

◆ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ◆

PRS-370 SERIES

Programmable Decade Resistance Substituter IEEE-488.2 Operation Manual



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WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable IET specifications. If within one year after original shipment, it is found not to meet this standard, it will be repaired or, at the option of IET, replaced at no charge when returned to IET. Changes in this product not approved by IET or application of voltages or currents greater than those allowed by the specifications shall void this warranty. IET shall not be liable for any indirect, special, or consequential damages, even if notice has been given to the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

Revision History

Revision	Description
March 2019	Initial release
January 2020	Firmware 1.22 adds Fluke 8588A DMM
January 2021	Section 4.1 and 5.1 indicates how version 1.23 Firmware adds new command SYSTEM:HIGHSPEED clarification as to how to control PRS-370 via IEEE bus
December 2022	added section 6.1.8 Trace Calibration
January 2023	Modified 6.1.3 for correct accuracy from nominal
January 19, 2023	Modified 6.1.3 for better clarification on resistance values
February 7, 2023	Modified 6.1.3 to match version 1.27 Firmware

SAFETY PRECAUTIONS

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS elsewhere in this manual may impair the protection provided by the equipment. Such noncompliance would also violate safety standards of design, manufacture, and intended use of the instrument.

IET Labs assumes no liability for the customer's failure to comply with these precautions.

The PRS-370 complies with INSTALLATION CATEGORY I as well as POLLUTION DEGREE 2 in IEC61010-1.

If an instrument is marked CAT I (IEC Measurement Category I), or it is not marked with a measurement category, its measurement terminals must not be connected to line-voltage mains.

The PRS-370 is an indoor use product.



DANGEROUS PROCEDURE WARNINGS



Comply with all WARNINGS - Procedures throughout in this manual and instructions on the instrument prevent you from potential hazard. These instructions contained in the warnings must be followed.

BEFORE APPLYING POWER

Verify that all safety precautions are taken. Make all connections to the instrument before applying power. Note the instrument's external markings described under "Safety Symbols".

GROUND THE INSTRUMENT

This is a Safety Class I instrument. To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

SAFETY PRECAUTIONS CONTINUED



- DO NOT Operate in an Explosive Atmosphere
- Do not operate the instrument in the presence of inflammable gasses or fumes
- Operation of any electrical instrument in such an environment clearly constitutes a safety hazard
- Use Caution around live circuits and whenever hazardous voltages > 45 V are present
- Operators must not remove instrument covers
- Component replacement and internal adjustments must be made by qualified maintenance personnel only
- DO NOT substitute parts or modify the instrument
- When working with high voltages; post warning signs, train personnel and keep unauthorized personnel away.

Do not apply any voltage or currents to the terminals of the instrument in excess of the maximum limits indicated in the specifications section of this manual.

To avoid the danger of introducing additional hazards, do not install substitute parts or perform unauthorized modifications to the instrument.

Return the instrument to an IET Labs for service and repair to ensure that safety features are maintained in operational condition.

Safety Symbols

General definitions of safety symbols used on the instrument or in manuals are listed below.



Caution symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual.



Hazardous voltage symbol: the product is marked with this symbol when high voltage maybe present on the product and an electrical shock hazard can exist.



Indicates the grounding protect terminal, which is used to prevent electric shock from the leakage on chassis. The ground terminal must connect to earth before using the product



Direct current.



Alternating current.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



On supply.



Off supply.



Hot surface. Avoid contact. Surfaces are hot and may cause personal injury if touched.

Disposal



Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This product complies with the WEEE Directive (2002/96/EC) marking requirements.

The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a “Monitoring and Control instrumentation” product.

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities.

Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being.

When replacing old appliances with new one, the retailer is legally obligated to take back your old appliances for disposal.

Proposition 65 Warning for California Residents



WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov.

This product may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm

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Chapter 1

INTRODUCTION

The PRS-370 (Figure 1.1) is a high precision manual and programmable decade substituter that can leverage an 8.5 digit DMM to improve the accuracy to < 10 ppm.

The PRS-370 is a Self-Adjusting Programmable Resistance Standard, just connect an 8.5 digit DMM; Fluke 8508A, 8588A or the Keysight 3458A to the PRS-370 via the IEEE-488 interface, and the PRS-370 becomes a short-term stable variable standard of resistance.

The PRS-370 instructs the DMM to make a measurement of the source resistance and then automatically fine adjusts the output resistance to achieve the “best” accuracy to the nominal resistance value, typically better than 10 ppm.

The PRS-370 utilizes both the front and rear binding posts so that the DUT and DMM can be connected at the same time. Once the resistance measurement is complete using the DMM and rear binding posts, the source resistance is switched to the front binding posts.

The PRS-370 substituter is a precision resistance source with excellent characteristics of stability, temperature coefficient, and power coefficient. These features combined with a low virtually constant “zero resistance” make for very versatile instruments.

Operation is both local using convenient touch screen, keypad and

standard and IEEE-488.2 interfaces.

The PRS-370 employs very low resistance, low thermal emf relays with gold-clad silver-alloy contacts. A special design keeps contact resistance to a minimum. The gold plating keeps the silver contacts from becoming tarnished when unused, or when only low currents are passed through them. This is most often the case when only minute test currents are drawn by digital multimeters and other test instruments. Contact resistance remains low and repeatable.

High-quality gold-plated tellurium-copper five-way binding posts serve to minimize the thermal emf effects, which would produce errors in dc resistance measurements.

With a resolution as low as 1 $\mu\Omega$ and a maximum available resistance of 20 M Ω , the PRS-370 may be used for exacting precision measurement applications requiring high



Figure 1.1: High Precision Programmable Decade Resistance Substituter

accuracy, good stability, and low zero resistance.

The PRS-370 is suited for automatic and manual calibration and testing, simulation of RTD's, programmable loads, and many other laboratory and industrial applications.

The PRS Series may be rack mounted to serve as components in measurement and control systems.

The PRS-370 (Figure 1.1) is part of the PRS family of high precision manual and programmable decade substituters. This series offers a wide choice of ranges, power, voltage, and accuracies for a wide variety of design and production applications.

The PRS-370 uses a microcontroller design to enhance the ease of use and calibration. It provides direct resistance substitution as well as RTD (Resistance Temperature Detector) simulation. It allows for higher precision and tight tolerances.

The PRS-370 is a precision resistance source with excellent characteristics of accuracy, stability, temperature coefficient, and power coefficient. It is direct reading without the need to subtract "zero resistance."

The PRS-370 offers the option of true 4-wire Kelvin measurement for calibration

applications and 2-wire mode for use in series as a substitute resistor and for RTD applications. The front panel display indicates the mode selected: 2-wire or 4-wire.

There are 4 pre-programmed RTD resistance tables, and others may be added by the user. The controller allows for other convenient programmed features.

The unique design makes adjustment of the PRS-370 for calibration semiautomatic. An internal calibration routine guides the user to perform measurements using only a precision ohmmeter and enter the measured values into the PRS-370. No other standards are required.

Chapter 2 SPECIFICATIONS

For convenience to the user, the pertinent specifications are given in an OPERATING GUIDE, shown typically in Figure 2.1, affixed to the case of the instrument.

2.1 Specifications

User interface:

Numeric keypad, softkeys and color capacitive touch screen

Accuracy:

±(70 ppm + 1 mΩ) 2 and 4 Terminal at 23°C ±5°C

Minimum setting: 0.100 000 Ω

Resolution: 1 μΩ or 6 digits

Range: 0.1 Ω - 20 MΩ

Stability: ±50 ppm/year

Thermal emf: <15 μV

Resistance difference front to rear binding posts:

±(2 ppm + 20 μΩ)

Maximum load: 2 A, 200 V (peak), 0.5 W whichever applies first

Resistors: Precision wire-wound and metal foil

TC of resistors: <1 ppm/°C for 1.37 Ω and above

Relays¹: Silver alloy contacts, expected life of 10⁸ cycles

Switching time: <100 ms second per change (SYSTEM:HIGHSPEED enabled)

RTD simulation:

9 RTD tables can be entered into memory to allow user selection of temperature and the correct value of resistance will automatically be programmed.

PT-100 and PT-1000 tables for both Fahrenheit and Celsius are pre-programmed into memory locations 1 to 4.

Adjustment:

Automatic adjustment procedure utilizing a high precision DMM eliminates the requirement for manual trimming of resistors.

Terminals:

Front and rear connections each consisting of 4 low-emf, gold-plated, tellurium-copper 5-way binding posts are used for **HI** and **LO** terminal pairs for **CURRENT** and **SENSE**. **GND** binding post is connected to the case, to chassis ground.

ac frequency response:

Residual capacitance terminals to GND: < 850 pF

Resistance	Typical ac/dc difference @ 1 kHz
0.1 Ω -10 kΩ	<100 ppm
10 - 100 kΩ	<200 ppm
100 kΩ - 1 MΩ	<1%
1 - 20 MΩ	<20%

Power requirements:

90 - 264 Vac , 47 - 63 Hz., 30 W. Max.

Fuse: T 0.8 A,250 V, 5 x 20 mm

Environmental conditions:

Operating: 10°C to 40°C;

<80% RH non-condensing

Storage: -40°C to 70°C; <90% RH non-condensing

Remote control:

GPIB:

GPIB standard 24 pin connector, conforms to IEEE-488.2; SCPI 1994.0 command set; Hardware or software configurable addressing range of 1 to 30.

Dimensions:

Bench model: 43 cm W x 8.9 cm H x 33 cm D (17" x 3.5" x 13") in front of panel: 3.8 cm (1.5")
 Rack Mount: 47 cm W x 8.9 cm H x 33 cm D (19" x 3.5" x 13") in front of panel: 3.8 cm (1.5")

Weight:

Bench model: 5.5 kg (12 lb) nominal

¹ Note: Warranty covers relays up to expected life

2.2 General Specifications and Stability

Warm-up:

This unit utilizes custom designed low thermal emf relays for high stability and low-level signal applications. This thermal voltage is nominally less than 15 μV under laboratory conditions. Please note that a change in this thermal emf will give a false drift in resistance as measured by a dc ohmmeter, since the ohmmeter will interpret this emf as an effective resistance. The worst case such effective drift after warm-up is less than ± 25 ppm, primarily due to stabilization of this emf at the relay contacts as settings are changed.

Unit should be allowed to stabilize for one hour. For maximum stability, allow unit to warm-up over two hours.

Recommended Calibration Interval:

Typical calibration interval 12 months. Adjustment can easily and automatically be accomplished via calibration menu. Adjusting the PRS-370 can improve accuracy associated with the drift of the resistors.

Environmental:



This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a “Monitoring and Control instrumentation” product.

Effects of Humidity:

Exposure to humidity $> 60\%$ for a periods of weeks can cause the resistors to drift some of that is reversible. It is recommended that the PRS-370 be stored at humidities less than 50% to minimize this.

Short-term Stability:

The PRS-370 was tested for extended periods of time. Based upon this testing the following stability information was determined. These specifications apply for the PRS-370 in 4 terminal mode with shorting links removed and without switching to another value.

Typical short-term stability without switching:

$< \pm(4 \text{ ppm} + 100 \mu\Omega) / 10 \text{ minutes}$

Typical 24 hr. Accuracy after Adjustment:

After performing an adjustment per 8.1.4 of this manual using a Fluke 8508A and then performing a calibration verification per 8.1.3 within 24 hours the typical accuracy is:

$\pm(30 \text{ ppm} + 300 \mu\Omega)$ for values $< 1 \text{ M}\Omega$
 $\pm 60 \text{ ppm}$ for values $> 1 \text{ M}\Omega$

See graph below for actual performance, shown in blue, with 6 digit resolution across resistance range. The red lines represent tolerance of $\pm(30 \text{ ppm} + 300 \mu\Omega)$.

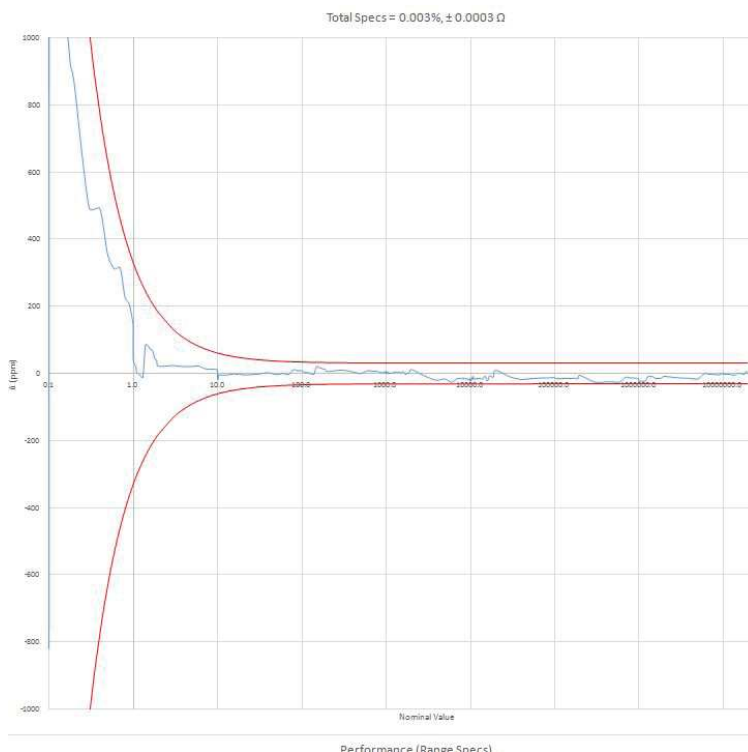


Figure 2-1 Error versus Resistance up to 1 MΩ

PRS-370 PROGRAMMABLE DECADE RESISTANCE SUBSTITUTER

CONSULT INSTRUCTION MANUAL FOR PROPER INSTRUMENT OPERATION

Accuracy: $\pm(70\text{ppm} + 1\text{ m}\Omega)$ 2 and 4 Terminal at 23°C $\pm 5^\circ\text{C}$

Minimum setting: 0.100 000 Ω

Resolution: 1 $\mu\Omega$ or 6 digits

Stability: ± 50 ppm/year

Range: 0.1 Ω - 20 M Ω

Thermal emf: $< 15\ \mu\text{V}$

Maximum load: 2 A, 200 V (peak), 0.5 W whichever applies first

Resistors: Precision wire-wound and metal foil

RTD tables:
 PT-100 and PT-1000 tables for both Fahrenheit and Celsius are programmed into memory locations.
 4 RTD tables can be entered into memory to allow user selection of temperature and the correct value of resistance will automatically be programmed.

Adjustment:
 Automatic adjustment procedure utilizing a high precision DMM eliminates the requirement for manual trimming of resistors.

Relays¹: Silver Alloy contacts, expected life of 10⁸ cycles

Terminals:

Four low-emf, gold-plated, tellurium-copper 5-way binding posts are used for **HI** and **LO** terminal pairs for **CURRENT** and **SENSE**. **GND** binding post is connected to the case, to the chassis ground and to the earth ground.

Switching time: < 100 ms per change

Power requirements:

90 - 264 Vac , 47 - 63 Hz. 30 W. Max.

Remote Control:

IEEE: GPIB standard 24 pin connector, conforms to IEEE-488.2; SCPI 1994.0 command set; software programmable addressing range of 1 to 30.

¹Note: Warranty covers relays up to expected life

MODEL: PRS-370

SN: B2-18431158

WARNING

Observe all safety rules when working with high voltages or line voltages. Connect the (GND) terminal to earth ground in order to maintain the case at a safe voltage. Whenever hazardous voltages ($> 45\text{ V}$) are used, take all measures to avoid accidental contact with any live components: a) Use maximum insulation and minimize the use of bare conductors. b) Remove power when adjusting switches. c) Post warning signs and keep personnel safely away.



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PRS-370 Nov. 2018

*FIGURE 2.1 Typical OPERATING GUIDE Affixed to Unit
 (Please see label affixed to your unit)*

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Chapter 3 OPERATION

3.1 Initial inspection and setup

This instrument was tested and carefully inspected before shipment. It should be in proper electrical and mechanical order upon receipt.

An **OPERATING GUIDE** is attached to the case of the instrument to provide ready reference to specifications.

3.1.2 Purpose

The purpose of the PRS-370 is to source resistance in the range of 0.1 Ω to 20 M Ω for calibration of DMMs, meters and use as an RTD Simulator.

3.1.3 Storage

If this instrument is to be stored for any lengthy period of time, it should be sealed in plastic and stored in a dry location. It should not be subjected to temperature extremes beyond the specifications. Extended exposure to such temperatures can result in an irreversible change in resistance, and require recalibration.

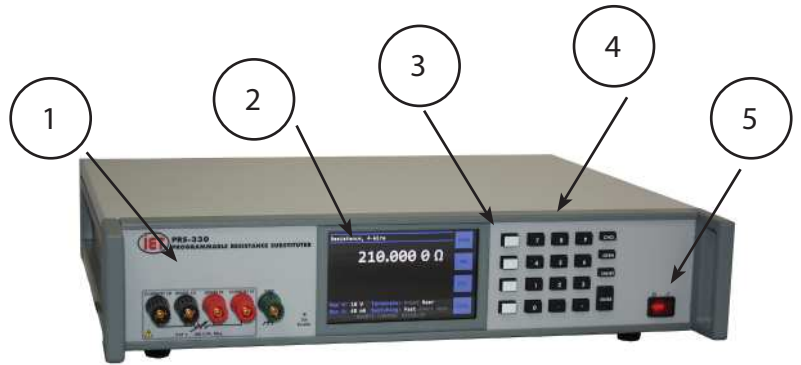
3.1.4 Bench and Rack Setup

The PRS-370 should be placed on a stable flat work surface. A front bail is provide to make viewing easier.

Mount the unit in a standard 19" rack if the rack mount option is specified.

3.1.5 Front and Rear Panel

The front panel has a capacitive touchscreen, front binding posts, softkeys, numeric keypad and power switch.



Front Panel

Model Ref.	Description
1	Front Binding Posts
2	Capacitive Touchscreen
3	Softkeys
4	Numeric Keypad
5	Power Switch

The rear panel has an IEC inlet module for connection to mains power, GPIB interface and rear binding posts.

Power requirements:

90 - 264 Vac , 47 - 63 Hz., 30 W. Max.



Fuse

Only replace fuse with the same type and rating.

UL/CSA type, T 0.8 A, 250 V, 5 x 20 mm



3.1.7 Environmental

Do not operate the instrument in the presence of flammable gasses or fumes.

The PRS-370 is for indoor use only.

To ensure that the safety requirements, the specifications, and the measurement accuracy of the PRS-370 are met, you must maintain the environmental temperature to within the specified range by providing an appropriate cooling clearance around the PRS-370 meter or, for the rack-mounted type, by forcefully air-cooling inside the rack housing if necessary.

Temperature and Humidity

Operating: 10°C to 40°C; <80% RH non-condensing

Storage: -40°C to 70°C ; <90% RH non-condensing

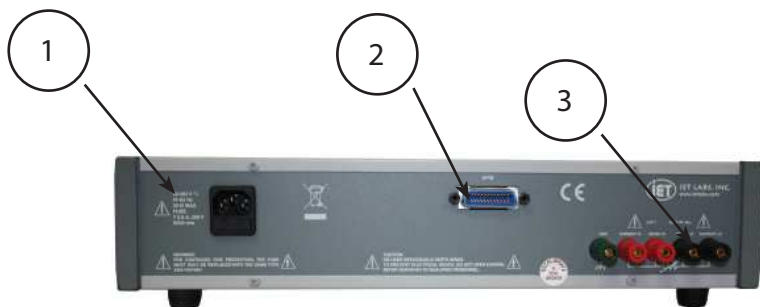
Altitude

Operating: 0 - 2000 m; storage: 0 - 4600 m



3.1.8 Safety Considerations

Refer to the Safety Summary page at the beginning of this guide for general safety information. Before installation or operation, review this guide for safety warnings and instructions. Safety warnings for specific procedures are located at appropriate places throughout this



Rear Panel

Model Ref.	Description
1	IET Inlet Module
2	GPIB Interface
3	Rear Binding Posts

3.1.6 Power Connections

Power connection to the rear panel is through an ac inlet module comprised of an ac connector and fuse drawer.

Always use an power cord and outlet that has a properly connected protection ground to avoid shock. The PRS-370 is provided with a 3-prong power cord with ground.

Plug the supplied IEC power cord into the instrument into a power receptacle that has a ground. The power cord may of course be selected to match the available receptacle.

Confirm that the power supplied to the PRS-370 meets the following requirements



guide.

There are no user serviceable parts inside the PRS-370. Servicing should be referred to qualified personnel.

3.1.9 Cleaning

To prevent shock unplug the 1863 and 1864 from mains prior to cleaning.

Use a dry cloth or a cloth slightly dampened with water to clean the external case parts.

Do not use detergents or chemical solvents.

Do not attempt to clean internally.

Denatured alcohol can be used to clean insulators around binding posts.

3.2 Connection

3.2.1 General Considerations

The PRS-370 Programmable Decade Resistance Substituter utilizes a 5-terminal connection. The binding posts are standard laboratory type and readily accept banana plugs, spade lugs, alligator clips, and bare wire. Binding posts are located on the front panel and rear panel of the instrument.

The Kelvin terminals consisting of a **CURRENT** and a **SENSE** pair, each labeled **HI** and **LO**. These minimize contact resistance.

4 Wire connection

The gold shorting links must be removed on the binding posts of the PRS-370 when set to 4 Wire.

2 Wire connection

The gold shorting links must be used on the

binding posts of the PRS-370 when set to 2 Wire. See section 3.4.4 for more information

The **GND** terminal on all models is connected to the case and to earth and chassis grounds. This may be used as a shield terminal.

3.2.2 Electrical Considerations

The performance of the PRS-370 is directly affected by the quality of the connection to the system under test. This is particularly true with the precision series models having higher-accuracy and/or lower-impedance decades.

For optimum performance, contact resistance should be kept to a minimum by using the most substantial mating connection possible, and by assuring that the connection is well secured to the binding posts.

3.3 Condensed Operating Instructions

1. Turn on the PRS-370 ON using POWER SWITCH
2. From the Home screen, select a desired resistance value in one of the following ways:
 - a) Enter a value using the number keys, then press **ENTER**.
 - b) Press the resistance value shown on the touch screen and then enter the resistance value using the touch screen or keypad.
3. The source resistance will be output to the front or rear binding posts and is indicated at on the bottom half of the Home screen. Front and rear binding posts can be selected by going to Main Menu>Resistance Settings.
4. 2-Wire or 4-Wire connection mode is shown at the top of the Home screen. This can be changed by going to Main Menu>Resistance Settings.

3.4 Menu Structure

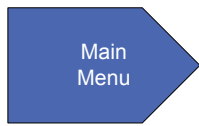
The tables on the next few pages shows the menu structure of the PRS-370.

Menu items with a “:” allow selection of a value or feature when **ENTER** pressed. Menu items without “:” have a submenu with more than 1 item.

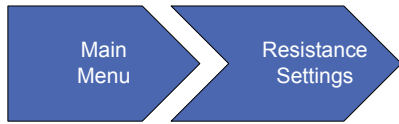
Press **MENU** to display **Main Menu** and press the **Back** key to return to **Home** screen.

Below is the basic menu structure of the PRS-370.

PRS-370



Resistance Settings
PRS-DMM Settings
Instrument Calibration (only shown when Cal Enable pressed)
About



Connection Mode: 4-Wire or 2 Wire
Terminal Selection: Front or Rear
Standard Values
RTD and Other Tables Settings
Switch Mode: Fast or Slow



*Set Value: 0.1 Ω
Standard Value:1%
Decade Value: 0.1 Ω
Percent Value: 0.001%



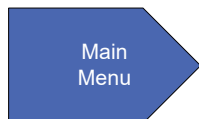
*Probe Type: <None, PT-100 °C, PT-100 °F, PT-1000 °C, PT-1000 °F, or Default >
User Selected RTD



User Function: Default
Units: <°F, °C, K>

Main Menu>Resistance Settings

PRS-370



Resistance Settings
PRS-DMM Settings
Instrument Calibration (only shown when Cal Enable pressed)
About

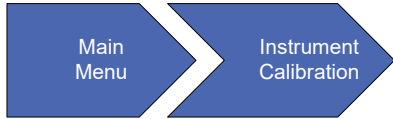


PRS-DMM: <Off, On>
Accuracy: <Slow, Fast>
Instrument Settings



DMM: <KS 3458A or FL8508A>
Address: <1 – 30>

Main Menu>PRS-DMM Mode



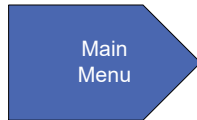
Full Calibration <Enter Password>
Trace Calibration <Enter Password>
Calibration History



Calibrated Resistor: <R1 – R43>

Main Menu>Calibration

PRS-370



Resistance Settings
PRS-DMM Settings
Instrument Calibration (only shown when Cal Enable pressed)
About



IET Labs, Inc.
PRS-370
SN: XX-XXXXXXXX
FW: 1.15
HW: 1.00
Reset to Default <Yes or No>
Factory Reset <Yes or No>

Main Menu>About

3.4.1 Home Screen

The home screen shows the resistance value in ohms or temperature if RTD tables are used. The main display also shows if the unit is configured for 4-wire mode or 2-wire mode in the upper left corner of the display after **Resistance**.



Figure 3-1 Home screen showing 2-Wire

See section 3.2.1 for more information on 2-wire and 4-wire connections.

Pressing **MENU** will display the main menu. Pressing **INC** or **DEC** will increment or decrement the resistance value based upon Resistance Settings>Standard Values. This allows increasing or decreasing the resistance value by a percentage, value in Ωs decade value or EIA preferred values.

Pressing the **LOCAL** key will switch from Remote control to local control.

The bottom part of the home screen shows relevant setup information. These settings can be changed in the Resistance Settings menu.

3.4.2 Setting a Resistance Value

To set a resistance value use the numeric keypad to enter the value followed by the **ENTER** key. Pressing the resistance or temperature value shown on the Home screen will also allow entry

of the value via the touch screen. During entry you can use softkeys to select **Ω**, **kΩ** or **MΩ**.

3.4.3 Menu Key

Pressing the **MENU** key will show the MAIN menu screen. See Figure 3-2.

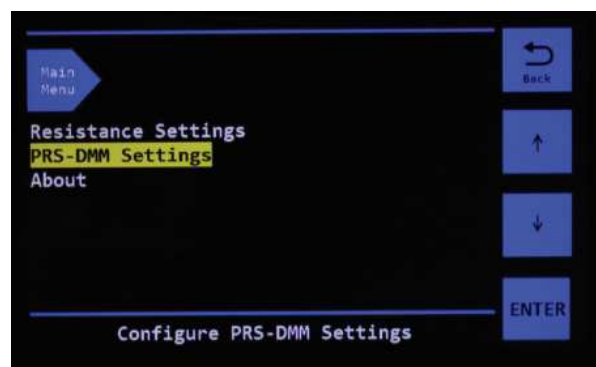


Figure 3-2 Menu Screen

Use the **↑** key to move UP and the **↓** to move DOWN within the items shown on screen.

Press the **ENTER** key to change the item's value or go to the next menu.

Press the **BACK** key to return to previous MENU or home screen at anytime.

3.4.4 Resistance Settings Menu

Using the UP and DOWN arrow keys **RESISTANCE SETTINGS** can be highlighted in yellow, press the **ENTER** key to go to the **RESISTANCE SETTINGS** menu.

Bread crumb navigation shown at the top of the screen shows exactly where you are in the menu system.

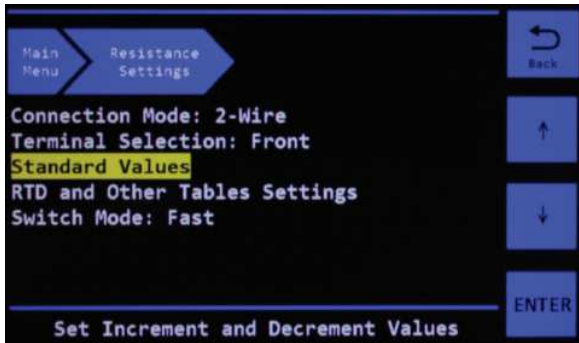


Figure 3-3 Resistance Settings Menu

There are 5 selections available in the **RESISTANCE SETTINGS** menu.

Highlight the selection and press **ENTER** to change the selection.

Connection Mode: allows the user to change between 2-Wire and 4-Wire connections.

In 2-Wire the shorting links should be connected between the two LO terminals, and between the two HI terminals.

In 2-Wire mode the internal trace resistance inside the PRS-370 is automatically compensated for, so no zero subtraction is required.

In 4-Wire mode shorting links should be removed from the binding posts. This mode was designed to be used with DMMs, other meters with 4 terminal (Kelvin connections) and temperature controllers and indicator using 4 terminal RTDs.

Terminal Selection: allows selection of either rear binding posts or front binding posts to be connected to the source resistance.

There is no significant difference in accuracy between the terminals.

In PRS-DMM mode rear terminals should be connected to the 8.5 digit DMM and front terminals to the DUT.

Switch Mode: Allows selection of Default, Open or Short modes. When the resistance or temperature value is changed via the front panel or when a SOURCE:DATA command is sent via the remote interfaces, the intermediate value between previous value and the new value will either be a SHORT, OPEN or undetermined in default switching case.

Standard Values and RTD and Other Tables Settings have separate menus which are described in the sections below.

3.4.5 Standard Values Menu

There are 4 selections available in the **STANDARD VALUES** menu. The **STANDARD VALUES** menu is only applicable to resistance values and not RTD or Tables.

The selection of the standard values controls how the **INC** and **DEC** softkeys work on the **Home** screen see Figure 3-1.

When a value is entered into one of the 4 selections such as Percent Value: shown in Figure 3-4 the **INC** and **DEC** keys will then in this example increment or decrement the resistance value by 10% each time the key is pressed. An * before the selection indicates which is active. The last selection to which a value was entered becomes the active selection.

3.4.5.1 Set Values

The **Set Value:** selection allows the resistance value to be changed by a specific value in Ω s each time the **INC**, increment, and **DEC**, decrement, key is pressed.

Highlight **Set Value:** and press **ENTER** to change the set value.

When a **Set Value:** is selected on the PRS-

370 pressing the **INC** and **DEC** softkeys will increment the resistance value to the next resistance value plus or minus the **Set Value**.

3.4.5.2 Standard Value

The **Standard Value**: allows the PRS-370 to be used as an automated resistance carousel with built-in EIA “preferred value” resistance tables of 1% (E96), 5% (E24), 10% (E12) increments or RATIOMETRIC user specified increment.

When a **Standard Value**: is selected on the PRS-370 pressing the **INC** and **DEC** softkeys will increment the resistance value to the next “preferred” resistance value.

RATIOMETRIC allows a custom tolerance value to be entered by the user. The default value is 0.8% but can be set to the required value in %.



Figure 3-4 Standard Values Menu

Resistors are available in a number of standard ranges, often called ‘preferred values’ These ranges, or series, are set out by the Electronic Industries Association (EIA), and common values are E12, E24, E48, and E96. The number after the ‘E’ denotes the number of resistance values the series contains per decade.

The series are logarithmic and are derived from the resistor tolerance; resistors with a tighter tolerance can have more values in the series that won’t overlap one another. The series are sometimes referred to by the tolerance, the two being related as follows:

- E12: 10% tolerance
- E24: 5% tolerance
- E48: 2% tolerance
- E96: 1% tolerance

3.4.5.3 Decade Value

The **Decade Value:** selection allows the resistance value to increment by a decade value in Ω s each time the **INC** and **DEC** key is pressed.

Highlight **Decade Value:** and then press the **ENTER** key to show the pull-down menu where decade values from 0.1 Ω to 10 $M\Omega$ can be selected.

When a **Decade Value:** is selected on the PRS-370 pressing the **INC** and **DEC** softkeys will increment the resistance value to the next decade resistance value.

3.4.5.4 Percent Value

The **Percentage Value:** selection allows the resistance value to increment or decrement by a specific percentage from 0.0001% to 10% each time the **INC** and **DEC** key is pressed.

Highlight **Percentage Value:** and press **ENTER** to change the set value.

When a **Percentage Value:** is selected on the PRS-370 pressing the **INC** and **DEC** softkeys will change the resistance value to the resistance value plus the resistance value multiplied by the **Percentage Value:**.

3.4.6 RTD and Other Tables Menu

Selecting the **RTD and Other Tables** menu allows use of tables.

There are 9 tables that can be selected. The first 4 tables, are defined as PT-100 $^{\circ}C$, PT-100 $^{\circ}F$, PT-1000 $^{\circ}C$ and PT-1000 $^{\circ}F$ where C is degrees Celsius and F is degrees Fahrenheit.

Press **ENTER** when **Probe Type:** is highlighted

to change between the various RTD tables.

Select **None** for no RTD table and resistance in Ω s will be displayed.

Selecting other tables the units will change to $^{\circ}C$, $^{\circ}F$, $^{\circ}K$ depending upon the table being selected.

DEFAULT is a user defined table and is configured as outlined in section 3.4.5.1.

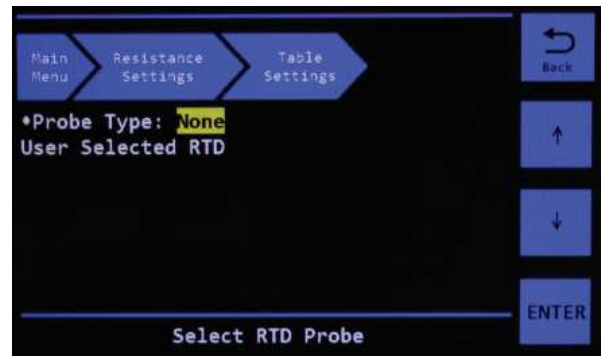


Figure 3-4 No RTD or Table

Press the **ENTER** key and then use the **↑** key to move UP and the **↓** to move DOWN within the items shown on screen, see Figure 3-5., to select the desired |RTD table to be used. For example pressing the **ENTER** key and using the **↑** key to move UP and the **↓** to move DOWN to highlight PT-100 $^{\circ}C$ and then pressing the **ENTER** key will select use of the PT-100 $^{\circ}C$ table as shown in Figure 3-5

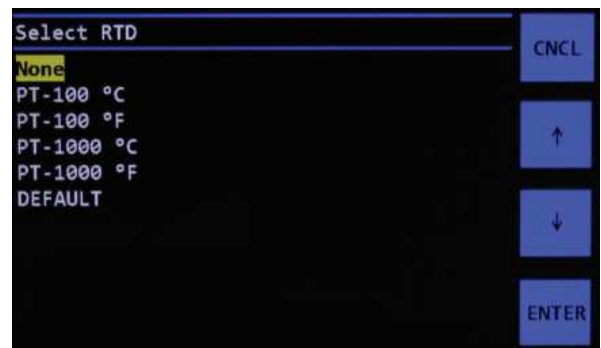


Figure 3-5 Select RTD

Once the table is selected the home screen will change for example to temperature on the display see Figure 3-6.



Figure 3-6 PT-100 °C set to 100 °C

3.4.6.1 User Select RTD Menu

Custom tables and other RTD tables can be configured by highlighting **User Select RTD** and pressing **ENTER**.

The **User Functions** menu will be shown which allows the user to add tables and specify a name for the table. See Figure 3-7

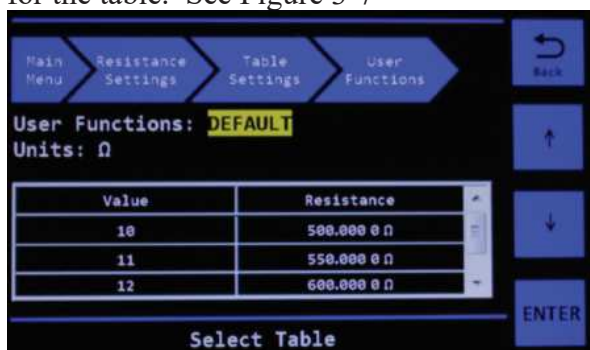


Figure 3-7 User Functions Menu

Highlight **User Functions: Default** and pressing **ENTER** opens the Select Name menu. Select **DEFAULT** From this menu you can press **ADD** or **DEL** to add or delete additional table names. See Figure 3-8.



Figure 3-8 Select Table Name

Pressing **ADD** key opens an entry screen so that a name of the table can be entered.

If there are tables which need to be deleted then highlight the table and press **DEL**.

Once the table name is entered, the table can be selected in **User Functions:** and then a value of Units of Ω , F, C or K can be entered.

Use the **↑** key to move UP and the **↓** to move DOWN between **User Functions:**, **Units:** and the **Table**.

The table shown in the bottom of Figure 3-7 can then be filled out highlighting the Table and pressing **ENTER**. This will allow you to **ADD** or **EDIT** the table.

When **ADD** is selected first enter the Value for the RTD, press **ENTER** and a prompt will be displayed for the desired resistance in Ω s. This can be done for as many points as required. The procedure within the firmware will do linear interpolation in between points so not all possible values need to be entered into the table.

3.4.7 PRS-DMM Settings Menu

Highlight **PRS-DMM Settings** and press **ENTER** key to access PRS-DMM settings. See Figure 3-8



Figure 3-8 PRS-DMM Settings

There are three selections **PRS-DMM Mode**, **Accuracy** and **Instrument Settings**. Highlight **PRS-DMM Mode** or **Accuracy** and press **ENTER** to change these settings. Highlight **Instrument Settings** and press **ENTER** to go to the Instrument Settings Menu.

3.4.7.1 PRS-DMM Mode

Highlighting and pressing **ENTER** on **PRS-DMM Mode** will show the menu in Figure 3-9.



Figure 3-9 PRS-DMM Mode

Use the **↑** key to move UP and the **↓** to turn PRS-DMM Mode **off** or **on**.

When PRS-DMM mode is turned **on** this allows the PRS-370 to control either a Fluke 8508A, 8588A¹ DMM or Keysight 3458A DMM and automatically adjust the output source resistance based upon measurements from the DMM.

¹The PRS-370 can also control the Fluke 8558A

by selecting the Fluke 8588A however the DMM catalog uncertainty shown in DMM mode on the PRS-370 display will be for the Fluke 8588A. You should consult the accuracy specifications for the Fluke 8558A instead of relying on the DMM catalog uncertainty shown.

3.4.7.2 Accuracy

Highlighting and pressing **ENTER** on **Accuracy** will allow selection of Slow or Fast accuracy in Figure 3-10.

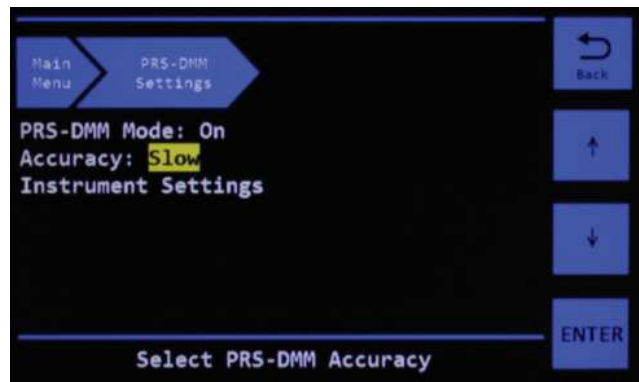


Figure 3-10 Accuracy

When Slow is selected the DMM is configured for 7.5 digits and 6.5 digits in Fast. This affects the speed or time required to perform adjustments in PRS-DMM Mode. Up to 5 iterations can be performed to adjust the source output in either accuracy.

3.4.7.2 Instrument Settings

Highlighting and pressing **ENTER** on **Instrument Settings** will show the menu in Figure 3-11



Figure 3-11 Instrument Settings Menu

Use the **↑** key to move UP and the **↓** to move between **DMM** and **Address**. Highlighting **DMM** and pressing **ENTER** will show the menu in Figure 3-12.



Figure 3-12 DMM

Use the **↑** key to move UP and the **↓** to select either the Fluke 8508A, 8588A or Keysight 3458A and then press **ENTER**.

Highlighting **Address** and pressing **ENTER** will show the menu in Figure 3-13.

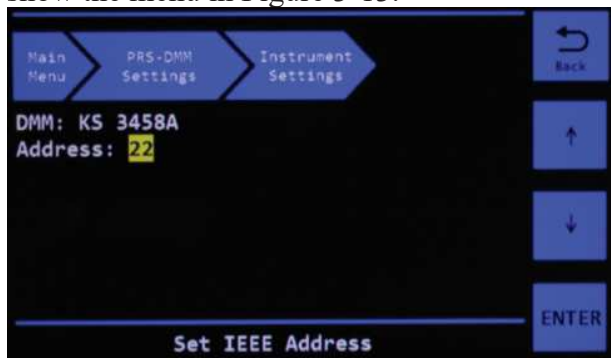


Figure 3-13 Address

Use the **↑** key to move UP and the **↓** to select the GPIB address that the Fluke 8508A, 8588A or Keysight 3458A DMM is set to and then press **ENTER**.

3.4.8 About Menu

The About menu shows manufacturer, Model, Serial number, Firmware (FW), Hardware (HW), and Reset to Default.

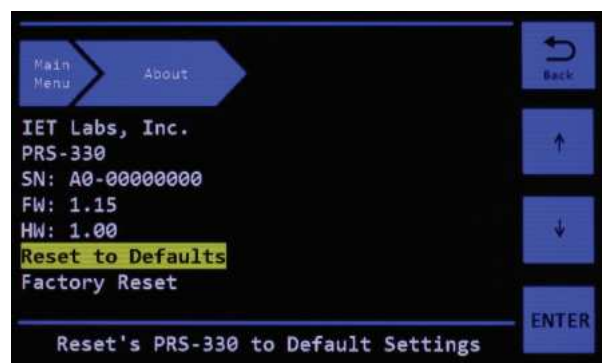


Figure 3-9 About Menu

The only item that can be highlighted and changed is **Reset to Defaults**. Pressing **ENTER** will allow the user to select **YES** or **NO** to reset all parameters back to default. The only item this reset does not affect is Calibration data.

3.5 Thermal emf Considerations

The PRS Series uses high-quality, low-emf components. Thermal emf is primarily attributable to the temperature difference between the leads of the relay and the contacts when temperature is applied to the coil. This emf is of the order of 5 μ V per relay, but is not usually additive. The typical worst case is <15 μ V.

If the effect of tens of microvolts is significant to your application, connect to the instrument

with low-thermal-emf materials only. Copper wire and copper alloys are recommended; brass and steel should be avoided. Tinned copper and solder are acceptable.

This emf will *not* be reflected if an ac measurement instrument is employed, and can be eliminated by using a meter with “True Ohm” capability. In other cases, the emf may represent a very small component of a dc resistance measurement.

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Chapter 4

PRS-DMM Mode

4.1 PRS-DMM Mode

4.1.1 Overview

When PRS-DMM mode is turned **on** this allows the PRS-370 to control, via the IEEE interface, either a Fluke 8508A, 8588A¹ DMM or Keysight 3458A DMM and automatically adjust the output source resistance based upon measurements from the DMM.

¹The PRS-370 can also control the Fluke 8558A by selecting the Fluke 8588A however the DMM catalog uncertainty shown in DMM mode on the PRS-370 display will be for the Fluke 8588A. You should consult the accuracy specifications for the Fluke 8558A instead of relying on the DMM catalog uncertainty shown.

The DMM is used to measure the resistance of the PRS-370, and firmware routine in the PRS-370 adjusts the output resistance to achieve the closest possible resistance value to the target resistance value.

This can improve the accuracy of the PRS-370 from $\pm(70 \text{ ppm} + 1 \text{ m}\Omega)$ to $<10 \text{ ppm}$ short-term without switching.

NOTE: If the IEEE card does not see a controller signal, the PRS-370 assumes control over the IEEE bus to function in PRS-DMM Mode.

See section 5.1 for information as to controlling

the PRS-370 via a PC.

If the PRS-370 has been controlled via a PC the IEEE cable must be disconnected from the PRS-370 and the power cycled on the PRS-370.

This allows the PRS-370 to assume control over the IEEE bus to function in PRS-DMM Mode.

4.1.2 General Requirements

PRS-DMM Mode allows the PRS-370 to control a Fluke 8508A, 8588A or Keysight 3458A DMM via the IEEE interface.

A GPIB cable must be connected between the IEEE interface on the PRS-370 and the IEEE interface on the DMM.

The rear binding post of the PRS-370 should be connected to the front binding post of the DMM using a high quality, 4 terminal kelvin connection.

No shorting links should be used on the front or rear binding posts of the PRS-370.

The PRS-370 configures the DMM for resistance, triggers the DMM to perform a measurement of resistance, and reads the resistance back from the DMM. The source resistance of the PRS-370 is then adjusted to achieve a closer value to the nominal. This process can be repeated in a loop up to 5 times.

Once the process is complete the nominal value, measured value from the DMM, delta from nominal and the absolute uncertainty at $k = 2$ of the DMM is shown on the display. See Figure 4-9

Absolute uncertainty is based upon catalog specifications given in the instruction manuals for the Keysight 3458A or Fluke 8508A, 8588A based upon 1 year absolute uncertainties for $TCAL \pm 1^\circ C$.

4.2 Configuration

Press **MENU** button and highlight **PRS-DMM Settings** and press **ENTER** key to access PRS-DMM settings.

4.2.1 Configure PRS-DMM Mode On

Use the **↑** key to move UP and the **↓** to turn PRS-DMM Mode **On**.

When PRS-DMM mode is turned **On** this allows the PRS-370 to control either a Fluke 8508A, 8588A DMM or Keysight 3458A DMM and automatically adjust the output source resistance based upon measurements from the DMM.

Note: The Fluke 8508A, 8588A will also be configured for Low Current, Fast AD Integration OFF, and Analog Filter OFF.

Note: The 3458A will be configured for PRESET NORM, AZERO ON, OHMF, OCOMP ON, NPCL 10, ARANGE ON and FSOURCE ACV.

4.2.2 Configure Accuracy

Highlighting and pressing **ENTER** on **Accuracy** will allow selection of Slow or Fast accuracy in Figure 4-3.

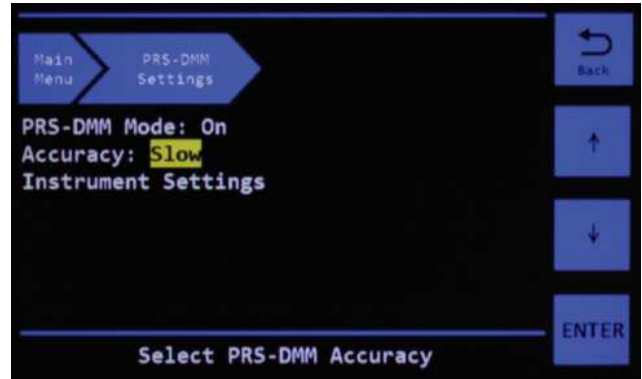


Figure 4-3 Accuracy

When Slow is selected the DMM is configured for 7.5 digits and 6.5 digits in Fast. This affects the speed or time required to perform adjustments in PRS-DMM Mode. Up to 5 iterations can be performed to adjust the source output in either accuracy.

4.2.3 Configure Instrument Settings

Highlighting and pressing **ENTER** on **Instrument Settings** will show the menu in Figure 4-4.



Figure 4-4 Instrument Settings Menu

Use the **↑** key to move UP and the **↓** to move between **DMM** and **Address**.

Highlighting **DMM** and pressing **ENTER** will show the menu in Figure 4-4.

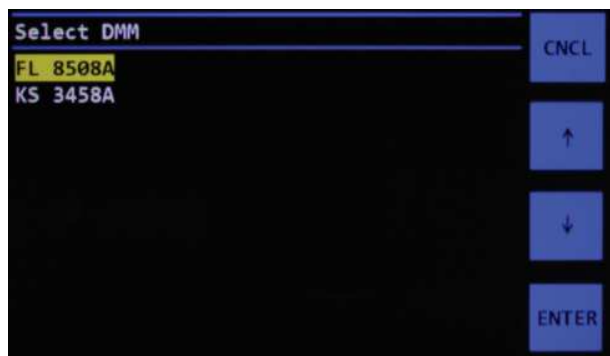


Figure 4-4 Select DMM

Use the **↑** key to move UP and the **↓** to select which DMM is being used in the system the Fluke 8508A, 8588A or Keysight 3458A and then press **ENTER**.

Highlighting **Address** and pressing **ENTER** will show the menu in Figure 4-5.

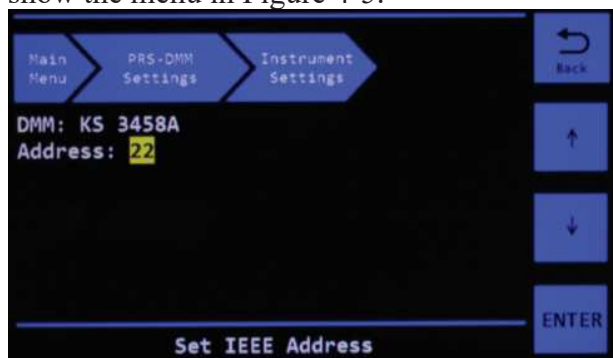


Figure 4-5 Address

Use the **↑** key to move UP and the **↓** to select the GPIB address that the Fluke 8508A, 8588A or Keysight 3458A DMM is set to and then press **ENTER**.

4.3 Performing an Adjustment

Once all of the PRS-DMM setting have been set press the **BACK** button to go to the Home Screen.

The top left of the screen indicates PRS-DMM, Resistance mode. The bottom half of the screen

shows the DMM being used and address. See Figure 4-6.



Figure 4-6 PRS-DMM Home Screen

Touching the resistance value brings up the entry screen for resistance or the numeric keypad can be used to enter the required resistance value as shown in Figure 4-7.



Figure 4-7 PRS-DMM Enter resistance value screen

Enter the required resistance value and press one of the unit buttons.

To initiate an adjustment make sure IEEE and measurement cables are connected between the DMM and the PRS-370. Make sure the DMM is turned on and then press the **DMM** button shown in Figure 4-6.

The Adjusting Screen will be shown in figure 4-8 during the adjustment process.



Figure 4-8 Adjusting Screen

Once the adjustment process is complete the screen shown in Figure 4-9 will be shown.



Figure 4-9 PRS-DMM Mode

Once the fine “Adjusting” has completed;

- Deviation from nominal
- Measured value from the DMM
- Uncertainty of the DMM

Absolute uncertainty is based upon catalog specifications given in the instruction manuals for the Keysight 3458A or Fluke 8508A, 8588A based upon 1 year absolute uncertainties for TCAL ± 1°C.

Once fine “Adjusting” is complete the front connections are switched in and the rear connections are switched off, on the PRS-370 so both the DMM and DUT can be simultaneously connected to the PRS-370.

When the source resistance is measured at the front terminals with a DMM, 15 minutes later the source resistance shows no significant change.

This allows the PRS-370 to become a 4 terminal, short-term stable variable laboratory resistance standard with an uncertainty close to the uncertainty of the DMM used.

Chapter 5

IEEE INTERFACE

5.1 Introduction

The PRS-370 is a IEEE-488.1 and SCPI 1994.0 compatible instrument.

Commands sent to the PRS-370 must be terminated with line feed <LF> or carriage return and line feed <CRLF>.

The IEEE interface can be programmed via any of the commands listed in Appendix A and B.

NOTE: To control the PRS-370 via a PC, the PC must be ON, SIC/ATN line asserted on the GPIB adapter and the IEEE cable connected prior to powering ON the PRS-370.

The IEEE card in the PRS-370 looks at the SIC/ATN line during power up.

If the IEEE card in the PRS-370, sees that the SIC/ATN line is active, the PRS-370 changes mode on power up so it can be controlled via a PC.

If the IEEE card does not see the SIC/ATN line asserted, the PRS-370 assumes control over the IEEE bus to function in PRS-DMM Mode.

See section 5.4 and 5.5 prior to controlling the PRS-370 via a PC to ensure that the GPIB adapter asserts control of the SIC/ATN line.

Firmware version 1.23 and higher

This firmware add an additional command **SYSTEM:HIGHSPEED <0,1>**. This command turns off the display to improve switching time between resistance values.

5.2 Capabilities

The IEEE option provides remote control over all functions except **POWER**. The IEEE option responds to all Basic Commands in Appendix B and all IEEE.2 Mandated common commands in Appendix A.

Commands in Appendix A and Appendix B should **NOT** be combined is a single string.

5.3 Address Switch and Communications Settings

The default GPIB address is 4. This address can be changed remotely by sending the command **SYSTEM:COMM:GPIB:ADDR <n>** where n is 1 - 30.

5.4 ICS GPIB Test Keyboard

To aid the user in operating the PRS, a GPIB “Keyboard” Controller program - the easiest way to control GPIB devices without writing a program - is available from IET. This GPIB Keyboard program automatically finds your device at start-up and it lets you enter just the data that you want to send to the device. This program works with ICS, Measurement Computing and National Instruments GPIB controllers.

To implement, request a download of **ICS_GPIBkybd_Install.zip** from IET Labs at http://www.ietlabs.com/Drivers/ICS_GPIBkybd_Install.zip or the latest version can be downloaded directly from ICS at https://www.icselect.com/pc_files/ICS_GPIBKybd_Install.zip.

Unzip the file and follow instructions to install.

Important

Open the ICS GPIB keyboard application, once the application is open then turn the PRS-370 on.

If you turn the PRS-370 on prior to this, the GPIB interface is not active and the PRS-370 will become a controller.

You may use the **Find Listeners** key to confirm that the PRS-370 is recognized. Other instruments may also be recognized at this time.

Enter and set the **Address** to the PRS address. Use the window to send a **command string** to the PRS, where the command string is constructed as described in Appendix A or B.

A command string might be, for example:

SOURCE:DATA 12.34567

5.5 GPIB Control with National Instruments NI-MAX and Programmatically

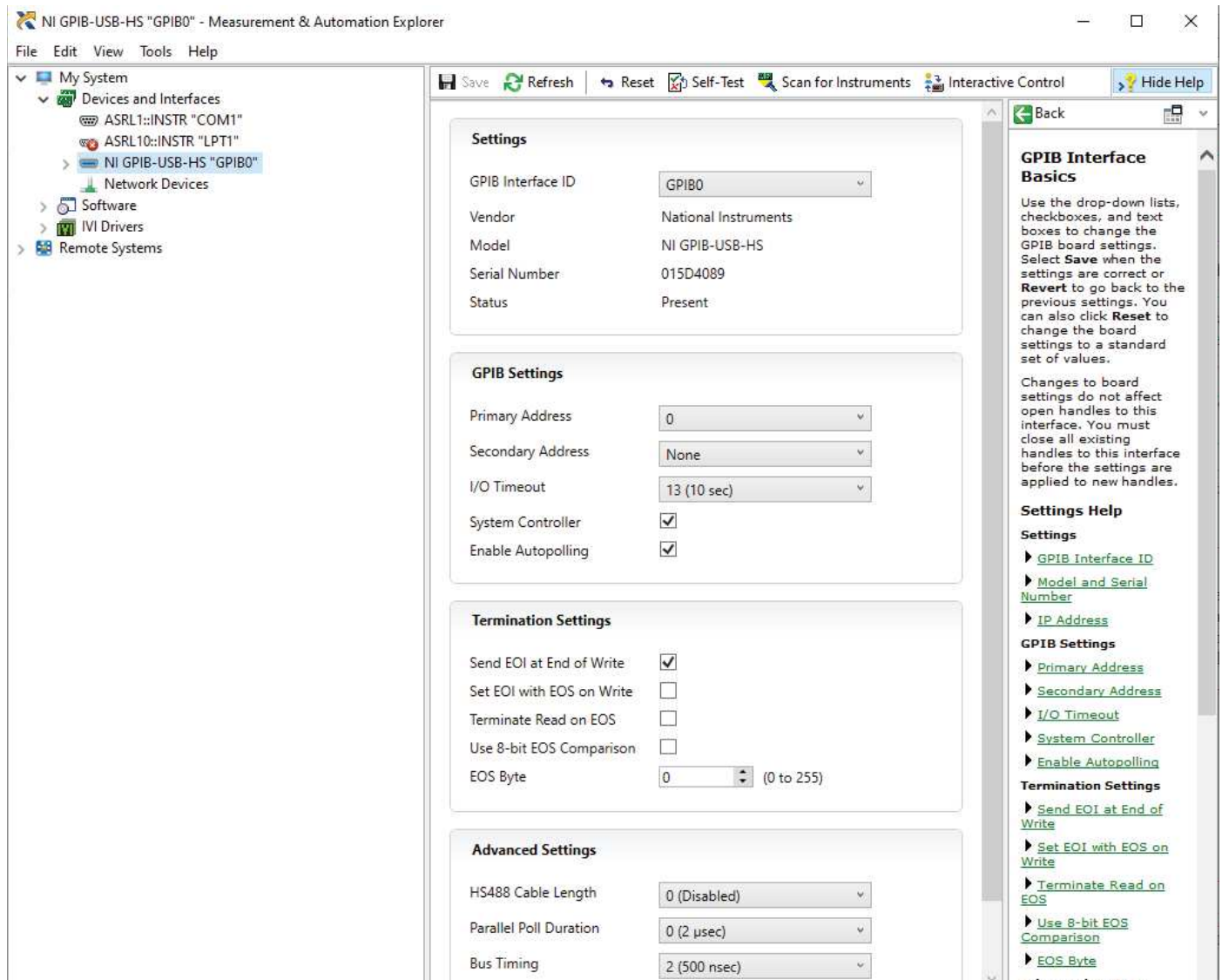
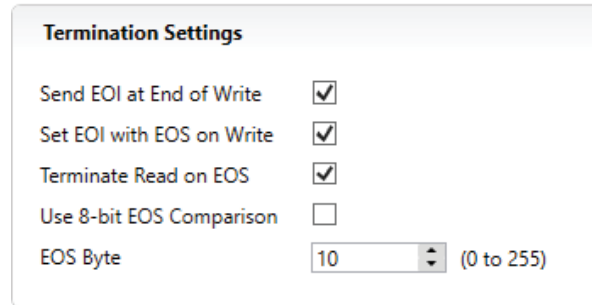
When controlling the PRS-370 via a PC, you must ensure the IEEE-488 interface asserts control of the SIC/ATN line prior to turning the PRS-370 ON.

This can be done in NI-Max or programmatically by following this example.

Connect the IEEE cable between the PC and PRS-370. Ensure the PRS-370 is OFF.

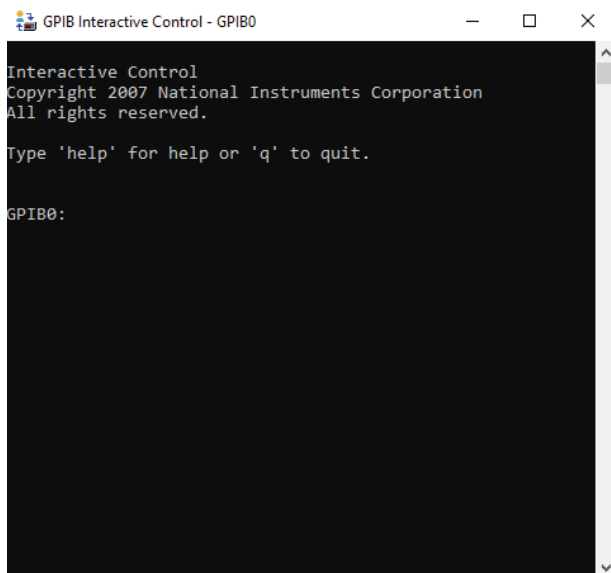
Open NI-MAX, expand devices and interfaces, and select NI GPIB-USB-HS "GPIB0" or GPIB interface being used.

Set the terminations settings as shown:



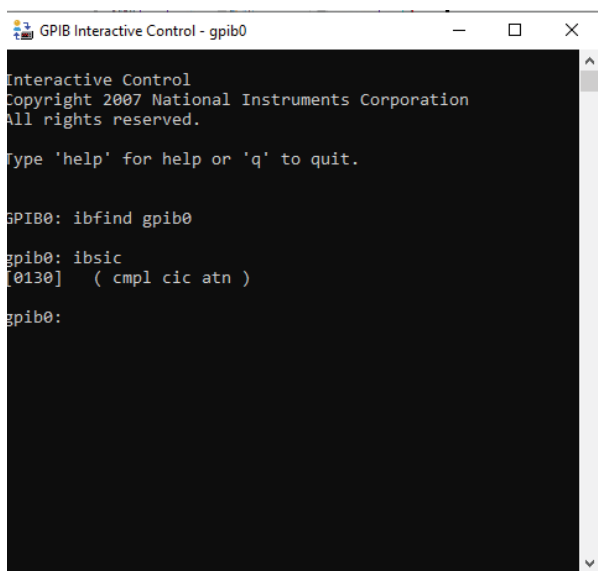
Click on Interactive Control button in NI-Max Measurement and Automation Explorer.

The interactive control window will open as show below.



Type the following into the Interactive Control Window:

“IBFIND GPIB0” and press the enter key
 “IBSIC” and press the enter key



Turn the PRS-370 on. The PRS-370 must complete the boot process with main screen shown prior to continuing.

Close the interactive control window.

From NI-Max Measurement and Automation Explorer, click on scan for instruments.

The PRS-370 will be found at its assigned address. The default address is 4.

Ensure all commands are terminated with a line feed “\n”.

IBFIND GPIB0 and SIC must be sent to the interface prior to turning on the PRS-370. National Instruments GPIB Interface does not asserting ATN until communication occurs over the bus or the SIC command has been sent.

This example is for NI-MAX; however, the same can be accomplished in LabVIEW, other languages such as Visual Basic using the legacy 488 or 488.1 commands.

Use 488 commands when using MET/CAL rather than 488.2 commands.

The terminator CRLF should also be used with MET/CAL as shown below:

1.001 IEEE SOURCE:DATA 20.1 [13][10]

Chapter 6

MAINTENANCE

6.1 Verification of Performance

6.1.1 Calibration Interval

The PRS Series instruments should be verified for performance at a calibration interval of twelve (12) months. This procedure may be carried out by the user, if a calibration capability is available, by IET Labs, or by a certified calibration laboratory. If the user should choose to perform this procedure, then the considerations below should be observed.

6.1.2 General Considerations

It is important, whenever testing the PRS Series Decade units, to be very aware of the capabilities and limitations of the test instruments used. Such instruments have to be significantly more accurate than the specified accuracy for all applicable ranges in order to perform this task, allowing for a band of uncertainty of the instrument itself, the test setup and the environment; consult IET Labs for information.

It is important to allow both the testing instrument and the PRS-370 to stabilize for a number of hours at the nominal operating temperature of 23°C, and at nominal laboratory conditions of humidity. There should be no temperature gradients across the unit under test.

In the case of the PRS-370 a Kelvin type 4-wire test terminals should be used to obtain accurate

low-resistance readings.

Steps should be taken to minimize thermal-emf effects, by maintaining an even temperature and by using only low-emf connectors. Use of meters with a “True Ohm” function is recommended.

Proper metrology practices should be followed in performing this verification.

NOTE: The mode in the PRS-370 affects how calibration is performed. If the PRS-370 is in PRS-DMM Mode then the calibration process is completely automated with the PRS-370 controlling the DMM during the calibration process. If in Source Resistance Mode the process is manual.

6.1.3 Calibration Procedure

Equipment Required:

Keysight 3458A, Fluke 8508A, 8588A or equivalent
KK-100, TL-600 Kelvin Cable or equivalent.

Procedure:

Configure the DMM for 7 ½ digits of resolution or better, Range Auto, Fast off, Filter Off, LOI Off, Zero function and 4 wire measurements.

The Fluke DMM should use Tru-Ω for resistances < 20 kΩ, Ohms for > 20 kΩ to < 2 MΩ and Hi-V for values above 2 MΩ.

The DMM should be zeroed prior to use. Please see the manufacturer's instruction manual for more information on performing a zero with the specific DMM.

The gold shorting links must be removed on the binding posts of the PRS-370.

Connect the DMM to the front binding posts of the PRS-370 using a 4 terminal Kelvin connection.

The PRS-370 consists of 43 internal resistors which are combined in either series or parallel to achieve the programmed resistance.

These resistors require periodic measurement to keep the PRS-370 within published specifications.

The resistors are measured using a DMM. The measured value is then stored in a table within the memory of the PRS-370. The measured values of the resistors are used in an algorithm to determine which resistors are used to create the programmed resistance value.

In addition to the 43 resistors the residual internal lead resistance is also measured at time of manufacture and entered into memory. The internal lead resistance does not need to be measured again unless repair has been performed to the PRS-370.

Below is a list of the 43 resistors and their nominal resistance value. These resistors should be within the percentages below to ensure the unit meets accuracy specifications.

$\pm(1\% + 5 \text{ m}\Omega)$ of the nominal value for R1 to R3

$\pm 1\%$ of the nominal value for R4 to R5

$\pm 0.1\%$ of the nominal value for R6 to R17

$\pm 1\%$ of the nominal value for R18 to R24

$\pm 10\%$ of the nominal value for R25 to R31

$\pm 0.1\%$ of the nominal value for R32 to R43

The Calibration History will show each resistor value and previous calibrated values so that drift of the individual resistors can be evaluated.

Resistance Number	Nominal Resistance Value
R1	0.172 Ω
R2	0.350 Ω
R3	0.700 Ω
R4	1.370 Ω
R5	2.660 Ω
R6	5.150 Ω
R7	10.20 Ω
R8	20.00 Ω
R9	38.80 Ω
R10	75.60 Ω
R11	148.0 Ω
R12	287.0 Ω
R13	570.0 Ω
R14	1.13 kΩ
R15	2.23 kΩ
R16	4.4 kΩ
R17	8.7 kΩ
R18	17.0 kΩ
R19	33.3 kΩ
R20	66.0 kΩ
R21	130.0 kΩ
R22	258.0 kΩ
R23	506.0 kΩ
R24	1.0 MΩ
R25	2.0 MΩ
R26	3.99 MΩ
R27	7.80 MΩ
R28	15.0 MΩ
R29	30.0 MΩ
R30	60.0 MΩ
R31	120.0 MΩ
R32	3.55 kΩ
R33	7.39 kΩ
R34	16.4 kΩ
R35	33.8 kΩ
R36	72.2 kΩ

R37	147.0 kΩ
R38	300.0 kΩ
R39	600.0 kΩ
R40	1.23 MΩ
R41	2.48 MΩ
R42	5.0 MΩ
R43	10.0 MΩ

During the adjustment process the firmware cycles through each resistor and in manual mode the technician can enter the measured resistance value in ohms. This should be done with a minimum of 7 ½ digits of resolution. The accuracy of measurement should be significantly more accurate than the ±(70 ppm + 1 mΩ) for all resistance values.

6.1.5 Calibration Menu and Process

To enter into the calibration process, press the **MENU** key, push in the **CAL ENABLE** key and keep pressed, and then select **Instrument Calibrate**.

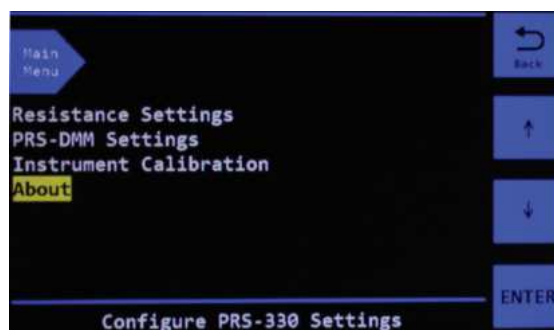


Figure 6-1 Main Menu with CAL ENABLE pressed

Only when the **CAL. ENABLE** key is pressed does the **Instrument Calibration** selection become available.

Select **Instrument Calibration** and press **ENTER**. The menu in Figure 8-2 will be shown. Once this menu is displayed the **CAL. ENABLE**

key can be released.

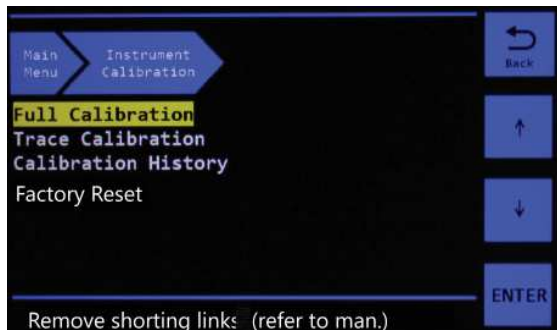


Figure 6-2 Instrument Calibration Menu

Full Calibration allows calibration of 1 or all 43 resistors. Calibration of a single resistor is only available in manual mode.

Trace Calibration is only required if the PRS-370 requires service which involves changing of the relay board, or internal wiring between binding post and the relay board. This compensates for the buss wire resistance between the main board and binding posts.

Calibration History allows the history of each resistor to be reviewed showing resistance at each calibration date.

6.1.6 Full Calibration (adjustment)

Full Calibration can be performed by selecting Full Calibration and pressing the **ENTER** key. A password is required as shown in Figure 6-3.

Figure 6-4 shows entry of the password which is **IET**. Note tapping twice on the alpha keys will select the second letter.

At the end of the process select all calibration values will be saved into memory.

At anytime pressing the **MENU** key will exit calibration without making any changes.



Figure 6-3 Password entry screen



Figure 6-4 Entry of IET as password

Once the password IET has been input via touch screen press the **ENTER** key. This will open the Calibration screen as shown in Figure 6-5.



Figure 6-5 Resistor 1 Calibration Screen

The process is to measure the resistance with a DMM using a 4 terminal Kelvin connection,

making sure the shorting links are not on the binding post.

IET Labs uses the Fluke 8508A, set to 7 1/2 digits of resolution, during the adjustment process to ensure the PRS-370 meets specifications.

NOTE: The mode the PRS-370 is in affects how calibration is performed. If the PRS-370 is in PRS-DMM Mode then the calibration process is completely automated with the PRS-370 controlling the DMM during the calibration process. If in Source Resistance Mode the process is manual.

If the PRS-370 is configured for PRS-DMM Mode prior to going into the calibration routine for the measurement of all 43 resistors is done automatically with the PRS-370 controlling the DMM. The PRS-370 should be configured as outlined in Chapter 4. This is a completely automated process.

If the PRS-370 is configured for source resistance mode the technician will have to manual perform each resistance measurement and then manually enter the resistance value for all 43 resistors.

Once the resistance is measured the resistance value can be manually entered in ohms using the keypad.

Once the resistance has been entered the NEXT key can be pressed to move to the next resistor value R2. The PREV key can be used to go back to the previous resistance value if required. There are 43 resistors which require calibration.

At anytime during the process the CNCL key can be pressed to cancel the calibration process. Cancelling the calibration process will not save any calibration data taken and the previous calibration data is used.

Pressing the EXIT key will save the current calibration data into memory. You will be prompted to enter the calibration date. and then the data is saved into memory. This data can be reviewed in the Calibration History menu.

6.1.7 Calibration History

The Calibration History menu is in the Calibration menu. This allows the user to view the resistance and date the adjustment procedure as perform in Section 6.1.4.

This information can be used to look at the drift of each of the 43 internal resistors. This data can be viewed in this menu. If exporting this data is required see Appendix B remote commands which allow this data to be transferred to a PC.

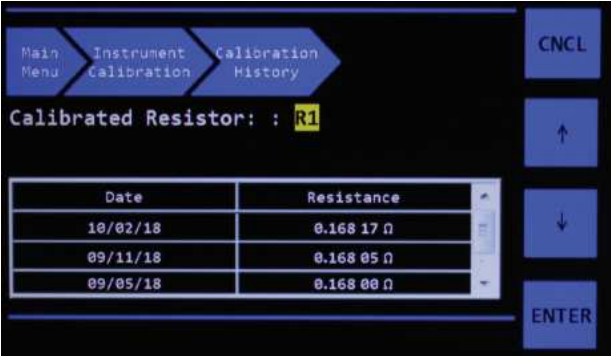


Figure 6-6 Calibration History Screen

From the Instrument Calibration menu select Calibration History and press ENTER. The menu in Figure 6-6 will be shown.

Each time an internal adjustment of the resistors is performed and saved per Section 8.1.4, a new line is added in the table.

Use the ↑ key to move UP and the ↓ to move DOWN which will show the resistors R1 to R43 and the calibration history of each resistor.

Press **CNCL** to return to the previous Instrument Calibration menu.

6.1.8 Trace Calibration

The Trace Calibration menu is in the Calibration menu. This allows the user to adjust the trace resistance, which is only required if there is change of the relay board, or internal wiring between binding post and the relay board. This compensates for the buss wire resistance between the main board and binding posts.

The trace resistance should be calibrated using a Fluke 8508A or IET Labs LOM-510A using kelvin clip connectors.

Prior to calibrating the trace resistance, the gold shorting links on the front and rear inputs should connect each paired red and black binding posts.

Trace Calibration can be performed by selecting Trace Calibration and pressing the **ENTER** key. A password is required as shown in Figure 6-3.

Figure 6-4 shows entry of the password which is **IET**. Note tapping twice on the alpha keys will select the second letter.

To calibrate r1, measure from the front panel black binding posts to the point of the board labeled **LO** in Figure 6-7, typically 0.005 Ω.

To calibrate r2, measure from the front panel red binding posts to the point of the board labeled **BYP** in Figure 6-7, typically 0.005 Ω.

To calibrate r3, measure from the front panel red binding posts to the point of the board labeled **NORM** in Figure 6-7, typically 0.005 Ω.

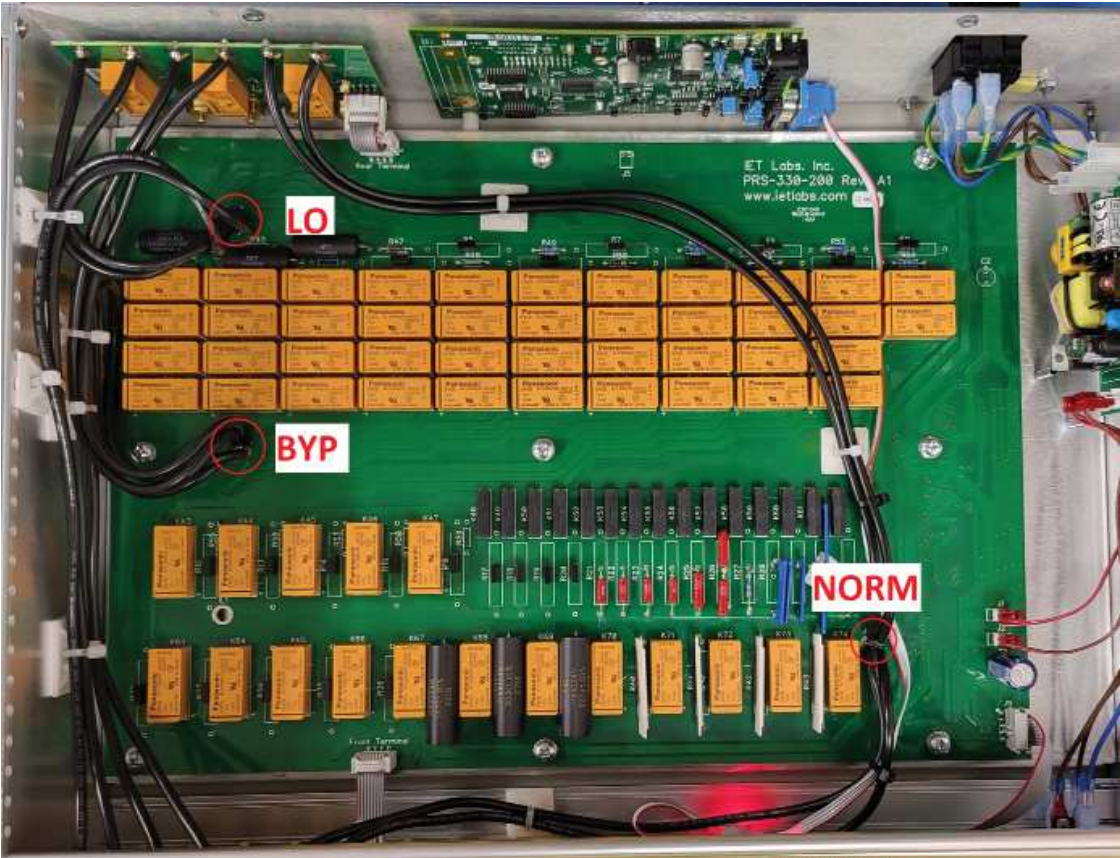


Figure 6-7 PRS Main Board

To calibrate r4, measure from the rear panel black binding posts to the point of the board labeled LO in Figure 6-7, typically 0.001 Ω .

To calibrate r5, measure from the rear panel red binding posts to the point of the board labeled BYP in figure 6-7, typically 0.005 Ω .

To calibrate r6, measure from the rear panel red binding posts to the point of the board labeled NORM in figure 6-7, typically 0.005 Ω .

6.2 Replaceable Parts List

Model Ref	IET Pt No	Description
1	BP-1000-RD	Binding Post, Red
2	BP-1000-BK	Binding Post, Black
3	BP-1000-GN	Binding Post, Green
Not Shown	PRS-370-Bail-Feet kit	4 x feet and bale kit
Not Shown	PRS-370 Relay Board	Relay Board Complete
Not Shown	PRS-370 CPU Board	CPU Board Complete
Not Shown	PRS-370 Remote Interface	IEEE,Interface Card
4	PRS-370 Touch Screen	Touch Screen
Not Shown	PRS-370 BP Board Front	Binding Post Board Front
Not Shown	PRS-370 BP Board Rear	Binding Post Board Rear
5	PRS-370 FP	Front Panel with Overlay and Bezel
6	PRS-370 Keypad	Keypad and Keypad board
7	PRS-370 Power Switch	Power Switch Illuminated

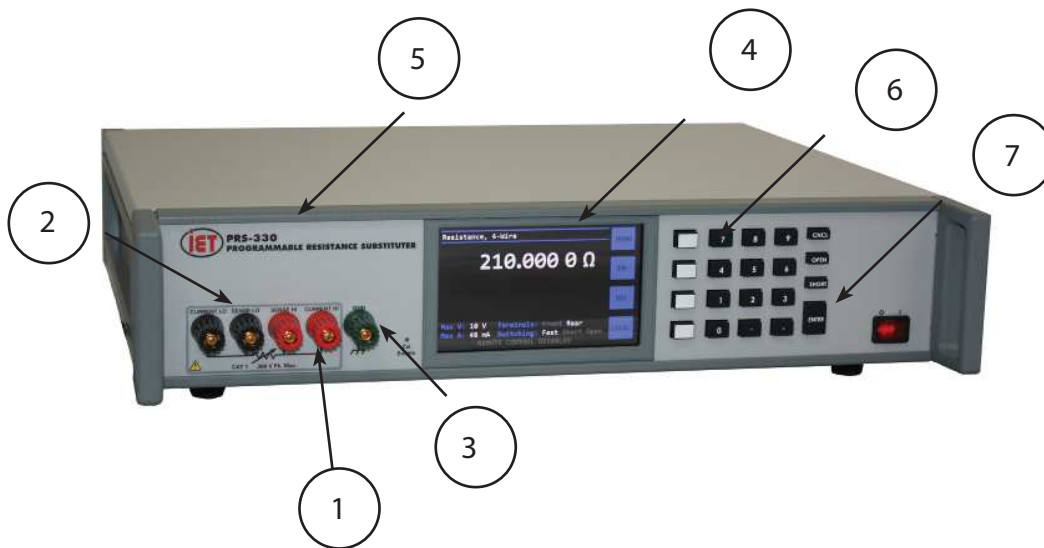


Figure 6-8 PRS Replaceable Parts

Appendix A

SCPI COMMAND REFERENCE

SCPI is an acronym for “Standard Commands for Programmable Instruments”. For additional information or an on-line copy of this standard, see:

<http://www.scpiconsortium.org>.

The IEEE 488.2 Standard was established in 1987 to standardize message protocols and status reporting and to define a set of common commands for use on the IEEE 488 bus. IEEE 488.2 devices are supposed to receive messages in a more flexible manner than they send. A message sent from GPIB controller to GPIB device is called: PROGRAM MESSAGE. A message sent from device to controller is called: RESPONSE MESSAGE. As part of the protocol standardization the following rules were generated:

- (;) Semicolons separate messages.
- (:) Colons separate command words.
- (,) Commas separate data fields.
- <nl> Line feed and/or EOI as last character terminates a ‘program message’.
Line feed (ASCII 10) and EOI terminates a RESPONSE MESSAGE.
- (*) Asterisk defines a IEEE 488.2 common command.
- (?) Ends a query where a reply is expected.

SCPI builds on the programming syntax of IEEE-488.2 to give the programmer the capability of handling a wide variety of instrument functions

in a common manner. This gives all instruments a common “look and feel”. SCPI commands are not case-sensitive.

The portion of commands shown in capitals denotes the abbreviated form of the keyword. Either the abbreviated or whole keyword may be used when entering a complete command. There must be a space between the command and a parameter or channel list. Multiple SCPI commands may be concatenated together as a compound command by using semicolons as command separators.

Keywords shown inside braces [] are defaults, and are optional when constructing a PROGRAM MESSAGE.

Commands not recognized have no effect on the unit’s operation and will set the corresponding bits in the Standard Event Status Register. SCPI commands that end with a question mark ‘?’ are queries. All queries should be followed by reading their response to avoid data loss.

Semicolon ‘;’ is used to separate more commands written on one line.

Terminators: For GPIB interface each command line must end with line feed <lf>. Response from the device also returns line feed <lf>.

IEEE-488.2 Common Commands

*IDN?

Returns instrument identification “IET
Labs,PRS-370,<Serial Number>,<software
version>”

*ESR?

Returns the read of the event status register.

*STB?

Returns the read of the status byte register.

*ESE?

Returns the read of the event status enable
register.

*SRE?

Returns the read of the service request enable
register.

*ESE

Set the event status enable register value

*SRE

Set the service request enable register value

*RST

Reset the buffer

*TST?

Self test query

*CLS

Clear standard event status register

*OPC

Operation complete

*OPC?

Operation complete query

*WAIT

Wait until operation is complete before execut-
ing next command(No Function in PRS)

*PCS

Power-on Status Clear

Note: Remote command can start with or without
* symbol for compatibility.

Appendix B PRS-370 COMMON COMMANDS

COMMON Commands:

- *IDN? Returns instrument identification “IET Labs Inc.,PRS-370,<Serial number>,<software version>”
Serial number in the form “Ax-xxxxxxx” x = 0 to 9. A = Alpha can be A to Z.
- *TST? Self-Test Returns ASCII 0 or 1, 0 = bad or 1 = good
- *RST Returns PRS-370 to default “power on” condition
- *SAV <number> Saves current resistance value into memory location 0 to 9
Number is 0 to 9
- *RCL< number> Recalls resistance value from memory location 0 to 9
Number is 0 to 9

SYSTEM Commands

SYSTEM:SERIAL <Ax-xxxxxxx> Sets the serial number in non-volatile memory < serial number>

Serial number in the form “Ax-xxxxxxx” x = 0 to 9. A = Alpha can be A to Z.

SYSTEM:SERIAL? Returns Serial number

SYSTEM:CONTRast <number> Sets system contrast specific number from 0 to 15

SYSTEM:KEY <number> Same as pressing key on front panel of PRS-370
<Number> is 0 to 24

keys 0-9	0 – 9
OPEN	14
MENU	15
TABLE	16
Decimal Point	21
BACK	23
ENTER	24
Short	17
Open	18

SYSTem:MODEL? Returns model number PRS-370 or PRS-370

SYSTem:SVERsion? Reads system version as a string <n.nn> where n = 1 to 9

SYSTem:HVERsion? Reads hardware version as a string <n.nn> where n = 1 to 9

SYSTEM:HIGHSPEED <0 or 1> Improves switching time to < 100 ms when set to “1”

Note: Updating the display takes significant time, so when set to “1” display updates are turned off to improve switching time.

Note: this function is not saved in memory so a power cycle will enable the display again.

Note: typical switching time is < 1 second as default or when set to “0”

Note: switching time is as well based upon the command CONFIGURE:SWITCH being set to FAST.

Setting CONFIGURE:SWITCH to OPEN or SHORT will increase overall switching time.

CALIBRATION Commands

CALIBrate:RESistance Goes into calibration mode starting at resistor 1 and then progressing to resistor 43. Each time the command CALI:RES:SET is used the resistor number is automatically incremented by 1.

CALIBrate:RESistance? Returns resistance number to be calibrated.

Numbers 1 to 43

CALIBrate:RESistance:SET <number> Sets calibrated value of resistance in ohms into memory. <number> is a floating point number representing the resistance value in ohms for the internal resistor being measured. Each time the command CALI:RES:SET is used the resistor number is automatically increments by 1.

CALIBrate:RESistance:SET? Returns the calibrated value of resistance in ohms

CALIBrate:DATE <mmddyyyy> Sets calibration date into memory

CALIBrate:DATE? Returns calibration date in format mmddyyyy

CALIBrate:HISTory:DATE <MMDDYYYY> Selects calibration date to retrieve data from

CALIBrate:HISTory:RES<number> ? Returns the resistance value based history date and resistance <number> 1 to 43

SOURCE Commands

SOURce:DATA <display value> Sets output resistance of the PRS-370 if table is set to None or the resistance value corresponding to the display value for the table selected.

Display value in form of number and decimal point representing desired display value.

example SOURce:DATA 1.000002 would set resistance value to 1.000002 Ω if Table is set to None.

SOURce:DATA? Returns display value currently shown in the PRS display

CONFIGURE Commands General

CONFigure:SElect <2 or 4> Sets PRS-370 for 2 wire or 4 wire mode.

CONFigure:SElect ? Returns number corresponding to 2 wire or 4 wire mode.

2 = 2 wire and 4 = 4 wire

CONFigure:TERMinal <FRONT, REAR> Selects front or rear binding posts

CONFigure:TERMinal? Returns FRONT or REAR

CONFigure:SWITCh <FAST, OPEN,SHORT>

CONFigure:SWITCh? Returns FAST, OPEN, SHORT

CONFIGURE DMM Mode (PRS-370 Only)

CONFigure:PRSDMM:ACCUracy <SLOW, FAST> Sets resolution of DMM 7 ½ or 6 ½ respectively

CONFigure:PRSDMM:ACCUracy? Returns <SLOW, FAST>

CONFigure:PRSDMM:METER <8508A, 8588A, 3458A> Sets which DMM is used

CONFigure:PRSDMM:METER? Returns string corresponding to selected DMM 8508A, 8588A 3458A

CONFigure:PRSDMM:ADDRes <1 - 30> corresponding to IEEE address 1 to 30 of DMM

CONFigure:PRSDMM:ADDRes? Returns IEEE address of for DMM <1 - 30>

CONFIGURE IEEE (PRS-370 Only)

SYSTem:COMMunicate:GPIB:ADDRes <n> Configure IEEE address <number> Range 1 to 30

Note must be space between ADDR and number.

Changing the IEEE address must be done using the ICS GPIB Keyboard program see section 5.4 for installation of the program.

Open the ICS GPIB Keyboard program

Turn on the PRS-370 The ICS program must be open prior to turning the PRS-370 on.

Using the ICS GPIB Keyboard program

Click on listeners and PRS-370 should be found at address 4

send *idn? And response should be IET Labs Inc.,PRS-370,A3-xxxxxxx,1.22 as a return string
click on Trigger button and response is GET sent.

send *idn? And response should be ICS Electronics, 488-SERIAL, S/N xxxxxx, Rev 01.X4 Ver
18.04.25

Using ICS GPIB Keyboard program

Send SYST:COMM:GPIB:ADDR 16 “in this case we are setting address to 16”

Send SYST:COMM:GPIB:ADDR? and you will get a response of 16.

Send *SAV 0

Power cycle PRS-370

Once PRS-370 has completed initialization

Using the ICS GPIB Keyboard program

Click on Find all listeners

PRS-370 should be found at address 16.

Note on units with serial number starting with A1, A2 or A3

Remove the top cover of the PRS-370

Locate W3 (Reset) jumper the GPIB-Serial Card and remove this jumper

Do not install W3. If you do install W3 the card will revert back to address 4.

Install top cover on PRS-370.

CONFIGURE Standard Values

CONFigure:STDValue <SET, STANard, DECade, RADiometric>

CONFigure:STDValue? Returns SET, STANard, DECade, RADiometric

CONFigure:STDValue:SET <number> 0.1 - 10M

CONFigure:STDValue:SET? Returns <number> 0.1 - 10M

CONFigure:STDValue:STD <1, 5, 10> EIA resistor %

CONFigure:STDValue:STD? Returns 1, 5, or 10 corresponding to EIA Resistor %

CONFigure:STDValue:DECade <number> 0.1 - 10M

CONFigure:STDValue:DECade? Returns <number> 0.1 - 10M

CONFigure:STDValue:RADiometric <number> 0.001 - 10 where number is in %

CONFigure:STDValue:RADiometric? Returns <number> 0.001% - 10%

CONFIGURE Tables

CONFigure:RTD <P100C, P100F, P1000C,P1000F>

CONFigure:RTD? Returns which RTD table is selected P100C, P100F, P1000C, or P1000F

CONFigure:TABLE:SElect <number> Selects Table to be used, <number> is 0 to 9. 0 is no table with display shown in ohms and 1, 2, 3 and 4 are predefined and 5 to 9 are user defined tables

CONFigure:TABLE:SElect? Returns table number that is selected

CONFigure:TABLE:NAME <name> Sets Table name, <name> is ASCII up to 20 characters such as "PT100"

CONFigure:TABLE:NAME? Returns the number, 1 to 4, of currently selected table

CONFigure:TABLE:ERASE Erases all rows in the table

CONFigure:TABLE:ADD <user_value,resistance_value> Adds a row to the end of table showing user value and resistance value in ohms.

example CONF:TABL:ADD 20, 95 means that if the table is selected and the operator enters 20 from the front panel the output will be set to 90 Ω .

CONFigure:TABLE:ADD? Returns the last entry in the table

CONFigure:TABLE:DISPlay? Returns all data in the table

Example of information returned

PT100

20, 95

CONFigure:TABLE:UNIT <Unit> Set units for tables up to 8 ASCII characters
As an example “C” could be send for Celsius or “F” for Fahrenheit

CONFigure:TABLE:UNIT? Returns ASCII string representing the units

