



Operators Manual

For The

Model 6622A Series T-Option

Automatic DCC Resistance/Thermometry Bridge

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TABLE OF CONTENTS

1. INTRODUCTION	1-1
1.1. SCOPE.....	1-1
1.2. GENERAL DESCRIPTION.....	1-1
2. PERFORMANCE SPECIFICATIONS	2-1
2.1. 6622A SERIES T-OPTION TEMPERATURE MEASUREMENT SPECIFICATION	2-1
3. OPERATING INSTRUCTIONS	3-1
3.1. FRONT PANEL OPERATING PROCEDURE	3-1
3.2. 6622A SERIES T-OPTION RESISTANCE/THERMOMETRY MEASUREMENT BRIDGE	3-1
3.3. TITLE SCREEN	3-5
3.4. MAIN MENU.....	3-5
3.4.1. <Measure> MENU Fn-1 (Main).....	3-5
3.4.1.1. <Measure> MENU Fn-1 (MAIN) Page 1 of 3	3-6
3.4.1.2. <Measure> MENU Fn-1 (MAIN) Page 2 of 3	3-6
3.4.1.3. <Measure> MENU Fn-1 (MAIN) Page 3 of 3	3-6
3.4.2. <Setup> MENU Fn-1 (Setup_MAIN).....	3-7
3.4.3. <Profiles> MENU Fn-1 (Profiles MAIN)	3-7
3.4.4. <Edit> MENU (Probe) Fn-2 (Edit MAIN).....	3-7
3.4.4.1. <IPTS 68> MENU Fn-1 (Edit MAIN)	3-8
3.4.4.2. <ITS 90> MENU Fn-2 (Edit MAIN)	3-9
3.4.4.3. <IEC 751> MENU Fn-3 (Edit MAIN).....	3-11
3.4.4.4. <Probe Set> MENU Fn-4 (Edit MAIN).....	3-11
3.5. MEASUREMENT OPERATION GUIDE	3-13
3.5.1. Thermometry Measurement Mode	3-13
3.6. BRIDGEWORKS-C DATA ACQUISITION SOFTWARE	3-15
4. MAINTENANCE	4-1
4.1. INTRODUCTION.....	4-1
4.2. TEMPERATURE RATIO VERIFICATION	4-1
4.2.1. PURPOSE.....	4-1
4.2.2. EQUIPMENT REQUIRED	4-1
4.3. MODEL 6622A BRIDGE WITH T-OPTION.....	4-2
4.3.1. Set Up	4-2
4.3.2. Inputs-Outputs Verification	4-2

LIST OF FIGURES

FIGURE 3-1: MENU TREE – MEASURE/SOFCAL 3-2
FIGURE 3-2 : MENU TREE – SETUP (RESISTOR) 3-3
FIGURE 3-3 : MENU TREE – SETUP (PROBE) 3-4
FIGURE 3-4 : REAR PANEL CONNECTIONS – PRT/SPRT..... 3-14

LIST OF TABLES

TABLE 3-1 : RECOMMENDED TEMPERATURE MEASUREMENT TEST SETUP 3-13

1. INTRODUCTION

1.1. SCOPE

This document describes the operation additional temperature functionality provided by the T-Option in the 6622A Series of Automatic DCC Resistance Bridge.

1.2. GENERAL DESCRIPTION

The model 6622A Series T-Option is and software and embedded software upgrade to your 6622A Series bridge. This upgrade includes functions and features that optimize primary temperature measurement, and calibration using your 6622A. These functions primarily include measurement operation at higher speed and temperature conversion. The installation of the T-Option does not change to resistance operation of the 6622A.

2. PERFORMANCE SPECIFICATIONS

2.1. 6622A SERIES T-OPTION TEMPERATURE MEASUREMENT SPECIFICATION

Measurement Specifications (12 Month)		6622A & 6622A-XR		6622A-XP & 6622A-XPR	
		6622A-HV			
Total Measurement Range: 0.001Ω ⇔ 100Ω					
R _s	0.08 Ω > R _x < 0.8 Ω	0.8 Ω > R _x < 6.3 Ω	6.3 Ω > R _x < 13.4 Ω	13.4 Ω > R _x < 107.5 Ω	24 Hour Range Stability
	± 1.2 μΩ/Ω	± 0.2 μΩ/Ω	± 0.2 μΩ/Ω	± 0.2 μΩ/Ω	< ± 0.06 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	< ± 0.04 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	< ± 0.04 μΩ/Ω
1 Ω	0.8m Ω > R _x < 0.008 Ω	0.008 Ω > R _x < 0.08 Ω	For Below Rows Only		
	± 100 μΩ/Ω	± 10 μΩ/Ω	< Specifications for 6622A & 6622A-XR		
	± 50 μΩ/Ω	± 5 μΩ/Ω	< Specifications for 6622A-XP & 6622A-XPR		
	± 50 μΩ/Ω	± 5 μΩ/Ω	< Specifications for 6622A-HV		
Total Measurement Range: 1Ω ⇔ 1kΩ					
R _s	1 Ω > R _x < 8 Ω	8 Ω > R _x < 63 Ω	63 Ω > R _x < 134 Ω	134 Ω > R _x < 1075 Ω	24 Hour Range Stability
	± 1.2 μΩ/Ω	± 0.2 μΩ/Ω	± 0.2 μΩ/Ω	± 0.2 μΩ/Ω	< ± 0.06 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	< ± 0.04 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	< ± 0.04 μΩ/Ω
Total Measurement Range: 10Ω ⇔ 10kΩ					
R _s	10 Ω > R _x < 80 Ω	80 Ω > R _x < 630 Ω	630 Ω > R _x < 1340 Ω	1.34 kΩ > R _x < 10.75 kΩ	24 Hour Range Stability
	± 1.2 μΩ/Ω	± 0.2 μΩ/Ω	± 0.2 μΩ/Ω	± 0.4 μΩ/Ω	< ± 0.06 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	± 0.2 μΩ/Ω	< ± 0.04 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	± 0.2 μΩ/Ω	< ± 0.04 μΩ/Ω
Total Measurement Range: 100Ω ⇔ 100kΩ					
R _s	100Ω > R _x < 800 Ω	800 Ω > R _x < 6.3 kΩ	6.3 kΩ > R _x < 13.4 kΩ	13.4 kΩ > R _x < 107.5 kΩ	24 Hour Range Stability
	± 1.2 μΩ/Ω	± 0.2 μΩ/Ω	± 0.2 μΩ/Ω	± 1.6 μΩ/Ω	< ± 0.06 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	± 1.0 μΩ/Ω	< ± 0.04 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.1 μΩ/Ω	± 1.0 μΩ/Ω	< ± 0.04 μΩ/Ω
Total Measurement Range: 1kΩ ⇔ 1MΩ					
R _s	1 kΩ > R _x < 8 kΩ	8 kΩ > R _x < 63 kΩ	63 kΩ > R _x < 134 kΩ	134 kΩ > R _x < 1.075 MΩ	24 Hour Range Stability
	± 1.2 μΩ/Ω	± 0.2 μΩ/Ω	± 0.4 μΩ/Ω	NA in T-Option	< ± 0.10 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.3 μΩ/Ω	NA in T-Option	< ± 0.06 μΩ/Ω
	± 0.8 μΩ/Ω	± 0.1 μΩ/Ω	± 0.3 μΩ/Ω	NA in T-Option	< ± 0.06 μΩ/Ω

1 - Specifications are based on 20 second reversal rate, 100 μW R_s power dissipation and temperature of 23 °C ± 3 °C.
 2 - Lowest possible R_x Ratio is defined as R_{xlow} = R_s x .08 and Maximum possible R_x Ratio is determined by R_{xhigh} = R_s x 107.5.
 3 - Maximum Upper Range is limited to 134 kΩ for the T-Option on all models with the maximum R_s allowed as 10 kΩ.
 4 - Ranges below 1 Ohm are only available for a R_s of 1Ω.

Notes:

- 1. The Relative Uncertainty specification is that measurement uncertainty of the 6622A Series Automatic DCC Resistance Bridges and 2 times the standard deviation of the sample set, but does not include the uncertainty of the Reference Standards. This Relative Uncertainty specification is applicable after the measurement has stabilized for the applicable Itest current applied to Rx, and for the reversal rate that is greater than or equal to those in the recommended test setups in Section 3. To calculate the Total Uncertainty of the Resistance Measurement, add the uncertainty of the Reference Standard to the Relative Uncertainty.**
- 2. The Relative Uncertainty specification is based on the Resistance Under Test being connected across the Rx terminals and the Reference Standard being connected across the Rs terminals.**

3. OPERATING INSTRUCTIONS

3.1. FRONT PANEL OPERATING PROCEDURE

The 6622A Series T-Option provides temperature related option to the manual operation from the front panel. The BridgeWorks-C Software User's Manual contains the operating instructions for fully automatic software control of the model 6622A Series T-Option via its computer system.

3.2. 6622A SERIES T-OPTION RESISTANCE/THERMOMETRY MEASUREMENT BRIDGE

The front panel operation of the model 6622A with the T-Option does not change for resistance measurement. All relevant in depth information on this mode of operation can be found in the OM6622A Operator's manual. The following information describes typical displays and corresponding menu descriptions for associated function keys for the additional functionality provided with the T-Option. Figures 3-1, 3-2, and 3-3 illustrate the model 6622A Series menu tree with the T-Option installed.

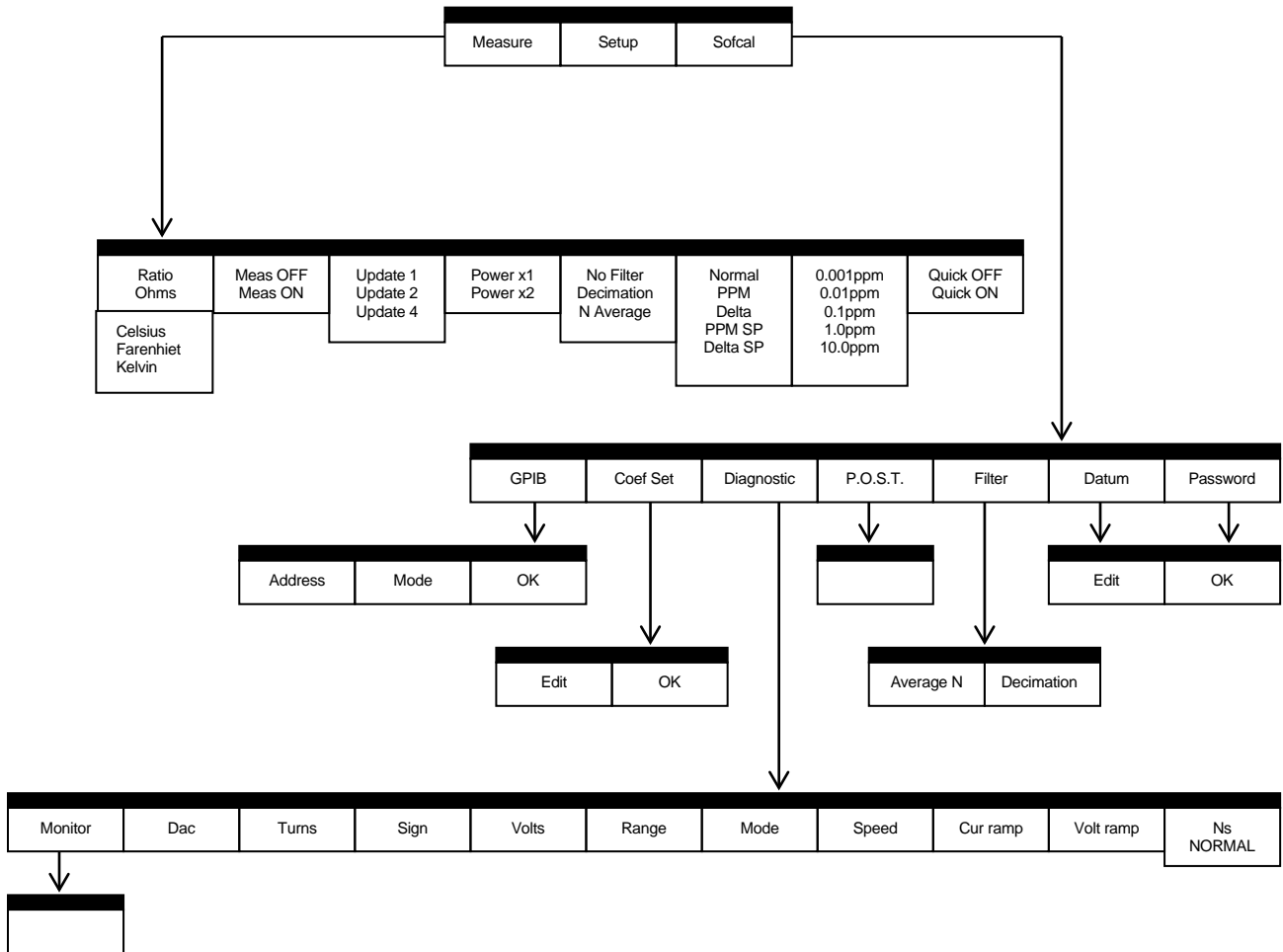


Figure 3-1: Menu Tree – MEASURE/SOFCAL

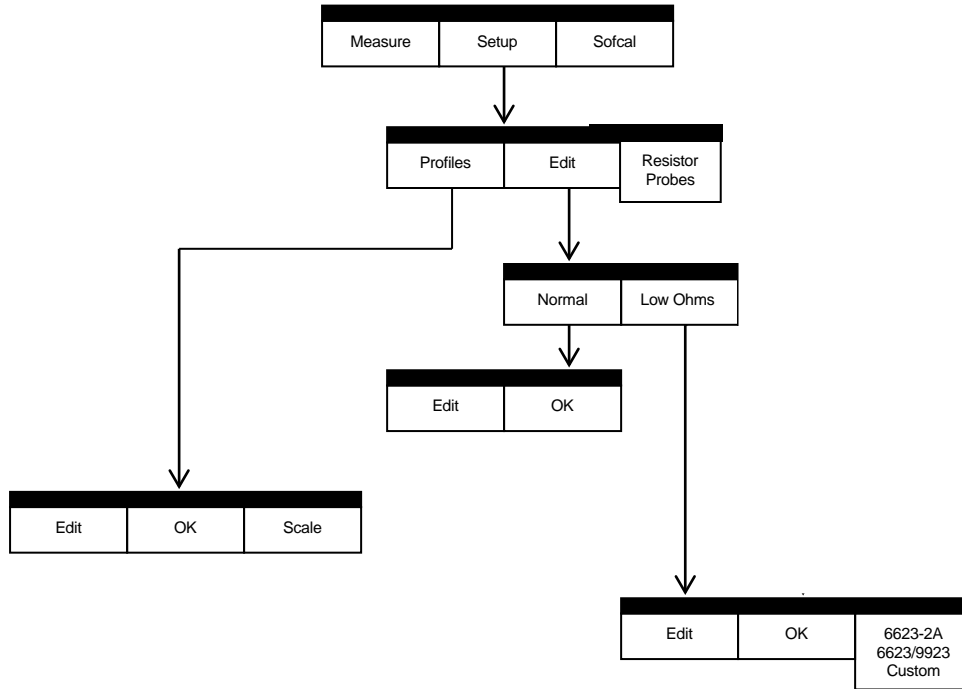


Figure 3-2 : Menu Tree – SETUP (Resistor)

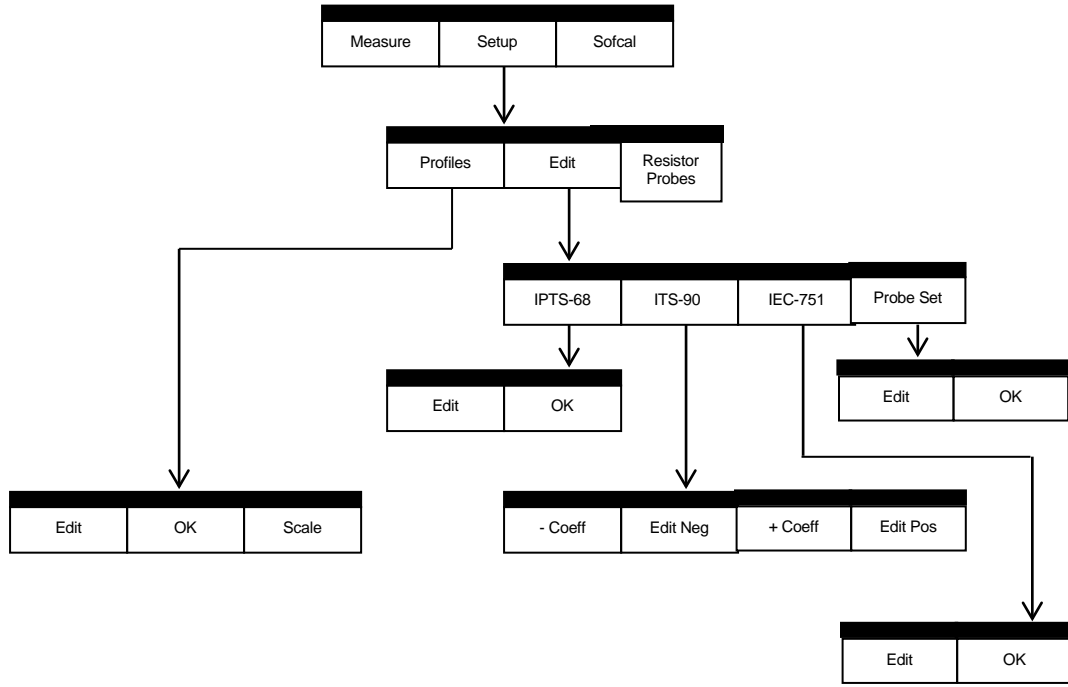
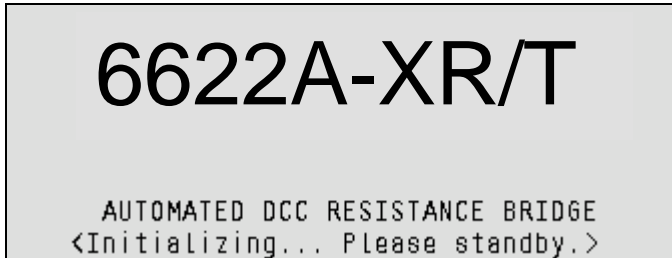


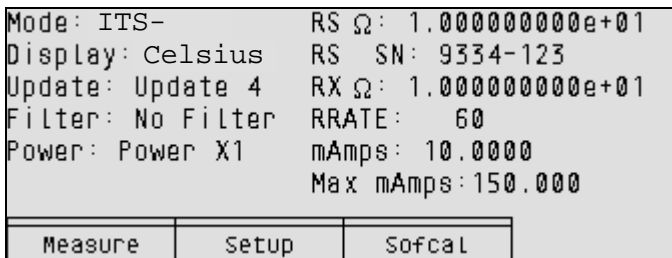
Figure 3-3 : Menu Tree – SETUP (Probe)

3.3. TITLE SCREEN

At power ON the model 6622A will start its internal power on self-test programming and display its opening banner. You will see a “/T” designation after the model number and variant indicating that the T-Option is installed.



3.4. MAIN MENU



The main menu with the T-Option installed is identical to the 6622A Series without the option installed with the exception that there is additional available information.

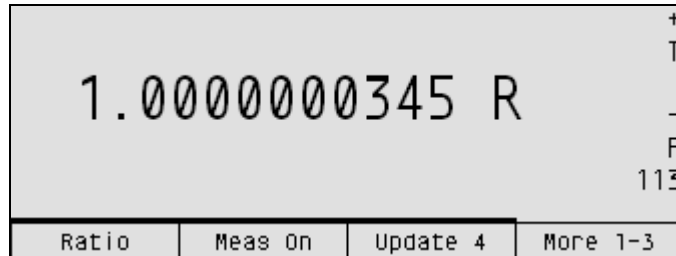
Of the additional information available the most pertinent is the units can be in thermometry based units and the mode can indicate a temperature scale.

3.4.1. <Measure> MENU Fn-1 (Main)

The measure menu has additional functionality included to allowing for additional selection of units.

Function key <Fn-1>, <Measure> will select the Measure sub-functions menu to control the measurement functions of the bridge.

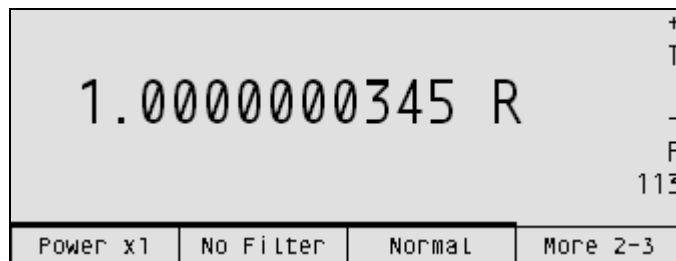
3.4.1.1. <Measure> MENU Fn-1 (MAIN) Page 1 of 3



Upgraded functions (menu page 1 of 3).

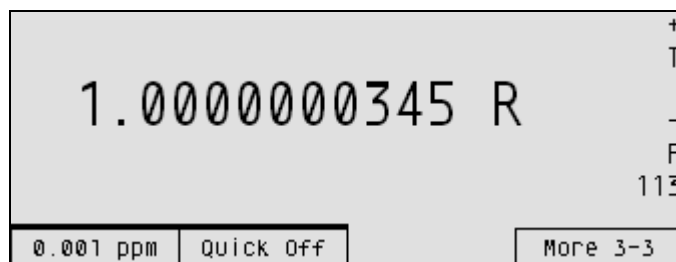
Function key <Fn-1> toggles through the set of available measurement units for the displayed result. For resistance mode the displayed result can have units of <Ratio> or <Ohms>. For resistance mode the displayed result can have units of <Celsius>, <Fahrenheit>, <Kelvin>, <Ratio> or <Ohms>. The active engineering units will be displayed in the <Fn-1> function key descriptor position.

3.4.1.2. <Measure> MENU Fn-1 (MAIN) Page 2 of 3



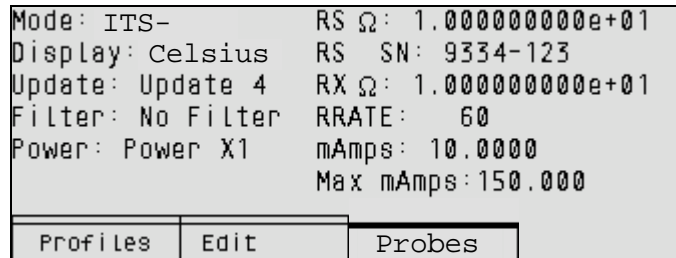
Upgraded functions (menu page 2 of 3). None

3.4.1.3. <Measure> MENU Fn-1 (MAIN) Page 3 of 3



Upgraded functions (menu page 3 of 3). None

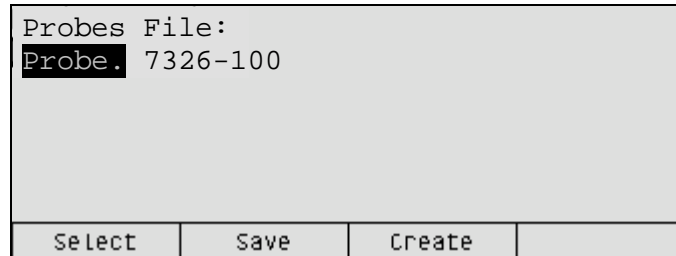
3.4.2. <Setup> MENU Fn-1 (Setup_MAIN)



Function key <Fn-3>, <Probes>, allows you to toggle between “Resistors” and “Probes”.

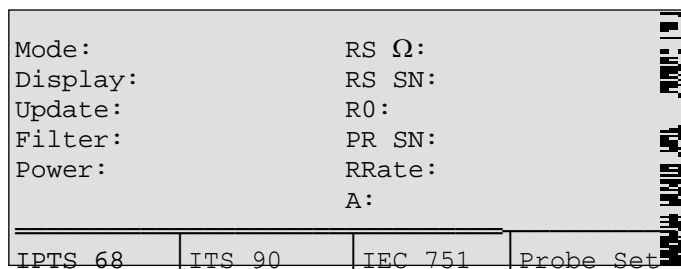
3.4.3. <Profiles> MENU Fn-1 (Profiles MAIN)

Profiles allow the user to save resistor configuration files and with the T-option installed, probe files can be stored as well. 15 resistor and 5 probe profiles are available. The profile menu otherwise operates the same as described in the Operator’s Manual OM6622A.



3.4.4. <Edit> MENU (Probe) Fn-2 (Edit MAIN)

The <Edit> menu will either be identical to the standard menu seen in the 6622A Series bridge, or be as described below depending on the selection of the Resistors/Probes mode toggle key in the <Setup> menu.



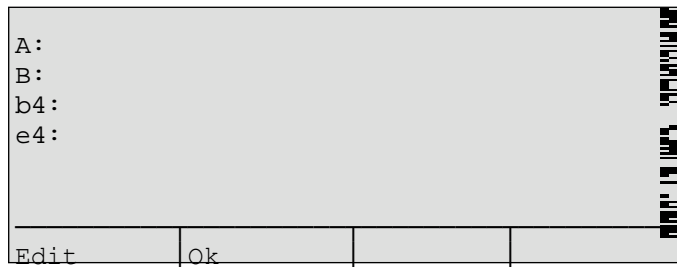
Function Key <Fn-1> ,<IPTS 68>, allows entry to the IPTS-68 measurement menu and enables the IPTS-68 coefficients for the probe to be viewed and or edited.

Function Key <Fn-2> ,<ITS 90>, allows entry to the ITS-90 measurement menu and enables the ITS-90 coefficients for the probe to be viewed and or edited.

Function Key <Fn-3> ,<IEC 751>, allows entry to the IEC-751 measurement menu and enables the IEC-751 coefficients for the probe to be viewed and or edited.

Function Key <Fn-4> ,<Probe Set>, allows entry to the Probe set menu and enables the test values for the probe to be viewed and or edited.

3.4.4.1. <IPTS 68> MENU Fn-1 (Edit MAIN)

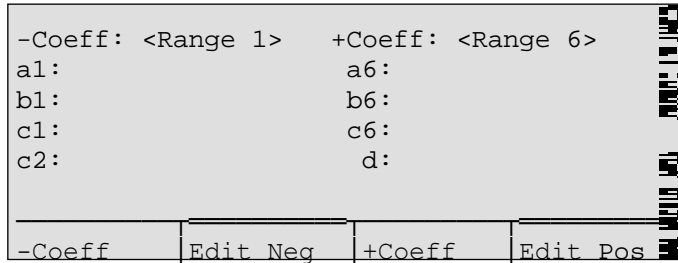


Press <Edit> and use arrow keys to move the highlight to the data line to be changed. Modify data and press <Ok>.

When <Edit> is pressed the PASSWORD CHECK display menu is activated.

Before the selected coefficient can be changed the correct password must be entered. If an incorrect password is entered, the error message "Invalid Password" will be displayed and the edit session will be terminated.

3.4.4.2. <ITS 90> MENU Fn-2 (Edit MAIN)



Function Key <Fn-1> ,<-Coeff>, selects from the ITS90 set of temperature ranges:

- <Range 1> := <13.8 K to 273.16 K> : screen display ‘-259C to 0C’
- <Range 2> := <24.5 K to 273.16 K> : screen display ‘-279C to 0C’
- <Range 3> := <54.4 K to 273.16 K> : screen display ‘-219C to 0C’
- <Range 4> := <83.8 K to 273.16 K> : screen display ‘-189C to 0C’
- <Range 5> := <234.3 K to 302.91 K> : screen display ‘-39C to 30C’

When <Range 5> is selected for <-Coeff> the menu options <+Coeff> and <Edit Pos> are removed from the display screen along with the display of “+Coeff” values.

Function key <Fn-3>, <-Coeff>, selects from the ITS90 set of temperature ranges:

- <Range 6> := <273.15 K to 1234.93 K> : screen display ‘0C to 962C’
- <Range 7> := <273.15 K to 933.47 K> : screen display ‘0C to 660C’
- <Range 8> := <273.15 K to 692.68 K> : screen display ‘0C to 420C’
- <Range 9> := <273.15 K to 505.08 K> : screen display ‘0C to 232C’
- <Range 10> := <273.15 K to 429.75 K> : screen display ‘0C to 157C’
- <Range 11> := <273.15 K to 302.91 K> : screen display ‘0C to 30C’

Function Key <Fn-2> ,<Edit Neg>, allows selection of the edit menu to enter and view the ITS90 probe (negative degree Celsius) temperature coefficients.

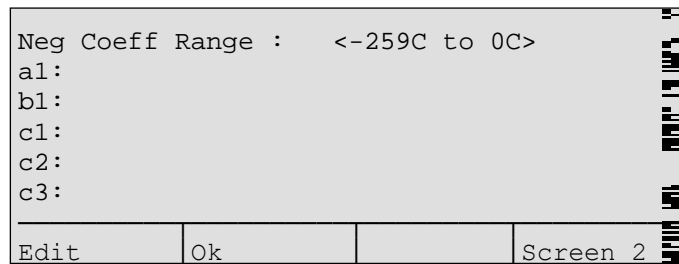
Function Key <Fn-4> ,<Edit Pos>, allows selection of the edit menu to enter and view the ITS90 probe (positive degree Celsius) temperature coefficients.

When either the <Edit Neg> or <Edit Pos> key is pressed the **PASSWORD CHECK** display menu is activated.

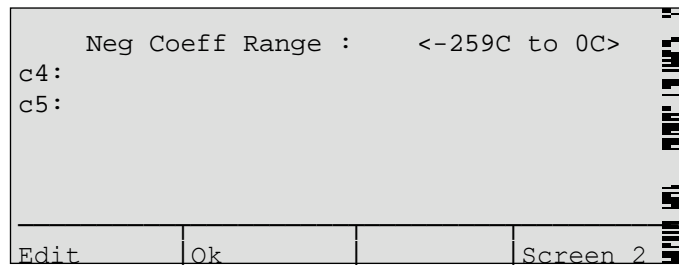
Before the selected set of coefficients can be changed the correct password must be entered.

If an incorrect password is entered, the error message "Invalid Password" will be displayed and the edit session will be terminated.

3.4.4.2.1. <Edit Neg> MENU Fn-2 (ITS90 Edit MAIN)

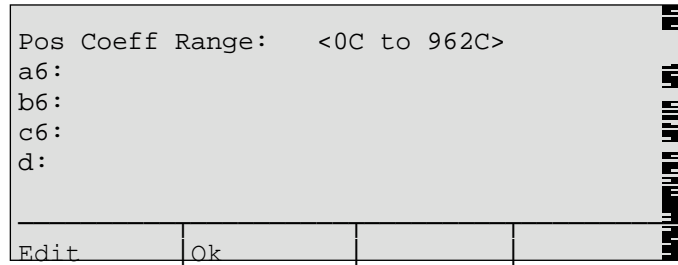


Press <Edit> and use arrow keys to move the highlight to the data line to be changed. Modify data and press <Ok>.



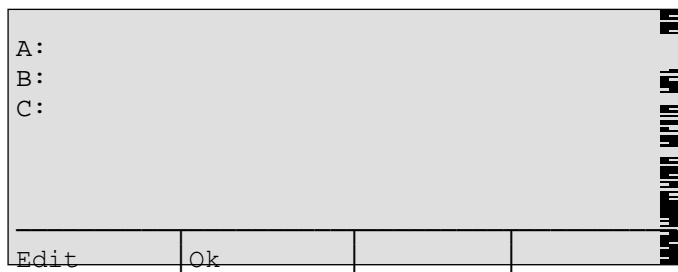
Press <Edit> and use arrow keys to move the highlight to the data line to be changed. Modify data and press <Ok>.

3.4.4.2.2. < Edit Pos> MENU Fn-4 (ITS90 Edit MAIN)



Press <Edit> and use arrow keys to move the highlight to the data line to be changed. Modify data and press <Ok>.

3.4.4.3. <IEC 751> MENU Fn-3 (Edit MAIN)



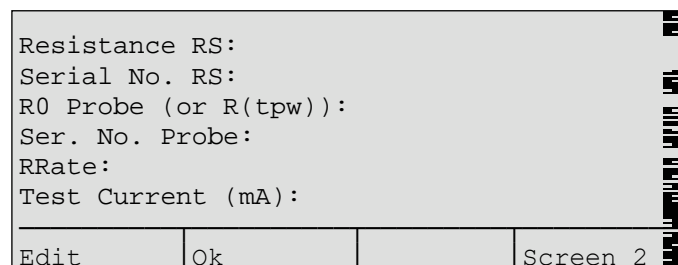
Press <Edit> and use arrow keys to move the highlight to the data line to be changed. Modify data and press <Ok>.

When <Edit> is pressed the PASSWORD CHECK display menu is activated.

Before the selected coefficient can be changed the correct password must be entered.

If an incorrect password is entered, the error message "Invalid Password" will be displayed and the edit session will be terminated.

3.4.4.4. <Probe Set> MENU Fn-4 (Edit MAIN)



Press <Edit> and use arrow keys to move the highlight to the data line to be changed. Modify data and press <Ok>.

A resistance value > 0 for the ice point resistance (R₀) or triple point of water resistance (R_{tpw}), MUST be entered for the probe before a measurement can take place.

Max Current (mA):			
Edit	Ok		Screen 2

Press <Edit> and use arrow keys to move the highlight to the data line to be changed. Modify data and press <Ok>.

3.5. MEASUREMENT OPERATION GUIDE

This section contains information regarding the measurement of probes in the range of 1m ohm to 100k ohms. This guide is provided for manual front panel control of the model 6622A Series bridge with the T-Option installed. An operation guide for full automatic control of the model 6622A bridge, in thermometry applications, is provided in the BridgeWorks-C Software User's Manual.

3.5.1. Thermometry Measurement Mode

The model 6622A in its Thermometry Measurement Mode is similar to Normal Ohm mode but is enables measurement of PRT and SPRT probes in the range of 1 mΩ to 100 kΩ. The following steps outline the general procedure for making Normal Ohm measurements. Figure 3-4 shows a typical rear panel connection for this measurement mode. The setup is the same as for the Normal mode described in the 6622A Operator's Manual OM6622A, except select the 'Probe' mode is enabled and the subsequent 'ITS-90', 'IPTS-68', or 'IEC-751' selection is made in step 4,

Ref. (Ω)	P.R.T. (Ω)	Itest (2) (mA)	I _{max} (mA)	Reversal Rate (sec)	Comment (1) Update 2 / Quick Measure
1	25	2 – 4	100	20	Limited by 10 mW max in standard
1	100	1	100	20	Limited by 10 mW max in standard
10	25	2 – 6.32	31.6	20	
10	100	1 – 3.16	31.6	20	
100	100	1 – 3.16	10	20	

Table 3-1 : Recommended Temperature Measurement Test Setup

- NOTE: 1. It is recommended to use the “Quick” mode of operation for the model 6622A when making temperature measurements to remove all digital filtering and improve measurement latency. Also using “Update Mode 2” sets the sample timing to match the reversal rate. These settings are best suited for high speed, unfiltered data as required for most temperature applications.**
- 2. Itest is based on a 100 μW to 1 mW power dissipation in the PRT at the triple point of water and maintaining less than 10 mW in the standard.**

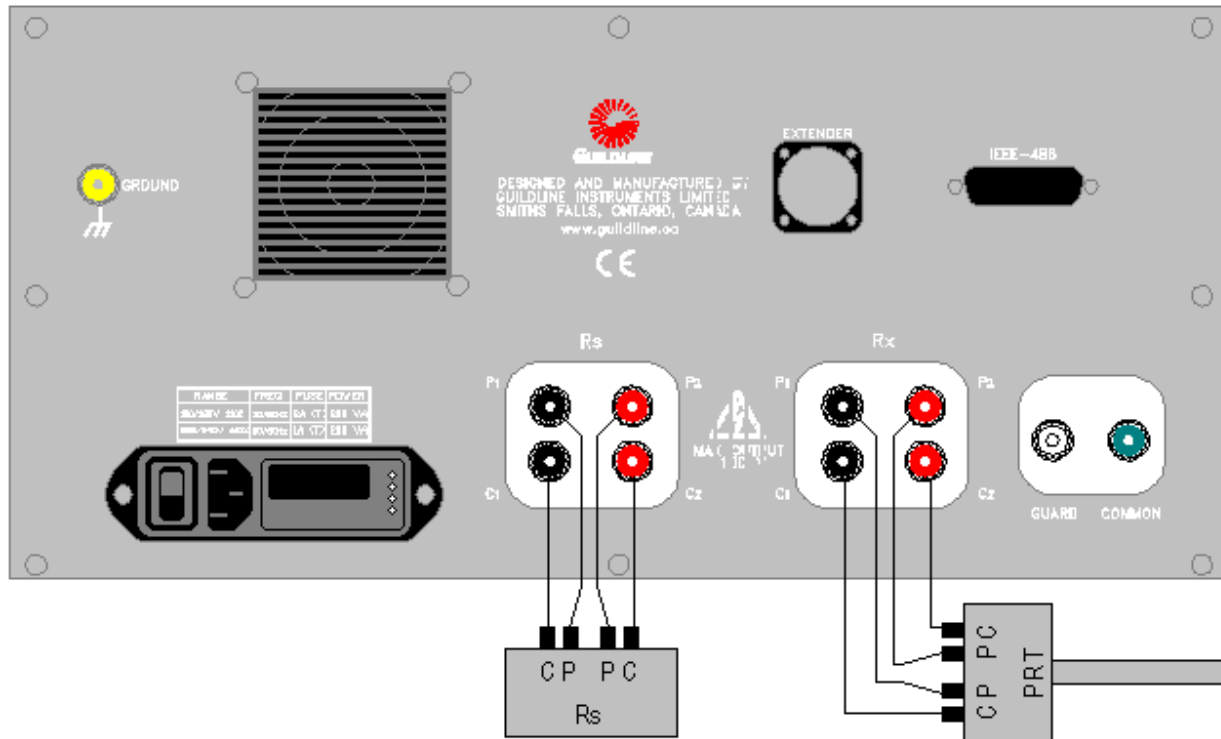


Figure 3-4 : Rear Panel Connections – PRT/SPRT

3.6. BRIDGEWORKS-C DATA ACQUISITION SOFTWARE

The BridgeWorks-C Data Acquisition Software is the control software for the model 6622A Bridge. Using the 6622A with the BridgeWorks-C Data Acquisition Software will increase the functionality and the productivity of the bridge. Adding optional 6664B and/or 6664-2A Scanner(s) to work along with 6622A and software control will create a fully automated Resistance Measurement System. Before using the model 6622A system with the computer, ensure that the operation of the software package is well understood. The computer controls the system through the IEEE-488 Interface (GPIB) of the model 6622A Resistance Measurement Bridge, and optionally, the model 6664B and 6664B-2A Scanners.

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.

Refer to the BridgeWorks-C Software User's Manual for a description of the software functions and automatic operation of the system under software control.

4. MAINTENANCE

4.1. INTRODUCTION

This section covers troubleshooting, repair and alignment of the model 6622A Series Automatic DCC Resistance/Thermometry Bridge.

4.2. TEMPERATURE RATIO VERIFICATION

This section outlines the recommended thermometry based ratio verification requirements for the model 6622A with the T-Option installed.

4.2.1. PURPOSE

The purpose of the procedure in this section is to assure that the model 6622A Series Bridge functions properly and meets the manufacturer's additional specifications for T-Option. It is recommended that these procedures be performed after any corrective maintenance activity, or if the operator perceives a problem.

It is recommended that all of these procedures be performed on an annual basis to verify performance of the model 6622A for its recertification.

4.2.2. EQUIPMENT REQUIRED

The following equipment is required for this procedure.

- 10 Ω standard resistor, stable to $\pm 0.01 \mu\Omega/\Omega$ over a 24 hour period (x2)
- 100 Ω standard resistor, stable to $\pm 0.01 \mu\Omega/\Omega$ over a 24 hour period (x2)
- 1 k Ω standard resistor, stable to $\pm 0.01 \mu\Omega/\Omega$ over a 24 hour period (x2)
- 25 Ω standard resistor, stable to $\pm 0.01 \mu\Omega/\Omega$ over a 24 hour period
- 400 Ω standard resistor, stable to $\pm 0.2 \mu\Omega/\Omega$ over a 24 hour period
- Temperature controlled environment sufficient to maintain the reference and working standard resistors to their specified uncertainties

Note: The eight standard resistors are available in the optional model 6634 Resistance Standard.

4.3. MODEL 6622A BRIDGE WITH T-OPTION

The following procedure is can be automated in using a test sequence BridgeWorks-C Data Acquisition Software if the 6622A is connected through a 6664B scanner.

4.3.1. Set Up

1. Ensure that the model 6622A is switched on as well as the optional 6664B, and 6634A Resistance Standard, if installed. Open the BridgeWorks Data Acquisition Software in the computer.

4.3.2. Inputs-Outputs Verification

1. Have the following resistors ready for connection to the 6622A or pre-connected to scanner channel leads from the optional 6664B scanner as listed below:

Resistor

10 Ω

10 Ω (2)

100 Ω

100 Ω (2)

1 k Ω

1 k Ω (2)

25 Ω

400 Ω

Set these standard resistors into the controlled temperature environment and allow time for them to stabilize.

2. Use the “Test Sequence” function of the “Configuration” menu of the BridgeWorks-C Data Acquisition Software to measure the resistance ratio of each resistor pair with the corresponding excitation current and reversal rate listed below. See the BridgeWorks-C Software User’s Manual for the particulars of running a test sequence. These measurements can also be made manually. If they are made manually, allow sufficient time for the measurement to settle and ensure that all measurements made that are related to a given closure are with in 24 hour of each other.

Meas. No.	R _x Resistor	R _s Resistor	Excitation Current	Reversal Rate	Meas. Mode
<i>Tests 1 – 13 for all 6622A T-Option bridges.</i>					
1	10 Ω	10 Ω	3.16 mA	20 sec	Normal
2	10 Ω	10 Ω	3.16 mA	20 sec	Normal
3	100 Ω	100 Ω	1.0 mA	20 sec	Normal
4	100 Ω	100 Ω	1.0 mA	20 sec	Normal
5	1 kΩ	1 kΩ	0.316 mA	20 sec	Normal
6	1 kΩ	1 kΩ	0.316 mA	20 sec	Normal
7	25 Ω	10 Ω	2.0 mA	20 sec	Normal
8	100 Ω	25 Ω	0.5 mA	20 sec	Normal
9	100 Ω	10 Ω	0.5 mA	20 sec	Normal
10	400 Ω	100 Ω	0.5 mA	20 sec	Normal
11	1 kΩ	400 Ω	0.2 mA	20 sec	Normal
12	1 kΩ	100 Ω	0.2 mA	20 sec	Normal
13	1 kΩ	10 Ω	0.2 mA	20 sec	Normal

- For each resistor pair, calculate and report the interchange closure error. For example, if the R_x:R_s ratio of the first measurement is R_a and the R_x:R_s ratio of the second measurement, where the two resistors are exchanged with one another, is R_b, then the interchange error e_i in parts per 10⁶ 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 (parts per 10⁶) for the following resistor pairs are:

Resistor	Resistor	Interchange Closure Error				
		6622A	6622A-XP	6622A-XR	6622A-XPR	6622A-HV
10 Ω	10 Ω	0.2	0.1	0.2	0.1	0.1
100 Ω	100 Ω	0.2	0.1	0.2	0.1	0.1
1 kΩ	1 kΩ	0.2	0.1	0.2	0.1	0.1

- For the first 10:1 ladder up closure error (100:10), the 10:1 ratio must agree to within the specification of the nominal ratio for either directly measuring the 10:1 ratio, or calculating the ratio from the product of the 10:2.5 ratio and the 2.5:1 ratio, as follows:

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

Where:

- R_a is the 10:1 ratio
- R_b is the 2.5:1 ratio
- R_c is the 10:2.5 ratio

6. For the second 10:1 ladder up closure error (1k:100), the 10:1 ratio must agree to within the specification of the nominal ratio for either directly measuring the 10:1 ratio, or calculating the ratio from the product of the 10:4 ratio and the 4:1 ratio, as follows:

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

Where:

- R_a is the 10:1 ratio
- R_b is the 4:1 ratio
- R_c is the 10:4 ratio

7. For the 100:1 ladder up closure error (1k:10), 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, as follows:

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

Where:

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

8. The maximum allowable ladder up errors (parts per 10⁶) for the following resistor sets are:

Resistor	Resistor	Resistor	Interchange Closure Error				
			6622A	6622A-XP	6622A-XR	6622A-XPR	6622A-HV
10 Ω	25 Ω	100 Ω	0.2	0.1	0.2	0.1	0.1
100 Ω	400 Ω	1 kΩ	0.2	0.1	0.2	0.1	0.1
10 Ω	100 Ω	1 kΩ	0.2	0.1	0.2	0.1	0.1