♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

PRS-202 SERIES

High Precision
Manual or SCPI Programmable
Decade Resistance Substituters

Operation Manual

PRS202 IEEE.2 im/October, 2002

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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 MERCHANTIBILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

WARNING

OBSERVE ALL SAFETY RULES
WHEN WORKING WITH HIGH VOLTAGES OR LINE VOLTAGES.

Dangerous voltages may be present inside this instrument. Do not open the case
Refer servicing to qulified personnel

HIGH VOLTAGES MAY BE PRESENT AT THE TERMINALS OF THIS INSTRUMENT

WHENEVER HAZARDOUS VOLTAGES (> 45 V) ARE USED, TAKE ALL MEASURES TO AVOID ACCIDENTAL CONTACT WITH ANY LIVE COMPONENTS.

USE MAXIMUM INSULATION AND MINIMIZE THE USE OF BARE CONDUCTORS WHEN USING THIS INSTRUMENT.

Use extreme caution when working with bare conductors or bus bars.

WHEN WORKING WITH HIGH VOLTAGES, POST WARNING SIGNS AND KEEP UNREQUIRED PERSONNEL SAFELY AWAY.

CAUTION

DO NOT APPLY ANY VOLTAGES OR CURRENTS TO THE TERMINALS OF THIS INSTRUMENT IN EXCESS OF THE MAXIMUM LIMITS INDICATED ON THE FRONT PANEL OR THE OPERATING GUIDE LABEL.

Chapter 1
INTRODUCTION

The PRS-202 (Figure 1.1) Series is a broad line of high precision manual and programmable decade substituters. They provide straight resistance substitution as well as RTD (Resistance Temperature Detector) simulation, in a wide selection of ranges, tolerances and ratings.

The PRS-202 substituter is a precision resistance source with excellent characteristics of stability, temperature coefficient, and power coefficient. High dynamic ranges are available, starting as low as 1 mΩ, and extending to as many as 10 decades. These features combined with a low virtually constant "zero resistance" make for very versatile instruments.

The PRS-202 Series features two optional special settings. An "open circuit" and a "short circuit". These modes are useful for obtaining reproducible transitions between settings, i.e. break-before-make or to short between settings. The "short circuit" setting also provides a reduced zero resistance.

Operation is both local using convenient direct reading front panel thumbwheel switches, and remote with optional parallel BCD or IEEE-4888 interfaces. Both can provide an optional extra "10" position for each decade.

The PRS-202 Series 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 artificially reflect a change in dc resistance measurements. All other conductors within the instrument, as well as the solder employed contain no metals or junctions that could contribute to thermal emf problems.

With a resolution as low as 1 mΩ and a maximum available resistance of over 100 MΩ, the PRS-202 Series may be used for exacting precision measurement applications requiring high accuracy, good stability, and low zero resistance. They are suited for automatic and manual calibration and testing, simulation of RTD'S, programmable loads, and many other laboratory and industrial applications.

The PRS-202 Series may be rack mounted to serve as components in measurement and control systems.

Figure 1.1: High Precision Manual or Programmable Decade Resistance Substituter

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PRS-202 SERIES OPERATING GUIDE

CONSULT INSTRUCTION MANUAL FOR PROPER INSTRUMENT OPERATION

Resistance Type: Resistance wire for 0.1 Ω steps and below; hermetically sealed, wirewound, low-inductance resistors for 1 Ω to 100 kΩ steps; precious metal-oxide film resistors for 1 MΩ steps and over.

Range: 0 to 99,999,999.9 Ω, with 0.1 Ω steps.

Accuracy: ±(0.05% + 15 mΩ), after subtraction of **Zero Resistance**, 4-terminal "true-ohm" measurement, at 23°C; traceable to **NIST**.

Zero Resistance: <140 mΩ, <100 mΩ, typical; add 20 mΩ if **OC** (Open Circuit) option is present; <20 mΩ, with **SC** (Short Circuit) option activated.

Drift after Warm-up: <±(75 ppm + 2 mΩ), true resistance drift; typically less.

Maximum Load: 3 A, or 200 V (dc + ac peak), or 0.5 Ω/step, or 4.5 Ω maximum, whichever applies first.

Interface: IEEE-488.2-1987,SCPI 1994.0; front panel switch selects **REMOTE** or **LOCAL** operation;
`"*IDN"` for S/N, Model & REV; **`"CAL:DATe?"`** for last calibration date

Terminals: Four gold-plated tellurium-copper binding posts are provided for **HI** and **LO** terminal pairs for **CURRENT** and **SENSE**. These binding posts virtually eliminate thermal emf effects at their junctions. One additional binding post, **GND,** is connected to the case, to chassis ground, and to earth ground.

POWER: **110-125 V or 210-250 V; 50-60 Hz;**
(internally switch selectable)
0.5 A fuse, 5x20 mm.

MODEL: **PRS-202W-IEEE.2**
SN: **G2-XXXXXXX**

WARNING

Observe all safety rules when working with high voltages or line voltages.
ELECTRICAL SHOCK HAZARD. DO NOT OPEN CASE.
REFER SERVICING TO QUALIFIED PERSONNEL.

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FIGURE 2.1 Typical OPERATING GUIDE Affixed to Unit

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.

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

3.2 Connection

3.2.1 General Considerations

The PRS-202 Series Decade unit is available in three or five terminal versions. The binding posts are standard laboratory type and readily accept banana plugs, telephone tips, spade lugs, alligator clips, and bare wire. Binding posts are located on the front panel of the instrument unless specifically ordered with a Rear Output option.

The three terminal version posts are labeled **HI**, **LO**, and **GND**. The **HI** and **LO** terminals are connected to the ends of the internal impedance being set.

5 terminal models provide four Kelvin terminals consisting of a **CURRENT** and a **SENSE** pair, each labeled **HI** and **LO**. These minimize contact resistance.

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-202 is directly affected by the quality of the connection to the system under test. This is particularly true with the precision series models equipped with higher accuracy, lower impedance decade values.

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

3.2.3 Four-Wire Kelvin Lead Connections

4-wire Kelvin leads minimize the effects of contact resistance and approach ideal performance. The **CURRENT** and **SENSE HI/LO** terminal pairs may be shorted together to provide a 2-terminal load in instances where high accuracy is not a concern.

3.2.4 Thermal emf Considerations

The PRS-202 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 □V per relay, but is not usually additive. The typical worst case is <15 μV.

If the effect of tens of microvolts are significant to your application, connect to the instrument with low thermal emf materials only. Copper wire and copper alloys are recommended, whereas brass and steel should be avoided. Tinned copper and solder is 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.

3.3 Dial Setting

Each decade is manually controlled via a front panel thumbwheel that provides positions for "0" through "9". The total impedance is set / read from the dial setting in a direct fashion. The decimal point, if any, is marked on the thumbwheel switches, and the steps are clearly marked on the panel. Short Circuit / Open Circuit mode control is only available using a Remote control option.

3.4 Environmental Conditions

The PRS is built, calibrated and intended for use in a laboratory environment with a nominal ambient temperature near 23°C. The accuracy of the unit may be affected when operated in non-laboratory environments. Always allow the instrument to stabilize to room temperature after unpacking or relocating the instrument. Humidity should be maintained at laboratory conditions.

3.5 Local Operation

Operation of the PRS-202 substituter is straightforward and graphically represented on the front panel.

1. Turn on the **POWER** switch. The **POWER** indicator lamp, if present, should come on. If a REMOTE option is present, the **READY** and **LOCAL** indicators should illuminate.

2. Set the **REMOTE/LOCAL** switch to **LOCAL**.

3. Connect any desired instrumentation to the front panel binding posts. The **GND** terminal may be connected to the ground of external equipment. The **GND** terminal is connected to the case and to both chassis and earth grounds.

4. Make 4-terminal or 2-terminal connections as described previously. A shielded set of cables is recommended whenever AC operation is involved.

5. Set the thumbwheel switches to provide the actual desired impedance in the actual units indicated on the front panel.

3.6 Remote Operation

The PRS includes a **REMOTE/LOCAL** switch on the front panel. The **REMOTE** position is a remote *enable*. When in **LOCAL** mode, the PRS supplies the impedance value selected using the front panel thumbwheel switches.

When the switch is in the **REMOTE** position, the PRS will supply the configured remote impedance value *only if* that option asserts remote control. If the option does not assert control, the front panel thumbwheel impedance value is supplied. The **REMOTE** and **LOCAL LEDs** always indicate which interface is controlling the impedance value.

Setting the front panel **REMOTE/LOCAL** switch to LOCAL *overrides* the REMOTE option settings and *always* sets the supplied impedance to the value selected using the front panel thumbwheels, regardless of the REMOTE option's assertion of control.
The REMOTE BCD option sets impedance values and asserts control using TTL logic. The impedance values are BCD encoded per table 4.2.

For IEEE and RS232 units, the **LOCAL** indicator remains on until communication with the unit is initialized. The mode changes to **REMOTE** after controller commands are given.

Chapter 4

BCD INTERFACE OPTION

4.1 BCD Programming

All PRS-202 units come with a **BCD** (**B**inary **C**oded **D**ecimal 1-2-4-8 coding) remote programming capability accessed through the **BCD INPUT** connector

The connector is a 50-pin female parallel interface industry standard connector found on the rear panel. Table 3.1 gives the connector pin assignment view. Table 3.2 gives the pin assignments for the BCD input for this connector. There can be as many as 10 digits to be input. For any unit with fewer than 10 digits, only the implemented subset of these will be operational. All other digits may be ignored, and the associated pins may be left open or shorted to ground.

Once the unit is switched to **REMOTE** with the front panel knob, it may be set to either **LOCAL** or **REMOTE**, states under external control by properly selecting pins 21 and 22 on the **BCD INPUT** rear panel connector as shown in Table 3.1. Note that both pins must be set. The **REMOTE** and **LOCAL** led's will respond accordingly. Once the PRS-202 is set into Remote, the thumbwheel switches become disabled, and impedance control is transferred to the rear panel connector.

In addition, two special optional function pins are provided to set the unit in open circuit or (optional) short circuit states across the **HI** and **LO** terminals on the front panel. Applying a low to pin 34 activates an open circuit condition. If the short circuit option is present (this option provides a lower resistance short circuit than a zero setting), applying a high to pin 35 provides a short circuit. If these functions are not required, these two pins may be left open, or the opposite logic levels may be applied, i.e. high to pin 34 and low to pin 35. If both pins are activated, the system will be in the short circuit mode. If the short circuit option is not present, pin 20 may be left in any state.

25	**24**	.....	**2**	**1**
50	**49**	.....	**27**	**26**

(Front View)

Table 4.1 BCD INPUT Connector

Pin No.	BCD Code Weight	Function	Description
30	1		
31	2		
32	4		0.01-0.09Ω
33	8		
43	1		
42	2		
41	4		0.1-0.9 Ω
16	8		
39	1		
38	2		
37	4		l-9 Ω
36	8		
47	1		
46	2		
45	4		10-90 Ω
44	8		
4	1		
3	2		
2	4		100-900 Ω
1	8		
8	1		
7	2		
6	4		1-9 kΩ
5	8		
12	1		
11	2		
10	4		10-9O kΩ
9	8		
16	1		
15	2		
14	4		100-900 kΩ
13	8		
20	1		
19	2		
18	4		l-9 M Ω
17	8		
29	1		
28	2		
27	4		10-90 M Ω
26	8		
34		Open circuit control	Low to activate; otherwise high or open.
35		Short circuit control (optional)	High to activate; otherwise low or open; If option is absent, pin may be in any state.
23		Earth ground	
24		+5V, l0 mA maximum	
25		Earth ground	
21		LOCAL/REMOTE select	High for LOCAL; Low for REMOTE
22		LOCAL/REMOTE select	Low for LOCAL; High for REMOTE
48		Reserved for IEEE-488	
49		Reserved for IEEE-488	
50		Reserved for IEEE-488	

Table 4.2 BCD INPUT Connector Pin Assignments

Chapter 5

IEEE INTERFACE OPTION

5.1 Introduction

The IEEE interface option makes the PRS-202 a IEEE-488.2-1987 and SCPI 1994.0 compatible instrument.

The IEEE STD 488.2 covers the electrical and mechanical bus specifications, and state diagrams for each GPIB bus function. It also establishes data formats, common commands for each 488.2 device and controller protocols. The standard is available on-line at http://www.ieee.org or by contacting the IEEE at:

IEEE Corporate Office
3 Park Avenue, 17th Floor
New York, New York
10016-5997 U.S.A.
Tel: +1 212 419 7900

The SCPI standard provides a tree like series of standard commands for programmable instruments so that similar instruments by different manufacturers can be controlled by the same program. SCPI information and a command reference are located in Appendix A.

5.2 Capabilities

The IEEE option provides remote control over all functions except **POWER**.

5.3 Address Switch and Communications Settings

Each GPIB bus device is identified by a five-bit binary address. There are 32 possible primary addresses 0 through 31; addresses 0 and 31 are reserved . The PRS **BUS ADDRESS** switch on the rear panel establishes the GPIB address of the unit. Bus address settings are read at power up. Refer to table 5.1.

Decimal Address	SWITCH SETTINGS 5-4-3-2-1	Decimal Address	SWITCH SETTINGS 5-4-3-2-1
0	0-0-0-0-0	16	1-0-0-0-0
1	0-0-0-0-1	17	1-0-0-0-1
2	0-0-0-1-0	18	1-0-0-1-0
3	0-0-0-1-1	19	1-0-0-1-1
4	0-0-1-0-0	20	1-0-1-0-0
5	0-0-1-0-1	21	1-0-1-0-1
6	0-0-1-1-0	22	1-0-1-1-0
7	0-0-1-1-1	23	1-0-1-1-1
8	0-1-0-0-0	24	1-1-0-0-0
9	0-1-0-0-1	25	1-1-0-1-0
10	0-1-0-1-0	26	1-1-0-1-0
11	0-1-0-1-1	27	1-1-0-1-1
12	0-1-1-0-0	28	1-1-1-0-0
13	0-1-1-0-1	29	1-1-1-0-1
14	0-1-1-1-0	30	1-1-1-1-0
15	0-1-1-1-1	31	Reserved, do not use

Table 5.1 IEEE Bus Address Settings

5.4 IEEE Option Operation

The IEEE controller asserts remote mode upon receipt of a valid command. The **REMOTE** LED will light and impedance settings will be controlled through the IEEE interface *if* the **REMOTE/LOCAL** switch is in the **REMOTE** position. Remote control may be dropped by issuing an IEEE GTL command. Dropping remote sets the PRS output to the value selected via the front thumbwheel switches. See Chapter 3 for information about **REMOTE/LOCAL** functionality.

Chapter 6

SERIAL INTERFACE OPTION

6.1 Introduction

The SERIAL option adds RS232C and SCPI 1994.0 capability to the PRS-202 series instruments. The SCPI standard provides a tree like series of standard commands for programmable instruments so that similar instruments by different manufacturers can be controlled by the same program. A PRS SCPI command reference is included in Appendix A.

6.2 Capabilities

The SERIAL option provides remote control over all functions except **POWER**.

6.3 Signal Interface and Communications Settings

A 25 pin male DTE interface connector conforming with EIA-STD-RS-530 is located on the rear-panel. The default communications parameters are:

Parameter	Default	Range/Choices
Baud	9600	300 - 115,200
Data Bits	8	7 or 8
Stop Bits	1	1 or 2
Parity	0	Odd, Even, None

Connection of a PC to the PRS SERIAL option is typically made through a simple null-modem or “LapLink” cable.

IET Pin	RS232	Signal Name	Direction *In / Out*
1	AA	Chassis	n/a
2	BA	Send Data	⇨
3	BB	Receive Data	⇦
4	CA	Request to Send	⇨
5	CB	Clear to Send	⇦
8	CF	Signal Detected	⇦
20	CD	Data Terminal Rdy	⇨

6.4 SERIAL Option Operation

The SERIAL option uses the same command set as the IEEE option. Additional commands exist for configuring the serial interface. Changes to the serial UART take place at power-on or after a reset.

SCPI command strings must be followed by a <CR> to terminate the message. Every command returns a response that includes a message terminator. The program/operator should wait for this message terminator before sending additional commands.

Command characters are not echoed to the interface on power up. Send <CTRL-E> to force the controller to echo commands back to the interface and <CTRL-F> to disable echo.

By default, the controller returns ">" and <LF> as a prompt after executing any command. When Echo is turned 'On', the controller returns <CR><LF> and ">"as a prompt after executing any command.

Echo-back Mode	RS232 Prompt	Message Terminator
On	CR LF >	CR LF
Off	>LF	LF

Chapter 7

PROGRAMMING

7.1 Introduction

PRS-202 units equipped with IEEE or SERIAL options implement a consistent SCPI interface. A PRS SCPI command reference is included in Appendix A.

7.2 Command String Structure

Output is controlled in the form of a single SCPI command followed by a space and a 12 character **Resistance String.** The first character controls **Open Circuit (OC)** and **Short Circuit (SC)** modes in units equipped with this feature.The remaining eleven characters represent the value of each possible decade.

The **Resistance String** is constructed as:

- **The number is in units of mΩ (0.001 Ω).**
- **All 12 characters must be provided; active characters are those matching front panel thumbwheel decades.**
- **The decade values are straight-reading, from left to right. All preceding and trailing zeros must be included to complete 12 characters; any other characters in those spaces will be ignored.**
- **A decimal point may not be included.**

The **Resistance String** has a minimum step of 0.001 Ω assigned to the right-most character in the string. To create the SCPI command:

- **Multiply the desired value, in ohms, by 1,000**
- **Convert integer portion of value to a string,**
- **Prepend 0's to create 12 character Resistance String**
- **Combine with "SOURce:DATA " command.**

For example:

Value	Command
600,567.9 Ω	`SOURce:DATA 000600567900`
2,700,000 Ω	`SOURce:DATA 002700000000`

Characters sent for decades not implemented are ignored. Setting a PRS with 4 decades and a minimum step size of 1,000 Ω to 10,600,567.9 would result in an actual value of 600,000 Ω. For example:

Command	Value
`SOURce:DATA 010600567900`	600,000 Ω

Optional **OC** and **SC** modes positioned at the first character of the **Resistance String.** for the OC and SC modes for a unit with a total of 7 decades and a minimum step of 0.001 Ω are:

Open circuit	`SOURce:DATA 1YYYYXXXXXXX`
Short circuit	`SOURce:DATA 2YYYYXXXXXXX`
	(where X = any decade value,
	Y doesn't matter, PRS not equipped)

OC and **SC** modes may be used to create a "controlled transition" between two values without concern for transitional switching of the relays.

- **Output command for R1.**
- **Output command for R1 plus a SC Mode Character.**
- **Output command for R2 plus a SC Mode Character.**
- **Output command for R2.**

This technique also applies to the OC mode.
OC/SC mode Character =
0, 4, 8, or absent for NORMAL operation
1, 5, or 9 for OPEN CIRCUIT operation -*optional*
2, 3, 6, or 7 for SHORT CIRCUIT operation -*optional*

7.3 Advanced Programming - Software Drivers

Basic control of a PRS can be automated by writing a function that accepts a numeric value and converts it to the string using the method described previously.

If the PRS is to be used in an automated environment where various models and options may be installed or where interchangeability is a requirement, a *driver* can be written that abstracts the device specific functions from the test sequence.

The PRS family of instruments are available in many models (including inductance, resistance and capacitance) ranges, (1milliOhm to 10MegaOhm) and with various options. Information to create a more robust driver to control a PRS instrument is listed below.

7.3.1 Determining the PRS Configuration

The IEEE 488.2 specification defines the *IDN string as containing 4 sections separated by commas; the manufacturer, the model, the serial number and the revision of the instrument.

The Model section of the *IDN string of the PRS has been encoded to provide information about the characteristics of the specific instrument being used. For example, a *IDN query to a PRS might return:

```
IET Labs,PRS-200-F-6-100m-0-0,D6-0211201,D6
```

In our example above, the Manufacturer section contains “IET Labs”, the Model section contains “PRS-200-F-6-100m-0-0”, the Serial Number section “D6-0211201” and the Revision section “D6”. The model is split into 7 parts with dashes to identify:

Type
Version
Tolerance
Number of Decades
Least Significant Decade
Slot of LSD
Options

Type:

PRS	Resistance Substituter

Version:

200
201
202

Tolerance:

X:	0.01%
Q:	0.02%
A:	0.05%
B:	0.1%
C:	0.5%
F:	1%
G:	2%
H:	4%

LSD:

1m	1 milliOhm
10m	10 milliOhm
100m	100 milliOhm
1	1 Ohm
10	10 Ohm
100	100 Ohm
1K	1 KOhm
10K	10 KOhm
100K	100 KOhm
1M	1 MegaOhm
10M	10 MegaOhm

Note: micro and Mega Ohms use the same suffix letter; case indicates magnitude.

Open Cicuit / Short Circuit Option:

0	not equipped
1	Open Circuit option present
2	Short Circuit option present
3	Both OC/SC present

7.3.2 Instrument Initialization

Reset the unit to power up defaults using *RST

Check that the instrument is “in cal” by reading the calibration date and compare it to current date/time using CALibrate:DATe?

Read the IDN string from the PRS

Parse the IDN string to extract the IDN String Model (second) section. Parse this further to determine:

let iType= type of device (R,L,C,RTD; enum 0-3)
let iModel = model (200,201,202; enum 0-2)
let iTol = tolerance (see section 7.3.1; enum 0-10)
let iDec = value of "Number of Decades"
let nMin = numeric value of LSD (see section 7.3.1)
let locLSD = location of the LSD on system board
let iOption = options installed (see section 7.3.1)
let iMax =(iMin*10**nDec)

Calculate iMax. In our example, the LSD is 100m or 0.1 Ohms and the number of decades is 6

iMax =(0.1*10**6)-iMin ; or iMax = 99,999.9

7.3.3 Source Impedance

Range test the desired output value against iMin and iMax. Coerce the supplied value to the max or min, return an error code, or use optionally equipped OC/SC features per your needs.

Example 1:
let iModel = 0 (model 200/201 system board)
let iValue equal 123.51
iValue is < 99,999.9 and > 0.1;
therefore iValue = 123.51

Example 2:
let iModel = 1 (model 202 system board)
let iValue equal 1,000,000
iValue is > 99,999.9;
if iOption = 1 or 3 then iValue = 100,000.0
else iValue = 99,999.9

Multiply iValue by one over iMin to shift the digits below the operating range of the PRS to the right of the decimal point (in this case, 10). Select the integer portion of iValue

Example 1:
iValue=iValue*(1/iMin)
iValue=123.51*(1/.1); or iValue = 1235.1
iValint=int(iValue); or iValint = 1235

Example 2:
iValue=iValue*(1/iMin)
iValue=100,000*(1/.1); or iValue= 1,000,000.0
iValint = int(iValue); or iValint = 1000000

Shift this value to align it with the location of the first decade in the PRS. locLSD from our IDN string evaluation is 1, so:

Example 1:
iValint = iValint * (1*10^(locLSD))
iValint = 1235 * (1*10^(0))
iValint = 1235 * 1; or iValue = 1235

Example 2:
iValint = iValint * (1*10^(locLSD))
iValint = 1000000 * (1*10^(0))
iValint = 1000000 * 1; or iValue = 1000000

Convert the number to a string value using a "format" function that includes leading zeros. A 200/201 series unit has 10 decade locations, a 202 has 12.

prsCmd = "SOURce:DATA " _
& format(iValue,"0000000000")

Example 1:
"SOURce:DATA 0000001235"

Example 2:
"SOURce:DATA 000001000000"

Send the prsCmd string to the PRS.

Chapter 8

MAINTENANCE

8.1 Verification of Performance

8.1.1 Calibration Interval

The PRS-202 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.

8.1.2 General Considerations

It is important, whenever testing the PRS-202 Series Decade units, to be very aware of the capabilities and limitations of the test instruments used. Such instruments would 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, consult IET Labs for information.
It is important to allow both the testing instrument and the PRS-202 Substituter to stabilize for a number of hours at the nominal operating temperature of 23^0C, and at nominal laboratory conditions of humidity. There should be no temperature gradients across the unit under test.

In the case of a resistance substituter, substantial Kelvin type 4-wire test terminals should be used to obtain accurate low resistance readings. It is convenient, once the zero resistance has been determined, to subtract it from the remaining measurements. This can be automatically done in many instruments which have an offset subtraction capability.

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

Proper metrology practices should be followed in performing this verification.

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, status reporting and 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 are used to separate messages.
(:) Colons to separate command words.
(,) Commas to 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 488.2 common command.
(?) Ends a query where a reply is expected.

SCPI builds on the programming syntax of 488.2 to give the programmer the capability 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 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.

Keyword	Parameter Form	Notes & Short Form Commands
SYSTem		**System Address**
:COMMunicate		
:GPIB		*IEEE option only*
:MODE	SINGle | DUAL | SECondary	
:SERial		*SERIAL option only*
:EXTernal	0|1 or OFF|ON [0]	
:BAUD	<numeric value> [9600]	
:PARity	EVEN | ODD | [NONE]	
:BITS	7 | [8]	
:SBITs	[1] | 2	
:NETwork	0|1 or OFF|ON [0]	
:ADDRess	0-15 [4]	
:UPdate	no value-command only	
:RS485	0|1 or OFF|ON [0]	
:ERRor?	(0, "No error")	
:VERSion?	(1994.0)	
SOURce		**Port Output**
[:DIGital]		
:DATA		
[:VALue]	10 digits representing the possible decade values	PO
CALibrate		**Calibrate**
:DATe?	mm-dd-yyyy	

Appendix B

IEEE-488.2 COMMON COMMANDS

The PRS-202 is compliant with the complete command set defined in the IEEE-488.2 specification. As an output device, the required input related commands such as SRQ and TRG are implemented in the controller but have no affect on the operation of the instrument.

COMMAND	NAME	DESCRIPTION
* CLS	Clear Status	Clears all event registers summarized in the status byte, except for "Message Available," which is cleared only if *CLS is the first message in the command line.
*ESR?	Event Status Register Query	PRS returns the <value> of the "Event Status Register" and then clears it. <value> is an integer whose binary equivalent corresponds to the state (1 or 0) of bits in the register. Reading of this register resets the contents to zero.

Bit	Description
7	Power On
6	User Request
5	Command Error
4	Execution Error
3	Dev. Dep. Error
2	Query Error
1	Request Control
0	Operation Complete

*IDN?	Identification Query	Returns its identification code as four fields separated by commas. These fields are: manufacturer, model, serial number and hardware version.
*RST	Reset	Restores the PRS to power-up state; state of IEEE interface is unchanged, including: instrument address and Status Byte. Allow the REMOTE option 150ms to complete command.
*SAV <value>	Save	Saves current configuration in the Flash. *SAV 0 saves the current setting as the new power on setting.
*STB?	Read Status Byte	Returns the value of the "Status Byte" with bit six as the "Mas ter Summary" bit. The value is an integer whose binary equiva lent corresponds to the state of bits in the register.