utility. The status will always fail a decade range if any element is measured to be outside of the entered specification in the Decade Box Utility.

2.7.10. Name Indicator

The "Name" indicator is where the test technician's name that was entered into the Environment Options is displayed.

2.7.11. Location Indicator

The "Location" indicator is where the company/lab name that was entered into the Environment Options is displayed.

2.7.12. Decade Serial Indicator

The "Decade Serial" indicator is where the serial number of the measured decade box that was entered in the Decade Box utility is displayed.

2.7.13. Decade Model Indicator

The "Decade Model" indicator is where the model number of the measured decade box that was entered in the Decade Box utility is displayed.

2.7.14. Reference Serial Indicator

The "Reference Serial" indicator is where the serial number of the reference standard that was used for that particular range in the decade box calibration.

2.7.15. Reference Model Indicator

The "Reference Model" indicator is where the model number of the reference standard that was used for that particular range in the decade box calibration.

2.8. DECADE BOX PROCEDURE

The following steps outline the general procedure for executing a "Decade Box" calibration.

Connect the IEEE-488.2 interface connector of the bridge to an IBM-PC compatible computer running WindowsTM and run the BridgeWorks software.

- Step 1)** Connect the required set of reference resistors' leads on the four wire terminals to any free scanner channels, where C_1P_1 identifies one current potential pair and C_2P_2 the other pair.
- Step 2)** Connect the Decade Box that you wish to calibrate to any free scanner channel.
- Step 3)** Open The "Decade Box" utility from the "Configuration" menu of the main window.
- Step 4)** Select the lower range of the decade box that you wish to calibrate using the "From" control, as well as select the upper range of the decade box that you wish to calibrate using the "To" control.
- Step 5)** For each decade range, you will now need to enter the specification. This includes percent accuracy, offset as well as how many steps are in the decade. To do this you use the "Decade Select" control to index the different decades. The lowest index representing the lowest decade range up to the highest index for the highest decade range. Type in the values for each in the labeled fields provided to the immediate right of the "Decade Select" control.
- Step 6)** Then, for each decade range, you will now need to enter the test parameters. This includes reversal rate, max samples, sample window, and crop depth. This is done the same as in Step 5. Refer to table of recommendations below.

This set of parameters is a good guideline for adjusting trim able decade boxes such as the ESI 925D. This test setup will run effectively indefinitely with a faster response window to allow your adjustments to be visible.

Decade Step Range	Rev Rate	Crop	Samples	Window	Accuracy	Offset *
1Ω/Step – 1kΩ/Step	10	999	999	1	Mfgr. Spec.	Mfgr. Spec.
10kΩ/Step – 10MΩ/Step	20	999	999	1	Mfgr. Spec.	Mfgr. Spec.

- Offset is in some cases such as ESI 925D a measured value obtained by the zero ohms measurement.

This set of parameters is a good guideline for confirming most decade boxes. This test setup will run for a reasonable expected test time with a window to allow sufficient data to calculate uncertainty and acquire a good mean value.

Decade Step Range	Rev Rate	Crop	Samples	Window	Accuracy	Offset *
1Ω/Step – 1kΩ/Step	10	10	100	10	Mfgr. Spec.	Mfgr. Spec.
10kΩ/Step – 10MΩ/Step	20	10	100	10	Mfgr. Spec.	Mfgr. Spec.

- Offset is in some cases such as ESI 925D a measured value obtained by the zero ohms measurement.

Step 7) Instead of performing steps 4, 5, and 6, you can load in an existing decade box profile by clicking on the "Open" button. This will call a prompt that will guide you to selecting what decade box profile you wish to load. The decade box profile prepared in steps 4, 5, and 6 can be saved by clicking on the "Save" button. Clicking the "Save" button will call a prompt asking you to select what name you wish to save your decade box profile under.

Step 8) Now select the channel that your decade box is connected to with the "Channel" control located beneath the "From" and "To" controls.

Step 9) Lastly, you will need to enter the serial number into the Serial Number field to finish describing the details of your decade box.

Step 10) Now you will need to load the reference resistor profiles by clicking on each of the "load" buttons that are flashing. After each button, you will be greeted with a Windows file dialog that asks you to locate the resistor file required. The prompt will read Open (resistor value) File, such as "Open 10k ohm File".

Step 11) Upon completion of loading all the required resistor files, select the scanner channels that they are physically connected to with the neighboring "Channel" controls.

Step 12) If you wish to run a zero ohms offset measurement, then click on the green "Go" button that is located next to the "0 ohms" indicator. The "Go" button will change to a red "Stop" button. This test requires that the 1 ohm reference resistor be configured, even if the corresponding "load" button is not flashing. The test is complete when this "Stop" button changes back to a "Go" button.

- Step 13)** When the zero ohms test is complete or if you are measuring a direct reading decade box that does not require the zero ohms test to be performed, click on the green "Start" button and the decade box calibration will begin. If you had not run the zero ohms test, you will be asked whether you really wish to skip the zero ohms test. If so, clicking on the "Skip" button of the prompt will bypass that test.
- Step 14)** This test will run completely automated using the connected scanners, with the exception of turning the decade box dials. The status indicators will display the progress of the decade box test process. You will also be prompted to switch the decade box dials as needed. This whole process will take approximately 1 hour for a 5 dial decade box.
- Step 15)** Upon completion of the Decade Box calibration, click on the "Report" button to see the results. A prompt will follow asking if you wish to load a saved file or view the current results. You need to select current to see the test you have just completed.
- Step 16)** Use the "Print" button if you desire a hard copy report.
- Step 17)** Use the "Details" button to view all the uncertainty data, which can also be printed.
- Step 18)** Close the report window using the "Close" button. This will return you to the utility window.
- Step 19)** Now exit the utility using its "Close" button. Upon clicking on "Close" in the utility, you will be greeted with a prompt asking if you wish to save the data. It is recommended that you do so by selecting "Yes" and typing a filename in the file dialog that follows. Then click on "Save" in the file dialog.
- Step 20)** You will now be back at the main window. If you selected "No" when asked to save, you will go straight back to the main window and will no longer have the opportunity to save the "Decade Box" data.

Note: If the data on the report, or the during the actual measurement process, a problem is detected then you can re-run the decade for the affected area. This can be done only on a per decade basis during the SAME Decade Box session. Simply click on the "Start" button as if to re-launch the whole process again. This will open a prompt allowing you to "Update" or start a "New" test. Selecting "Update" will give you an options window to choose the decade range you wish to re-run. Once you have exited the utility the ability to "patch" measurements is reset.

2.9. DECADE BOX PROCESS

The table below contains the predetermined test schedule for the complete calibration of a decade box. All tests are based on a user defined maximum sample depth that has a default of 20 readings, with user defined window used for the average. The default for this window is 3 samples. This average is constantly updated at every new reading to allow for the test to exit before the max sample readings if the acceptance criteria are met.

Range (Ω)	Rs Used (Ω)	Excitation	Mode
0 ohms test	1 ws (ch. 17)	150 mA	Current
0.01 / step	1 ws (ch. 17)	140 mA	Current
0.1 / step	1 ws (ch. 17)	100 mA	Current
1 / step	1 ws (ch. 17)	10 mA	Current
10 / step	1 ws (ch. 17)	1 mA	Current
100 / step	100 ws (ch. 19)	1 mA	Current
1 k / step	100 ws (ch. 19)	0.1 mA	Current
10 k / step	10 k ws (ch. 21)	0.1 mA	Current
100 k / step	10 k ws (ch. 21)	10 V	Voltage
1 M / step	1 M ws (ch. 23)	90 V	Voltage
10 M / step	10 M ws (ch. 24)	90 V	Voltage
100 M / step	10 M ws (ch. 24)	90 V	Voltage

Table 2-2 : Decade Box Test Schedule

The first stage of the Decade Box is to measure the 0 ohms value against the 1 ohm Working Standard (optional). This value is subtracted from all readings obtained in the Decade Box. Skip this portion if the Decade Box is a direct reading type, or if you do not want zero compensation.

Next, the utility will index through all the steps and ranges selected by the user from lowest to highest. The test excitation, reference used, and current/voltage mode are all automatically selected by the program based on the range you are measuring. These values are outlined in the table above.

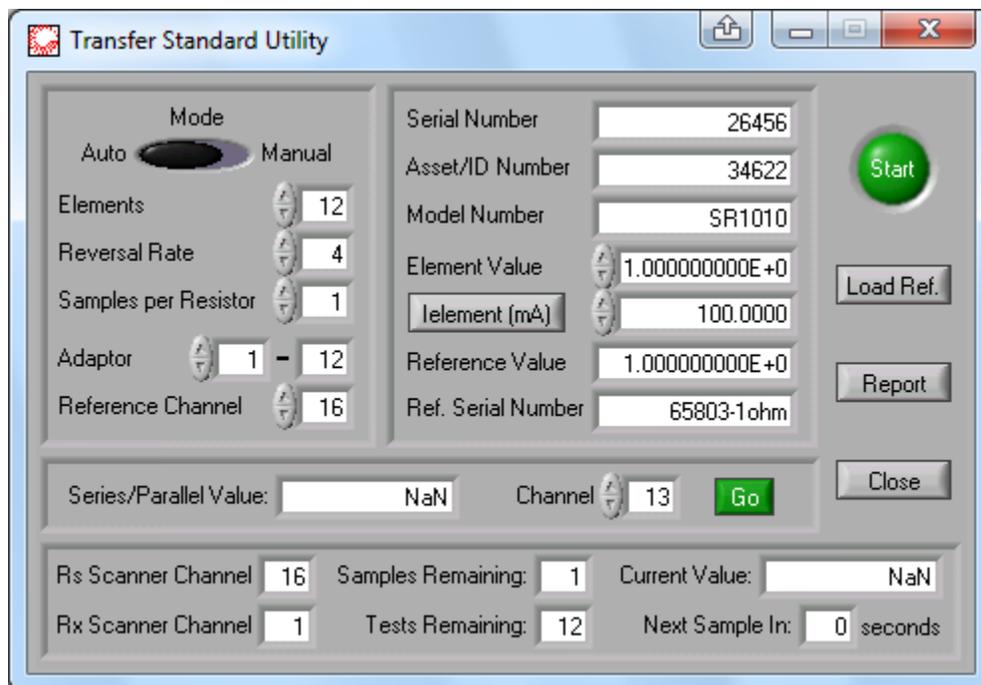
The resistance values are calculated by: $R_{element} = Ratio \times R_{ref} - R_{zero}$

This calculated value must be within the percentage specified after accounting for the offset error.

This is determined by the relationship:

$$R_{nominal} + R_{offset} - (R_{nominal} \times Error) < R_{measured} < R_{nominal} + R_{offset} + (R_{nominal} \times Error)$$

2.10. TRANSFER STANDARD UTILITY



The Transfer Standard utility is a calibration tool that will use the attached scanners and a special SR1010 Adapter to calibrate and verify your SR1010 or similar type resistor transfer standards. At the launch of the utility, a prompt will remind you of the specific hardware configuration required to execute this test process. The prompt must be acknowledged by the user by clicking the "OK" button to continue. In "Auto" mode, the 12 Rx channels required for the transfer standard via the SR1010 Adapter are displayed. This mode is used for transfer standards that do not include switches such as SR1010, SR1030, and SR1060. If you have selected "Manual" mode, then the single Rx channel required for the transfer standard is displayed. This mode is used for transfer standards that include switches such as SR1050. In "Auto" mode, the test is fully automated. In "Manual" mode, you will then be prompted before each resistor change to switch the transfer standard to the necessary resistor for that test. While in operation, the status area at the bottom will gauge your progress. After the test's completion, you can then view and print out your results by clicking the "Report" button. The final report gives you the choice to view the results based on the first ten elements or all twelve. When exiting the Transfer utility, you will be prompted to save this report. At any time, you can stop the test by clicking again on the "Stop" button.

2.10.1. Start/Stop Button

Clicking the green "Start" button will execute the tests and toggle the button to be a red "Stop" button. Clicking the "Stop" button will terminate the test process and toggle it back to a "Start"

button. When the test is completed, the "Stop" button will automatically toggle back to a "Start" button.

2.10.2. Mode Switch

The "Mode" switch toggles between a manual or automatic mode of operation. In the automatic mode, this utility utilizes the SR1010 Adapter and 12 channels of the scanner to calibrate your decade transfer standards that are directly compatible with the ESI™ SR1010 series of resistors. In manual mode, the utility uses only the one channel and prompts the user between tests to reconfigure the hardware for the next element. This can be used with ESI™ SR1050 or similar transfer standards.

2.10.3. Reversal Rate Control

The "Reversal Rate" control allows you to select the measurement reversal rate in seconds for all the elements in the transfer standard.

2.10.4. Samples Per Resistor Control

The "Samples per Resistor" control allows you to select the measurement sample depth for all the elements in the transfer standard. The utility automatically takes 10 readings **before** the number entered here to allow for settling. It is suggested to use a sample size that is adequate to calculate a meaningful standard deviation such as 10 samples. The value **must** be greater than 1 for and standard deviation to be calculated as the initial 10 readings taken are not counted in any report calculations.

2.10.5. Adapter Channels Control

The "Adapter Channels" control allows you to select the channel set that the SR1010 Adapter is connected to while in "Auto" mode. The SR1010 Adapter is normally connected to channels 1 through 12, which is the default setting. If you are in "Manual" mode, this is merely the selection of the individual channel used for your transfer standard. You may use any free channel above channel 12.

2.10.6. Reference Channel Control

The "Reference Channel" control allows you to assign the scanner channel in which your reference resistor is connected.

2.10.7. Serial Number Field

The "Serial Number" field is where the serial number can be logged for the transfer standard under test

2.10.8. Asset/ID Field

The "Asset/ID" field is where the control number can be logged for the transfer standard under test

2.10.9. Model Number Field

The "Model Number" field is where the model number can be logged for the transfer standard under test

2.10.10.Element Value Control

The "Element Value" control is where the nominal resistance value for the individual elements of the transfer standard is entered.

2.10.11.Ielement/Velemet Button

The "Ielement (mA)/Velemet (V)" button is where you can select the use of voltage or current measurement mode for your transfer standard. See section 4.1 for recommendations on setting test currents and voltages.

2.10.12.Ielement/Velemet Control

The "Ielement (mA)/Velemet (V)" control is where the test current value in mA or test voltage in V for the individual element tests of the transfer standard is entered.

2.10.13.Reference Value Indicator

The "Reference Value" indicator displays the value of the loaded reference resistor.

2.10.14.Reference Serial Indicator

The "Reference Serial" indicator displays the Serial number of the loaded reference resistor.

2.10.15.Load Ref. Button

Clicking the "Load Ref." button will call a prompt that will guide you to selecting what standard resistor profile you wish to use to calibrate your transfer standard.

2.10.16.Series/Parallel Value Indicator

The "Series/Parallel Value" indicator displays the measured series parallel value of the transfer standard.

2.10.17.Channel Control

The "Channel" control sets what channel you have configured the series/parallel measurement on.

2.10.18.Go Button

Clicking the "Go" button will initiate the series parallel measurement for your transfer standard.

2.10.19.Report Button

Clicking the "Report" button will call a prompt that will guide you to selecting what report you wish to view, either current or from stored report data.

2.10.20. Close Button

Clicking the "Close" button will prompt you to save your current data and then exit the Transfer Standard Utility after you have responded to the prompt.

2.10.21. Rs Scanner Channel Indicator

The "Rs Scanner Channel" indicator displays the currently selected Rs scanner channel by BridgeWorks for the current test in the transfer standard calibration process.

2.10.22. Rx Scanner Channel Indicator

The "Rx Scanner Channel" indicator displays the currently selected Rx scanner channel by BridgeWorks for the current test in the transfer standard calibration process.

2.10.23. Samples Remaining Indicator

The "Samples Remaining" indicator displays the number of samples remaining for the current test in the transfer standard calibration process, not including the present sample.

2.10.24. Tests Remaining Indicator

The "Tests Remaining" indicator displays the number of tests remaining in the current transfer standard calibration process, not including the present test.

2.10.25. Current Value Indicator

The "Current Value" indicator displays the last Rx:Rs ratio sample value read in by BridgeWorks for the current test in the transfer standard calibration process.

2.10.26. Next Sample In Indicator

The "Next Sample In" indicator displays the amount of time in seconds before the next sample is expected for the current test in the transfer standard calibration process. Note that this is an estimation made by BridgeWorks, and will differ greatly from the bridge during the rough null stage (first few samples) of any test. For the remainder of that test, it is a good estimate.

2.10.27. Saving Transfer Standard Report Data

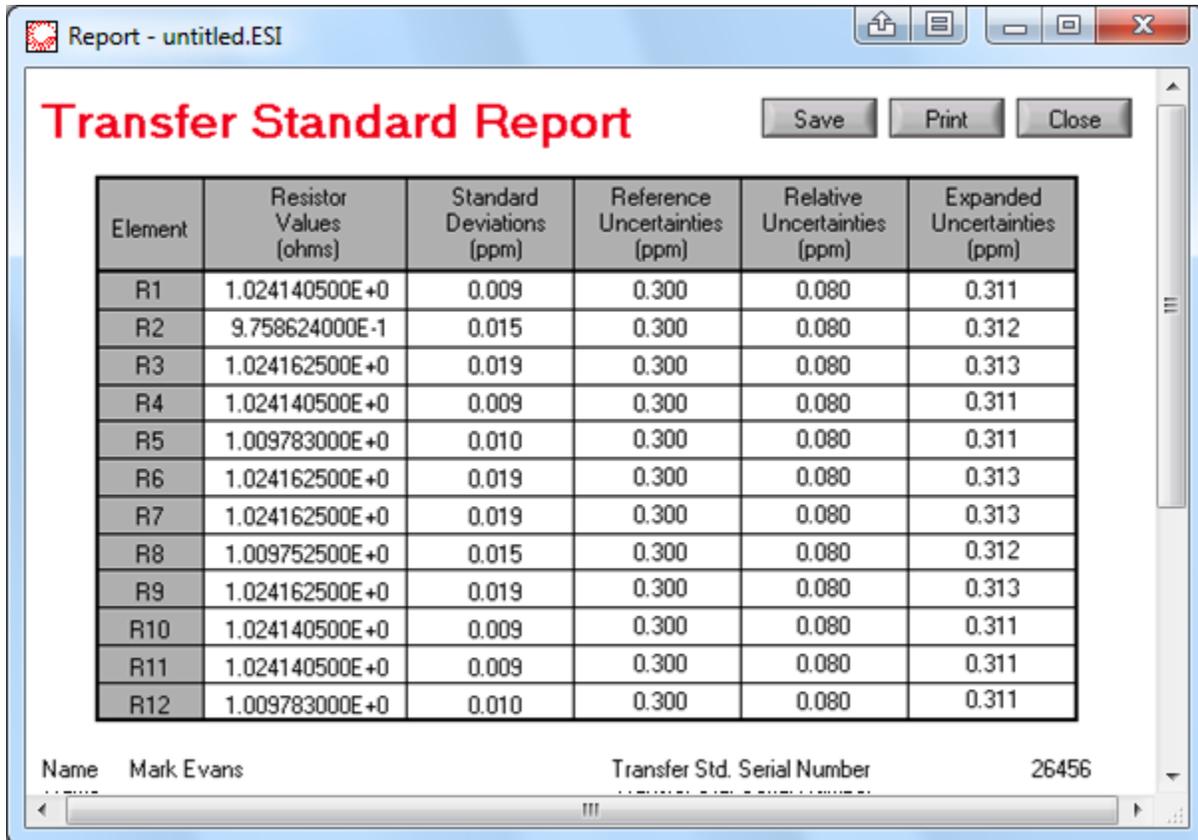
Upon exiting the Transfer Standard Utility window, you will be prompted to save the data currently stored in memory from the utility. At this time you can select "No" to discard the data or "Yes" where you will then be given a windows file dialog prompting you for the name you wish to save the data under. The file extension ".ESI" will automatically be added your saved Transfer Standard file.

2.10.28. Loading/Viewing Transfer Standard Report Data

To load or view a Transfer Standard Report, click on the "Report" button in the Transfer Standard Utility window. You will then be asked to select between viewing the current data or from a saved report file. If you choose current data, then the information that is currently available from the last run test will be loaded. If you choose to load a file, then a standard

Windows file dialog will prompt you to select a file with ".ESI" extension. You then find and select the file of choice, highlight it and then click on "Open" to view it. Refer to section 2.23 for the Transfer Standard Report itself.

2.11. TRANSFER STANDARD REPORT



Element	Resistor Values (ohms)	Standard Deviations (ppm)	Reference Uncertainties (ppm)	Relative Uncertainties (ppm)	Expanded Uncertainties (ppm)
R1	1.024140500E+0	0.009	0.300	0.080	0.311
R2	9.758624000E-1	0.015	0.300	0.080	0.312
R3	1.024162500E+0	0.019	0.300	0.080	0.313
R4	1.024140500E+0	0.009	0.300	0.080	0.311
R5	1.009783000E+0	0.010	0.300	0.080	0.311
R6	1.024162500E+0	0.019	0.300	0.080	0.313
R7	1.024162500E+0	0.019	0.300	0.080	0.313
R8	1.009752500E+0	0.015	0.300	0.080	0.312
R9	1.024162500E+0	0.019	0.300	0.080	0.313
R10	1.024140500E+0	0.009	0.300	0.080	0.311
R11	1.024140500E+0	0.009	0.300	0.080	0.311
R12	1.009783000E+0	0.010	0.300	0.080	0.311

Name Mark Evans Transfer Std. Serial Number 26456

The Transfer Standard Report displays the current or a saved Transfer Standard results in an easy to follow printable report. The report is accessed through the "Report" button on the Transfer Standard Utility window.

2.11.1. Save Button

Clicking the "Save" button will save the displayed report to a file.

2.11.2. Print Button

Clicking the "Print" button will print the report as shown.

2.11.3. Close Button

Clicking the "Close" button will exit the report window and return you to the Transfer Standard Utility.

2.11.4. Value Indicators

The "Value" indicators are in a table organized by element. These indicators display measured resistances from each of the tests conducted in the Transfer Standard utility.

2.11.5. Standard Deviation (ppm) Indicators

The "Standard Deviation (ppm)" indicators are in a table organized by element. These indicators display measured standard deviation from each of the tests conducted in the Transfer Standard utility.

2.11.6. Reference Uncertainty (ppm) Indicators

The "Reference Uncertainty (ppm)" indicators are in a table organized by element. These indicators display uncertainty from the reference standard contributed for each of the tests conducted in the Transfer Standard utility.

2.11.7. Coefficient Uncertainty (ppm) Indicators

The "Coefficient Uncertainty (ppm)" indicators are in a table organized by element. These indicators display uncertainty from the bridge coefficient contributed for each of the tests conducted in the Transfer Standard utility.

2.11.8. Expanded Uncertainty (ppm) Indicators

The "Expanded Uncertainty (ppm)" indicators are in a table organized by element. These indicators display calculated expanded uncertainty for each of the tests conducted in the Transfer Standard utility.

2.11.9. Name Indicator

The "Name" indicator is where the test technician's name that was entered into the Environment Options is displayed.

2.11.10. Location Indicator

The "Location" indicator is where the company/lab name that was entered into the Environment Options is displayed.

2.11.11. Date Indicator

The "Date" indicator is where the test date and time are shown. This date and time are stamped at test completion into the saved Transfer Standard file.

2.11.12. Series/Parallel Value Indicator

The "Series/Parallel Value" indicator displays the measured series/parallel configuration for elements R1-R10.

2.11.13. Delta Average Indicator

The "Delta Average" indicator displays the calculated delta average for elements R1-R10.

2.11.14. Calculated Series Value (R1-R10) Indicator

The "Calculated Series Value (R1-R10)" indicator displays the calculated series resistance in ohms of the first 10 resistance elements that are being displayed.

2.11.15. Calculated Parallel Value (R1-R10) Indicator

The "Calculated Parallel Value (R1-R10)" indicator displays the calculated parallel resistance in ohms of the first 10 resistance elements that are being displayed.

2.11.16. Mean Resistor Value (R1-R10) Indicator

The "Mean Resistor Value (R1-R10)" indicator displays the calculated average resistance in ohms of the first 10 resistance elements that are being displayed.

2.11.17. Transfer Std. Serial Number Indicator

The "Transfer Std. Serial Number" indicator is where the serial number of the transfer standard that was calibrated using the Transfer Standard utility is displayed.

2.11.18. Transfer Std. Asset/ID Number Indicator

The "Transfer Std. Asset/ID Number" indicator is where the control number of the transfer standard that was calibrated using the Transfer Standard utility is displayed.

2.11.19. Transfer Std. Model Number Indicator

The "Transfer Std. Model Number" indicator is where the model number of the transfer standard that was calibrated using the Transfer Standard utility is displayed.

2.11.20. Reference Serial Number Indicator

The "Reference Serial Number" indicator is where the serial number of the reference standard that was used to calibrate the transfer standard is displayed.

2.11.21. Reference Model Number Indicator

The "Reference Model Number" indicator is where the model number of the transfer standard that was calibrated using the Transfer Standard utility is displayed.

2.11.22. Calculated Series Value (all) Indicator

The "Calculated Series Value (all)" indicator displays the calculated series resistance in ohms of all 12 resistance elements that are being displayed.

2.11.23. Calculated Parallel Value (all) Indicator

The "Calculated Parallel Value (all)" indicator displays the calculated parallel resistance in ohms of all 12 resistance elements that are being displayed.

2.11.24. Mean Resistor Value (all) Indicator

The "Mean Resistor Value (all)" indicator displays the calculated average resistance in ohms of all 12 resistance elements that are being displayed.

2.12. TRANSFER STANDARD PROCEDURE

The following steps outline the general procedure for executing a "Transfer Standard" calibration.

Connect the IEEE-488.2 interface connector of the bridge to an IBM-PC compatible computer running Windows™ and run the BridgeWorks software.

- Step 1)** Connect the reference resistor leads on the four wire terminals to any free scanner channels, where C_1P_1 identifies one current potential pair and C_2P_2 the other pair.
- Step 2)** Connect the transfer standard in which you wish to calibrate to the SR1010 Adapter or to any free scanner channel.
- Step 3)** Open the "Transfer Standard" utility from the "Configuration" menu of the main window.
- Step 4)** Select the "Mode" in which you would like to conduct this test. The "Auto" mode uses the SR1010 Adapter to automatically index the transfer standard resistor elements. The "Manual" mode will require you to manually reconfigure the transfer standard under test for types that are not compatible with the adapter.
- Step 5)** Next, select the reversal rate and number of samples you wish to use to test each element of the transfer standard.
- Step 6)** Now select the channel set or channel that your transfer standard is connected to with the "Adapter Channels" control.
- Step 7)** Lastly, you will need to enter the serial number, Asset/ID control number and model number into the respective fields to finish describing the details of your transfer standard.
- Step 8)** Now you will need to load the reference resistor profile by clicking on "Load Ref." button. You will then be greeted by a Windows file dialog that is prompting you to select the reference resistor configuration file.
- Step 9)** Upon completion of loading the reference resistor file, select the scanner channel that it is physically connected to with the "Reference Channel" control.
- Step 10)** Now click on the green "Start" button and the transfer standard calibration will begin.
- Step 11)** This test will run completely automated using the connected scanners, with the exception of transfer standard reconfiguration only used in "Manual" mode. The status indicators will display the progress of the working set calibration process. You will also be prompted to reconfigure the transfer standard in "Manual" mode as needed. This whole process will take approximately 1/2 to 1 hour for a typical transfer standard.

- Step 12)** If a series/parallel measurement is desired disconnect the SR1010 adaptor and configure the SR1010 (or similar) to the series parallel configuration for elements R1-R10.
- Step 13)** Connect the SR1010 to a free scanner channel and configure the software to measure the series/parallel value on that channel.
- Step 14)** Click on “Go” to initiate the test.
- Step 15)** Upon completion of the Transfer Standard calibration, click on the "Report" button to see the results. A prompt will follow asking if you wish to load a saved file or view the current results. You need to select current to see the test you have just completed.
- Step 16)** Use the "Print" button if you desire a hard copy report.
- Step 17)** Close the report window using the "Close" button. This will return you to the utility window.
- Step 18)** Now exit the utility using its “Close” button. Upon clicking on "Close" in the utility, you will be greeted with a prompt asking if you wish to save the data. It is recommended that you do by selecting "Yes" and typing a filename in the file dialog that follows. Then click on "Save" in the file dialog.
- Step 19)** You will now be back at the main window. If you selected "No" when asked to save, you will go straight back to the main window and will no longer have the opportunity to save the "Transfer Standard" data.

2.13. TRANSFER STANDARD PROCESS

The table below contains the predetermined test schedule for the complete calibration of your transfer standard. All tests are based on a user defined sample depth, reversal rate and excitation current of an individual element. This test setup is repeated for all the elements in the transfer standard. All resistors in the standard use the same Rs resistor.

Element	Channel	4-wire Connection
R1	1	(A0, B0) - (B1,C1)
R2	2	(B1, C1) - (A2,B2)
R3	3	(A2, B2) - (B3,C3)
R4	4	(B3, C3) - (A4,B4)
R5	5	(A4, B4) - (B5,C5)
R6	6	(B5, C5) - (A6,B6)
R7	7	(A6, B6) - (B7,C7)
R8	8	(B7, C7) - (A8,B8)
R9	9	(A8, B8) - (B9,C9)
R10	10	(B9, C9) - (A10,B10)
R11	11	(A10, A10) - (B11,C11)
R12	12	(B11, C11) - (A12,B12)

Table 2-3 : Transfer Standard Test Schedule

The utility indexes the scanner to create the 4-wire connections listed in the table above through an adapter designed to mate with ESI™ SR1010 and similar style transfer standards.

The resistance element values are calculated by: $R_{element} = Ratio \times R_{ref}$

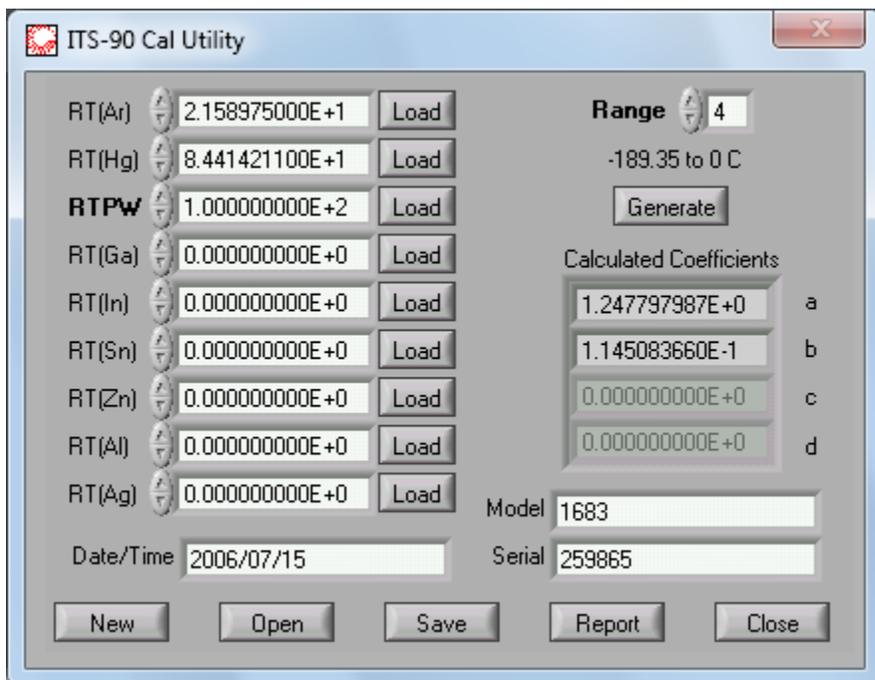
The series resistance is calculated by: $R_{series} = \sum_1^{10} R_n$

The parallel resistance is calculated by: $R_{parallel} = 1 \div \left(\sum_1^{10} \frac{1}{R_n} \right)$

As a final test the Series Parallel value can be measured for which its value is calculated the same as any single element value and should be approximately that same value as a single element. From this the Delta Average is calculated

The Delta Average is calculated by: $R_{deltaaverage} = (9 \times R_{series/parallel} + R_{10}) \div 10$

2.14. ITS-90 COEFFICIENT UTILITY



The ITS-90 Calibration Utility is a more simplified approach to generating the ITS-90 coefficients for you SPRT.

NOTE: All the tests are to be run in the standard test window and imported into the ITS-90 Utility.

2.14.1. Fixed Point Measurements Control

The “Fixed Point Measurements” indicators are in the left column of the ITS-90 Coefficient Utility. These controls allow you to set and display fixed points measured.

2.14.2. Load Buttons

Clicking the “Load” buttons will load the “Test Overview” window to allow for the selection of the test data for each required fixed point. The “Load” buttons will flash for all the required values to calculate the range specified in the “Range” control until they are loaded.

2.14.3. Range Control

The “Range” control set the desired ITS-90 range used to calibrate you SPRT.

2.14.4. Generate Button

Clicking the “Generate” button will execute the calculation for the generation of the ITS-90 coefficients in the selected range.

2.14.5. Coefficients Indicators

The “Coefficients” indicators are in the right column of the ITS-90 Coefficient Report. These indicators display calculated ITS-90 coefficients for the specified range.

2.14.6. Serial Number Control

The “Serial Number” control is where you can enter the serial number of the SPRT that was calibrated using the ITS-90 Coefficient utility.

2.14.7. Model Number Control

The “Model Number” control is where you can enter the model number of the SPRT that was calibrated using the ITS-90 Coefficient utility.

2.14.8. Cal Date Control

The “Cal Date” control is where you can enter the calibration date of the SPRT that was calibrated using the ITS-90 Coefficient utility.

2.14.9. New Button

Clicking the “New” button will reset ITS-90 utility and clear all data.

2.14.10. Open Button

Clicking the “Open” button will open a saved ITS-90 calibration.

2.14.11. Save Button

Clicking the “Save” button will save an ITS-90 calibration to a file.

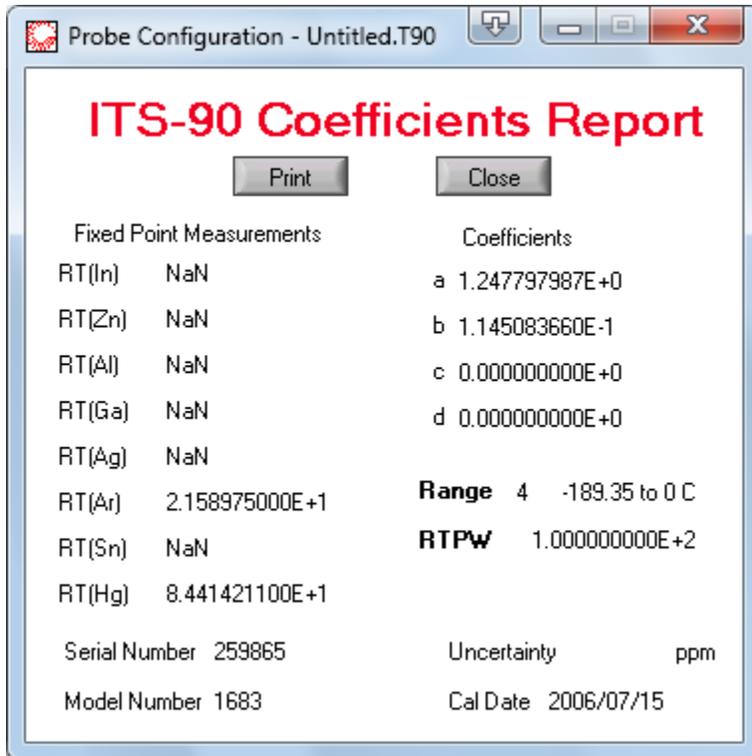
2.14.12. Report Button

Clicking the “Report” button will view the data in a report format.

2.14.13. Close Button

Clicking the “Close” button will close the ITS-90 Coefficient Utility.

2.15. 2.9. ITS-90 COEFFICIENT REPORT



The ITS-90 Coefficient Report displays the results in an easy to follow printable report. The report is accessed through the “Report” button on the ITS-90 Coefficient Report Utility window.

2.15.1. Print Button

Clicking the “Print” button will print the report as shown.

2.15.2. Close Button

Clicking the “Close” button will exit the report window and return you to the ITS-90 Coefficient Report Utility.

2.15.3. Fixed Point Measurements Indicators

The “Fixed Point Measurements” indicators are in the left column of the ITS-90 Coefficient Report. These indicators display fixed points measured.

2.15.4. Coefficients Indicators

The “Coefficients” indicators are in the right column of the ITS-90 Coefficient Report. These indicators display calculated ITS-90 coefficients for the specified range.

2.15.5. Uncertainty Indicator

The “Uncertainty” indicator displays calculated uncertainty in ppm of calibrated probe in the ITS-90 Coefficient Report.

2.15.6. Serial Number Indicator

The “Serial Number” indicator is where the serial number of the SPRT that was calibrated using the ITS-90 Coefficient utility is displayed.

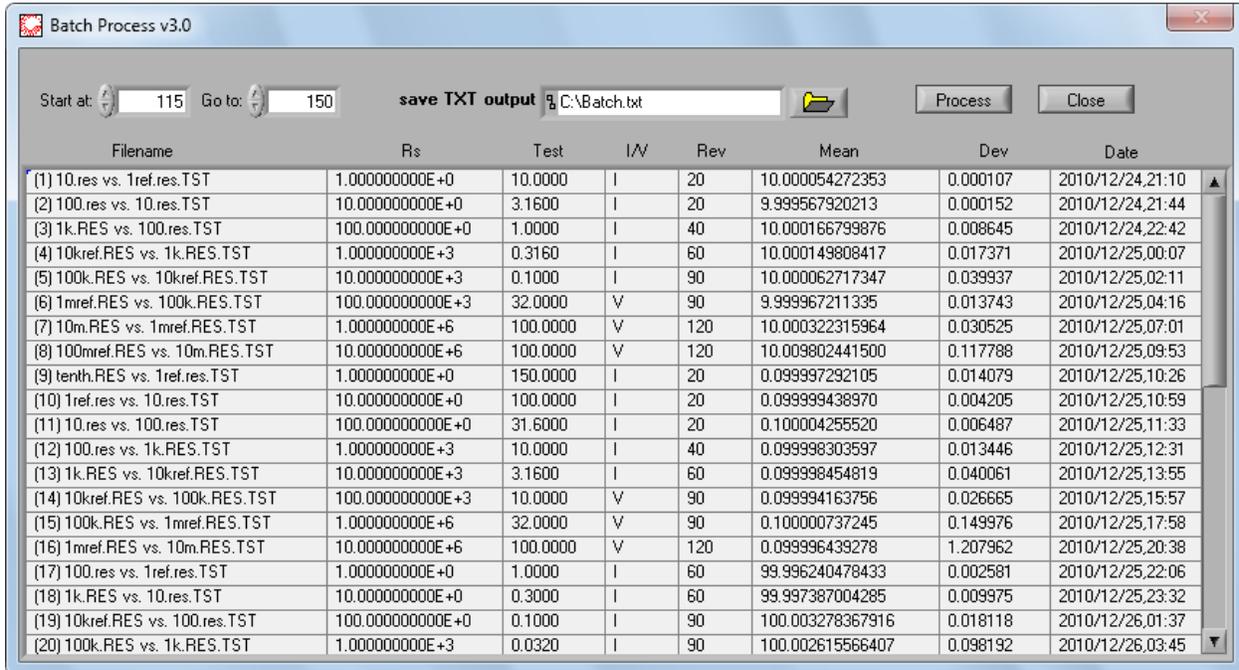
2.15.7. Model Number Indicator

The “Model Number” indicator is where the model number of the SPRT that was calibrated using the ITS-90 Coefficient utility is displayed.

2.15.8. Cal Date Indicator

The “Cal Date” indicator is where the test date and time are shown. This date and time are stamped at test completion into the saved ITS-90 Coefficient Report file.

2.16. BATCH PROCESS



Filename	Rs	Test	I/V	Rev	Mean	Dev	Date
(1) 10.res vs. 1ref.res.TST	1.000000000E+0	10.0000	I	20	10.000054272353	0.000107	2010/12/24,21:10
(2) 100.res vs. 10.res.TST	10.000000000E+0	3.1600	I	20	9.999567920213	0.000152	2010/12/24,21:44
(3) 1k.RES vs. 100.res.TST	100.000000000E+0	1.0000	I	40	10.000166799876	0.008645	2010/12/24,22:42
(4) 10kref.RES vs. 1k.RES.TST	1.000000000E+3	0.3160	I	60	10.000149808417	0.017371	2010/12/25,00:07
(5) 100k.RES vs. 10kref.RES.TST	10.000000000E+3	0.1000	I	90	10.000062717347	0.039937	2010/12/25,02:11
(6) 1mref.RES vs. 100k.RES.TST	100.000000000E+3	32.0000	V	90	9.999967211335	0.013743	2010/12/25,04:16
(7) 10m.RES vs. 1mref.RES.TST	1.000000000E+6	100.0000	V	120	10.000322315964	0.030525	2010/12/25,07:01
(8) 100mref.RES vs. 10m.RES.TST	10.000000000E+6	100.0000	V	120	10.009802441500	0.117788	2010/12/25,09:53
(9) tenth.RES vs. 1ref.res.TST	1.000000000E+0	150.0000	I	20	0.099997292105	0.014079	2010/12/25,10:26
(10) 1ref.res vs. 10.res.TST	10.000000000E+0	100.0000	I	20	0.099999438970	0.004205	2010/12/25,10:59
(11) 10.res vs. 100.res.TST	100.000000000E+0	31.6000	I	20	0.100004255520	0.006487	2010/12/25,11:33
(12) 100.res vs. 1k.RES.TST	1.000000000E+3	10.0000	I	40	0.099998303597	0.013446	2010/12/25,12:31
(13) 1k.RES vs. 10kref.RES.TST	10.000000000E+3	3.1600	I	60	0.099998454819	0.040061	2010/12/25,13:55
(14) 10kref.RES vs. 100k.RES.TST	100.000000000E+3	10.0000	V	90	0.099994163756	0.026665	2010/12/25,15:57
(15) 100k.RES vs. 1mref.RES.TST	1.000000000E+6	32.0000	V	90	0.100000737245	0.149976	2010/12/25,17:58
(16) 1mref.RES vs. 10m.RES.TST	10.000000000E+6	100.0000	V	120	0.099996439278	1.207962	2010/12/25,20:38
(17) 100.res vs. 1ref.res.TST	1.000000000E+0	1.0000	I	60	99.996240478433	0.002581	2010/12/25,22:06
(18) 1k.RES vs. 10.res.TST	10.000000000E+0	0.3000	I	60	99.997387004285	0.009975	2010/12/25,23:32
(19) 10kref.RES vs. 100.res.TST	100.000000000E+0	0.1000	I	90	100.003278367916	0.018118	2010/12/26,01:37
(20) 100k.RES vs. 1k.RES.TST	1.000000000E+3	0.0320	I	90	100.002615566407	0.098192	2010/12/26,03:45

The Batch Process utility is a tool that allows you to process multiple TST data files stored within the same directory. This tool will crop the data on all tests in the directory based on the “Start at:” and “Go to:” controls and report the mean and standard deviation for each test. This result is displayed along with the main test details in the table. This result is also saved to a tab delimited text file which can be chosen in the “save TXT output” field. This file is then easy to import into commonly used spreadsheet applications. Note that NONE of the actual TST files are modified in this process.

2.16.1. Start at: Control

The "Start at:" numerical control will set the beginning of the crop data in the batch process. This is set to 115 as per Guildline recommended practice for full rated accuracy of the 6622A.

2.16.2. Go to: Control

The "Go to:" numerical control will set the end of the crop data in the batch process. This is set to 150 as per Guildline recommended practice for full rated accuracy of the 6622A.

2.16.3. Save TXT Output Field

The "save TXT output" field allows you to select the filename and location of the tab delimited text file summarizing the batch process.

2.16.1. Process Button

Clicking the "Process" button will call a file prompt that will guide you to selecting what directory you wish to process. Once the selection is made the batch process will run and display the report. Note that NONE of the actual TST files are modified in this process.

2.16.2. Close Button

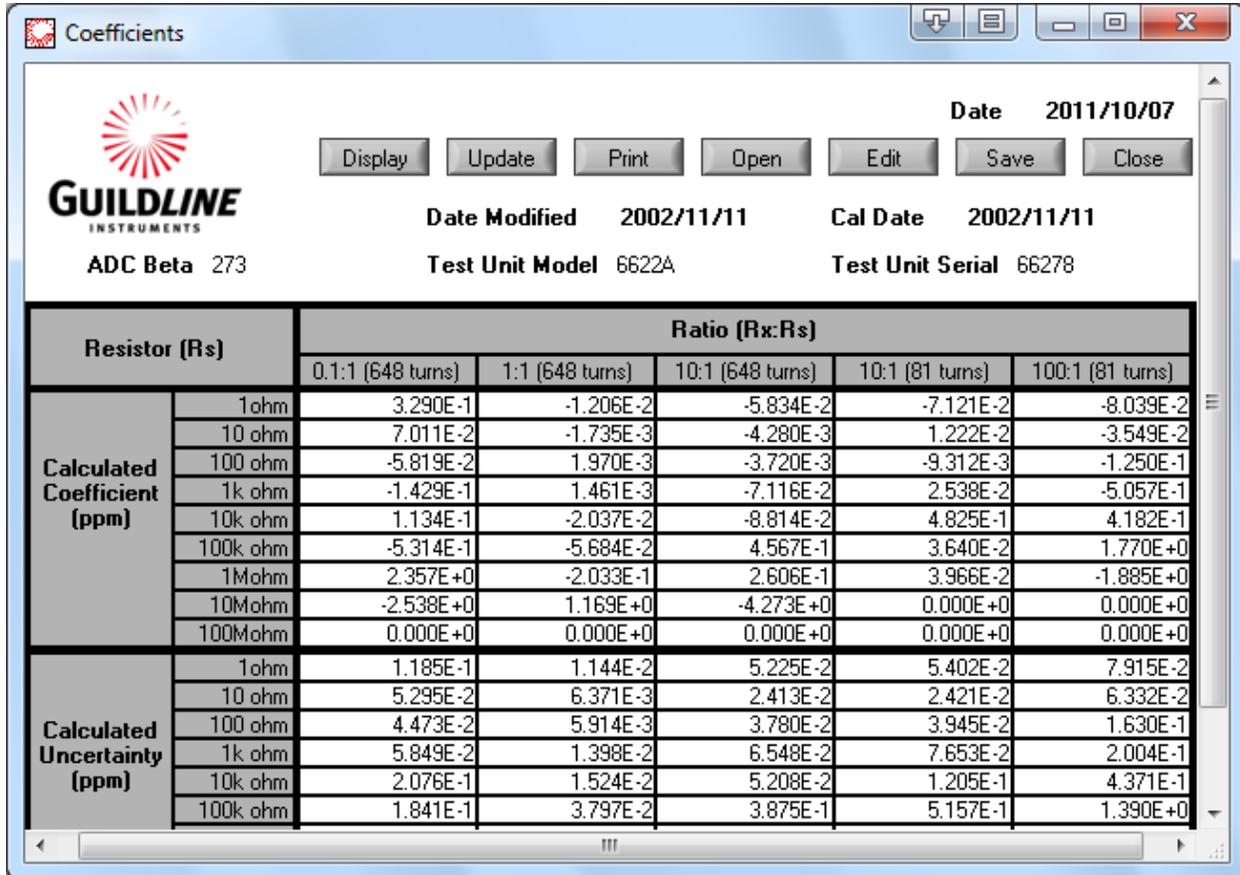
Clicking the "Close" button will exit the Batch Process Utility.

2.16.3. Report Table/Field

The report table/field is where the results of the batch process is displayed in a table form. It contains columns for TST filename, Rs value, test excitation, test mode (current/voltage), reversal rate, mean, standard deviation, and test date.

2.17. COEFFICIENT UTILITY

WARNING: This utility has the potential to modify your bridge software coefficients. Improper use of this program can void the calibration your hardware. This item is therefore by default locked under Administrative Options.



The screenshot shows the 'Coefficients' utility window. At the top, it displays the date '2011/10/07' and several control buttons: Display, Update, Print, Open, Edit, Save, and Close. Below these are fields for 'Date Modified' (2002/11/11), 'Cal Date' (2002/11/11), 'Test Unit Model' (6622A), and 'Test Unit Serial' (66278). The main area contains a table with two sections: 'Calculated Coefficient (ppm)' and 'Calculated Uncertainty (ppm)'. Each section lists resistor values from 1 ohm to 100 Mohm and their corresponding ratios (0.1:1, 1:1, 10:1, 10:1, 100:1) with associated coefficient values in scientific notation.

Resistor (Rs)		Ratio (Rx:Rs)				
		0.1:1 (648 turns)	1:1 (648 turns)	10:1 (648 turns)	10:1 (81 turns)	100:1 (81 turns)
Calculated Coefficient (ppm)	1ohm	3.290E-1	-1.206E-2	-5.834E-2	-7.121E-2	-8.039E-2
	10 ohm	7.011E-2	-1.735E-3	-4.280E-3	1.222E-2	-3.549E-2
	100 ohm	-5.819E-2	1.970E-3	-3.720E-3	-9.312E-3	-1.250E-1
	1k ohm	-1.429E-1	1.461E-3	-7.116E-2	2.538E-2	-5.057E-1
	10k ohm	1.134E-1	-2.037E-2	-8.814E-2	4.825E-1	4.182E-1
	100k ohm	-5.314E-1	-5.684E-2	4.567E-1	3.640E-2	1.770E+0
	1Mohm	2.357E+0	-2.033E-1	2.606E-1	3.966E-2	-1.885E+0
	10Mohm	-2.538E+0	1.169E+0	-4.273E+0	0.000E+0	0.000E+0
100Mohm	0.000E+0	0.000E+0	0.000E+0	0.000E+0	0.000E+0	
Calculated Uncertainty (ppm)	1ohm	1.185E-1	1.144E-2	5.225E-2	5.402E-2	7.915E-2
	10 ohm	5.295E-2	6.371E-3	2.413E-2	2.421E-2	6.332E-2
	100 ohm	4.473E-2	5.914E-3	3.780E-2	3.945E-2	1.630E-1
	1k ohm	5.849E-2	1.398E-2	6.548E-2	7.653E-2	2.004E-1
	10k ohm	2.076E-1	1.524E-2	5.208E-2	1.205E-1	4.371E-1
	100k ohm	1.841E-1	3.797E-2	3.875E-1	5.157E-1	1.390E+0

The Coefficient Utility that allows you to display, modify and print out the calibration coefficients stored in your bridge. It is a good practice to open this utility and save the contents of your bridge ratio calibration to a file when you first get the system and the software running together. This can be done using the “Save” button.

Other than this, the utility should only be used in the event of the bridge being re-calibrated, to restore your old calibration from a non-volatile memory failure, or as part of a test. Misuse of this utility can remove the calibration from your bridge.

The calculated coefficients stored in your bridge are the corrections in ppm that the bridge applies to its measured Rx:Rs ratio.

The calculated uncertainties stored in your bridge are the uncertainties of the bridge in ppm that BridgeWorks uses to determine the total measurement uncertainty. Refer to section 4.2.2.

The calculated coefficients and uncertainties shown in the picture above are the defaults that the bridge uses in the event that it suffers a non-volatile memory failure.

2.17.1. Display Button

Clicking the "Display" button will display the current bridge's coefficients/uncertainties in the Coefficient Utility window.

2.17.2. Update Button

Clicking the "Update" button will update the bridge to the coefficients/uncertainties shown.

2.17.3. Print Button

Clicking the "Print" button will print the report as shown.

2.17.4. Open Button

The "Open" button allows you to open an existing coefficient table file. Clicking on this button will open a file dialog box prompting you for a coefficient table file "*.COE" to open.

2.17.5. Save Button

The "Save" button allows you to save the edited or created coefficient table to a file. Clicking on this button will open a file dialog box prompting you for a coefficient table file "*.COE" name to save the data under.

2.17.6. Close Button

Clicking the "Close" button will exit the Coefficients Utility.

2.17.7. Test Unit Serial Indicator

The "Test Unit Serial" indicator is where the serial number of the bridge is displayed.

2.17.8. Model Number Indicator

The "Model Number" indicator is where the model number of the bridge being communicated with is displayed.

2.17.9. Ratio Coefficient Values Indicator

The "Ratio Coefficient Values" indicators are in a table to the top of the Coefficients Utility window. These indicators display calibration coefficients for each decade ratio point in ppm. These values are positive or negative, depending on whether a positive or negative correction to the measured Rx:Rs ratio is required.

2.17.10. Ratio Coefficient Uncertainties Indicator

The "Ratio Coefficient Uncertainties" indicators are in a table to the bottom of the Coefficients Utility window. These indicators display calibration coefficient uncertainties for each decade ratio point in ppm. These are always positive values.

2.17.11. Cal Date Indicator

The "Cal Date" indicator is where the date stamped for the last formal calibration is shown.

2.17.12. Date Modified Indicator

The "Date Modified" indicator is where the date of the last coefficient modification is shown.

2.17.13. Date Indicator

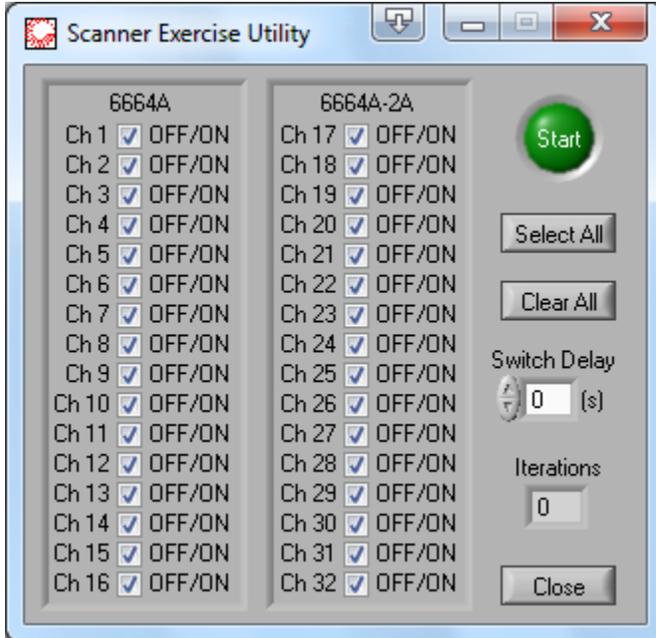
The "Date" indicator is where the current date is shown.

2.17.14. Calibration Restoration Procedure

Launch the Coefficient Utility from the BridgeWorks "Maintenance" menu. Once the utility is loaded, you should follow the steps outlined in the "Procedure" indicator. These steps are outlined below.

- Step 1)** Read in your bridge's current coefficients by clicking on the "Display" button.
- Step 2)** Verify that they match the coefficient report provided with your bridge. If they are correct, you do not need to continue and should exit this program by clicking on the "Close" button. If they are wrong, proceed to "Step 4".
- Step 3)** Load the coefficients from the report supplied with your bridge into the program by clicking on the "Open" button, and selecting the "Results" option in the following dialog box. You will then be greeted with a table in which to type in the proper values. Close the entry window when completed.
- Step 4)** The values you typed in should now be displayed on the report. When you have determined that they are correct, click on "Update" to load the values into the bridge.
- Step 5)** Turn the bridge's power off then and back on again and return to step 2.

2.18. SCANNER EXERCISE UTILITY



The Scanner Exercise Utility that allows you to run a sequence to actuate all the scanner channels in the 6625 system. These relays are mechanical and can get “stuck” over a long period of non-usage. Routinely running this utility (once a month) will prevent this from occurring. This utility can also focus on specific relays that are already stuck to work them back into smooth operation.

2.18.1. Start/Stop Button

Clicking the green "Start" button will execute the routine and toggle the button to be a red "Stop" button. Clicking the "Stop" button will terminate the routine and toggle it back to a "Start"

2.18.2. Numbered Checkboxes (Ch 1 – Ch 32)

Selecting a numbered checkbox (Ch 1 through Ch 32) will enable that scanner channel to be part of the scanner exercise routine. Thus meaning the channel will be actuated within the counted sequence. All channels are selected by default.

2.18.3. Select All Button

Clicking the "Select All" button will select all scanner channel checkboxes.

2.18.4. Clear All Button

Clicking the "Clear All" button will deselect all scanner channel checkboxes.

2.18.5. Switch Delay Button

The “Switch Delay” button allows you to set a timed delay between scanner channel actuations. This delay can be used in conjunction with a DMM to confirm a shorted or closed channel.

2.18.6. Iterations Indicator

The “Iterations” indicator displays the number of times the scanner exercise routine has completed. For maintenance purposes it is recommended that you execute this routine once a month on all channels for 10 iterations.

2.18.7. Close Button

Clicking the "Close" button will exit the Scanner Exercise Utility.

2.18.8. Scanner Exercise Procedure

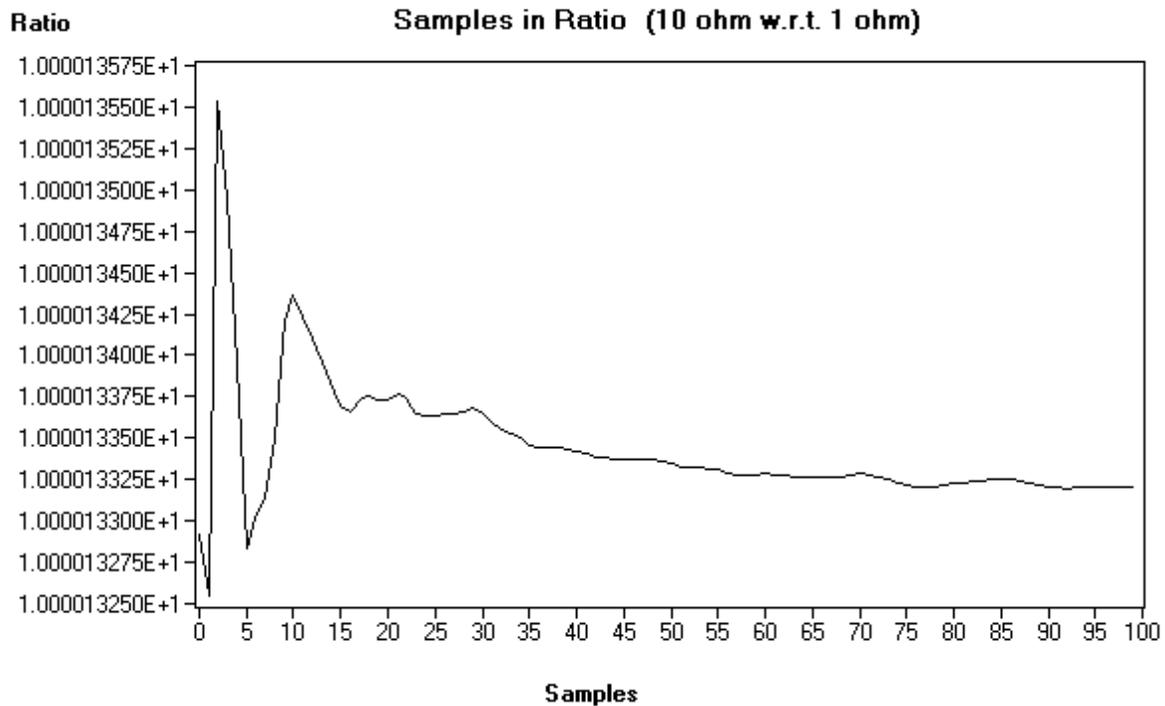
Launch the Scanner Exercise Utility from the BridgeWorks “Maintenance” menu. Once the utility is loaded, you should follow these steps are outlined below.

- Step 1)** Power on your scanners and ensure they are connected to the computer. Also ensure that no other programs are running on the computer.
- Step 2)** With all checkboxes selected click on the “Start” button.
- Step 3)** Verify that all channels actuate by observing the close channel indicators on the front panel of the scanners.
- Step 4)** If any channel that does not correctly actuate select the “Clear All” button and select only the channel(s) that are not working correctly. Otherwise proceed to Step 8.
- Step 5)** Allow the routine to break in the relay for an adequate (about ½ hour per relay).
- Step 6)** Stop the routine and click on the “Select All” button.
- Step 7)** Return to Step 2.
- Step 8)** Run the sequence on all channels for 10 iterations and then click on the “Stop” button.

3. USER NOTES

3.1. MEASUREMENT OPERATION GUIDE

This section contains information regarding the measurement of resistors in the ranges of 1 mΩ to 100 MΩ. This guide is provided for full automatic control of the system through the terminal of the system computer running the BridgeWorks software package. An operating guide for manual control of the system is provided in the DCC Bridge Technical Manual. A typical example of a resistance measurement response versus test sample is illustrated below.



Resistance Measurement Response Versus Test Sample

3.1.1. Resistance Measurement Normal Mode - $1 \Omega \leq R_s \leq 10 \text{ k}\Omega$

The bridge in its Normal mode enables measurement of resistance of values up to $100 \text{ k}\Omega : 10 \text{ k}\Omega$ ($R_x : R_s$) and $100 \text{ k}\Omega : 1 \text{ k}\Omega$ ($R_x : R_s$) for 100:1 ratio. Several types of resistances, each involving a different resistance range, as well as reference resistor current can also be measured in this mode.

NOTE:

In this as in all measurements, optimum results will be obtained if the environment is controlled. The recommendations in the Instrument Society of America (ISA) publication ISA RE52.1, especially in regards to relative humidity should be observed.

The following steps outline the general procedure for making the Normal measurement.

Connect the IEEE-488.2 interface connector of the bridge to an IBM-PC compatible computer running Windows™ and run the BridgeWorks software.

- Step 1)** Connect the resistors' leads to be measured on the four wires from your chosen scanner channels, where C_1P_1 identifies one current potential pair and C_2P_2 the other pair.
- Step 2)** Select the reference resistor and connect them to the four wires from your chosen scanner channels. Normally a value is chosen that will make the expected bridge ratio for each test lie between 1 : 1 and 100 : 1 ($R_x : R_s$). This ensures the best available precision. Selection of the scanner channels is done automatically in the software when by assigning resistors to the scanner channel in the test setup window. The software can invert ratios when selected as described in section 1.6.10 for ratios less than 1 to achieve this optimum precision, if both R_x and R_s are greater than 1 ohm.
- Step 3)** You can change the scale being displayed by clicking on the "Units" control on the BridgeWorks main window. The default unit for resistance is "Ohms". The units available are:

Ratio	The ratio of $R_x : R_s$
Ohms	Ratio $\times R_s$
Delta (ppm)	The difference between Ratio and the nominal ratio expressed in ppm of nominal (the nominal ratio is determined from the Resistor Configuration files)

NOTE:

The displayed units do not affect the stored data. Test data is always stored in ratio.

- Step 4)** Click on the “Test” button on the BridgeWorks main window.
- i) Click on the “Edit” button beside the “Load” button.
 - ii) Enter all the pertinent information for the resistor to be used on the Rs side in the Resistor Configuration window, if this has not already been done. The following parameters can be entered:

Manufacturer/Model	used to identify resistor in test file, test overview, and history file
Asset/ID Number	used to identify resistor in test file, test overview, and history file
Serial Number	used to identify resistor in test file, test overview, and history file
R (ohms)	Value in ohms of the resistor – required for Rs, optional for Rx
I test (mA)	Test current applied when the resistor is attached to Rx during a normal ohms measurement – must be a value between 0.0005 and 150 inclusive (typically resistance measurements are made at a 10 mW power level)
I max (mA)	Maximum current that will be applied to the resistor when attached to Rs during a normal ohms measurement – must be greater than or equal to I test and less than or equal to 150
V test (V)	Test voltage applied when the resistor is attached to Rx during a high ohms measurement – must be a value between 1 and 100 inclusive (typically resistance measurements are made at a 10 mW power level)
V max (V)	Maximum voltage that will be applied to the resistor when attached to Rs during a high ohms measurement – must be greater than or equal to V test and less than or equal to 100.
Uncertainty (ppm)	Uncertainty of the resistance value in ppm of the nominal value – used to calculate the measurement uncertainty
Cal. Date	For reference only
Cal. Due	For reference only
Cal Temp (C)	For reference only
Temp. Coef. (ohm/C)	For reference only
 - iii) Click on the “Save” button.
 - iv) Enter an appropriate name for the configuration file and click on the “Save” button in the Save Resistor File dialog box.
 - v) Repeat these sub-steps for the other resistors to be used on the Rs side.

- Step 5)** Load the parameters for the resistors to be used on the Rs and Rx side by selecting the desired scanner channel using the "Edit Scanner Channel No." index. This is followed by clicking on "Load" and selecting the appropriate resistor file. Repeat for the other resistors to be used.
- Step 6)** Set the Rs and Rx Channel selection as well as the desired test current in milli-Ampres.
- Step 7)** Set the reversal rate by entering the appropriate value in seconds in the Reversal Rate box. The recommended value for resistance measurement to the specified accuracy is in most cases is from 20 to 60 seconds.
- Step 8)** If you do not wish to let the software optimize the reversal rate, set the Auto Reversal Rate to "Fixed, with Auto Reversal Rate set to Disabled". If you are measuring a varying resistance, you will be able to track the changes better if the Auto Reversal Rate to "Minimum, with Auto Reversal Rate set to Tracking". If you want to use a shorter reversal rate but still maintain a given accuracy, set the Auto Reversal Rate to "Maximum, with Auto Reversal Rate set to Stabilize". If the Auto Reversal Rate is not set to "Fixed, with Auto Reversal Rate set to Disabled", then enter a value in the Threshold (ppm) box to determine how much deviation will cause a change in the reversal rate.
- Step 9)** Select the scanner channels that you wish to compare in the "Test Sequence" area, as well as entering in the excitation value for the test. Clicking on the "Delete" button will delete a test step that is not required.
- Step 10)** Set the Test Criteria for the number of samples to be taken and test timing. The criteria are as follows:
- | | |
|-----------------|---|
| Sample Limit | The maximum number of samples that will be recorded. A good set of samples is 150 readings. |
| Sample Window | The size of the number of samples to be considered for the Test Criteria. |
| Deviation (ppm) | The maximum deviation of the last windowed number of samples before the measurement will be terminated. If the No. of Readings criteria in the "Sample Window" is reached before the Deviation criteria, the measurement is terminated. Make this value your target deviation for your measurement. |
- Step 11)** You can establish time delays in the test process.
- | | |
|---------------------|---|
| Start Process | This is either the specific time and date, or number of seconds from now. To choose the method of entering in your startup delay, use the "in/at" control and then enter the corresponding information. |
| Between Test Delays | This is how much time, in seconds, you wish to pause between tests in your sequence. |
- Step 12)** You can describe the environment of the test facilities by clicking on the "Environment" button. This will open a Test Environment window, where you

can enter the pressure, temperature and humidity of the test facilities, plus the location of the facilities and the operator's name. This information will be logged in the test data file.

- Step 13)** Save this test configuration by clicking on the "Save" button, entering an appropriate name for the configuration file and clicking on the "Save" button in the Save Sequence File dialog box.
- Step 14)** Click on the "Start" button. The measurement will now begin, after you have assigned a directory for the measurements to be automatically saved in.
- Step 15)** You can shorten the time required to reach a stable measurement value by clicking on the "Quick" control. This control will allow you to toggle the quick mode of operation on or off. This mode is primarily used when Rx is changing (such as when calibrating decade resistance boxes). Selecting "Quick" reduces the resolution to 7 digits. This control is only available while not running an auto reversal rate function, as the auto-reversal rate optimizes this feature as well. For most tests, this should be left off.
- Step 16)** You can double the power applied to Rx by clicking on the "Power" control. This control will allow you to toggle the power between $\times 1$ and $\times 2$. This control is useful for extrapolating to zero power resistance. For most tests this should be left at $\times 1$.
- Step 17)** You may terminate the measurement at any time by clicking on the "Stop" button.
- Step 18)** You may save the displayed data file by selecting "File" on the menu bar, selecting "Save Data As", entering an appropriate name for the configuration file and clicking on the "Save" button in the Save Data File dialog box.
- Step 19)** To process the results, open the "Test Overview" window from the "View" menu of the main window.
- Step 20)** Then within the "Test Overview" window, select "Open" from file menu and select the data file you wish to view.
- Step 21)** From here you can make data adjustments and print out the report with the options in the menu bar. Once completed, you then close the "Test Overview" and return to the main window.

3.1.2. Resistance Measurement - Low Ohms Mode - $R_x \leq 0.1 \Omega$

The bridge in its Low Ohms mode enables measurement of resistance values where typically $R_s = 1 \Omega$, $R_x \leq 100 \text{ m}\Omega$. This setup requires the use of a Current Range Extender. Ratio measurements made with the Range Extender should be made such that the conditions:

$$R_x \times \text{Extender Ratio} / R_s \leq 2 \text{ is maintained.}$$

NOTE:

In Low Ohms mode, there must be a connection between the bridge and the range extender.

NOTE:

In this, as in all measurements, optimum results will be obtained if the environment is controlled. The recommendations in the Instrument Society of America (ISA) publication ISA RE52.1, especially in regards to relative humidity, should be observed.

The following steps outline the general procedure for making the Low Ohms measurement.

Connect the IEEE-488.2 interface connector of the bridge to an IBM-PC compatible computer running WindowsTM and run the BridgeWorks software.

- Step 1)** Connect the shunt's leads to be measured on the four wires, where C_1 and C_2 are connected to the desired current range on the range extender. Physical use of the scanners in low ohms is only applicable for the P1 and P2 terminals that are connected to the shunt.
- Step 2)** Select a reference resistor (typically 1Ω or 10Ω), and connect it to the four wires from your chosen scanner channels. Selection of the scanner channels is done automatically in the software when by assigning resistors to the scanner channel in the test setup window.

Step 3) You can change the scale being displayed by clicking on the “Units” control on the BridgeWorks main window. The default unit for resistance is “Ohms”. The units available are:

Ratio	The ratio of $R_x : R_s$
Ohms	$\text{Ratio} \times R_s$
Delta (ppm)	The difference between Ratio and the nominal ratio expressed in ppm of nominal (the nominal ratio is determined from the Resistor Configuration files)

NOTE:

The displayed units do not affect the stored data. Test data is always stored in ratio.

Step 4) Click on the “Test” button on the BridgeWorks main window.

- vi) Click on the “Edit” button beside the “Load R_s ” button.
- vii) Enter all the pertinent information for the resistor to be used on the R_s side in the Resistor Configuration window, if this has not already been done. The following parameters can be entered:

Manufacturer/Model	used to identify resistor in test file, test overview, and history file
Asset/ID Number	used to identify resistor in test file, test overview, and history file
Serial Number	used to identify resistor in test file, test overview, and history file
R (ohms)	Value in ohms of the resistor – required for R_s , optional for R_x
I test (mA)	Test current applied when the resistor is attached to R_x during a low ohms measurement – must be a value between 0.0005 and 300 inclusive (typically resistance measurements are made at a 10 mW power level)
I max (mA)	Maximum current that will be applied to the resistor when attached to R_s during a low ohms measurement – must be greater than or equal to $I_{\text{test}}/20$ and less than or equal to 150
V test (V)	Test voltage applied when the resistor is attached to R_x during a high ohms measurement – must be a value between 1 and 100 inclusive (typically resistance measurements are made at a 10 mW power level)
V max (V)	Maximum voltage that will be applied to the resistor when attached to R_s during a high ohms

measurement – must be greater than or equal to V test and less than or equal to 100.

Uncertainty (ppm) Uncertainty of the resistance value in ppm of the nominal value – used to calculate the measurement uncertainty

Cal. Date For reference only

Cal. Due For reference only

Cal Temp (C) For reference only

Temp. Coef. (ohm/C) For reference only

viii) Click on the “Save” button.

ix) Enter an appropriate name for the configuration file and click on the “Save” button in the Save Resistor File dialog box.

x) Repeat these sub-steps for the other resistors to be used on the Rs side.

Step 5) Load the parameters for the resistors to be used on the Rs and Rx side by selecting the desired scanner channel using the "Edit Scanner Channel No." index. This is followed by clicking on “Load” and selecting the appropriate resistor file. Repeat for the other resistors to be used.

Step 6) Set the Rs and Rx Channel selection as well as the desired extender current in Ampres.

Step 7) Set the reversal rate by entering the appropriate value in seconds in the Reversal Rate box. The recommended value for resistance measurement to the specified accuracy is in most cases is 60 seconds.

Step 8) If you do not wish to let the software optimize the reversal rate, set the Auto Reversal Rate to “Fixed, with Auto Reversal Rate set to Disabled”. If you are measuring a varying resistance, you will be able to track the changes better if the Auto Reversal Rate to “Minimum, with Auto Reversal Rate set to Tracking”. If you want to use a shorter reversal rate but still maintain a given accuracy, set the Auto Reversal Rate to “Maximum, with Auto Reversal Rate set to Stabilize”. If the Auto Reversal Rate is not set to “Fixed, with Auto Reversal Rate set to Disabled”, then enter a value in the Threshold (ppm) box to determine how much deviation will cause a change in the reversal rate.

Step 9) Select the scanner channels that you wish to compare in the "Test Sequence" area, as well as entering in the excitation value for the test. Clicking on the “Delete” button will delete a test step that is not required.

Step 10) Set the Test Criteria for the number of samples to be taken and test timing. The criteria are as follows:

Sample Limit The maximum number of samples that will be recorded. A good set of samples is 150 readings.

Sample Window The size of the number of samples to be considered for the Test Criteria.

Deviation (ppm) The maximum deviation of the last windowed number of samples before the measurement will be

terminated. If the No. of Readings criteria in the “Sample Window” is reached before the Deviation criteria, the measurement is terminated. Make this value your target deviation for your measurement.

- Step 11)** You can establish time delays in the test process.
- Start Process** This is either the specific time and date, or number of seconds from now. To choose the method of entering in your startup delay, use the "in/at" control and then enter the corresponding information.
 - Between Test Delays** This is how much time, in seconds, you wish to pause between tests in your sequence.
- Step 12)** Next you will need to set the 6623A Extender Ratio. This will be either the x20, x200, or x2000 corresponding to the connections made for the C terminals of the shunt.
- Step 13)** You can describe the environment of the test facilities by clicking on the “Environment” button. This will open a Test Environment window, where you can enter the pressure, temperature and humidity of the test facilities, plus the location of the facilities and the operator’s name. This information will be logged in the test data file.
- Step 14)** Save this test configuration by clicking on the “Save” button, entering an appropriate name for the configuration file and clicking on the “Save” button in the Save Sequence File dialog box.
- Step 15)** Click on the “Start” button. The measurement will now begin, after you have assigned a directory for the measurements to be automatically saved in.
- Step 16)** You can shorten the time required to reach a stable measurement value by clicking on the "Quick" control. This control will allow you to toggle the quick mode of operation on or off. This mode is primarily used when Rx is changing (such as when calibrating decade resistance boxes). Selecting "Quick" reduces the resolution to 7 digits. This control is only available while not running an auto reversal rate function, as the auto-reversal rate optimizes this feature as well. For most tests, this should be left off.
- Step 17)** You can double the power applied to Rx by clicking on the "Power" control. This control will allow you to toggle the power between $\times 1$ and $\times 2$. This control is useful for extrapolating to zero power resistance. For most tests this should be left at $\times 1$.
- Step 18)** You may terminate the measurement at any time by clicking on the "Stop" button.
- Step 19)** You may save the displayed data file by selecting “File” on the menu bar, selecting “Save Data As”, entering an appropriate name for the configuration file and clicking on the “Save” button in the Save Data File dialog box.
- Step 20)** To process the results, open the "Test Overview" window from the "View" menu of the main window.

- Step 21)** Then within the "Test Overview" window, select "Open" from file menu and select the data file you wish to view.
- Step 22)** From here you can make data adjustments and print out the report with the options in the menu bar. Once completed, you then close the "Test Overview" and return to the main window.

3.1.3. Resistance Measurement - High Ohms Mode - $100\text{ k}\Omega \leq R_s \leq 10\text{ M}\Omega$; $R_x \leq 100\text{ M}\Omega$

The bridge in its High Ohms mode enables measurement of resistance values up to $100\text{ M}\Omega:10\text{ M}\Omega$ ($R_x:R_s$) and $100\text{ M}\Omega:1\text{ M}\Omega$ ($R_x:R_s$) for 100:1 ratios.

CAUTION:

Voltages up to 100 V DC can appear at the resistor connections during high resistance measurements.

NOTE:

In this, as in all measurements, optimum results will be obtained if the environment is controlled. The recommendations in the Instrument Society of America (ISA) publication ISA RE52.1, especially in regards to relative humidity, should be observed.

The following steps outline the general procedure for making the High Ohms measurement.

Connect the IEEE-488.2 interface connector of the bridge to an IBM-PC compatible computer running Windows™ and run the BridgeWorks software.

Step 1) Connect the resistors' leads to be measured on the four wires from your chosen scanner channels, where C_1P_1 identifies one current potential pair and C_2P_2 the other pair.

Step 2) Select the reference resistor and connect them to the four wires from your chosen scanner channels. Normally a value is chosen that will make the expected ratio for each test lie between 1 : 1 and 100 : 1 ($R_x : R_s$). This ensures the best available precision. Selection of the scanner channels is done automatically in the software when by assigning resistors to the scanner channel in the test setup window. The software can invert ratios when selected as described in section 1.8.10 for ratios less than 1 to achieve this optimum precision, if both R_x and R_s are greater than 1 ohm.

Step 3) You can change the scale being displayed by clicking on the "Units" control on the BridgeWorks main window. The default unit for resistance is "Ohms". The units available are:

Ratio	The ratio of $R_x : R_s$
Ohms	$\text{Ratio} \times R_s$
Delta (ppm)	The difference between Ratio and the nominal ratio expressed in ppm of nominal (the nominal ratio is determined from the Resistor Configuration files)

NOTE:

The displayed units do not affect the stored data. Test data is always stored in ratio.

- Step 4)** Click on the “Test” button on the BridgeWorks main window.
- xi) Click on the “Edit” button beside the “Load Rs” button.
 - xii) Enter all the pertinent information for the resistor to be used on the Rs side in the Resistor Configuration window, if this has not already been done. The following parameters can be entered:

Manufacturer/Model	used to identify resistor in test file, test overview, and history file
Asset/ID Number	used to identify resistor in test file, test overview, and history file
Serial Number	used to identify resistor in test file, test overview, and history file
R (ohms)	Value in ohms of the resistor – required for Rs, optional for Rx
I test (mA)	Test current applied when the resistor is attached to Rx during a normal ohms measurement – must be a value between 0.0005 and 150 inclusive (typically resistance measurements are made at a 10 mW power level)
I max (mA)	Maximum current that will be applied to the resistor when attached to Rs during a normal ohms measurement – must be greater than or equal to I test and less than or equal to 150
V test (V)	Test voltage applied when the resistor is attached to Rx during a high ohms measurement – must be a value between 1 and 100 inclusive (typically resistance measurements are made at a 10 mW power level)
V max (V)	Maximum voltage that will be applied to the resistor when attached to Rs during a high ohms measurement – must be greater than or equal to V test and less than or equal to 100.
Uncertainty (ppm)	Uncertainty of the resistance value in ppm of the nominal value – used to calculate the measurement uncertainty
Cal. Date	For reference only
Cal. Due	For reference only
Cal Temp (C)	For reference only
Temp. Coef. (ohm/C)	For reference only
 - xiii) Click on the “Save” button.
 - xiv) Enter an appropriate name for the configuration file and click on the “Save” button in the Save Resistor File dialog box.
 - xv) Repeat these sub-steps for the other resistors to be used on the Rs side.

- Step 5)** Load the parameters for the resistors to be used on the Rs and Rx side by selecting the desired scanner channel using the "Edit Scanner Channel No." index. This is followed by clicking on "Load" and selecting the appropriate resistor file. Repeat for the other resistors to be used.
- Step 6)** Set the Rs and Rx Channel selection as well as the desired test voltage in Volts.
- Step 7)** Set the reversal rate by entering the appropriate value in seconds in the Reversal Rate box. The recommended value for resistance measurement to specified accuracy is in most cases 90 to 120.
- Step 8)** If you do not wish to let the software optimize the reversal rate, set the Auto Reversal Rate to "Fixed, with Auto Reversal Rate set to Disabled". If you are measuring a varying resistance, you will be able to track the changes better if the Auto Reversal Rate to "Minimum, with Auto Reversal Rate set to Tracking". If you want to use a shorter reversal rate but still maintain a given accuracy, set the Auto Reversal Rate to "Maximum, with Auto Reversal Rate set to Stabilize". If the Auto Reversal Rate is not set to "Fixed, with Auto Reversal Rate set to Disabled", then enter a value in the Threshold (ppm) box to determine how much deviation will cause a change in the reversal rate.
- Step 9)** Select the scanner channels that you wish to compare in the "Test Sequence" area, as well as entering in the excitation value for the test. Clicking on the "Suggest" button will load a table with all the recommended test setups. Clicking on the "Delete" button will delete a test step that is not required.
- Step 10)** Set the Test Criteria for the number of samples to be taken and test timing. The criteria are as follows:
- | | |
|-----------------|---|
| Sample Limit | The maximum number of samples that will be recorded. A good set of samples is 150 readings. |
| Sample Window | The size of the number of samples to be considered for the Test Criteria. |
| Deviation (ppm) | The maximum deviation of the last windowed number of samples before the measurement will be terminated. If the No. of Readings criteria in the "Sample Window" is reached before the Deviation criteria, the measurement is terminated. Make this value your target deviation for your measurement. |
- Step 11)** You can establish time delays in the test process.
- | | |
|---------------------|---|
| Start Process | This is either the specific time and date, or number of seconds from now. To choose the method of entering in your startup delay, use the "in/at" control and then enter the corresponding information. |
| Between Test Delays | This is how much time, in seconds, you wish to pause between tests in your sequence. |
- Step 12)** You can describe the environment of the test facilities by clicking on the "Environment" button. This will open a Test Environment window, where you

can enter the pressure, temperature and humidity of the test facilities, plus the location of the facilities and the operator's name. This information will be logged in the test data file.

- Step 13)** Save this test configuration by clicking on the "Save" button, entering an appropriate name for the configuration file and clicking on the "Save" button in the Save Sequence File dialog box.
- Step 14)** Click on the "Start" button. The measurement will now begin, after you have assigned a directory for the measurements to be automatically saved in.
- Step 15)** You can shorten the time required to reach a stable measurement value by clicking on the "Quick" control. This control will allow you to toggle the quick mode of operation on or off. This mode is primarily used when Rx is changing (such as when calibrating decade resistance boxes). Selecting "Quick" reduces the resolution to 7 digits. This control is only available while not running an auto reversal rate function, as the auto-reversal rate optimizes this feature as well. For most tests, this should be left off.
- Step 16)** You can double the power applied to Rx by clicking on the "Power" control. This control will allow you to toggle the power between $\times 1$ and $\times 2$. This control is useful for extrapolating to zero power resistance. For most tests this should be left at $\times 1$.
- Step 17)** You may terminate the measurement at any time by clicking on the "Stop" button.
- Step 18)** You may save the displayed data file by selecting "File" on the menu bar, selecting "Save Data As", entering an appropriate name for the configuration file and clicking on the "Save" button in the Save Data File dialog box.
- Step 19)** To process the results, open the "Test Overview" window from the "View" menu of the main window.
- Step 20)** Then within the "Test Overview" window, select "Open" from file menu and select the data file you wish to view.
- Step 21)** From here you can make data adjustments and print out the report with the options in the menu bar. Once completed, you then close the "Test Overview" and return to the main window.

3.1.4. Thermometry Measurement $1 \Omega \leq R_s \leq 10 \text{ k}\Omega$

The bridge in its Thermometry mode enables measurement of resistance temperature devices such as PRT's and SPRT's of values ranging from 0.001Ω : $100 \text{ k}\Omega$. This measurement is only available in BridgeWorks-T and BridgeWorks-C.

NOTE:

In this as in all measurements, optimum results will be obtained if the environment is controlled. The recommendations in the Instrument Society of America (ISA) publication ISA RE52.1, especially in regards to relative humidity should be observed.

The following steps outline the general procedure for making a Thermometry measurement.

Connect the IEEE-488.2 interface connector of the bridge to an IBM-PC compatible computer running Windows™ and run the BridgeWorks software.

Step 1) Connect the resistance probe's leads to be measured on the four wires from your chosen scanner channels, where C_1P_1 identifies one current potential pair and C_2P_2 the other pair.

Step 2) Select the reference resistor and connect them to the four wires from your chosen scanner channels. Normally a value is chosen that will make the expected ratio for each test lie between 1 : 1 and 100 : 1 ($R_x : R_s$). This ensures the best available precision. Selection of the scanner channels is done automatically in the software when by assigning resistors/RTD's to the scanner channel in the test setup window.

Step 3) You can change the scale being displayed by clicking on the "Units" control on the BridgeWorks main window. The default unit is "Ratio". The units available are:

Ratio	The ratio of $R_x : R_s$
Ohms	Ratio $\times R_s$
Celsius	Based on either ITS-90 or ITPS-68 scales
Kelvin	Based on either ITS-90 or ITPS-68 scales
Fahrenheit	Based on either ITS-90 or ITPS-68 scales
Delta (ppm)	The difference between Ratio and the nominal ratio expressed in ppm of nominal (the nominal ratio is determined from the Resistor Configuration files)

NOTE:

The displayed units do not affect the stored data. Test data is always stored in ratio.

- Step 4)** Click on the “Test” button on the BridgeWorks main window.
- xvi) Click on the “Edit” button beside the “Load” button.
 - xvii) Enter all the pertinent information for the resistor to be used on the Rs side in the Resistor Configuration window, if this has not already been done. The following parameters can be entered:

Manufacturer/Model	used to identify resistor in test file, test overview, and history file
Asset/ID Number	used to identify resistor in test file, test overview, and history file
Serial Number	used to identify resistor in test file, test overview, and history file
R (ohms)	Value in ohms of the resistor – required for Rs, optional for Rx
I test (mA)	Test current applied when the resistor is attached to Rx during a normal ohms measurement – must be a value between 0.0005 and 150 inclusive (typically thermometry measurements are made at a 1 mA)
I max (mA)	Maximum current that will be applied to the resistor when attached to Rs during a normal ohms measurement – must be greater than or equal to I test and less than or equal to 150
V test (V)	Test voltage applied when the resistor is attached to Rx during a high ohms measurement – must be a value between 1 and 100 inclusive (this is not applicable to thermometry)
V max (V)	Maximum voltage that will be applied to the resistor when attached to Rs during a high ohms measurement – must be greater than or equal to V test and less than or equal to 100.
Uncertainty (ppm)	Uncertainty of the resistance value in ppm of the nominal value – used to calculate the measurement uncertainty
Cal. Date	For reference only
Cal. Due	For reference only
Cal Temp (C)	For reference only
Temp. Coef. (ohm/C)	For reference only
 - xviii) Click on the “Save” button.
 - xix) Enter an appropriate name for the configuration file and click on the “Save” button in the Save Resistor File dialog box.
 - xx) Load the RTD profile to be used on the Rx side.
- Step 5)** Load the parameters for the resistors/RTD’s to be used on the Rs and Rx side by selecting the desired scanner channel using the “Edit Scanner Channel No.” index.

This is followed by clicking on “Load” and selecting the appropriate resistor or probe file. Repeat for the other resistors/RTD’s to be used.

Step 6) Set the reversal rate by entering the appropriate value in seconds in the Reversal Rate box. The recommended value for thermometry measurement to specified accuracy is typically from 20 seconds.

Step 7) If you do not wish to let the software optimize the reversal rate, set the Auto Reversal Rate to “Fixed, with Auto Reversal Rate set to Disabled”. If you are measuring a moving temperature, you will be able to track the changes better if the Auto Reversal Rate to “Minimum, with Auto Reversal Rate set to Tracking”. If you want to use a shorter reversal rate but still maintain a given accuracy for a stable triple point, set the Auto Reversal Rate to “Maximum, with Auto Reversal Rate set to Stabilize”. If the Auto Reversal Rate is not set to “Fixed, with Auto Reversal Rate set to Disabled”, then enter a value in the Threshold (ppm) box to determine how much deviation will cause a change in the reversal rate.

Step 8) Select the scanner channels that you wish to compare in the “Test Sequence” area, as well as entering in the excitation value for the test. Clicking on the “Delete” button will delete a test step that is not required.

Step 9) Set the Test Criteria for the number of samples to be taken and test timing. The criteria are as follows:

No. of Samples	The maximum number of samples that will be recorded.
Deviation (ppm)	The maximum deviation of the last windowed number of samples before the measurement will be terminated. If the No. of Readings criteria in the “Sample Window” is reached before the Deviation criteria, the measurement is terminated. Make this value your target deviation for your measurement.
Start Process	This is either the specific time and date, or number of seconds from now. To choose the method of entering in your startup delay, use the “in/at” control and then enter the corresponding information.
Between Test Delays	This is how much time, in seconds, you wish to pause between tests in your sequence.

Step 10) You can describe the environment of the test facilities by clicking on the “Environment” button. This will open a Test Environment window, where you can enter the pressure, temperature and humidity of the test facilities, plus the location of the facilities and the operator’s name. This information will be logged in the test data file.

Step 11) Save this test configuration by clicking on the “Save” button, entering an appropriate name for the configuration file and clicking on the “Save” button in the Save Sequence File dialog box.

- Step 12)** Click on the “Start” button. The measurement will now begin, after you have assigned a directory for the measurements to be automatically saved in.
- Step 13)** You can shorten the time required to reach a stable measurement value by clicking on the “Quick” control. This control will allow you to toggle the quick mode of operation on or off. This mode is primarily used when Rx is changing (such as when moving into a triple point plateau). Selecting “Quick” reduces the resolution to 7 digits. This control is only available while not running an auto reversal rate function, as the auto-reversal rate optimizes this feature as well. For most tests, this should be left off.
- Step 14)** You can double the power applied to Rx by clicking on the “Power” control. This control will allow you to toggle the power between $\times 1$ and $\times 2$. This control is a quick way to help determine an RTD’s self heating. For most tests this should be left at $\times 1$.
- Step 15)** You may terminate the measurement at any time by clicking on the “Stop” button.
- Step 16)** You may save the displayed data file by selecting “File” on the menu bar, selecting “Save Data As”, entering an appropriate name for the configuration file and clicking on the “Save” button in the Save Data File dialog box.
- Step 17)** To process the results, open the “Test Overview” window from the “View” menu of the main window.
- Step 18)** Then within the “Test Overview” window, select “Open” from file menu and select the data file you wish to view.
- Step 19)** From here you can make data adjustments and print out the report with the options in the menu bar (see section 1.10 for more details). Once completed, you then close the “Test Overview” and return to the main window.

3.2. DATA STORAGE

In BridgeWorks, as in any other software, a good practice is to have a backup method. A good backup method will incorporate the storage of all important data used in the program and by the program on a reliable non-volatile media that can be removed from the system in which it is used. Supplied on the installation CD are all of your program files and necessary drivers for BridgeWorks to operate. The software, being based on a personal computer, allows for many options in backup media. The most common form being a network archive or CD-R/DVD-R. To store a file on disk, you can load the file in its associated viewer and then resave it to the network location as well as on your hard drive. You can also copy the chosen files through Windows Explorer or the command prompt as well as use CD-R/DVD-R recording/archive software.

3.3. TROUBLESHOOTING BRIDGEWORKS

In the event that your computer system is not working properly, it is also quite likely that the BridgeWorks software will not operate properly either. You must first fix the problems in the

computer and then retry using the software. The most common problems that occur in a computer system are improper configuration and viruses. If you have recently changed your computer system settings, you should review those changes to ensure that the changes are not the cause of your problem. If this has been ruled out, then be certain that someone has not tampered with the computer. In either case, using the device manager in Windows™ will help you find any conflicts in your system setup. If you have shared files on your computer with other computers, then you should also check for viruses. A virus scan and repair utility is NOT provided with the system, but if you are sharing files, you should make every attempt to control those files transferred to your computer and use a current virus scan and repair utility on your system. In the event that there was never a problem with the computer or the problem was repaired, and BridgeWorks still is not operating properly then you should try reinstalling it as directed in section 1.1 of this manual. If this still fails, then contact Guildline for technical support.

3.3.1. Error Messages

If, while using BridgeWorks, a hardware problem occurs, error messages will pop up to guide you towards a solution. This error message must be cleared by the user, except in the case of a sequence file. In this case, the message is suppressed in favor of proceeding to the next test, so that all progress is not held up for the sake of one bad test. In the event an error occurs during one of the utilities (Verification, Working Set, Transfer Standard or Decade Box), then the utility will display the error and will remain at its current position in the measurement in process. You can then, at your own discretion, correct the problem and re-invoke the measurement manually (see the DCC Bridge Technical Manual for Front Panel operation) to complete this, and the remaining tests. Remember to consider that the nominal ratios will be factored into your test at that point, and if restarted late into a measurement will have adverse effects on your results. Affects such as distorting your overall average and standard deviation of the test, plus the test not having enough time to re-stabilize can occur. Below is a list of the error messages placed into BridgeWorks and their associated number as referred to by the bridge.

If you stop the operation of BridgeWorks in the event of an error, the error will still remain in the queue in the bridge. This error will be displayed by BridgeWorks on the startup of the next test. For this reason, it is advised to allow BridgeWorks to clear the error before taking any action. Most errors are reported by BridgeWorks within a second of occurring. However, the error may not be directly reported to BridgeWorks in the event of a series of subsequent errors or if the bridge completely stops responding. In these cases, BridgeWorks will automatically query for errors if no response is received from the bridge within 4 times the reversal rate plus an additional 30 seconds. The result will be either the current error in queue or a timeout error.

Error 0: Test canceled...
 There has been a detector
 communication failure. Restart
 your bridge and retry your test. If

this problem persists please contact your local Guildline representative, or technical support.

- Error 1: Test canceled...
Invalid test setup.
Please check your settings and retry.
- Error 2: Test canceled...
The servo has railed. Check your hardware setup and also be sure the ratio is not too high. If this problem persists please contact your local Guildline representative, or technical support.
- Error 3: Test canceled...
The nanovoltmeter is not responding. Restart your bridge and retry your test. If this problem persists please contact your local Guildline representative, or technical support.
- Error 4: The null has gone out of range. Check your test settings and retry. If this problem persists please contact your local Guildline representative, or technical support.
- Error 5: Test canceled...
The maximum test ratio has been exceeded for your current test setup. Please check your settings and retry.

Error 6: Test canceled...
The EEPROM has failed, all
values will be reset to default.
Please run the "Coefficient" utility.

Error 7: Test canceled...
No serial number
specified. Enter in the
serial number in the
device file (*.RES)
and retry.

Error 8: Test canceled...
The nanovoltmeter has gone
out of range. Please check your
setting and retry. If this problem
persists please contact your
local Guildline representative,
or technical support.

Error 9: Test canceled...
The P.O.S.T. had failed. Restart
your bridge and retry your test.
If this problem persists please
contact your local Guildline
representative, or technical
support.

Error 10: Test canceled...
Invalid Passcode.
Retype the passcode
and try again.

Timeout Error: Test canceled...
The bridge has timed out.
Restart your Bridge, check the
communication cables and retry
your test. If this problem
persists please contact your
local Guildline representative,
or technical support.

This error will appear if the hardware has not responded when expected, but has no error to report or cannot report an error.

Communication Error: There has been
 a communication failure. Please
 verify that all cables are connected
 and rescan for bridge.

This error will appear if communication has been lost or hardware has not responded when initiating any test or test process. If this error appears, all functions that communicate to the bridge will be disabled as if the bridge had never been located at startup. The only way to re-enable these functions is to have successfully verified communication through the "Rescan for Bridge" function.

P.O.S.T. Errors: This error message lists all Power On Quick Check errors at the time when your bridge is first detected on the GPIB bus. If this happens, try restarting your hardware. If there continues to be errors listed, then contact your local Guildline representative.

Hardware Errors Reported: (These are described in detail in the maintenance section of the Technical Manual.)

- ROM 1 Checksum
- ROM 2 Checksum
- EEPROM Checksum
- 40V Positive Rail
- 40V Negative Rail
- Calibration
- DAC A
- DAC B
- Nanovolt Detector

3.3.2. Warnings

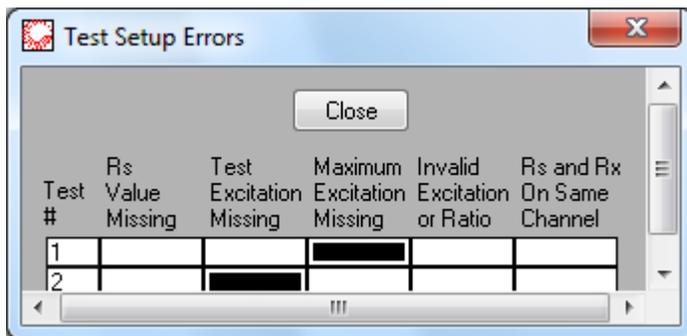
There are several warning messages you will encounter while you are using BridgeWorks. These warnings are placed in the software as a preventative measure against unintentional data loss or to notify you about a hardware configuration detail that needs to be addressed. This warning message must be cleared by the user.

"Replace <path and filename>?"

This warning will appear whenever you attempt to save data information to a name that already exists in that directory. This message is a precautionary step that helps prevent accidental overwrites, but allows for intentional overwrites.

"You may not select an existing file."

This warning will only show up in the File Manager when you highlight a file and click on the "Open" button. What is meant by this error is that you are not to select a particular file with this file dialog box. Instead, you are to find the directory that contains the desired files and click on "Select Cur Dir".



"Rs value is missing."

This warning will come up if you attempt to start a test sequence without an Rs loaded. This is a preventative measure to reduce the number of failed tests.

"Maximum excitation is missing."

This warning will come up if you attempt to start a test sequence without an I max loaded. This is a preventative measure to reduce the number of failed tests.

"Test excitation is missing."

This warning will come up if you attempt to start a test sequence without an I test loaded. This is a preventative measure to reduce the number of failed.

"Invalid excitation or ratio."

This warning will come up if you attempt to start a test sequence while the condition:

$$I \text{ test } \times R_x/R_s > I \text{ max}$$

is true. This is a preventative measure to reduce the number of failed tests.

This calibration utility is specifically intended for use with a an ESI SR1010 type Transfer Standard and a Guildline

scanner. The Rs must be connected to line A, and the Rx connected to the SR1010 type adapter connected to the scanner using line B."

This warning shows up at the launch of the Transfer Standard Utility. It is to serve as a reminder that the utility is written for specific hardware, which you must have connected in order to use that utility properly.

"The decade box utility will measure up to 7 decade ranges in sequence and remove the zero error. The first step to take is to measure the 0 ohms value of your decade box. Set all dials to zero and ensure that the values and system configuration are what you intend to use. Also ensure that the setup is properly displayed in this window. When this is done click on the "Go" button to initiate the 0 ohms test or "Start" if you are measuring a direct reading decade box"

This warning shows up at the launch of the Decade Box Utility. It is to serve as a reminder that the utility is written for specific hardware, which you must have connected in order to use that utility properly, as well as direct you to the first step to take.

"Your first step is to establish the 0 ohms value of your decade box. This is done by setting all dials to zero and clicking on the "Go" button to initiate the 0 ohms test. If your decade box is of the direct reading type then you should skip the zero ohms test. Do you wish to skip the zero ohms test?"

This warning will appear if you initiate a decade box test without getting a zero ohms reading. You will have the option to return to the decade box window and take the zero ohms reading, or to skip this test for direct reading decade boxes.

3.3.3. Passcode Removal

In the event that you have forgotten or lost the BridgeWorks "Administrative Options" passcode. You can return to the installation default of no passcode and no file protect by opening up a Command Prompt window and typing:

```
"del C:\Program Files\BridgeWorks\bridgecmd.sys"
```

Or, the file can be removed by locating with "Windows Explorer" or "Find Files", highlighting the file and then pressing the "Delete" key.

This file is created by BridgeWorks after using the "Administrative Options" and by deleting it you will return to the BridgeWorks installation default.

3.4. KEY NAVIGATION

Throughout the BridgeWorks software, you can use "hotkeys" to navigate through the various options. These keys allow for use without a mouse, and as a quick shortcut to window and menu items. The most important keys are the "Alt" key to highlight the menu which can then be navigated using the arrow keys, or by selecting the underlined letter of the available options. As well, you can use the "Tab" key to cycle through the windows various controls and fields. Holding the "Shift" key while "Tabbing" through the controls/fields will let you cycle in the opposite direction. To use the selected control you can press the space bar for activating buttons or switches, and arrow keys for cycling through multi-selection dials. Fields can be typed into with the desired information, and tabbed out of when done. In the windows that contain an "OK" or "Cancel" button, the "Enter" key can be used to activate the "OK" button and the "Esc" key can be used to activate the "Cancel" button at any time.

Some of the more common menu functions have a direct hotkey linked to them, allowing you to access them without having to access the menu first. These keys are always the "Ctrl" key held in conjunction with a letter key. Below is a list of the various direct hotkey links and the windows in which they are used.

<i>Ctrl + S (Save data as...)</i>	This hotkey is used only in the main window. This will save the current test to a chosen test file.
<i>Ctrl + S (Save)</i>	This hotkey is used only in the test overview window. This will save the displayed/modified test file to a chosen name.
<i>Ctrl + P (Print)</i>	This hotkey is used in the main, test overview, and history chart window. This will print the active window from which it is launched.
<i>Ctrl + Q (Quit)</i>	This hotkey is used only in the main window. This will quit the program.
<i>Ctrl + H (Help)</i>	This hotkey is used only in the main window and will load up BridgeWorks help file.
<i>Ctrl + O (Open)</i>	This hotkey is used in the test overview window and will open the test file of your choice to be viewed.
<i>Ctrl + W (Close Window)</i>	This hotkey is used in the test overview and the history chart window and will close that window.

<i>Ctrl + E (Editor)</i>	This hotkey is used in the history chart window and will open the file editor so you can create or edit a history file.
<i>Ctrl + D (Display)</i>	This hotkey is used in the history chart window and will open the history file of your choice to be displayed.

3.5. USING BRIDGEWORKS DEMO PROGRAM

3.5.1. On Other Computers

With the BridgeWorks Demo program, you can set up other computers for "off-line" training, keeping the actual system reserved for official measurement use. Installing the demo on other computers also creates separate workstations for data processing, including printing. These workstations can be made part of a network with the actual system computer to make the access to the stored data even simpler, as BridgeWorks, along with the demo, supports network file functions within Windows.

3.5.2. On the System Computer

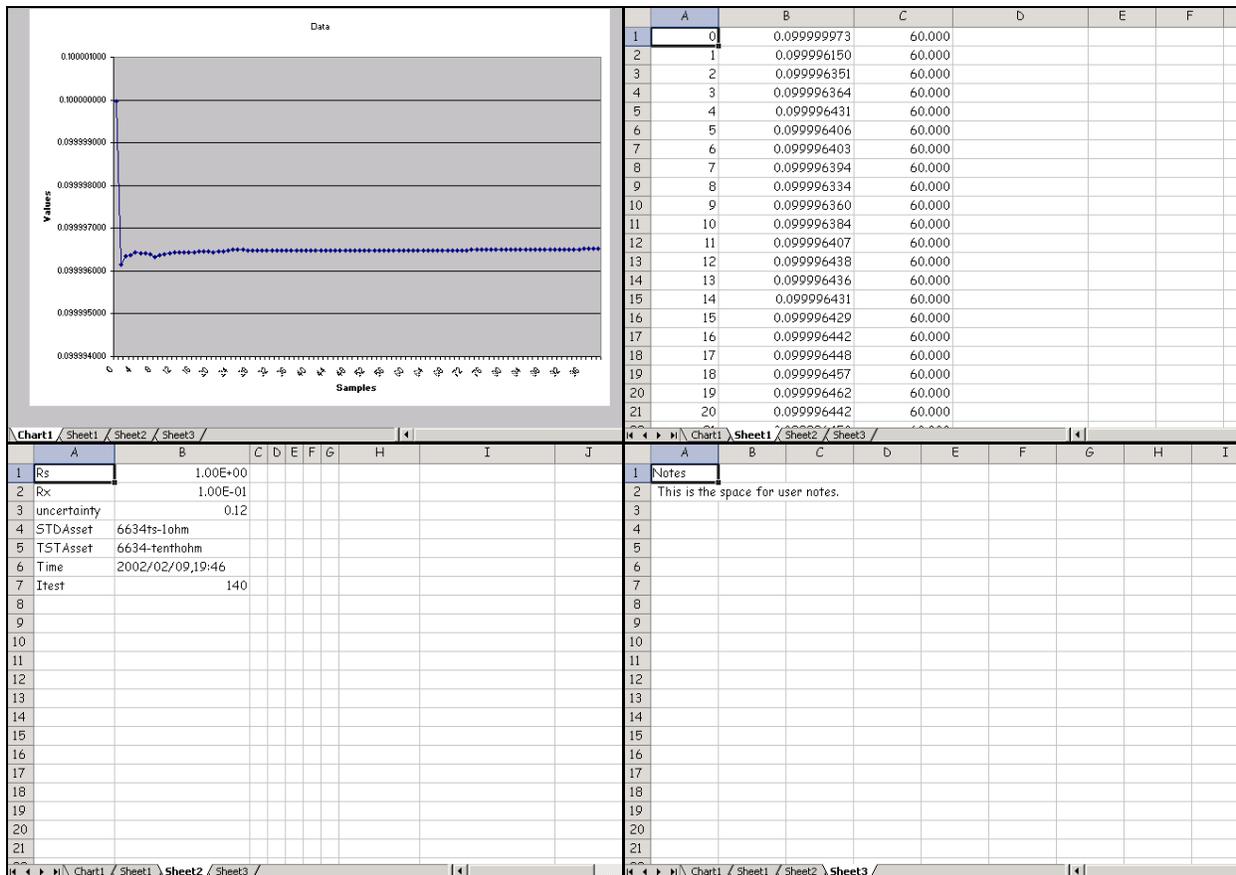
The demo version also can be run simultaneously to the full version in the system computer to allow you to manage or process files while you wait for measurements to complete. This makes the system computer equivalent to the earlier mentioned data workstations. Being a completely separate program and process allows access to all data management and configuration windows, regardless if the system running the full version BridgeWorks is in a state that does not. With the demo version, you can take preliminary looks at the completed tests in longer processes such as the verification test and the working set calibration while they are still in operation. You can also debug test setups to see if they will run as expected even while an actual test is being run in the standard BridgeWorks.

3.6. EXPORTING DATA

Data can be exported to Microsoft™ Excel to apply your own custom mathematics or to webpage format for publishing. You can export test or history data to both Excel and a webpage through the Test Overview and History Chart windows. Knowing the format by which the data is exported will make it easier to navigate the contents of the exported file.

3.6.1. Exporting to Excel

The example given below is an Excel export from the Test Overview (*.TST) window. The basic layout is spread across 4 worksheets. The first worksheet contains a graph of the exported ratio data. The second worksheet is the raw ratio data and reversal rate information from the test file. The third worksheet contains all the test variable information such as the test excitation reference resistor value and uncertainty. The last worksheet contains all of the user notes.

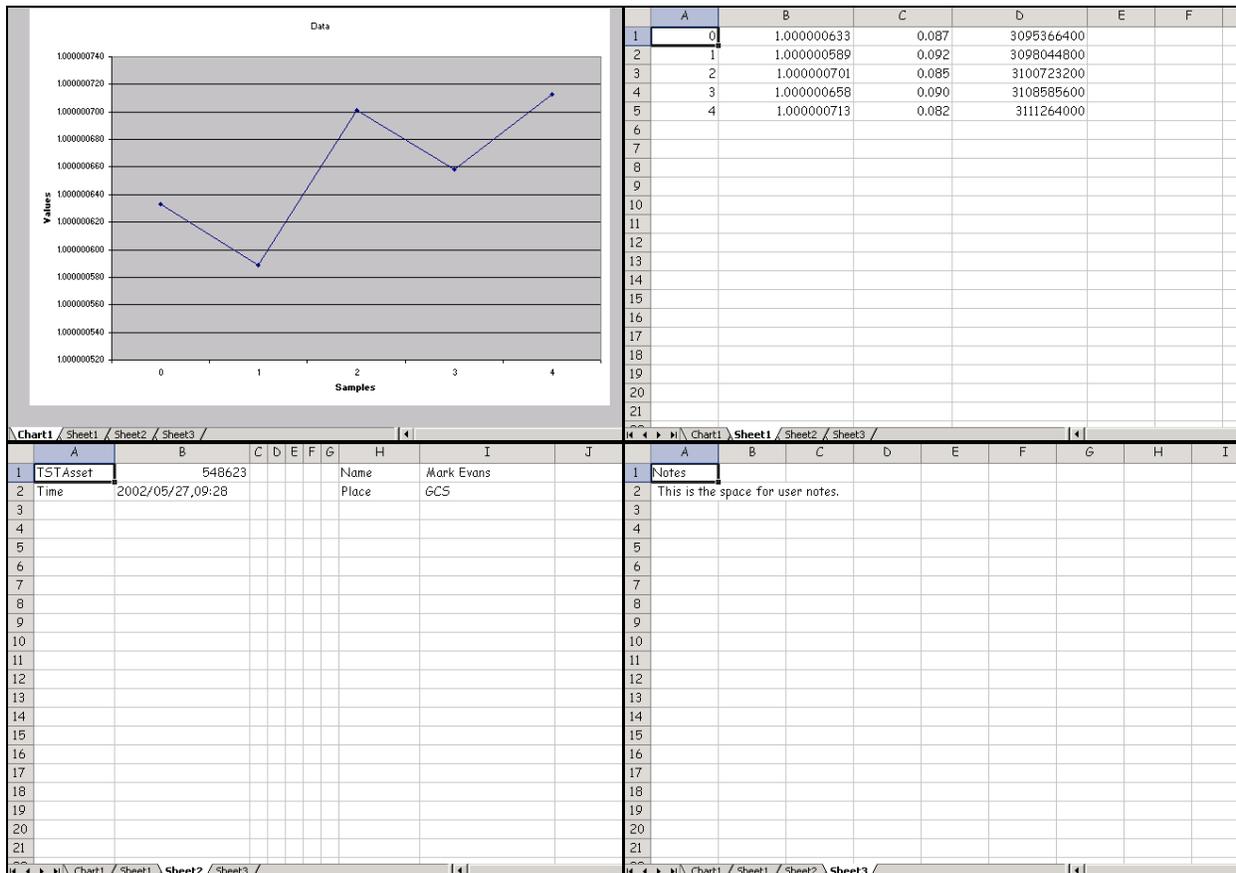


Note:

The Rs title is always applied to the reference resistor in the saved data. In an inverted ratio test, the measurement is actually conducted with the reference on

the Rx side. However, the reciprocals of the inverted tests are stored with the reference moved over to the Rs field, so that it is treated the same as a direct ratio measurement. This process occurs at the time that the test is executed so that all test data is stored the same.

The next example given below is an Excel export from the History Chart (*.HIS) window. The basic layout is also spread across 4 worksheets. The first worksheet contains a graph of the exported history point data. The second worksheet is the history point data with date/time and uncertainty information from the file. The third worksheet contains all the history control information such as the date stamp and asset/ID information. The last worksheet contains all of the user notes.

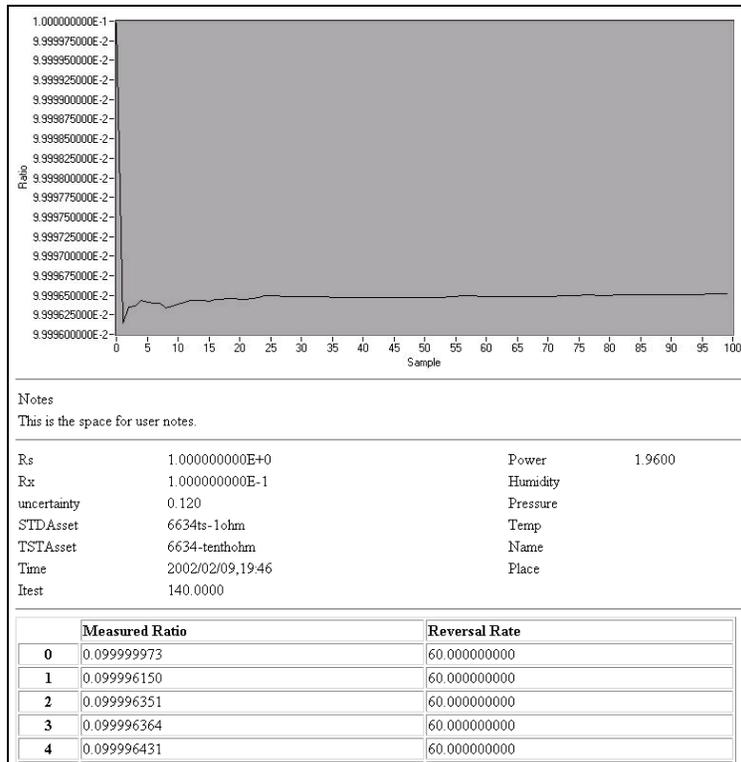


Note:

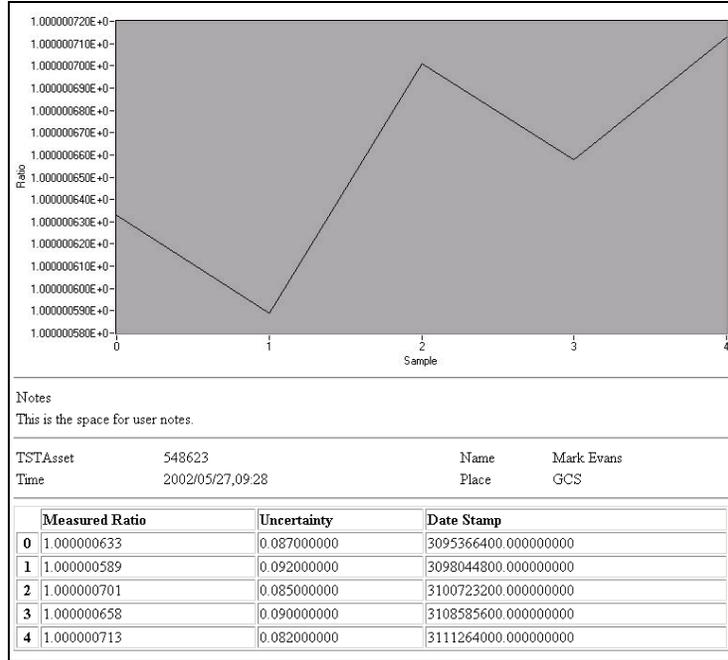
The date in the Column D is recorded as a time-zone-independent number of seconds that have elapsed since 12:00 a.m., January 1, 1904, Universal Time. This differs from Microsoft™ Excel's reference date of 12:00 a.m., January 1, 1900, Universal Time.

3.6.2. Exporting Webpage

Both reports can be exported to a webpage to be published online or used as a generic data exchange format. These reports contain all data, graphs and variables stored in the history or test file. You will be prompted to make a name for the webpage created. All necessary graphics and data webpage source will be placed into a directory with the name you have chosen. Both Test Overview (top) and History Chart (next page) webpage examples are shown below.



Test Overview Web Export



History Chart Web Export

Note:

The date in the Date Stamp column is recorded as a time-zone-independent number of seconds that have elapsed since 12:00 a.m., January 1, 1904, Universal Time. This differs from Microsoft™ Excel's reference date of 12:00 a.m., January 1, 1900, Universal Time.

4. APPENDIX

4.1. SUMMARY OF RECOMMENDED TEST SETUPS

NOTE: The first 115 measurement samples should be discarded, to allow for sufficient stabilization time to achieve the specified uncertainty.

a) Normal mode

Ref. (Ω)	U.U.T. (Ω)	I _{test} (mAmps)	I _{max} (mAmps)	Reversal Rate (sec)	Comment (1)
1	0.1	150	150	60	Output current limited to 150 mAmps
1	1	100	150	20	
1	10	10	150	20	
1	100	1	150	60	
10	1	100	100	20	
10	10	31.6	31.6	20	
10	100	3.16	31.6	20	
10	1 k	0.316	31.6	60	
100	10	31.6	31.6	20	
100	100	10	10	20	
100	1 k	1	10	40	
100	10 k	0.1	10	90	
1 k	100	10	10	40	
1 k	1 k	3.16	3.16	40	
1 k	10 k	0.316	3.16	60	
1 k	100 k	0.032	3.2	90	
10 k	1 k	3.16	3.16	60	
10 k	10 k	1	1	60	
10 k	100 k	0.1	1	90	

Table 4-1 : Recommended Normal Mode Test Setup

b) High Ohms mode 100V bridges.

Ref. (Ω)	U.U.T. (Ω)	V _{test} (V)	V _{max} (V)	Reversal Rate (sec)	Comment (1)
10 k	1 M	10	32	90	
1 M	1 M	100	100	90	Output limit of voltage source
1 M	10 M	100	100	120	Output limit of voltage source
1 M	100 M	100	100	120	Output limit of voltage source
10 M	10 M	100	100	120	Output limit of voltage source
10 M	100 M	100	100	120	Output limit of voltage source

Table 4-2 : Recommended 100V High Ohms Mode Test Setup

c) High Ohms mode 1000V bridge.

Ref. (Ω)	U.U.T. (Ω)	V _{test} (V)	V _{max} (V)	Reversal Rate (sec)	Comment (1)
10 k	1 M	10	32	90	
1 M	1 M	100	100	90	
1 M	10 M	100	100	120	
1 M	100 M	100	320	120	
100 M	100 M	1000	1000	120	
100 M	1 G	1000	1000	150	

Table 4-3 : Recommended 1000V High Ohms Mode Test Setup

- d) Low Ohms mode, Current Range Extender measurements. These measurements have been standardized at maximum current in the current shunt, as limited by the current or the Rs current limit. Note that the measurement made in Low Ohms mode should be made such that the following condition is maintained:

Ref. (Ω)	U.U.T. (Ω)	I _{test} (A)	Rs Current (mA)	Extender Ratio/Range	Reversal Rate (sec)	Comment (1)
1	0.01	3	30	20:1 / 3A	60	Limit of x 20, 3A Range
1	0.05	2	100	20:1 / 3A	60	Limit of 10 mW in Rs
1	0.1	1	100	20:1 / 3A	60	Limit of 10 mW in Rs
10	0.1	3	30	20:1 / 3A	60	Limit of x 20, 3A Range
100	0.5	3	15	20:1 / 3A	60	Limit of x 20, 3A Range
1000	10	0.8	8	20:1 / 3A	60	Limit of Voltage Compliance
1	0.001	15	15	200:1 / 15A	60	Limit of x 200/15A Range
1	0.005	15	75	200:1 / 15A	60	Limit of x 200/15A Range
1	0.01	10	100	200:1 / 15A	60	Limit of 10 mW in Rs
10	0.01	15	15	200:1 / 15A	60	Limit of x 200/15A Range
10	0.05	6.32	31.6	200:1 / 15A	60	Limit of 10 mW in Rs
100	0.1	10	10	200:1 / 15A	60	Limit of 10 mW in Rs
1	1u	300	0.3	2000:1 / 300A	60	Limit of x2000/300A Range
1	10u	300	3	2000:1 / 300A	60	Limit of x2000/300A Range
1	50u	300	15	2000:1 / 300A	60	Limit of x2000/300A Range
1	100u	300	30	2000:1 / 300A	60	Limit of x2000/300A Range
1	0.0005	200	100	2000:1 / 300A	60	Limit of 10 mW in Rs
10	0.0005	300	15	2000:1 / 300A	60	Limit of x2000/300A Range
10	0.001	300	30	2000:1 / 300A	60	Limit of x2000/300A Range

Table 4-4 : Recommended Low Ohms Mode Test Setup (6623A-300)

- e) Temperature mode measurements have been standardized at 1mA current in the RTD. Note that the measurement made in temperature mode should be made such that the following condition is maintained: (BridgeWorks-T and BridgeWorks-C only)

Ref. (Ω)	P.R.T. (Ω)	I _{test} (mAmps)	I _{max} (mAmps)	Reversal Rate (sec)	Comment Update 4 / Quick Measure
1	25	1	100	20	These recommendations are based on being at the triple point of water. The actual resistance of the RTD will change dramatically as a function of temperature.
1	100	1	100	20	
10	25	1	31.6	20	
10	100	1	31.6	20	
100	100	1	10	20	

Table 4-5 : Recommended Temperature Mode Test Setup

4.2. FORMULAS

4.2.1. Standard Deviation

The Standard deviation is computed using the following formula:

$$\sigma_x = \sqrt{\frac{1}{n} \sum_{i=0}^{n-1} (x_i - \mu)^2} ,$$

Where $\mu = \frac{1}{n} \sum_{i=0}^{n-1} x_i$, and n is the number of elements in X.

4.2.2. Uncertainty

The direct addition uncertainty is computed using the following formula:

$$U = 2\sigma_x + \sum_{i=0}^{n-1} x_i ,$$

Where X_i are known uncertainties.

These uncertainties include:

Uncertainty of the standard resistor (applicable for ohms measurements only).

Uncertainty of the bridge (applicable for ohms measurements only).

The sum of squares uncertainty is computed using the following formula:

$$U = \sqrt{(2\sigma_x)^2 + \sum_{i=0}^{n-1} (x_i)^2} ,$$

Where X_i are known uncertainties.

These uncertainties include:

Uncertainty of the standard resistor (applicable for ohms measurements only).

Uncertainty of the bridge (applicable for ohms measurements only).

4.2.3. Interchange Error

The interchange error is computed using the following formula:

$$E_i = |R_N \times R_I - 1| \div 2 ,$$

Where R_N is the normal measurement ratio and R_I is the interchange measurement ratio

4.2.4. Closure Error

The closure error is computed using the following formula:

$$E_i = |R_a - R_b \times R_c| \div (3 \times R_N) ,$$

Where:

R_a is the measurement ratio of resistors r_3/r_1 .

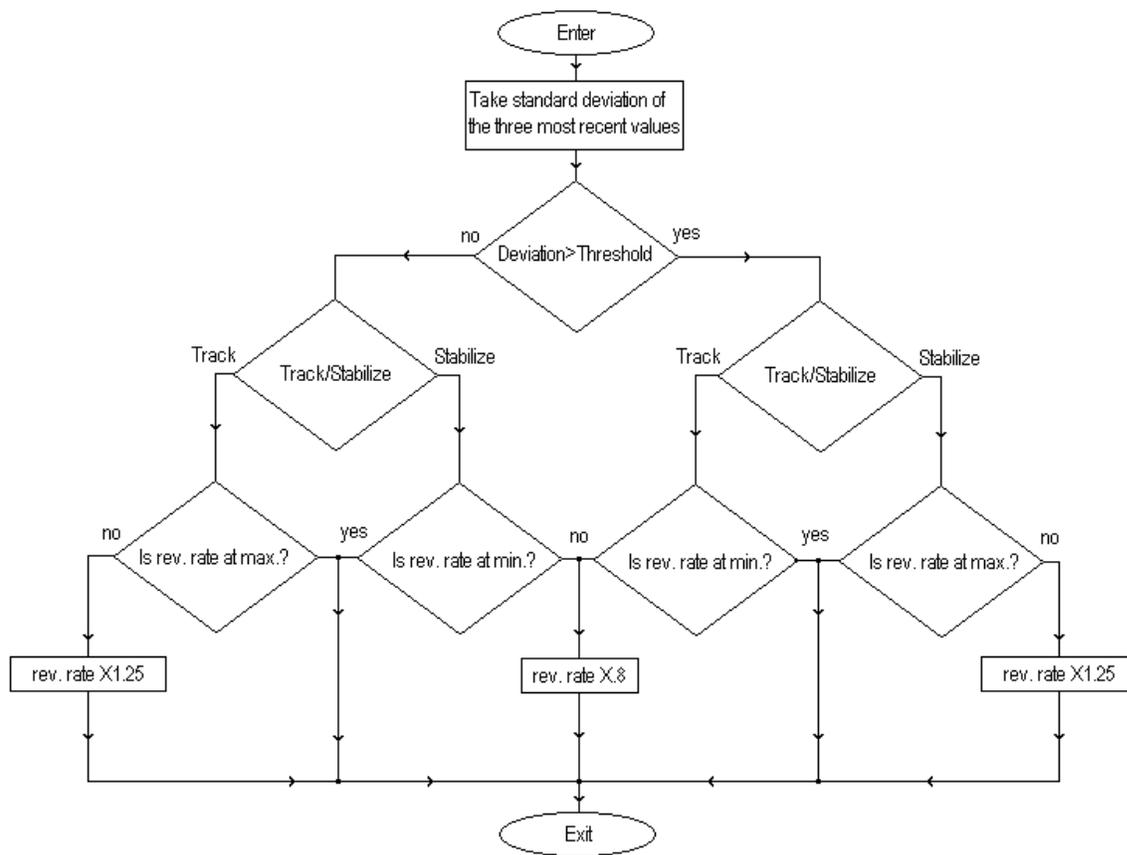
R_b is the measurement ratio of resistors r_2/r_1 .

R_c is the measurement ratio of resistors r_3/r_2 .

R_N is the nominal ratio for R_a .

4.3. AUTO REVERSAL RATE

The flow chart below describes the process by which the auto reversal rate varies the reversal rate in each operation mode. The “Stabilize” mode is designed to help achieve the fastest reversal rate without compromising a predefined measurement quality. The “Track” mode is designed to maintain fast reversal rates for tracking moving values such as temperature change and slowing down to achieve full rated accuracy at stable points such as a triple point.



5. GLOSSARY

ASCII - "American Standard Code for Information Interchange" is a pre-determined standard for text. This is the format in which all of the information stored and used by BridgeWorks.

Auto-Scaling - This is a feature of some graphs in a LabVIEWTM based program. When enabled, that graph will set the scale of the axis(s) of your choice to adjust itself to give the most magnification but still maintain that all the points are showing.

Best Fit Curve - The best fit curve is defined as the curve on a graph that best represents the points plotted. This line does not usually go through all the points. The purpose of the best fit curve is to see the trend of the plot without the random peaks. In BridgeWorks, a linear best fit for all best fit curve analysis is used.

Calibration - This is the act of taking a comparison of a given device to a known reference point with the intent to make the unknown device known, traceable to the reference.

Checksum - This is a numeric value that is reached when a mathematical algorithm is applied to the memory. This value is stored and used to verify the integrity of the information in the memory chips.

Closure - Closure is what is meant by verifying your calibration through taking another measurement to trace back to a second Standard Resistor or via an interchange.

Control - There are many types of controls, with different appearances and functions. The one thing that is common, and is their defining factor, is that they are how the user of any program inputs their commands.

Crop - To crop is to select a section of data that you wish to keep and then remove the rest.

EEPROM - Electronically Erasable Programmable Read Only Memory is a non-volatile memory that is used to store data inside the DCC Bridge. This memory can be erased or changed within the system but will retain its contents when the power is off.

EPROM - Erasable Programmable Read Only Memory is a non-volatile memory that is used to store the programming inside the DCC Bridge. This memory cannot be erased or changed within the system and retains its contents when the power is off.

Field - This is a type of control in which you are to enter a text or numeric value directly.

High Ohms - This is a mode in which your bridge is applying a constant voltage source, internal to the bridge portion, to the unknown resistor for high value resistor measurements

Highlight - This is the action of selecting in WindowsTM. When you have selected a control or a section of text, Windows will outline the selection. This outline "highlights" your current selection to show that Windows will direct your commands/entry to that specific part of the active window.

Hotkey - This is a keystroke or key combination that, when pressed, has a predetermined function. Some of these will vary in different programs and windows, while others are universal throughout WindowsTM. A complete listing of valid hotkeys is listed in the Key Navigation section of User Notes (3.5).

IEEE 488.2 - This is a standardized interface for communication over a GPIB bus. This is both a hardware and command level standard that BridgeWorks and your DCC Bridge adheres to. See DCC Bridge Technical Manual for more information.

Indicator - There are many types of indicators, with different appearances and functions. The one thing that is common, and is their defining factor, is that they are how the any program displays information to the user and cannot be modified.

Interchange - A resistance verification measurement where you measure two resistors, then reverse their configuration and measure them again to see if you get the original ratio's reciprocal.

Inverted Ratio - A method allowing the measurement of ratios that are less than 1:1 to use the more accurate 1:1 to 100:1 range. This is an automated process by which BridgeWorks measures a resistor on the Rs input with respect to the Rx input resistor and use the measured ratio's reciprocal.

Imax - This is the maximum current you wish to allow through a given resistor. This is set as a safety precaution for your resistor connected to the Rs side of the bridge.

Itest - This is test current used for the Rx side of the bridge, and should be selected so that it is less than Imax times the ratio of Rs over Rx.

Load - This is the action of selecting and opening a file into active memory for use within a program.

Low Ohms - This is a mode in which your bridge is using an external current range extender to increase the measurement current for low value resistor measurements.

Menubar - The menubar contains an organized list of pertinent commands and is located at the top of the window. This can be accessed with the "Alt" key or your pointing device.

Normal - This is a mode in which your bridge is applying a constant current source, internal to the bridge portion, to the unknown resistor for resistor measurements.

Null - The bridge balances a torroid through turns switching to obtain the resistor ratio. Null is a balance condition. See the DCC Bridge Technical Manual for more information.

P.O.S.T - Power On Self Test

Ref. - (Reference) Resistor. This is an abbreviation that means the resistance standard that you are referencing your resistor under test to.

Reversal Rate - This is the rate in which the bridge reverses the current while in the measurement cycle. See the DCC Bridge Technical Manual for more information.

Save - This is the action of copying a file out of active memory to a non-volatile storage media for later recall within a program.

SR1010 - The SR1010 is an ESI Corporation™ model number for their Resistance Transfer Standard. They are more complex than a typical 4-wire resistor, being made up of multiple resistors and having more than one configuration.

Standard Deviation - The Standard Deviation is a calculated value that expresses how much the points within a set deviate from the mean of that set. The formula in which this is calculated can be found in section 4.2.

Uncertainty - Uncertainty is a calculated value that expresses how confident the mean value from a set of recorded values is the actual value. This takes into consideration the known

uncertainties of the system and the standard deviation of the sample set. The formula in which this is calculated can be found in section 4.2.

U.U.T. - *(Unit Under Test). This is an abbreviation that means the resistance that you are testing.*

V_{max} - *This is the maximum voltage you wish to allow through a given resistor. This is set as a safety precaution for your resistor connected to the R_s side of the bridge.*

V_{test} - *This is test voltage used for the R_x side of the bridge, and should be selected so that it is less than V_{max} times the ratio of R_s over R_x.*

6. INDEX

"

"*.HIS", 1-42

"*.RES", 1-11

"*.SEQ", 1-11

"*.TST", 1-38, 1-48

*

*.PRB, 1-11

6

6623-2A, 3-6

6664A, 3-23

A

Alt, 3-25

ASCII, 5-1

Auto Reversal Rate, 1-26, 1-28

Auto scaling, 1-8

Auto-Scaling, 5-1

B

backup, 3-18

Best Fit Curve, 5-1

BridgeWorks, 1-1

C

Calibration, 5-1

Checksum, 5-1

Closure, 5-1

CONFIGURATION, 1-3, 1-26

Control, 5-1

Controls, 1-6

crop, 1-40

Crop, 5-1

Ctrl, 3-25

Ctrl + E, 3-26

Ctrl + P, 3-25

Ctrl + Q, 3-25

Ctrl + W, 3-25

Ctrl+E, 1-45, 1-46

Ctrl+O, 1-38

Ctrl+P, 1-11, 1-37, 1-44, 1-45

Ctrl+Q, 1-11

Ctrl+S, 1-10, 1-32, 1-36, 1-37, 1-38, 1-43, 1-44

D

data, 1-1, 1-2, 1-6, 1-8, 1-9, 1-10, 1-12, 1-13, 1-14, 1-32,
1-33, 1-34, 1-36, 1-39, 1-40, 1-42, 1-44, 1-45, 2-
1, 3-2, 3-4, 3-5, 3-7, 3-9, 3-11, 3-14, 3-15, 3-
17, 3-18, 3-22, 3-25

Decade Box, 1-12, 2-24, 3-24

Decade Transfer Standard, 2-34

delay, 1-29

E

EEPROM, 5-1

Environment, 1-12

Environmental, 1-21, 1-29, 1-30, 1-47, 2-43, 2-46

EPROM, 5-1

Error, 3-19, 3-20, 3-21, 3-22

F

Field, 5-1

Fields, 1-7

format, 1-8, 1-33, 1-34

G

graph, 1-8

H

Help, 1-14, 1-15, 3-25

High Ohms, 3-11, 4-2, 5-1

Highlight, 5-1

Hotkey, 5-1

hotkeys, 3-25

I

IEEE 488.2, 5-2

I_{max}, 1-21, 5-2

Indicator, 5-2

Indicators, 1-6

Installation, 1-3, 1-4

Interchange, 5-2

I_{test}, 1-21, 5-2

ITS-90 Cal, 1-12

K

key navigation, 1-2

L

Load, 5-2

Low Ohms, 3-6, 4-3, 4-4, 5-2

M

menu bar, 1-7

Menubar, 5-2

Mode, 1-10, 1-35, 1-36, 1-42, 1-43

N

No. of Samples, 1-29

Normal, 3-2, 4-1, 5-2

Null, 5-2

O

Open, 1-22, 1-30, 1-38, 1-48, 2-4, 2-15, 2-28, 3-23, 3-25

options, 1-1, 1-7, 1-11, 1-16, 1-17, 2-1, 3-18, 3-25

P

passcode, 1-11, 1-16, 1-17

Power, 1-9

Q

Quick, 1-9

R

range, 1-10, 1-12, 3-2, 3-20, 3-21

recommended setup, 1-1

Reversal Rate, 5-2, 5-3

routines, 1-1, 2-1

S

Sample Window, 1-29

Save, 1-10, 1-22, 1-30, 1-32, 1-36, 1-38, 1-43, 1-48, 3-3,
3-5, 3-8, 3-9, 3-12, 3-14, 3-16, 3-17, 3-18, 3-25,
5-2

Section 1, 1-1

Section 2, 1-1

Section 3, 1-1

Section 4, 1-2

Self Test, 1-14

Shift, 3-25

SR1010, 3-23, 3-24, 5-2

Standard deviation, 4-5

Standard Deviation, 5-2

Start, 1-26

Stop, 1-9, 3-5, 3-9, 3-14, 3-18

System Requirements, 1-3

T

Tabbing, 3-25

Test, 1-9, 1-20, 1-21

Threshold, 1-28

Transfer Standard, 1-12

U

Uncertainty, 1-21, 3-3, 3-8, 3-12, 3-16, 4-5, 5-2

Units, 1-9, 1-16, 1-17, 1-18, 1-19, 1-20

update, 1-44

Update, 1-47

utility, 2-10, 2-17, 2-19, 2-21

V

Verification, 1-12, 1-13

Vmax, 1-21, 5-3

Vtest, 1-21, 5-3

ESI and ESI Corporation are trademarks of ESI Corporation.

LabVIEW and National Instruments are trademarks of National Instruments Corporation.

Pentium is a trademark of Intel Corporation.

Windows and Microsoft are trademarks of Microsoft Corporation.