Model 4176

Programmable Micro-Ohmmeter

Operation Manual

VALHALLA SCIENTIFIC

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VALHALLA SCIENTIFIC INC. CERTIFICATION

Valhalla Scientific Inc. certifies that this instrument was thoroughly tested, inspected, and found to meet published specifications when shipped from the factory. Valhalla Scientific, Inc. further certifies that its calibration measurements are traceable to the National Institute of Standards and Technology to extent allowed by N.I.S.T.'s calibration facility.

Due to continuing product refinement and due to possible parts manufacturer change, Valhalla Scientific, Inc. reserves the rights to change any or all specifications without notice.

VALHALLA SCIENTIFIC INC. WARRANTY STATEMENT

The warranty period for this instrument is stated on your invoice and packing list. Please refer to these to determine appropriate warranty dates.

Valhalla Scientific, Inc. will repair the instrument during the warranty period provided it is return to our repair and calibration facility freight prepaid. No other warranty is expressed or implied.

Valhalla Scientific, Inc. is not liable for consequential damages.

Permission and a Return Material Authorization number (RMA) must be obtained directly from the factory for warranty repairs. No liability will be accepted if returned without such permission.

VALHALLA SCIENTIFIC

4176 Programmable µ-Ohmmeter User & Maintenance Manual

Edition 1

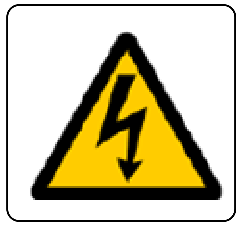
DOCUMENTATION HISTORY

All Editions and Updates of this manual and their creation date are listed below. The first edition of the manual is 1. The edition number increases by 1 whenever the manual is revised. Updates, which are issued between editions, contain replacement pages to correct or add additional information to the current Edition of the manual. Whenever a new Edition is created, it will contain all of the update information for the previous Edition. Each new Edition or Update also includes a revised copy of this documentation history page.

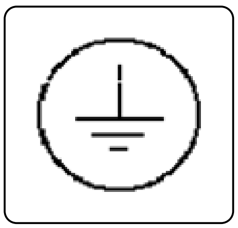
Edition 1 …………………………………………………………………….….November, 2004

Safety Symbols

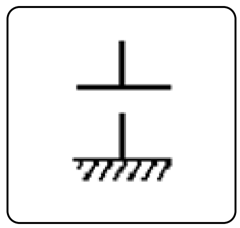
Instruction manual symbol affixed to product. Indicates that the user must refer to the user manual for specific WARNING or CAUTION information to avoid personal injury or damage to the product.



WARNING, RISK OF ELECTRICAL SHOCK.



Indicates the field wiring terminal that must be connected to ground before operation the equipment --- protects against electrical shock in case of fault.



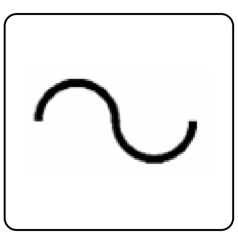
Frame or chassis ground terminal --- typically connects to the equipment's metal frame.

CAUTION

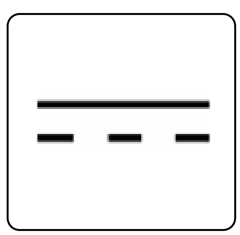
Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

WARNING

Calls attention to a procedure, practice, or condition that could cause bodily injury or death.



Alternating current (AC)



Direct current (DC)

Warnings

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. Valhalla Scientific assumes no liability for the customer's failure to comply with these requirements.

Ground the equipment: For Safety class 1 equipment (equipment having a protective earth terminal), an interrupted safety earth ground must be provided from the main power source to the product input wiring terminals or supplied power cable.

DO NOT operate the product in an explosive atmosphere or in presence of flammable gases or fumes.

For continued protection, replace the line fuse(s) only with fuse(s) of the same voltage and current rating and type. DO NOT use repaired fuses or short-circuited fuse holders.

Keep away from live circuits: Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for the use of service-trained personnel only. Under certain conditions, dangerous voltage may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until safe operation can be verified by service-trained personnel. If necessary, return the product to Valhalla Scientific for service and repair to ensure that safety features are maintained.

DO NOT service or adjust alone: Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT substitute parts or modify equipment: Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to Valhalla Scientific for service and repair to ensure that safety features are maintained.

Measuring high voltage is always hazardous: ALL multimeters input terminals (both front and rear) must be considered hazardous whenever inputs greater than 42V (dc or peak) are connected to ANY input terminal.

Permanent wiring of hazardous voltage or sources capable of delivering grater than 150VA should be labeled, fused, or in some other way protected against accidental bridging or equipment failure.

DO NOT leave measurement terminals energized when not in use.

PREFACE

This manual contains installation, operating and programming, and configuration information for the Valhalla Scientific, Inc. Model 4176 Programmable μ-Ohmmeter.

The manual consists of the following chapters:

CHAPTER 1 INSPECTION AND INSTALLATION
This chapter contains information on initial inspection, bench use and rack mounting instructions. It also contains the initial adjustments necessary to start operations.

CHAPTER 2 SPECIFICATIONS
This Chapter lists all the specification applicable to this model.

CHAPTER 3 GETTING STARTED
This chapter covers the fundamentals of ohmmeter operation. It shows you how to use the ohmmeter's front & rear panel, how to make connections, and describes the display sections and messages.

CHAPTER 4 MEASUREMENT MODES & FUNCTIONS
This chapter explains how to setup the instrument for all standard measurements, temperature compensated measurements and hi-lo comparison. Also contains information and procedures on how to configure the settings.

CHAPTER 5 OPTIONAL FEATURES AND ACCESSORIES
This chapter lists and describes all the optional equipment and accessories available for this model.

CHAPTER 6 REMOTE INTERFACE
This chapter illustrates the remote capabilities and explains how to send commands to the ohmmeter from remote, and how to retrieve data from remote.

CHAPTER 7 BCD INTERFACE
This chapter illustrates the remote capabilities and explains how to send commands to the ohmmeter from remote, and how to retrieve data from remote.

CHAPTER 8 ROUTINE MAINTENANCE
This chapter illustrates how to perform routine maintenance to the ohmmeter. It covers the calibration procedures and fuse replacement.

CHAPTER 9 SPECIAL PROCEDURES
This chapter contains a number of useful tips that should be noted when working with inductive loads.

CHAPTER 10 THEORY OF OPERATION
This chapter describes the theory of operation of the ohmmeter and its features. It gives a detailed circuit description and troubleshooting information.

CHAPTER 11 ADDENDUMS
This chapter lists updates and addendums for this manual.

CHAPTER 12 PARTS LIST
This chapter lists all the parts and components used in the manufacturing of the ohmmeter.

CHAPTER 13 DRAWINGS AND SCHEMATICS
This chapter contains all the assembly drawings and schematics for the ohmmeter.

TABLE OF CONTENTS

Chapter 1 INSPECTION AND INSTALLATION

1.1 Introduction

Welcome to the world of low resistance measurement! The precision instrument you have just purchased offers super-stable measurement capability for hard-to-test items such as transformers, coils, shunts, and even the resistance of wire itself. Other features include temperature compensation, hi-lo comparison and several interface options.

Please read this manual thoroughly and all accompanying addendums before attempting to operate this ohmmeter.

1.2 Inspection

If the shipping carton is damaged, request that the carrier's agent be present when the unit is unpacked. If the instrument appears damaged, the carrier's agent should authorize repairs before the unit is returned to the factory. Even if the instrument appears undamaged, it may have suffered internal damage in transit that may not be evident until the unit is operated or tested to verify conformance with its specifications. If the unit fails to operate or fails to meet the performance specifications of chapter 2, notify the carrier's agent and the nearest Valhalla Sales Office. Retain the shipping carton for the carrier's inspection. DO NOT return equipment to Valhalla Scientific, Inc. or any of its sales offices prior to obtaining authorization to do so.

1.3 Line Voltage/Fuse Selection

The only adjustments required before placing the unit in operation are:

1. Verify that the instrument has been set for the proper local AC line voltage. The AC line voltage is selected via a sliding switch mounted on the rear panel of the ohmmeter.

Table 1 - Line Voltage Limits

Nominal Value (RMS)	Allowable Limits (RMS)
115V	105Vac to 125Vac
230	210Vac to 250Vac

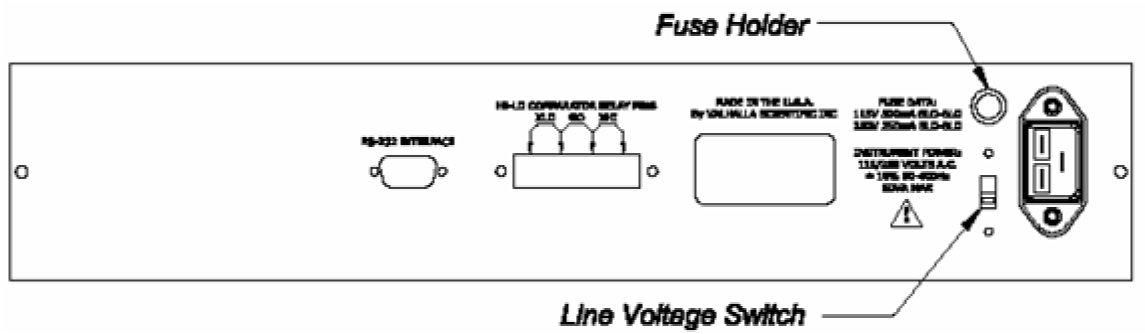


Figure 1 - 4176 Rear Panel

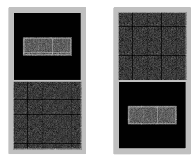


Figure 2 - Line Voltage Switch Position

2. Verify that the proper fuse for this voltage has been installed as follows:

$$115\,Vac = 0.250\,Amp\ Slo-Blo\ Fuse$$
$$230\,Vac = 0.125\,Amp\ Slo-Blo\ Fuse$$

1.4 Bench Use

The ohmmeter is supplied with all the hardware required for bench use and special instructions for use in this manner are not necessary. The user should become familiar with chapters 3 and 4 before attempting to operate the instrument.

1.5 Rack Mounting

Optional brackets are available for mounting the ohmmeter in a standard 19" equipment rack. The rack mount kit consists of two brackets plus 4 flat head screws. The brackets are easily installed on the front end of each side rail as show in drawing № 4176-xxx in chapter 11. The kit is listed in chapter 5 as *Option-R*

The size of the ohmmeter and the location of its center of gravity dictate that it must be supported on both sides along its entire length through the use of trays or slides. If it is to be transported while mounted in a rack, it should be supported so as to prevent upward or downward movement.

It is recommended that blank panels at least 1.75 inches high be installed between this and any other units in the rack to ensure freedom of air flow. Under no circumstances should the ambient air temperature around the unit exceed 50°C while the unit is in operation or 70°C when power is removed.

1.6 Safety Precautions

The power plug must be a three-contact device and should be inserted only into a three-contact mating socket where the third contact provides a ground connection. If power is provided through an extension cable, the ground connection must be continuous. **Any discontinuity in the ground lead may render the unit unsafe for use!**

The testing of inductive loads such as transformers requires that special precautions be taken to avoid damage to the instrument and/or injury to the operator! Please refer to chapter 7.

Chapter 2 SPECIFICATIONS

The specifications for the 4176 Programmable µ-Ohmmeter are listed in the following paragraphs. In all cases the specifications are valid for full Kelvin Four-Terminal measurements using connections having less than 20mΩ of lead resistance per wire.

2.1 Standard Measurement Mode Specifications

Table 2 – Range Characteristics

Range	Full Scale	Maximum Resolution	Current Source[1]
20mΩ	20.000mΩ	1µΩ	1A
.2Ω	.30000Ω	10µΩ	1A
2Ω	3.0000Ω	100µΩ	100mA
20Ω	30.000Ω	1mΩ	10mA
200Ω	300.00Ω	10mΩ	1mA
2kΩ	3.0000kΩ	100mΩ	100µA
20kΩ	30.000kΩ	1Ω	10µA

[1] Current source is ±1% absolute accuracy.

Table 3 – Standard Measurement Mode Accuracy

Range	Accuracy[2] (± % of reading ± % of range)		Temperature Coefficient[3]
	24 hours	1 Year	
20mΩ	±0.006 ± 0.012	±0.02 ± 0.02	±0.002%/°C
.2Ω	±0.006 ± 0.012	±0.02 ± 0.02	±0.002%/°C
2Ω	±0.006 ± 0.012	±0.02 ± 0.02	±0.002%/°C
20Ω	±0.006 ± 0.012	±0.02 ± 0.02	±0.002%/°C
200Ω	±0.006 ± 0.012	±0.02 ± 0.02	±0.002%/°C
2kΩ	±0.006 ± 0.012	±0.02 ± 0.02	±0.002%/°C
20kΩ	±0.006 ± 0.012	±0.02 ± 0.02	±0.002%/°C

[2] The accuracy specifications listed are valid following a 30 minute warm-up at an ambient temperature between 15°C and 35°C, and include the effects of line voltage variations within the allowed range.

[3] Temperature coefficient specified for temperature ranges from 0°C to 15°C and 35°C to 50°C.

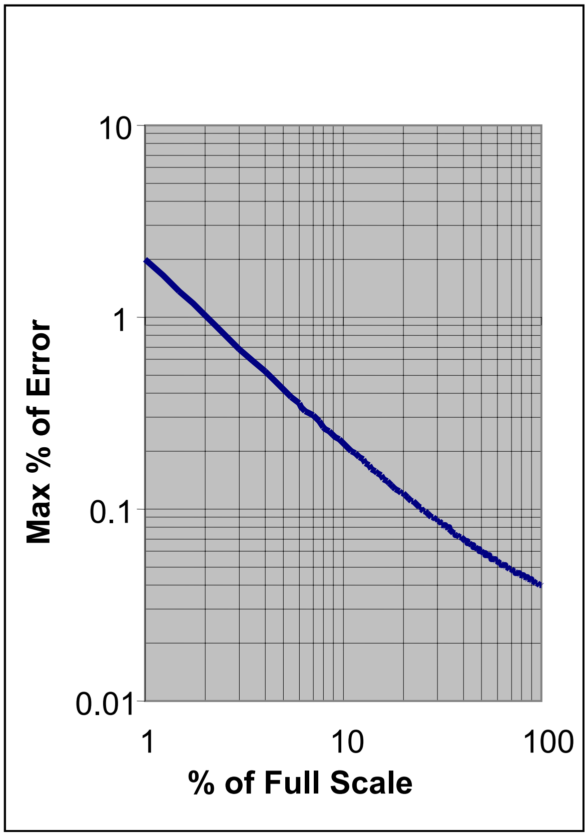


Figure 3 - 20mΩ Range Error Graph

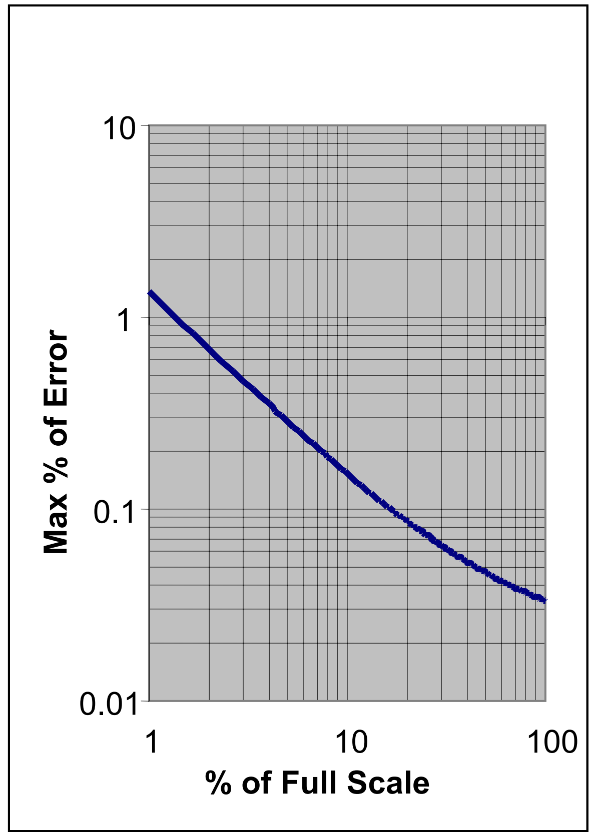


Figure 4 - 200mΩ to 20kΩ Range Error Graph

2.2 Temperature Compensator Mode Specifications

Table 4 - Temperature Compensator Mode Specifications

Range	Accuracy[4]	
	T[5]<25°C (± % of reading ± % of range ± % of	T[5]>25°C (± % of reading ± % of range ± % of
20mΩ	±0.02 ± 0.07 ± 0.001	±0.02 ± 0.07 ± 0.001
.2Ω	±0.02 ± 0.07 ± 0.001	±0.02 ± 0.07 ± 0.001
2Ω	±0.02 ± 0.07 ± 0.001	±0.02 ± 0.07 ± 0.001
20Ω	±0.02 ± 0.07 ± 0.001	±0.02 ± 0.07 ± 0.001
200Ω	±0.02 ± 0.07 ± 0.001	±0.02 ± 0.07 ± 0.001
2kΩ	±0.02 ± 0.07 ± 0.001	±0.02 ± 0.07 ± 0.001
20kΩ	±0.02 ± 0.07 ± 0.001	±0.02 ± 0.07 ± 0.001

[4] The accuracy specifications listed are valid following a 30 minute warm-up at an ambient temperature between 15°C and 35°C, and include the effects of line voltage variations within the allowed range.

[5] T indicates the temperature in °C of the test area.

2.3 General Specifications

Display Type: .... 5 digits VFD

A-to-D Conversion Rate: .... 45 conversions/seconds

Display Update: .... 5 user selections (100msec, 200msec, 300msec, 400msec, 500msec)

Overload:

   20mΩ Range .... 99.95% of range

   200mΩ thru 20kΩ .... 119.95% of range

Overload Indication: .... flashes "***OVERLOAD***"[6]

Terminal Configuration: .... Four-wire Kelvin

Test Current Polarity: .... Positive (flows High to Low)

Test Current Compliance Voltage: .... 5V minimum

Settling Time: .... 300 milliseconds

2.4 Environmental and Power Requirements

Power Supply: .... 115VAC or 230VAC ±10% @ 50Hz to 400Hz; 25VA max

Operating Temperature Range: .... 0°C to 50°C

Storage Temperature Range: .... -40°C to +85°C

2.5 Physical Specifications

Humidity: .... 80% RH max. @ 40°C (non-condensing)

Dimensions: .... 17"(43cm) W x 11½"(29.5cm) D x 4"(10cm) H

Weights: .... 10.36lbs (4.7kg) NET; 15lbs (7kg) SHIPPING

[6] If the overload indication is on for approximately 10 seconds, the instrument will enter *Safe Mode*. See section 7 of chapter 3 for details.

Chapter 3 GETTING STARTED

3.1 Introduction

This chapter covers the fundamentals of ohmmeter operation. It shows how to use the ohmmeter's front & rear panel, how to make connections, and describes the display sections and messages.
Before explaining how to make measurements, it is useful to describe the sections of the front and rear panel of the 4176.

3.2 Front Panel

The front panel of the 4176 can be broken down into eight parts. In Figure 5 you can see the regions indicated by their name.

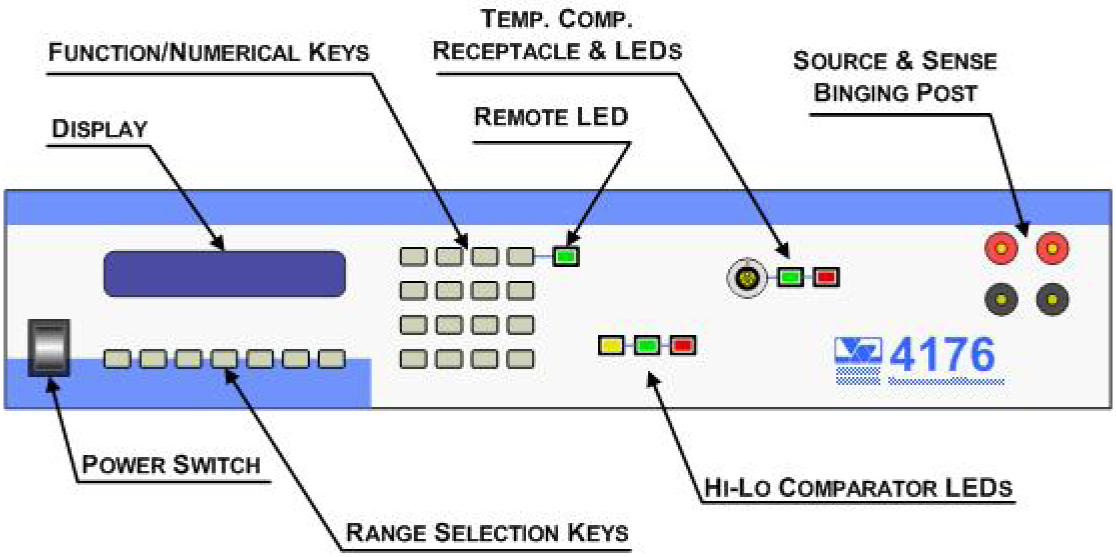


Figure 5 - 4176 Front Panel Sections

3.2.1 Power Switch

The power switch is a two position ON/OFF rocking switch, used to apply (ON position) or disconnect (OFF position) the AC power source from the internal circuitry of the ohmmeter.

3.2.2 Display

During measurements, the display presents 3 windows described in the table below.

Window	Description
Measurement Window	Displays the measured load value or the temperature compensated value.
Range Window	Displays the selected range or the auto range function is on, this section of the display will alternate between the automatically selected range and the word “AUTO”.
Function Window	Displays the Valhalla Scientific Logo. If a function is activated, this section of the display will alternate between the Logo and the abbreviated function name.

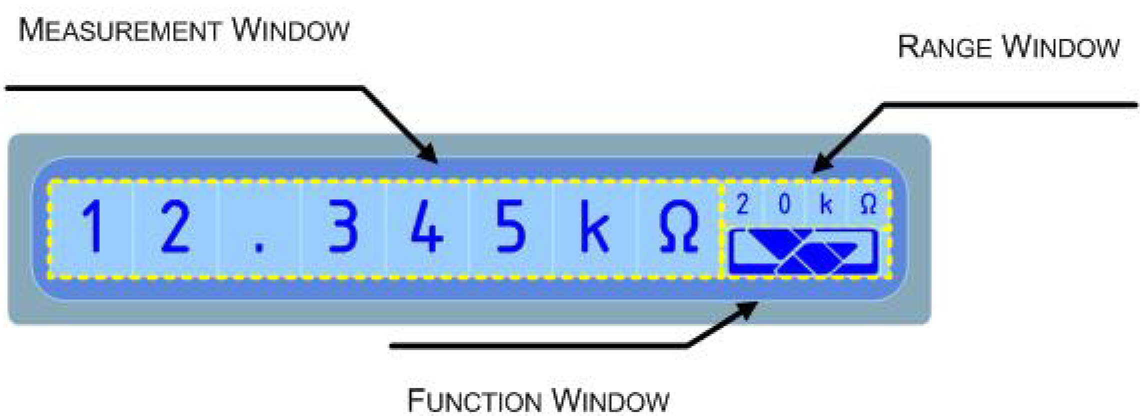


Figure 6 - Display Window sections

The display is also used to prompt the user with alerts and messages

3.2.3 Range Selection Keys

The seven range keys simply allow the user to select the required measurement range of the ohmmeter. The range keys are labeled with the respective range value and current source value.

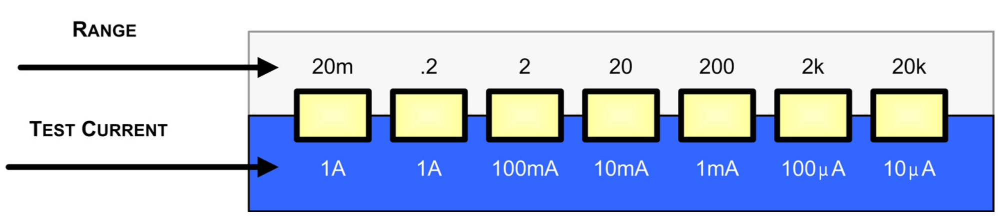


Figure 7 - Range Keys

CAUTION	**Extra care must be taken when working with inductive loads. Always select the highest resistance range before connecting or disconnecting the test leads.**

3.2.4 Function/Numerical Keys

The Function/Numerical keys are sixteen and are used to trigger the standard and/or optional ohmmeter functions and for data entry. In figure 8 shows the key arrangement while table 5 lists a brief description of the keys and its use. The Function/Numerical keys will be further described throughout this manual.

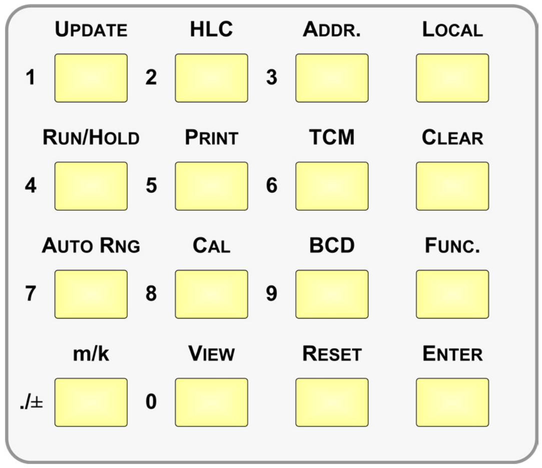


Figure 8 - Function/Numerical Keys

Table 5 - Function/Numerical Key Description

Key	Function Description	Numerical Value
FUNC.	The *FUNC.* key is used in combination with other keys to change stored settings. This key is also used as a "Forward" button to skip through screens.	none
VIEW	The *VIEW* key is used in combination with other function keys. It is used to view stored settings.	0
UPDATE	The *UPDATE* key is used to set and/or view display update rate and intensity.	1
HLC	The *HLC* key is used to enable or disable the 4176's internal "Multi-Range Dual Limit Comparator. Also used to set and/or view the limits used.	2
ADDR.	The *ADDR.* key is used to view the setting information for all of the standard or optional remote interfaces.	3
RUN/HOLD	The *RUN/HOLD* key is used to switch between run and hold state. Also used to select the hold configuration.	4
PRINT	The *PRINT* key is used to trigger the output of a print or log package to the RS-232 port. Also used to select the print/log setting.	5
TCM	The *TCM* key is used to enable or disable the TCM mode. Also used to select temp. coefficient and reference, and for TC calibration.	6
AUTO RNG	The *AUTO RNG* key enables the automatic selection of the range according to the value of the load.	7
CAL	The *CAL* key is used to initiate the standard and TCM calibration procedure.	8
BCD	The *BCD* key enables the binary coded decimal output on models where the BCD option is installed.	9
CLEAR	The *CLEAR* key functions like a backspace when entering values. The key is also used to return to the previous screen.	none
RESET	The *RESET* key resets the ohmmeter returning it to Start-Up state.	none
LOCAL	The *LOCAL* key is used to return from a remote to a local state.	none
ENTER	The *ENTER* key is the user confirmation to a display prompt.	none
m/k	The *m/k* key is used to toggle between polarity symbols where active.	./±

3.2.5 TCM Receptacle and LEDs

This portion of the front panel is utilized only during temperature compensated type measurements (TCM). TCM mode is described in detail in chapter 4 section 2.

Critical to this measurement mode is precise temperature sensing, which entails solid and reliable connections between the sensing device and the instrument. The temperature sensor receptacle is designed so that the mating connector/sensor, the Valhalla Scientific **Omni Compensator**[7], can be inserted only in the proper mating position. A red dot on the Omni Compensator and a red tab on the receptacle are met to guide you in the insertion of the connector in the receptacle.

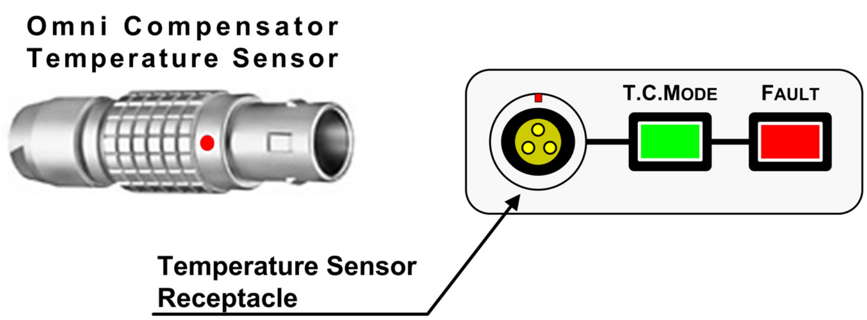


Figure 9 - Temperature sensor, TCM LEDs and Receptacle

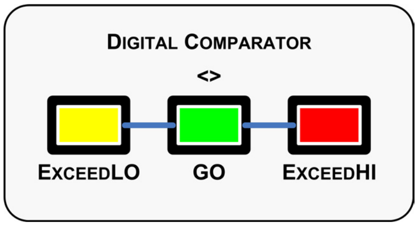
The TCM feature of the 4176, arithmetically calculates the resistance value to display utilizing the ambient temperature and other parameters that will be present in later chapters. It is solemn for the user to be aware if the TCM mode is enabled or disabled so that the display reading may be interpreted correctly.

The green LED labeled "T.C.Mode", is the visual indication that the TCM mode is on. Keeping an eye on the red LED, labeled "Fault", also as important. "Fault" is the indicator that alerts of missing contacts between the sensor and the instrument.

CAUTION	**Values displayed while the fault indicator is illuminated are not to be considered valid in any case.**

[7] The Omni Compensator is an optional accessory to the 4176. See chapter 5 section 2.1 for more detail.

3.2.6 HLC LEDs

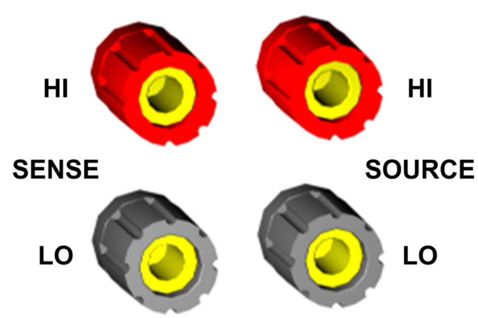


This portion of the front panel is designated to give the user a visual indication of the HLC results. HLC mode is described in detail in chapter 4 section 3. The HLC LEDs are active only when the Hi-Lo comparator mode (HLC) is activated. The green LED, labeled “GO”, is on if the measured resistance value is between the limits[8] set by the user. The yellow LED, labeled “ExceedLO”, is on if the measured resistance value is less then the lower limit. The red LED, labeled “ExceedHI”, is on if the measured resistance value is greater then the upper limit. Only one LED can be on at a time; if more then one LED is on for any length of time, it is recommended that you contact the Valhalla Scientific Tech Support Team.

3.2.7 Remote LED

The Remote Led indicates the remote/local state of the instrument. If the LED is on, the instrument is in remote state and can only receive commands through one of its remote interface ports. If the LED is off, the ohmmeter is in local state will receive commands only from the front panel keys.

3.2.8 Source and Sense Binding Post



Connections to the 4176 are made via the front panel source/sense terminals, which consist of two red and two black standard binding posts with gold plated brass contact material. The posts can accept standard banana plugs, wires up to 12 AWG, or spade lugs. The four terminals provide full 4-Wire Kelvin measurement capability. The right posts are the positive and negative current source terminals and provide the test current, while the left posts are the positive and negative voltage sense terminals used to monitor the voltage drop across the load.

The 4-Wire configuration eliminates errors normally caused by test lead and contact resistances. In many applications the contact resistance can exceed the value of the load by several orders of magnitude. The 4176 bypasses this potential error source by providing two terminals of constant current and an additional two terminals for high impedance voltage sensing. The result is a fast, accurate resistance measurement of the load, independent of the

[8] See chapter 4 section 3.2 for detail on how to set the Hi-Lo limits.

resistance of the current carrying leads. The Theory of Operation chapter 4 section 1 will illustrate how the 4-wire principle is used to eliminate lead, wire, and contact resistances as potential error sources.

3.3 Rear Panel

The rear panel of the 4176 may vary from unit to unit according to the optional features installed. This section of the manual refers to the standard model without any optional features or modifications. If the 4176 that you are using features terminals or connectors not describe in this section, please refer to chapter 9 of this manual for addendums that reference the particularities of your model.
We will now outline the use of each of the rear panel controls and connectors.

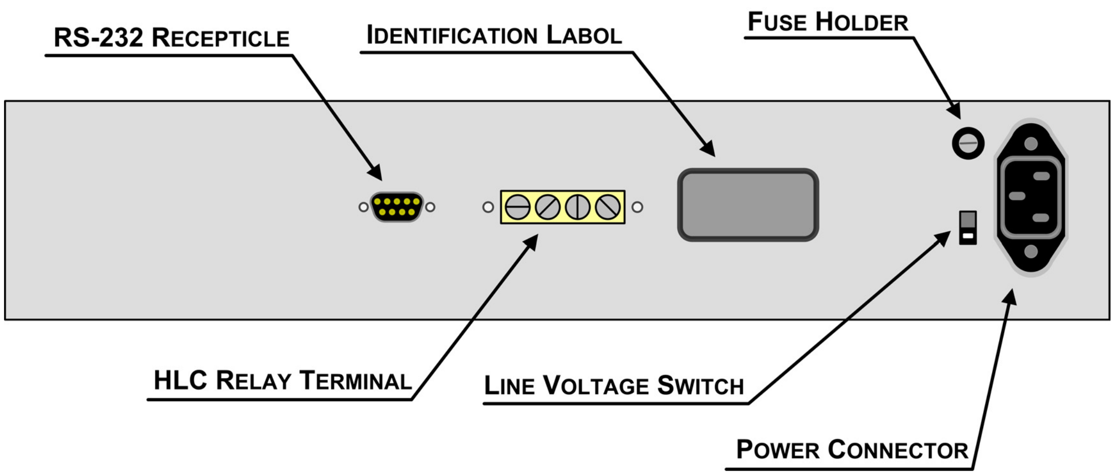
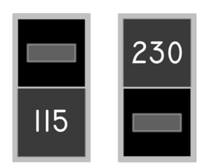


Figure 10 - 4176 Standard Rear Panel

3.3.1 Line Voltage Switch

The line voltage switch allows the user to select the power settings according to the local AC line voltage. By sliding the switch upwards, the number 115 will appear on the switch. The instrument is now configured for line voltages of 115VAC ± 10%. By sliding the switch downwards, the number 230 will appear. The instrument can now be used with line voltages of 230VAC ±10%. Prior to powering on the ohmmeter it is conscious to verify that the switch is set for the correct line voltage.



WARNING	**Selecting the incorrect line voltage setting may cause damage to the instrument!**

3.3.2 Fuse Holder

The rear panel fuse holder provides access to the main power fuse. Fuse values are listed below:

$$115Vac = 0.250 Amp\ Slo - Blo\ Fuse$$

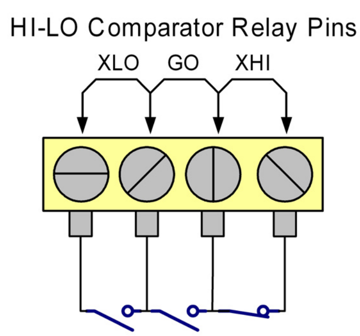
$$230Vac = 0.125 Amp\ Slo - Blo\ Fuse$$

WARNING	**Replace blown fuses with their exact equivalent only!**

3.3.3 Power Connector

The 3-prong power connector on the rear panel of the ohmmeter is for the application of AC power to the instrument. The mating power cord is included with the instrument at time of purchase. Refer to chapter 1 section 3 for available voltages and safety precautions.

3.3.4 HLC Relay Terminal



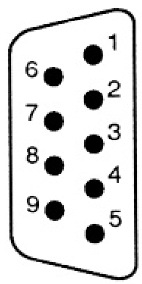
The HLC relay terminal is internally wired to three relays which are active only when the HLC mode is selected. According to the result of the comparison, one of the relays will have its contacts close while the remaining two relays will have contacts open. The standard "relay contact closure" feature allows an automated sorting process to be set up at an economical cost. The screw type terminal allows connections to wires or spade lugs. Contacts are rated at 100 volts, 100mA. Truth table of the contacts is listed below. Ω's symbol represents the load measured value, UL is the upper limit and LL is the lower limit set by the user.

Table 6 - HLC Truth Table

HLC STATE	HLC RESULT	XLO	GO	XHI
ON	LL≤Ω≤UL	OPEN	CLOSED	OPEN
ON	Ω<LL	CLOSED	OPEN	OPEN
ON	UL<Ω	OPEN	OPEN	CLOSED
OFF	LL≤Ω≤UL	OPEN	OPEN	OPEN
OFF	Ω<LL	OPEN	OPEN	OPEN
OFF	UL<Ω	OPEN	OPEN	OPEN

3.3.5 RS-232 Connector

The RS-232 serial interfacing is done through the 9 pin female D-Sub connector located on the rear panel of the instrument. Knowledge of the specific pin functions of the serial connector may be necessary for certain applications; table 7 lists the pin assignment for the RS-232 connector.



Pin #	Pin Function
1	No connection
2	Receive Data (RxD) (input)
3	Transmit Data (TxD) (output)
4	No connection
5	Signal Ground (GND)
6	No connection
7	No connection
8	No connection
9	No connection

Table 7 - RS-232C Connector Pin Assignment

3.4 Applying Power

Before applying power, please refer to chapter 1 section 3.

Turn on the ohmmeter by placing the front panel power switch in the ON position. If the ohmmeter does not to turn on, verify that the instrument is connected to the power line. If line power is not the problem, remove the power cord and check the line power fuse and the line voltage selection switch settings.

3.4.1 Power-On Default Settings

Once you turned on the ohmmeter its power-on routine. On the display you should see the following messages:

Figure 11 - Power-On Display Messages

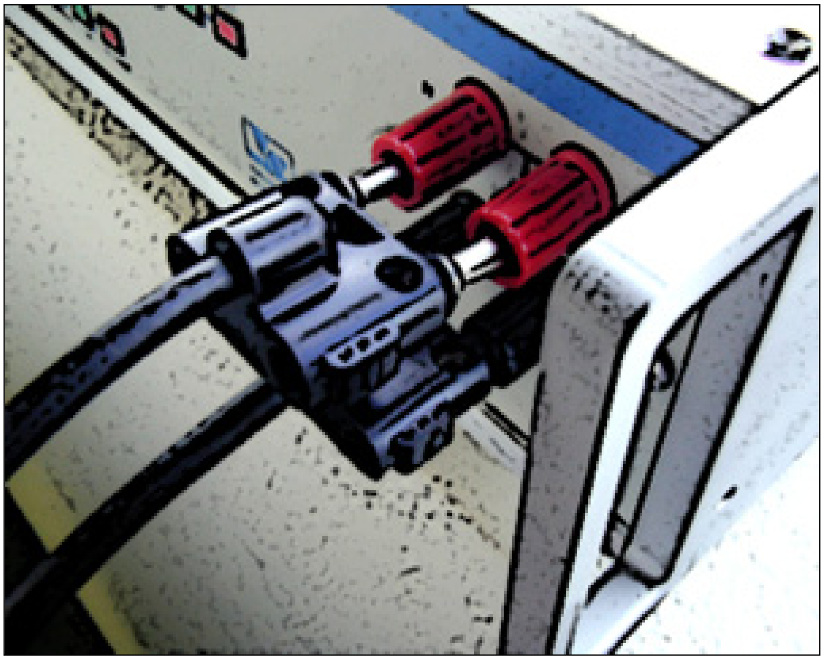
When the power-on routine is finished, the ohmmeter will beep twice.

By design the standard measurement mode the auto range function will be selected automatically to avoid an overload condition if any load is applied to the ohmmeter.
The power-on routine will default the ohmmeter's functions as described in the following table.

Table 8 - Power-On default settings

Functions	Setting
Standard Measurement Mode	ON
Range	20kΩ
Auto-Range (Automatic Range Selection)	ON
TCM (Temperature Compensation Mode)	OFF
HLC (Hi-Lo Comparator Mode)	OFF
BCD (Binary Coded Decimal Output Mode)	OFF
PIM (Printer/Log Mode)	OFF

3.5 Connecting a Load to the 4176



The first step in using the ohmmeter is to connect to a load. Valhalla Scientific, Inc. offers a number of different test leads that can be used with the Model 4176 and other Valhalla ohmmeter models (see chapter 5 for a list of available test leads).
All ohmmeter test leads are composed of a pair of leads, both terminated in a multi-stacking dual banana plug. It is important to notice the position of the ground maker on the plug. Marked side of each banana jack is connected to the **current** terminals (see table 9).

Table 9 –Connecting test leads to the ohmmeter

Lead 1	Connect between SENSE HI and SOURCE HI, with the ground maker on the source side.
Lead 2	Connect between SENSE LO and SOURCE LO, with the ground maker on the source side.

This configuration ensures that current source is carried in the largest conductor of the cable, and that the sense input is shielded.

The opposite end of the lead may vary in style of termination. On the following page you will find a description of the three most common terminations used.

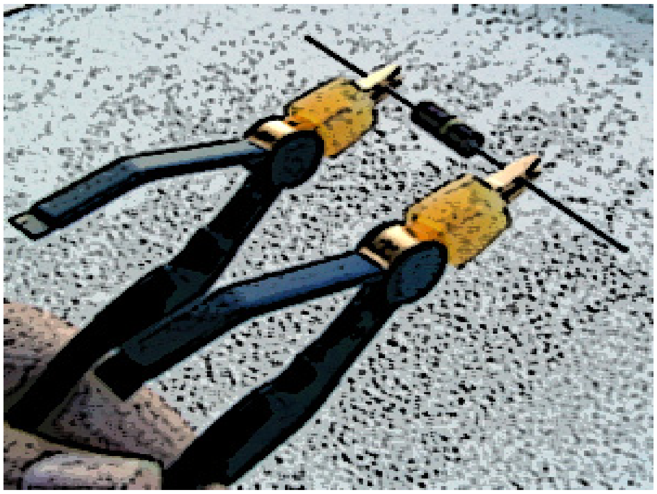


Figure 12 - Alligator type clips

The most common termination is **alligator type clips**.
If this is your choice of leads, simply connect one clip to one end of your load and the other clip to the opposite side of the load.

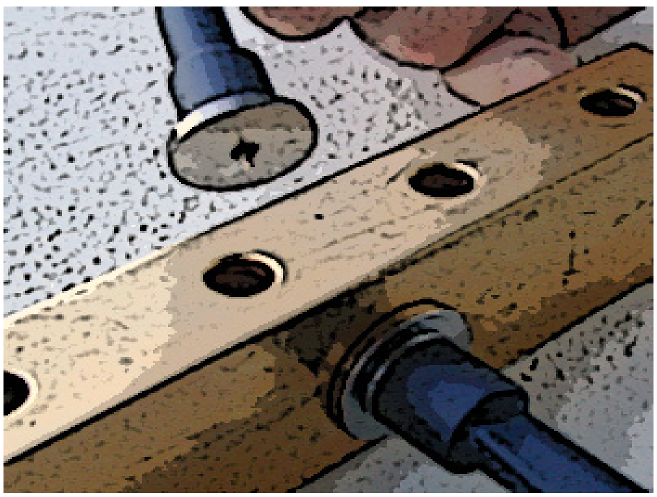


Figure 13 - Surface type probes

For flat surfaces, you can use between two different **spring loaded surface probes**.
If this is your choice of leads, simply press one probe against one side of the surface of your load, making sure that the surface of the probe is in full contact with the surface of the load. Press the second probe against the surface at the oppose side of your load making sure that the surface of the probe is in full contact with the surface of the load.

Figure 14 - Dual needle type probes

For hard to reach surfaces, Valhalla Scientific offers three different sets of **spring loaded dual needle probes** that differentiate in overall size and distance between the needles.
If this is your choice of leads, simply press both the needles of one probe against one end of the surface of your load, press both needles of the second probe against the surface at the oppose end of your load.

3.6 Range Selection

The ohmmeter is designed to automatically start up in Auto-Range. According to the load the instrument will automatically select the range that will display the measurement with the greatest resolution possible. While in auto range, the display range window will show "AUTO". In many applications where the test current is critical, the user can manually select a range.

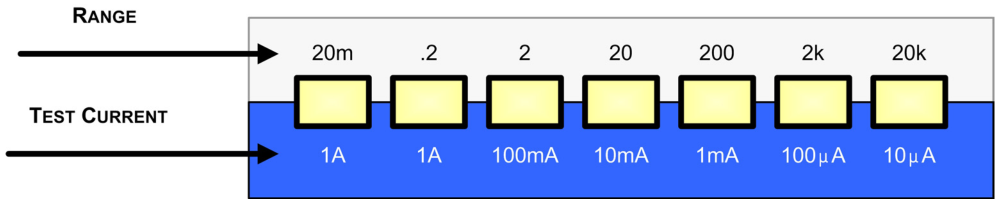


Figure 15 - Range Key Pad

Ranges are easily selected by pressing the appropriate key. The range keys are labeled using the value of the range and the respective test current value. The range selected will be displayed on the range window. To return to the auto range mode, press the "**AUTORNG**" key on the front panel.

3.7 Overload and Safe Mode

When the value of the load exceeds the range limit, the instrument will be in an *Overload* state. In cases of overload, the display will repeatedly flash the word "OVERLOAD". If this occurs, select a higher range setting or press the Auto key so that the instrument can automatically select the appropriate range. If the load value exceeds the limit of the highest range, promptly disconnect the load from the instrument to avoid damage to the equipment.

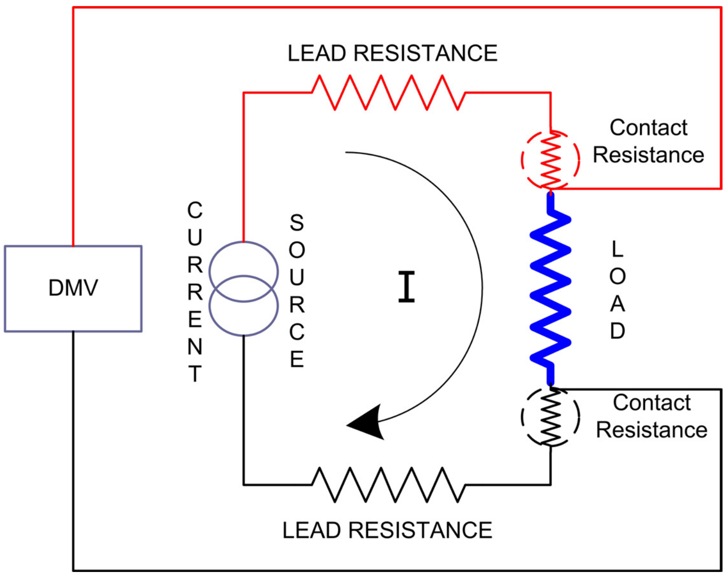
As a safety precaution, the 4176 is designed to switch into Safe Mode if the overload persists for more then 10 seconds. In safe mode the 4176 shuts down its current source, and displays the word "SAFEMODE" the screen. The ohmmeter does not automatically recover from safe mode; the user must press the Enter key to return to measurement mode. This is so that the user can be aware that an overload has occurred, so that the cause maybe investigated if necessary.

Chapter 4 MEASUREMENTS MODES AND FUNCTIONS

The main characteristic of the 4176 is 4-wire resistance measurements. In addition to standard measurements, the 4176 presents the TCM and HLC modes. These features may significantly ease time and cost of temperature sensitive and automated selection applications.

4.1 Standard Measurement Mode

The 4176 powers on in the standard measurement mode, in this mode, the instrument simply measure the value of the applied load using a 4-wire configuration. This configuration eliminates errors normally caused by test lead and contact resistances. In many applications the contact resistance can exceed the value of the load by several orders of magnitude. The 4176 bypasses this potential error source by providing two terminals of constant current and an additional two terminals for high impedance voltage measurement. The result is a fast, accurate resistance measurement of the load, independent of the resistance of the current carrying leads.



The figure on the right illustrates how the 4-wire principle is used to eliminate lead, wire, and contact resistances as potential error sources. The internal current source inherently overcomes all series resistance (within compliance voltage limits) and delivers a precise constant current. The internal high-impedance DVM senses the voltage drop across the load. There is negligible contact and lead resistance error created by the voltage measurement because the high input impedance of the DVM limits current flow in the voltage leads.

4.2 "TCM" - Temperature Compensated Measurement Mode

Valhalla Engineers are pioneers in the technology of accurate measuring devices using recognized formulas that compensate for measurement inaccuracies as a result of environmental changes. The TCM feature simulates a constant ambient temperature chamber for materials which are normally subject to varying ambient temperatures. When in the TCM mode, the temperature sensor, the Omni Compensator, automatically senses the ambient temperature and compensates the reading to indicate what the actual resistance value should be in a controlled environment (usually 20°C). The compensated value is calculated with the following equation:

$$\frac{\Delta R}{R_0} = \alpha \Delta T$$

The variation of resistance (ΔR) divided by the initial resistance (R_0), is equal to the temperature coefficient of the material (α) multiplied by the variation of temperature (ΔT).

Expressed in terms of the resistance:

$$\frac{R - R_0}{R_0} = \alpha(T - T_0) \qquad \text{or} \qquad R = R_0[1 + \alpha(T - T_0)]$$

To better understand our uses of the equation, we will now express it in terms of our application.

$$R_M = R_C[1 + \alpha(T_A - T_R)]$$

Where R_C is the compensated value, R_M is the measured resistance, T_A is the ambient temperature and T_R is the temperature reference. The compensated resistance is therefore calculated as follows:

$$R_C = \frac{R_M}{1 + \alpha(T_A - T_R)}$$

The user can select from a list of temperature coefficients and temperature references. The list is based on the most commonly used values. The user can also customize these settings with unique values.

Once the temperature coefficient and the temperature reference are set, the instruments task is to measure the load resistance and the ambient temperature. After all the variables are determined, the 4176 automatically calculates the compensated resister value.

Here is an example of the equation.

Let's assume that we are measuring a copper wire, and we wish to know the resistance value at a temperature of 20°C. The temperature coefficient of copper is 0.003931Ω/°C.

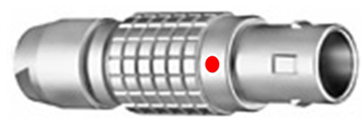
If the load measures 1.0000Ω and the ambient temperature is 22.5°C:

$$R_C = \frac{1}{1 + .003931(22.5 - 20)} = 0.9903\Omega$$

The value of the load at 20°C would be 0.09903Ω.

4.2.1 Omni Compensator

OMNI COMPENSATOR TEMPERATURE SENSOR



The 4176 measures the ambient temperature through a removable external sensor, the Omni Compensator. This item does not come standard with the ohmmeter, and must be purchased separately. If the 4176 and the Omni Compensator are purchased at the same time, the pair will be calibrated together. Each instrument should have a dedicated sensor. The user cannot interchange sensors between different ohmmeters without prior calibration. Calibration will also be necessary if the sensor is purchased as a single item. The TCM calibration routine is describe in section 2.4 of this chapter.

4.2.2 TCM ON

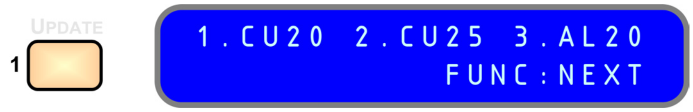
The TCM mode can be selected from the front panel by pressing the TCM function key. The display will briefly read "TCM ON". The instrument will continuously notify the user that the TCM mode is active by lighting the green TCM led on the front panel. If the TCM fault LED is also lit, discard the displayed measurements and check if the Omni Compensator in properly connected to the front panel. To return to the standard measurement mode, repress the TCM key. The display will briefly read "TCM OFF".

4.2.3 TCS – Temperature Compensator Setup

As describe in section 1.2 of this chapter, the 4176 needs to reference a temperature coefficient and a temperature reference to calculate the compensated value. Stored in the instruments memory are six configurations that can be selected. The next table illustrates the values associated to each of the configurations.

Material	Configuration	Temperature Coefficient	Temperature Reference
Copper	CU20	3931ppmΩ/°C	20°C
	CU25		25°C
Aluminum	AL20	4030ppmΩ/°C	20°C
	AL25		25°C
Gold	AG20	3000ppmΩ/°C	20°C
	AG25		25°C

The following procedure illustrates how to select one if these configuration and how to setup a customized configuration. This procedure does not need to be repeated every time the TCM mode is selected. The configuration that is selected or the custom values inputted will be set as default.

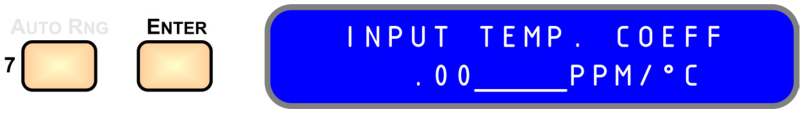


[1 + **ENTER**] sets the CU20 configuration
[2 + **ENTER**] sets the CU25 configuration
[3 + **ENTER**] sets the AL20 configuration

Press the **FUNC** key to display the next set of configurations.

[4 + **ENTER**] sets the AL25 configuration
[5 + **ENTER**] sets the AG20 configuration
[6 + **ENTER**] sets the AG25 configuration

Press the **CLEAR** key will return to the previous screen.
Press the **FUNC** key to display the next screen



Using the numeric keys, input a value for the temperature coefficient followed by the **ENTER** key. To input a negative coefficient, press the ± key. For corrections use the **CLEAR** key.

After pressing Enter, the instrument will display the coefficient that you have typed. Check the value and press enter to confirm. If the value is incorrect, press clear to return to the input screen.

Using the numeric keys input a value for the reference temperature followed by the **ENTER** key. For corrections use the **CLEAR** key.

After pressing Enter, the instrument will display the reference temperature that you have typed. Check the value and press enter to confirm. If the value is incorrect, press clear to return to the input screen.

4.2.4 TCC – Temperature Compensator Calibration

This procedure is used to match a 4176 with its Omni Compensator.

CAUTION	**The Temperature Compensator Calibration must be done in a temperature controlled area.**

FUNC. TCM

PRESS 1: FOR TCS
PRESS 2: FOR TCC

2

CONNECT THE SENSOR
AND PRESS ENTER

ENTER

WAIT WHILE SENSOR
STABILIZES

When the readings stabilize, the instrument will automatically skip to the next screen.

INPUT AMBIENT TEMP
… … . … °C

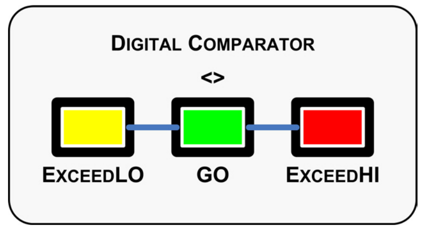
Using the numeric keys input a value for the reference temperature followed by the **ENTER** key. For corrections use the **CLEAR** key.

STORING NEW SETUP
DATA IN NOVRAM

The new values will be stored in memory.

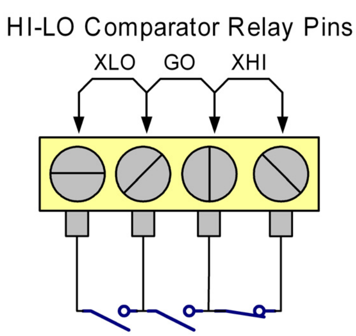
4.3 *"HLC" - Hi-Lo Comparator Mode*

Another useful feature of the 4176 is the Dual Limit Comparator (HLC). This feature helps eliminate operator interpretation of ohmmeter readings. Operator error and fatigue are significantly reduced while realizing an increase in testing efficiency.



A common application is receiving inspection of precision resistors by unskilled operators using the HLC mode. If, for example, the resistors to be inspected and tested are 1 KΩ ± 0.1%, the 4176 would be set on the 2kΩ range; the upper limit would be set at 1.0010kΩ, and the lower limit to 0.9990kΩ. If measured resistance is within these limits, the GREEN indicator will remain illuminated, indicating a within tolerance condition. If either RED or the YELLOW indicator is illuminated, that respective limit has been exceeded and the test sample should be rejected.

4.3.1 HLC Relay Terminal



The 4176 provides relay closure outputs which can be used to implement an automated batch sorting system for components or products, operate counters, sound alarms or shut off a process. Resistors, transformers, strain gauges, thermocouples and thermistors are a few items which could be individually toleranced in this manner for matching purposes.

The HLC relay terminal is internally wired to three relays which are active only when the HLC mode is selected. According to the result of the comparison, one of the relays will have its contacts close while the remaining two relays will have contacts open. The standard "relay contact closure" feature allows an automated sorting process to be set up at an economical cost. The screw type terminal allows connections to wires or spade lugs. Contacts are rated at 100 volts, 100mA. Truth table of the contacts is listed below. Ω's symbol represents the load measured value, UL is the upper limit and LL is the lower limit set by the user.

Table 10 - HLC Truth Table

HLC STATE	HLC RESULT	XLO	GO	XHI
ON	LL≤Ω≤UL	OPEN	CLOSED	OPEN
ON	Ω<LL	CLOSED	OPEN	OPEN
ON	UL<Ω	OPEN	OPEN	CLOSED
OFF	LL≤Ω≤UL	OPEN	OPEN	OPEN
OFF	Ω<LL	OPEN	OPEN	OPEN
OFF	UL<Ω	OPEN	OPEN	OPEN

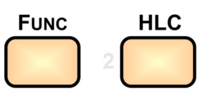
4.3.2 Setting the Limits

Each range has a different set of limits that can be programmed by the user. Table 11 lists the default values programmed for each range. Once the user sets new values, the default settings will be overwritten and the user settings will be stored in memory.

Table 11 - Default Comparator Limits

Range	Lower Limit	Upper Limit
20mΩ	10.000mΩ	20.000mΩ
.2Ω	0.10000Ω	0.20000Ω
2Ω	1.0000Ω	2.0000Ω
20Ω	10.000Ω	20.000Ω
200Ω	100.00Ω	200.00Ω
2kΩ	1.0000kΩ	2.0000kΩ
20kΩ	10.000kΩ	20.000kΩ

To set your custom readings, simply select the range that better fits your load and follow this procedure.



Using the numerical keys, enter the value of the upper limit. For corrections use the **CLEAR** key. After entering the value, press **ENTER**. The screen will display the following messages:

If an error was made while typing the value, press Enter to return to the previous screen. Otherwise using the numerical keys, enter the value of the lower limit. For corrections use the **CLEAR** key. After entering the value, press **ENTER**. The screen will display the following messages:

Now the limits are set and will be stored in memory.
Each range has a different set of limits that can be programmed by the user. Table 12 lists the default values programmed for each range. Once the user sets new values, the default settings will be overwritten and the user settings will be stored in memory.

Table 12 - Default Comparator Limits

Range	Lower Limit	Upper Limit
20mΩ	10.000mΩ	20.000mΩ
.2Ω	0.10000Ω	0.20000Ω
2Ω	1.0000Ω	2.0000Ω
20Ω	10.000Ω	20.000Ω
200Ω	100.00Ω	200.00Ω
2kΩ	1.0000kΩ	2.0000kΩ
20kΩ	10.000kΩ	20.000kΩ

4.3.3 HLC ON

To start working with the HLC mode, simply select the correct range for your application and press the HLC key. The screen will briefly display "HLC" and you'll see one of the three HLC LEDs illuminate. It is always good practice to check if the limits set for that particular range meet your specifications.

To check the readings, press the **VIEW** key followed by the HLC key. The screen will display the both the upper and lower limit set for that range.

To exit the view mode, press the **VIEW** key. If the values are correct, you can start your measurements. Otherwise, see section 3.2 of this chapter to set new values.

4.4 Update Function

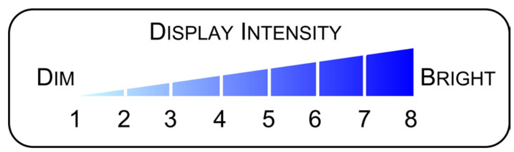
The Update function is designed to allow the user to set the display update rate and the display intensity. The user can chose from a list of five possible display update rates and eight levels of display intensities.

The display update rate indicates the time interval in-between very display update. Table 13 lists these values and the equivalent in updates per second.

Table 13 - Display Update Rates

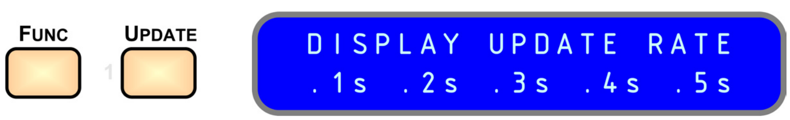
	display update rate	display updates/second
.1s	100msec	10
.2s	200msec	5
.3s	300msec	3.3
.4s	400msec	2.5
.5s	500msec	2

The intensity of the display is broken down into 8 levels, where level 1 is the least intense and level 8 is the most intense.



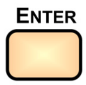
4.4.1 Setting the Display Update Rate and Intensity

Press the **FUNC**. key followed by the **UPDATE** key.



Select a rate using the numerical keys from 1 thru 5 and press **ENTER**.

Select an intensity level using the numerical keys from 1 thru 8 and press **ENTER**.



The values are stored in memory and the instrument will automatically return to the previous mode.

4.5 Run/Hold Function

The Run/Hold function of the 4176 can be configured in three different ways:

HOLD – Pressing the **RUN/HOLD** key will freeze the readings on the display. The function window of the screen will flash "HOLD". To exit the hold state, press the **RUN/HOLD** key again.

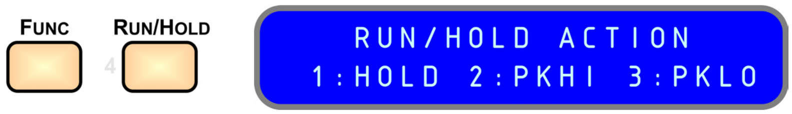
PKHI – Pressing the Run/**HOLD** key will activate the Peak-Hi state. The readings on the display will only increment therefore showing the maximum value measured. While in Peak-Hi state, the function window of the screen will flash "PKHI". To exit this state press the **RUN/HOLD** key again.

PKLO - Pressing the Run/**HOLD** key will activate the Peak-Lo state. The readings on the display will only decrease therefore showing the minimum value measured. While in Peak-Lo state, the function window of the screen will flash "PKLO". To exit this state press the **RUN/HOLD** key again.

4.5.1 Configuring the Run/Hold Function

The Run/Hold function can be set to HOLD, PKHI or PKLO. Follow these simple steps to configure the function.

Press the **FUNC**. key followed by the **RUN/HOLD** key.



Using the numerical keys from 1 thru 3, select the action that you wish the Run/Hold function to use and press **ENTER**.
The screen will display:

The instrument will automatically return to the previous mode.

4.6 Print/Log Function

The Print/Log function allows the user to receive the measurements through the instrument's RS-232 or USB interface. A thermal printer/labeler or the HyperTerminal of a PC can be used to capture the readings. The measurements can also be log to an Excel spreadsheet by using a Data Sources Open Database Connectivity (ODBC) to access data from ohmmeter

The Print/Log function can be configured in three different ways:

PRINT – When the Print key is pressed, the instrument transmits one reading as it is displayed on the ohmmeter's screen.

LOG – When the Print key is pressed, the instrument transmits continuously the measurements at a rate equal to the display update rate[9]. Pressing the once again the print key will terminate the transmission. The measurements are transmitted in the same format in witch they are displayed on the ohmmeter's screen.

LOG2 - When the **PRINT** key is pressed, the instrument transmits continuously the measurements at a rate equal to the display update rate. Pressing the once again the print key will terminate the transmission. The measurements are transmitted in engineering format.

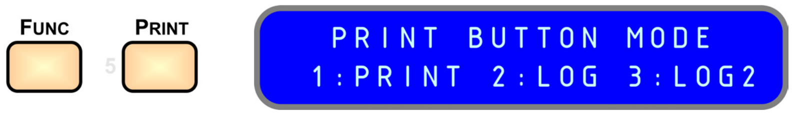
For example: $10.000k\Omega = 1.00E + 04$

[9] See section 4 of chapter 4.

4.6.1 Configuring the Print/Log Function

The Print/Log function can be set to PRINT, LOG or LOG2. Follow these simple steps to configure the function.

Press the **FUNC**. key followed by the **PRINT** key.



Using the numerical keys from 1 thru 3, select the action that you wish the Print/Log function to use and press **ENTER**.
The screen will display:

The instrument will automatically return to the previous mode.

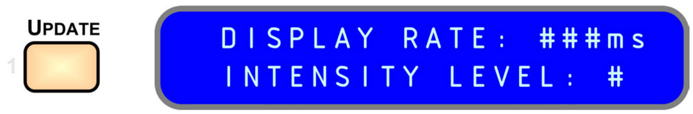
4.7 View Function

The View function allows the user to view how the instrument's functions are configured. This function is easy to use and is very useful especially for HLC and TCM users.

4.7.1 Using the View function

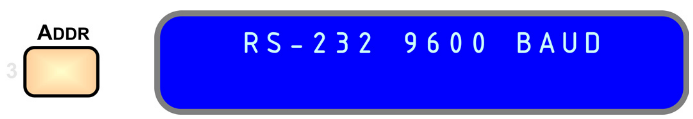
Pressing the **VIEW** key initiates the View mode. Once in this mode, the user can select one of the following function keys. To exit the View mode press the **VIEW** key at ay time.

UPDATE – The screen displays the display update rate and intensity settings.



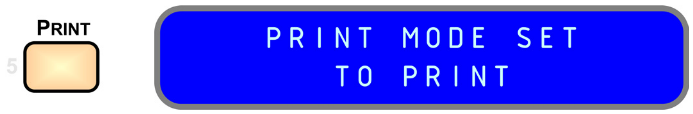
HLC - The screen displays the HLC limits for the range that is selected at the time. In this mode, the user can switch through the ranges to view all the values set as limits.

ADDR. – The screen displays the BAUD rate of the RS-232 interface. Also if Option GPIB is installed, the screen will display the GPIB address. ViewAddr will also show if the Option BCD or USB are installed.

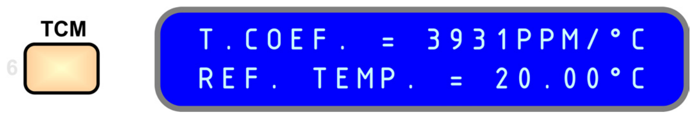


RUN/HOLD – The screen will display the configuration of the Run/Hold key.

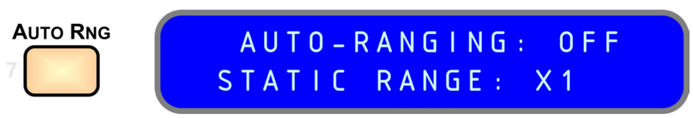
PRINT – The screen will display the configuration of the Print/Log feature.



TCM – The screen will display the temperature coefficient and temperature reference value set for the TCM mode.



AUTO RNG – The screen will display the auto range status (on or off), and the range that is in use.



CAL – The screen displays the date of the last calibration. This is update from the interface.

BCD – The screen will indicate if the instrument has Option BCD installed.

4.8 SafeMode

As a safety precaution, the 4176 is designed with an optional Safe Mode feature. With the Safe Mode option activated, if an overload persists for more then 10 seconds, the 4176 shuts down its current source, and displays "SAFEMODE" on its screen. The ohmmeter does not automatically recover from safe mode; the user must press the Enter key or any range (including Auto) to return to measurement mode. This is so that the user can be aware that an overload has occurred, so that the cause maybe investigated if necessary.

4.8.1 Enabling SafeMode

To enable the SafeMode option, press the FUNC. key followed by the **m/k** key. The screen will display the following messages.

4.8.2 Disabling SafeMode

If SafeMode is enabled, it can simply be disabled by following these steps.

Disconnect all lead from the binding post and allow the instrument to go in to SafeMode. Once in SafeMode press the FUNC. key followed by the **m/k** key.

Chapter 5 OPTIONAL FEATURES AND ACCESSORIES

The 4176 µ-Ohmmeters are shipped with a detachable power cord, and an Operation Manual as standard equipment. This section lists several items that may be desirable for special applications.

5.1 Options

5.1.1 BCD: Data Output

This option provides parallel BCD data on a rear-panel 50-pin connector. All outputs are TTL compatible levels with a drive capability of 1 LS load. Also refer to chapter 7.

5.1.2 GPIB

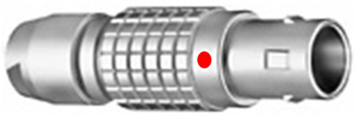
The Valhalla 4176 comes standard with a RS-232 interface. Also available is an optional GPIB IEEE-488.2 compatible interface. The interface is talk/listen, and provides range and ohmmeter function control. Also refer to chapter 6.

5.1.3 USB

Another interface that is available is USB. The interface is talk/listen, and provides range and ohmmeter function control. Drivers are provided.

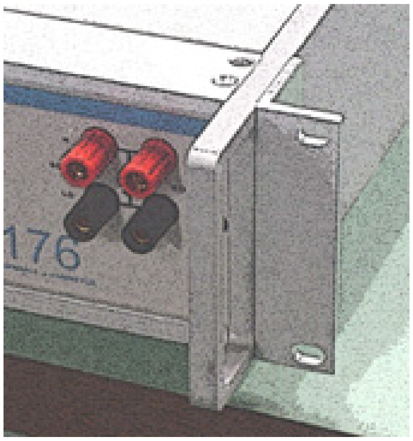
5.2 Accessories

5.2.1 Omni Compensator



To be able to use the TCM feature of the 4176, the user will need an Omni Compensator temperature sensor. This item allows the ohmmeter to compensate for temperature variations when testing any material.

5.2.2 Option R: Rack Mount Adapter



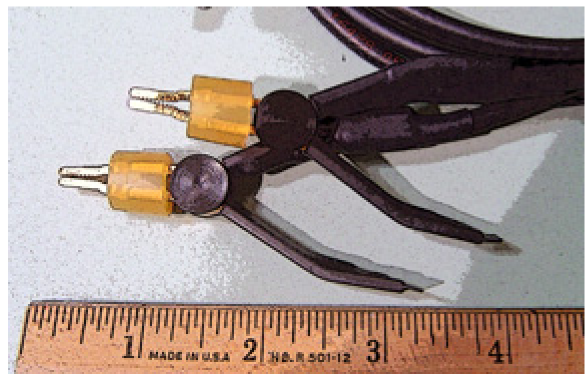
The 4176 μ-ohmmeters may be mounted in a standard 19" equipment rack using a set of optional rack ears. Option-R comes with all the necessary hardware for installation and mounting. An assembly diagram on how to install to rack ears on to the instrument can be found in Chapter 11 of this manual.

5.3 Test Leads

This section details the different test lead sets and connectors available for use with the 4176 µ-ohmmeters. All cables and test leads are manufactured by Valhalla Scientific Inc. and are tested before shipping.

5.3.1 Alligator Clip Type Leads

5.3.1.1 Option K: Kelvin Lead Set

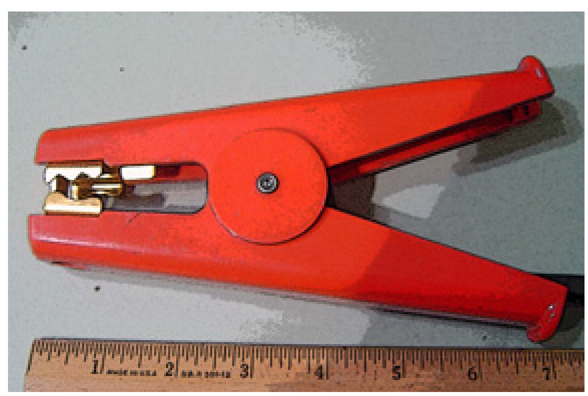


Option "K" is a shielded, 4-wire Kelvin cable set, 48 inches in length terminated in gold-plated alligator clips *(Option-KCS)*. Option "K" is the recommended general purpose lead set for most applications.

Option KCS: Gold-Plated Clips

Option "KCS" are gold-plated alligator clips used on the Option "K" lead set for 4-wire measurements of smaller components and leads. Clips open to 1/2 inch and accommodate test currents of up to 10 amperes.

5.3.1.2 Option KK: Heavy-Duty Lead Set

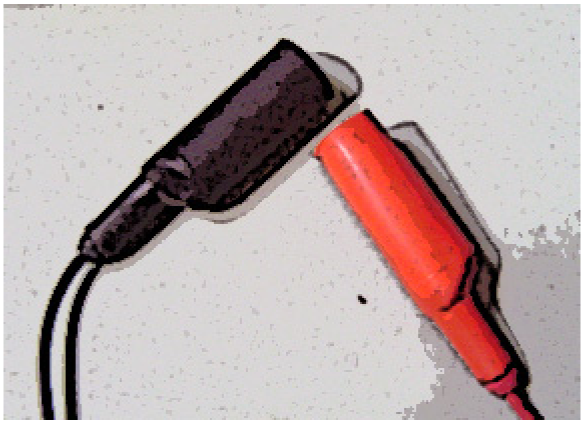


Option "KK" is a 4-wire Kelvin cable set, 48-inches in length terminated in heavy-duty gold-plated clamps *(Option-JAWS)*.

Option JAWS: Gold-Plated Clamps

Option "JAWS" are gold-plated heavy-duty clamps used to terminate Option "KK" lead set. Clamps open to 2 inches for connection to large motors, bushings, etc.

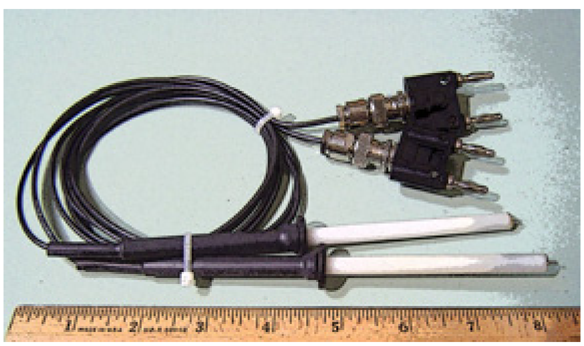
5.3.1.3 Option C: Banana-to-Clip Cable



Option "C" is a 48" general purpose shielded lead set terminated on one end in dual banana plugs and on the other end in red and black alligator clips.

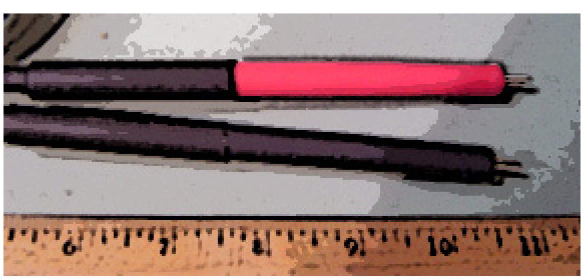
5.3.2 Needle Type Probes

5.3.2.1 Option MP-1: Kelvin Micro-Probes



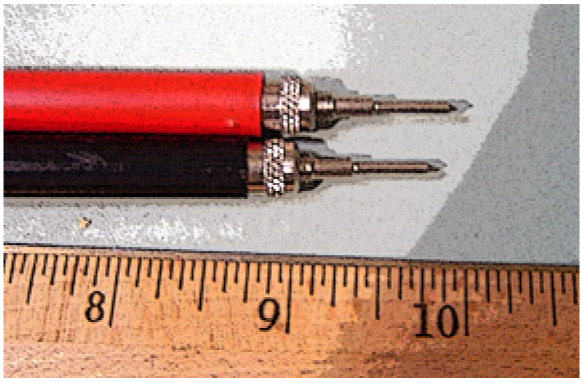
Option "MP-1" is a 48-inch shielded 4-wire Kelvin cable set with a 1A test current capacity employing a set of Kelvin Micro-Probes. The probes are equipped with spring-loaded stainless steel tips with 0.05" spacing.

5.3.2.2 Option MP-2: Kelvin Mini-Probes



Option "MP-2" is a 48-inch shielded 4-wire Kelvin cable set with a 1A test current capacity employing a set of Kelvin Mini-Probes. The probes are equipped with spring-loaded stainless steel tips with 0.18" spacing.

5.3.2.3 Option MP-S: Single Pointed Probe Set

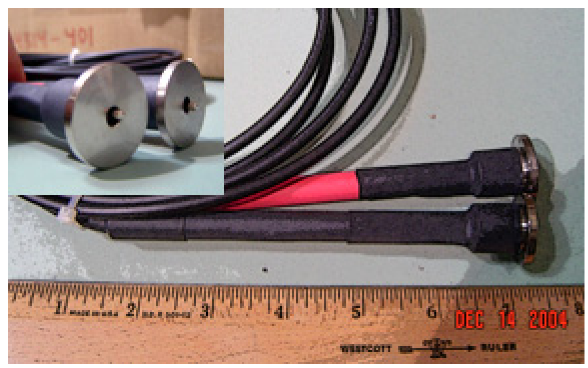


Option "MP-S" is a 48-inch shielded cable set with a 1A test current capacity employing a set of single pointed handheld pencil type probes. (2 wires to each point)

5.3.3 Surface Probes

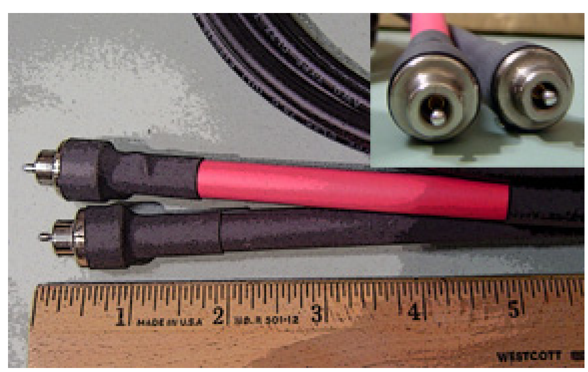
5.3.3.1 Option MP-4: Surface Probes

These probes permit rapid, repeatable bonding testing on a variety of screened or flat surfaces. Test current is evenly distributed through the probe base while sensing is accomplished via a spring loaded center contact. The target area is 1-inch in diameter.



5.3.3.2 Option MP-5: Surface Probes

These probes permit rapid, repeatable bonding testing on a variety of screened or flat surfaces. Test current is evenly distributed through the probe base while sensing is accomplished via a spring loaded center contact. The target area is ½ inch in diameter.

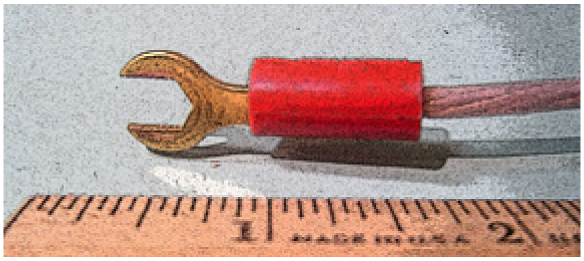


5.3.4 Other Lead Sets

5.3.4.1 Option BBL: Banana-to-Banana Cable

Option "BBL" is a 48" shielded cable terminated on both ends in dual stacking banana plugs. This cable may be used for voltage and current connections to the ohmmeter.

5.3.4.2 Option SL-48: Low Thermal Leads



Option "SL-48" is a 48" shielded lead set terminated in gold-plated spade lugs. This lead set is designed to eliminate problems caused by thermal EMF's and is rated for the maximum output current of 1A.

Chapter 6 REMOTE INTERFACE

6.1 INTRODUCTION

The 4176 is a fully interactive automatic measurement system. Communication between the 4176 and host computers is easily accomplished. The standard RS232 interface or optional GPIB and USB interface provide the capability to automate testing, retrieve actual resistance readings in different formats, retrieve temperature measurements, log data, and also calibrate the 4176.

6.2 CONNECTING THE 4176 VIA GPIB INTERFACE

6.2.1 The GPIB interface capabilities:

The GPIB interface of the 4176 corresponds to the standard of IEEE488.1-1987, IEEE488.2-1992 and SCPI-1994. The GPIB interface functions are listed as follows:

SH1(Source Handshake):	The 4176 can transmit multilane messages across the GPIB.
AH1(Acceptor Handshake):	The 4176 can receive multilane messages across the GPIB.
T6(Talker):	Talker interface function includes basic talker, serial poll, and unaddress if MLA capabilities, without talk only mode function.
L4 (Listener):	The 4176 becomes a listener when the controller sends its listen address with the ATN (attention) line asserted. The power supply does not have "listen" only capability.
SR1 (Service Request):	The 4176 asserts the SRQ (Service request) line to notify the controller when it requires service.
RL1 (Remote/Local):	The 4176 responds to both the GTL(Go to Local) and LLO(Local Lock Out) interface messages.
PP0 (Parallel Poll):	The 4176 has no Parallel Poll interface function.
DC1 (Device Clear):	The 4176 has Device clear capability to return the device to power on status.

DT0 (Device Trigger):	The 4176 has no Device Trigger interface function.
C0 (Controller):	The 4176 can not control other devices.

6.2.2 Notes for GPIB installation

When the 4176 is set up with a GPIB system, please check the following things:

- *Only a maximum of 15 devices can be connected to a single GPIB bus.*
- *Do not use more than 20m of cable to connect devices to a bus.*
- *Connect one device for every 2m of cable used.*
- *Each device on the bus needs a unique device address. No two devices can share the same device address.*
- *Turn on at least two-thirds of the devices on the GPIB system while using the system.*
- *Do not use loop or parallel structure for the topology of GPIB system.*

6.2.3 Computer's Connection

A personal computer with a GPIB card is the essential facilities in order to operate the 4176 via GPIB interface.

The connections between power supply and computer are following:

I. Connect one end of a GPIB cable to the computer.

II. Connect the other end of the GPIB cable to the GPIB port on the 4176.

III. Turn on the 4176.

IV. Turn on the computer.

6.2.4 The GPIB connection testing

If you want to test whether the GPIB connection is working or not, you can send a GPIB command from computer. For instance, the query command

*idn?

should return the Manufacturer, model number, serial number and firmware version in the following format:

```
VALHALLA SCIENTIFIC 4176,1.01G,0"
```

If you do not receive a proper response from the 4176, please check if the power is on, the GPIB address is correct, and all cable connections are active.

6.3 CONNECTING THE 4176 VIA RS232 INTERFACE

6.3.1 The RS232 interface capabilities:

The RS232 interface provides a point-to-point connection between two items of equipment such as a computer and the 4176. There are some parameters you need to set on the both sides. Once you have set these parameters, you can control the 4176 through the RS232 interface.

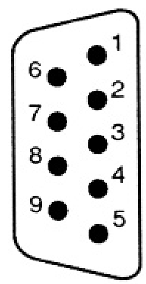
- Baud rate: 9600 baud.
- Parity bit: none.
- Data bit: 8 bits.
- Stop bit: 1 stop bit.
- Data flow control: none.

6.3.2 Notes for RS232 installation

The 4176 is a DCE (Data Channel Equipment) device with a 9-pin D-type shell RS232 connector located on the rear panel. Table 14 shows the 9-pin connector (Female) with its pin number assignments. Figure 17 shows the wiring configuration for DB9 to DB9. When the 4176 is set up with a RS232 interface, please check the following points:

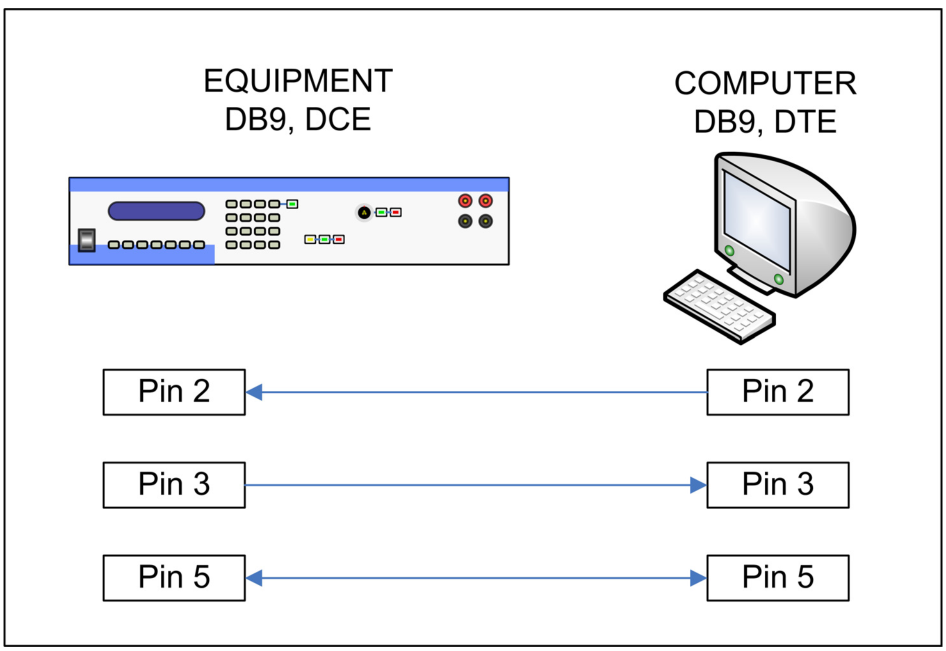
- Many devices require a constant high signal on one or more input pins.
- Ensure that the signal ground of the equipment is connected to the signal ground of the external device.
- Ensure that the chassis ground of the equipment is connected to the chassis ground of the external device.
- Do not use more than 15m of cable to connect devices to a PC.
- Ensure the same baud rate is used on the device as the one used on PC terminal.
- Ensure the connector for the both side of cable and the internal connected line are met the demand of the instrument.

Table 14 – RS-232 Connector Pin Configuration



Pin #	Pin Function
1	No connection
2	Receive Data (RxD) (input)
3	Transmit Data (TxD) (output)
4	No connection
5	Signal Ground (GND)
6	No connection
7	No connection
8	No connection
9	No connection

Figure 17 - Wiring Configuration DB9 to DB9



6.3.3 Connecting to a Computer

A personal computer with a COM port is the essential facilities in order to operate the 4176 via RS232 interface.
The connections between 4176 and computer are as follows:

I. Connect one end of a RS232 cable to the computer.
II. Connect the other end of the cable to the RS232 port on the 4176.
III. Turn on the 4176.
IV. Turn on the computer.

6.3.4 Checking Connections

If you want to test whether the RS232 connection is working or not, you can send a command from computer. For instance, using a terminal program send the query command

```
*idn?
```

should return the Manufacturer, model number, serial number and firmware version in the following format:

```
VALHALLA SCIENTIFIC 4176,1.02C,0"
```

If you do not receive a proper response from the 4176, please check if the power is on, and all cable connections are active.

6.4 INPUT AND OUTPUT QUEUE

The design of 64 bytes input queue and 128 bytes output queue for storing the pending commands or return messages is to prevent the transmitted commands of remote control and return messages from missing. As the maximum stored capacity for Error/Event Queue is 20 groups of messages, it should be noted that input data exceeding the capacity by using these buffers will cause data missing.

6.5 COMMANDS AND SYNTAX

6.5.1 RS232 message terminators

As there is no signal of end message on RS232 bus, therefore, use LF, CR, or CR/LF as message terminator. After the 4176 processes a command a CR/LF is placed in the output buffer and delivered. As for query command, the return message of the instrument is also added a LF for PC to judge message terminator.

6.5.2 Entering Commands

The standards that govern the command set for the 4176 allow for a certain amount of flexibility when you enter commands. The 4176 does not adhere to any friendly listening standards so the commands and queries must be typed as specified.

6.5.3 Command Characters

The 4176s are not sensitive to the case of command characters. You can enter commands in either uppercase or lowercase.

You can execute any command with preceding white space characters. You must use at least one space between the parameter and the command header. Subsequent parameters are separated by commas.

6.5.4 Combining Commands

You can use a semicolon (;) to combine commands, but not queries.

Example:

RANGE 4; HLCHI 14.999<LF>

6.5.5 Synopsis of Commands

The tables in this section summarize the commands of the programmable 4176 Ohmmeter.

6.6 DETAILS OF COMMAND REFERENCE

Each command in this chapter will give a detailed description. The examples of each command will be provided and what query form might return.

Syntax and return values for each are explained in the function header. The *STB? gives the status of the command.

Remote mode is entered when a valid printable character is received and is exited with the LOCAL front panel key or LOCAL command.

6.6.1 Command Index

:SYST:ERR?

QUERY Sends the System Error value to the remote host.

Cleared with *CLS<crlf>

Syntax: :SYST:ERR?

Example: :SYST:ERR?<crlf>

Response: 1F<crlf>

Power-on default = 0

ADDRS COMM

Sets the GPIB address in RAM memory not in non-volatile memory.

Syntax: ADDRS <decimal address>

Response: <crlf>

Parameter: Address number = 1 - 32 (decimal)

Example: ADDRS 7<crlf>
ADDRS?<crlf>
7<crlf>

Power-on default = 10

Note: Value can be saved to non-volatile memory with SAVESETUP command.

ADDRS QUERY

Sends the GPIB address from RAM data volatile memory in decimal format.

Syntax: ADDRS?

Example: ADDRS?<crlf>

Response: 10<crlf> (Address number = 1 - 32)

Power-on default = None, must be set with "ADDRS 10" and SAVESETUP.

BCD COMMAND

Selects BCD mode on or off

Syntax: BCD <ON or OFF>

Example: BCD ON<crlf>
BCD?<crlf>
ON<crlf>

Power-on default = OFF

Note: BCD mode on puts the logic level BCD on the rear panel connector and the ranges on the relays outputs. See chapter 7 for BCD connector pin-outs and relay descriptions.

BCD QUERY

Responds with BCD mode on or off

Syntax: BCD?

Example: BCD?<crlf>
ON<crlf>

Response: <"ON" or "OFF">

Power-on default = OFF

CALDATE QUERY

Request the last calibration date and technician initials.

Syntax: CALDATE?

Response: "00-00-04 VSI"

Power-on default = "00-00-00 VS####"

***CLS COMMAND**

Sets buffers to power on default.

Syntax: *CLS<crlf>

CNFG COMMAND

Turns on and off system configuration items. Alarms, key beeps, other features.

```
Syntax:     CNFG <item number>, <ON or OFF>

Example:    CNFG 1, ON<crlf>
            CNFG? 1<crlf>
            ON<crlf>

            1 - Supress Alarms
            2 - Supress Key Beeps

Power-on defaults = OFF
```

CNFG QUERY

Responds with CNFG mode on or off

```
Syntax:     CNFG?

Example:    CNFG? 2<crlf>
            ON<crlf>

Response:   <"ON" or "OFF">

            1 - Supress Alarms
            2 - Supress Key Beeps

Power-on defaults = OFF (pleasantly noisy)
```

FAULT COMMAND

Sets an alarm fault to watch the system react.

```
Syntax:     FAULT <Hexadecimal number>
```

FAULT_ALARM_NO_FAULT	00	
FAULT_ALARM_OVER_TEMP	01	Internal temperature too high
FAULT_ALARM_CAL_LIMIT	02	Input level for calibration exceeded limit
FAULT_ALARM_TCM	04	Input level for TCM calibration exceeded limits
FAULT_ALARM_CMD_CHAR	08	Unprintable characters received or cmd too long
FAULT_TXBUF_SPACE	10	Low on space in transmit buffer
FAULT_ALARM_TXBUF_FULL	20	Serial transmitter buffer full
FAULT_ALARM_RCVBUf_FULL	40	Serial receiver buffer full
FAULT_ALARM_NVRAM	80	NV RAM fault

Power-on default = 00

FAULT QUERY

Returns the alarm bit mapped byte.

Syntax: FAULT?

Response: 2 digit Hexadecimal number

FAULT_ALARM_NO_FAULT	00	
FAULT_ALARM_OVER_TEMP	01	Internal temperature too high
FAULT_ALARM_CAL_LIMIT	02	Input level for calibration exceeded limit
FAULT_ALARM_TCM	04	Input level for TCM calibration exceeded limits
FAULT_ALARM_CMD_CHAR	08	Unprintable characters received or cmd too long
FAULT_TXBUF_SPACE	10	Low on space in transmit buffer
FAULT_ALARM_TXBUF_FULL	20	Serial transmitter buffer full
FAULT_ALARM_RCVBUf_FULL	40	Serial receiver buffer full
FAULT_ALARM_NVRAM	80	NV RAM fault

Power-on default = 00

HLC COMMAND

Selects HLC mode on or off

Syntax: HLC <ON or OFF>

Example: HLC ON<crlf>
HLC?<crlf>
ON<crlf>

Power-on default = OFF

Note: HLC mode on puts the logic level HLC relays on the rear panel connector and the ranges on the relays outputs. See chapter 4 section 3 for HLC relay contact descriptions.

HLC QUERY

Responds with HLC mode on or off

Syntax: HLC?

Example: HLC?<crlf>
ON<crlf>

Response: <"ON" or "OFF">

Power-on default = OFF

HLCHI COMMAND

Sends the Hi-Lo Comparator High Limit for current range.

Syntax: HLCHI <value>

Where value = 1.0000 for 1 Ohm in the 3 Ohm range and 100.00 for 100mOhm in the 100m Ohm range, and 00.500 for .5k Ohms in the 20kOhm range.

This command writes the value to RAM memory only. To store these values in non-volatile memory follow with SAVSETUP.
Send RANGE command before sending this command. Must send all 5 digits with leading zeroes.

Power-on default = Depends on range.

HLCHI? QUERY

Reads the Hi-Lo Comparator high value from RAM for range.

Syntax: HLCHI?

Response: Floating (fixed) point Ohm value for current range.

"1.0000" for 1 Ohm in the 2 Ohm range and 100.00 for 100m Ohm in the 200m Ohm range.

This command reads the value from RAM memory only. If you have used the HLCHI command to write a HLC value it will be different than the value stored in non-volatile memory if the SAVSETUP command has not been sent.

Power-on default = Depends on range.

HLCLO COMMAND

Sends the Hi-Lo Comparator Low Limit for current range.

Syntax: HLCLO <value>

Where value = 1.0000 for 1 Ohm in the 1 Ohm range, 100.00 for 100m Ohm in the 100m Ohm range, 1.000 for 1k in the 1k Ohm range.

This command writes the value to RAM memory only. To store these values in non-volatile memory follow with SAVSETUP.
Send RANGE command before sending this command.

Power-on default = Depends on range.

HLCLO? QUERY

Reads the Hi-Lo Comparator low value from RAM for range.

Syntax: HLCLO?

Response: Floating (fixed) point Ohm value for current range.

"1.0000" for 1 Ohm in the 1 Ohm range and 100.00m for 100m Ohm in the 100m Ohm range, 1.0000k for 1k Ohm in the 1k Ohm range.

This command reads the value from RAM memory only. If you have used the HLCLO command to write a HLC value it will be different than the value stored in non-volatile memory if the SAVSETUP command has not been sent.
Send RANGE command before sending this command.

Power-on default = Depends on range.

***IDN? QUERY**

Returns the IEEE or RS-232 identification string from non-volatile.

Syntax: *IDN?<crlf>

Response: ID string "VALHALLA SCIENTIFIC 4176,1.01G,0"

Example: *IDN?<crlf>
"VALHALLA SCIENTIFIC 4176,1.01G,0"<crlf>

```
ID_STRING       :   "VALHALLA SCIENTIFIC"
VERSION         :   "1.01G"
MODEL           :   "4176"
HARDWARE_VER    :   "0"
OPTION_STRING   :   "Option(s) : GPIB(IEEE488.2)"
```

KEY COMMAND

Presses a key from the interface, use for macros when the command you desire is not listed here.

Syntax: KEY <key number>

Response: <crlf> (only after the key has been processed)

Key number = 0 - 24

0	KEY_NO_KEY	20	KEY_RANGE_1
1	KEY_0	21	KEY_4
2	KEY_3	22	KEY_RANGE_0
3	KEY_CLEAR	23	KEY_7
4	KEY_9	24	KEY_RANGE_3
5	KEY_LOCAL	25	KEY_UNKNOWN
6	KEY_RESET		
7	KEY_FUNC	KEY_UPDATE	KEY_1
8	KEY_ENTER	KEY_HLC	KEY_2
9	KEY_DP	KEY_ADDR	KEY_3
10	KEY_RANGE_4	KEY_RUNHOLD	KEY_4
11	KEY_2	KEY_PRINT	KEY_5
12	KEY_RANGE_5	KEY_TCM	KEY_6
13	KEY_5	KEY_AUTO_RNG	KEY_7
14	KEY_RANGE_6	KEY_CAL	KEY_8
15	KEY_8	KEY_BCD	KEY_9
16	KEY_6	KEY_VIEW	KEY_0
17	KEY_NOTUSED	KEY_DISPLAY	KEY_1
18	KEY_RANGE_2	KEY_mk	KEY_DP
19	KEY_1		

Power-on default = 0

Note: The remote key macro command was developed so our customers can literally perform any action from the remote available to the key press enthusiast. This capability is not without restrictions. Illegal key sequences may get the machine in a menu you do not expect or cause the meter to not process properly the keys you send. Key presses are human interface and therefore not buffered.
Because of this key delays may be necessary as sending keys too quickly may lose keys.

KEY? QUERY

Returns the decimal number of the key last key processed by the state machine. This query returns any key in the remote mode even if the key is locked out by remote mode, i.e. KEY_LOCAL is not locked out.

Syntax: KEY?<crlf>
21<crlf>

Response: Decimal Key value between 0-24, 0 = No key pressed

0	KEY_NO_KEY	20	KEY_RANGE_1
1	KEY_0	21	KEY_4
2	KEY_3	22	KEY_RANGE_0
3	KEY_CLEAR	23	KEY_7
4	KEY_9	24	KEY_RANGE_3
5	KEY_LOCAL	25	KEY_UNKNOWN
6	KEY_RESET		
7	KEY_FUNC	KEY_UPDATE	KEY_1
8	KEY_ENTER	KEY_HLC	KEY_2
9	KEY_DP	KEY_ADDR	KEY_3
10	KEY_RANGE_4	KEY_RUNHOLD	KEY_4
11	KEY_2	KEY_PRINT	KEY_5
12	KEY_RANGE_5	KEY_TCM	KEY_6
13	KEY_5	KEY_AUTO_RNG	KEY_7
14	KEY_RANGE_6	KEY_CAL	KEY_8
15	KEY_8	KEY_BCD	KEY_9
16	KEY_6	KEY_VIEW	KEY_0
17	KEY_NOTUSED	KEY_DISPLAY	KEY_1
18	KEY_RANGE_2	KEY_mk	KEY_DP
19	KEY_1		

Usage: Keys are polled every 25ms in a timer interrupt. This routine changes mode to local and responds with the last key pressed. It can sense keys even in remote mode. Keys are debounced but are not tested for each menu state.
In other words, sending KEY 4 in a state that does not accept that key will have no effect to change the state. In addition if the KEY X commands are sent without enough interval the key handler task will not have executed and the key press can be overwritten by the next key command and the previous one is skipped. This is due to no buffering of remote key presses.

LOCAL COMMAND

Returns meter to local mode, remote LED off, Goto Local.

Syntax: LOCAL

Returns: <crlf>

Power-on default = LOCAL mode

Notes: REMOTE mode is selected when the meter receives a valid character (not <crlf>. Once selected, all keys are disabled and will not be scanned. Therefore no key beeps with the exclusion of the LOCAL key at the top right of the key pad. This key is active in REMOTE mode and will extinguish the REMOTE LED and transition the device to the front panel local user mode.

LOG COMMAND - Selects LOG mode on or off

Syntax : LOG <ON or OFF>,0 (synonomous with OHMS?)

Example:
```
LOG ON 0<crlf>   (space or comma)
13.693<crlf>
13.664<crlf>

LOG ON,4        (default)
13.693<crlf>
13.664<crlf>

LOG ON,6
13.693,23.2,.0003931,13.699,20.0
```

Possible options, responses as if the following queries sent
===============

0 – OHMS?
1 – OHMS?,ATOD1?,RDNG?
2 – ATOD1?
3 – ATOD1?,RDNG?
4 – RDNG?
5 – RDNG?,RANGE?
6 – OHMS?,EXTEMP?,Setup.TC.Load_Coeff,COMPENSATED_OHMS,Ref_Degress
7 - EXTEMP?
8 - EXTEMP?,RDNG? (Run TCM ON first)
9 - LOG PENDING, starts when user presses PRINT

Power-on default = OFF

OHMS? QUERY

Responds with reading from the front panel display and causes an immediate update of the conversion so repeated query requests gets most accurate data. Send range command or AUTO prior to sending this to get the scaling factor.
The Ohms omega, milli and kilo characters are removed during remote formatting.

Syntax: OHMS?

Example: OHMS?<crlf>
20.000<crlf> (on 20m or 20k Ohm ranges)

Response: <20.000<crlf>>

Power-on default = 0.000

Note: For Scientific notation/Engineering format, use RDNG?

---

*OPT? QUERY

Returns the option text strings factory installed on meter from non-volatile.

Syntax: *OPT?

Example: *OPT?<crlf>
"Option(s) :
GPIB(IEEE488.2),BCD,PLC,HLC,TCM,AUTO,RS232,USB<crlf>

RANGE COMMAND

Selects a resistance/current range

Syntax: RANGE <range number>

Range number = 0 - 7
1 = R20mOHM
2 = R200mOHM
3 = R2_OHM
4 = R20_OHM
5 = R200_OHM
6 = R2K_OHM
7 = R20K_OHM
A = RANGE_AUTO

Power-on default = 7

If the range is AUTO, auto-ranging is selected.

RANGE QUERY

Returns the selected range.

```
Syntax:     RANGE?

Response:   Range number = 0 - 7

            0 = RANGE_OFF   (SAFE MODE)
            1 = R20mOHM
            2 = R200mOHM
            3 = R2_OHM
            4 = R20_OHM
            5 = R200_OHM
            6 = R2K_OHM
            7 = R20K_OHM
            A = RANGE_AUTO
```

Power-on default = 7

RDNG? QUERY

Responds with reading from the device in engineering notation. Query function also uses an immediate update of the conversion so repeated query requests gets the most accurate data.

```
Syntax:     RDNG?

Example:    RDNG?<crlf>
            2.4321e+1<crlf>       (on 20.000 Ohm ranges)

Response:   <value in reduced engineering notation<crlf>>
```

Power-on default = 0.000e+0

CAUTION: Will not work if the transmit interrupt happens to be busy with a display update and the following occurs:

```
Remote ->RANGE 6   <2k Ohm)
System ->Places "REM^" in TX buffer (Tiny Display)
System ->Change to R6
System ->Places "2k^" in TX buffer (Tiny Display)
System ->Formats Display String "1.6543k^"
Remote ->READING?
System ->Places in TX buffer to VFD 'D' characters
Remote ->RANGE 4
System ->Change to R4
System ->Executes READING? query, uses Range=4 and last displayed value
System ->Places in TX buffer, next 'R' characters
```

RESET COMMAND

Executes a soft reset of the ADuC834 processor system.

Syntax: RESET

Response: Front panel display show soft reset initiation. "RESETTING" is displayed flashing inverse mode for 300ms while all system configurations are returned to power up default.

Example: RESET<crlf>

Response: <crlf>

Notes: Resetcpu() executes as soft reset of the system by "nicely" changing the return stack function and popping it. Expect a 500ms delay after receiving the linefeed before transmitting next command.

***RST COMMAND**

Sets buffers to power on default.

Syntax: *RST<crlf>

Response: <crlf>

Remote command buffer, Serial I/O, history, statistics, stability

---

SAVSETUP COMMAND

Stores current RAM setup data in NV RAM.

Syntax: SAVSETUP<crlf>

SAVSETUP? QUERY

Refreshes the current Setup from NV-RAM and then sends it to the remote port.

Syntax: SAVSETUP?<crlf>

Response:

```
FF EE DD CC BB AA 99 88 77 66 55 44 33 22 11 00<crlf>
FF EE DD CC BB AA 99 88 77 66 55 44 33 22 11 00<crlf>
FF EE DD CC BB AA 99 88 77 66 55 44 33 22 11 00<crlf>
............BB AA 99 88<crlf>
```

***STB? QUERY**

Returns the command status byte.

Syntax: *STB?

Response: Command status number = 0 - 0xFF

Example:

```
*STB?<crlf>
01<crlf>
```

Fragment:

```
TCM ON<crlf>
*STB?<crlf>
TCM AFF<crlf>
**STB?<crlf>        (returns * ERROR)
03<crlf>
TCM?<crlf>
ON<crlf>
```

```
0 = CMD_LAST_COMPLETE
1 = CMD_UNKNOWN
2 = CMD_MISSING_PARAM
4 = CMD_INVALID_PARAM
8 = CMD_MODE_OFF
16 = CMD_INCORRECT_NUMBER_PARAMS
32 =
64 =
128 = CMD_CALLAREALPGMR
```

Power-on default = 0

Note: After a command or query with or without a response, the *STB? query responds with hexadecimal number with bits mapped as in the table above. The *STB? query clears the command status byte as does any other correctly completed command. The bits are "sticky" through the sending of the *STB? query response but are cleared after the data is transmitted.

TCM COMMAND

Selects TCM mode on or off

Syntax: TCM <ON or OFF>

Example: TCM ON<crlf>
TCM?<crlf>
ON<crlf>

Power-on default = OFF

TCM QUERY

Responds with TCM mode on or off

Syntax: TCM?

Example: TCM?<crlf>
ON<crlf>

Response: <"ON" or "OFF">

Power-on default = OFF
Send this date after the calibration is complete followed by a SAVESETUP to store in EE memory.

---

*TST? QUERY

Causes internal self-test to run and returns the result.

Syntax: *TST?

Response Format: %hd CAUTION:THIS FORMAT IS THE ONLY ACCEPTABLE BY IVI DRIVER.

Chapter 7 BCD INTERFACE

7.1 General

Option "BCD" provides parallel Binary Coded Decimal data output that corresponds to the display indication.
Signals are also provided for range information, and overload. A run/hold line is also provided to halt the 4176.
The signals are TTL compatible ($0 \leq .8V$, and $1 \geq 2.4V$) and will drive 1 LS TTL load.

7.2 BCD Pin Assignments

DATA
This is the BCD coded data which is identical to that being displayed by the 4176.

Pin #	FUNCTION
1	1
20	2
2	4
21	8
3	10
22	20
4	40
23	80
5	100
24	200
6	400
25	800
7	1000
26	2000
8	4000
27	8000
9	10000
28	20000

RANGE

Pin #	FUNCTION
10	R0
29	R1
11	R2
30	R3

Table 15 - RCD Range Truth Table

Range	PIN 30 R3	PIN 11 R2	PIN 29 R1	PIN 10 R0
Ranges OFF	0	0	0	0
20mΩ	0	0	0	1
200mΩ	0	0	1	0
2Ω	0	0	1	1
20Ω	0	1	0	0
200Ω	0	1	0	1
2kΩ	0	1	1	0
20kΩ	0	1	1	1

OVERLOAD – PIN 12

This is a logic 1 when the data on the lines above is an overload indication. (Note: The Data is arbitrary during this condition.)

AVDD & AGND

Pin #	FUNCTION
14	AVDD
15	AVDD
32	AVDD
33	AVDD
34	AVDD

Pin #	FUNCTION
1	1
2	4
3	10
4	40
5	100
6	400
7	1000
8	4000
9	10000
10	R0
11	R2
12	OVERLOAD
13	NC
14	AVDD
15	AVDD
16	AGND
17	AGND
18	NC
19	NC

Pin #	FUNCTION
20	2
21	8
22	20
23	80
24	200
25	800
26	2000
27	8000
28	20000
29	R1
30	R3
31	NC
32	AVDD
33	AVDD
34	AVDD
35	AGND
36	AGND
37	NC

Table 16 - BCD Pin Assignment Reference Table

Chapter 8 ROUTINE MAINTENANCE

8.1 General

This Chapter provides general maintenance information and a procedure for calibrating the ohmmeter. The Model 4176 μ-ohmmeter should be calibrated on a routine basis (every 12 months is recommended) to ensure continued accuracy.

Before performing the calibration procedure below, the ohmmeter should be allowed to warm up at a stable temperature for at least 30 minutes with the covers in place.

8.2 Required Test Equipment

The following equipment is required to perform calibration of the 4176:

1) Precision resistors with known values within ±0.005%, the following values will be used: 0.01Ω, 0.1Ω, 1Ω, 10Ω, 100Ω, 1kΩ and 10kΩ.
2) DC voltage standard capable of outputting 10mV, 300mV and 1V. Valhalla Model 2701C is suitable for the task.
3) Four wire test lead set.
4) Precision Digital Voltmeter.

Note: If this equipment is not available, the ohmmeter may be returned to Valhalla Scientific for calibration traceable to NIST.

8.3 Pre-Calibration Procedure

The calibration adjustments are accessed by removing the top cover of the instrument. The locations of the adjustment potentiometers are shown in drawing № 4176-700 (see chapter 13). Leave the cover in place as much as possible. After each adjustment is made, the cover should be replaced and the instrument allowed to stabilizing.

CAUTION	**Dangerous AC line voltages exist inside the instrument. Use caution when making adjustments to avoid contact with these voltages.**

8.4 4176 Calibration Procedure

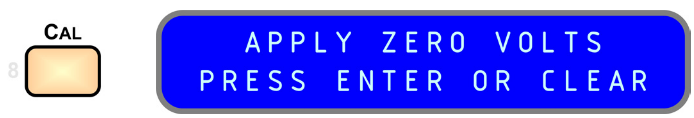
8.4.1 Standard Calibration

The standard calibration consists of three parts: sense calibration, source calibration and final adjustment. The sense calibration and the final adjustment calibration is cover-on and automated; the instrument will prompt the user throughout the steps. The source calibration is performed by adjusting six potentiometers located on the 4176 main board. All three calibrations must be performed for a complete calibration of the 4176.

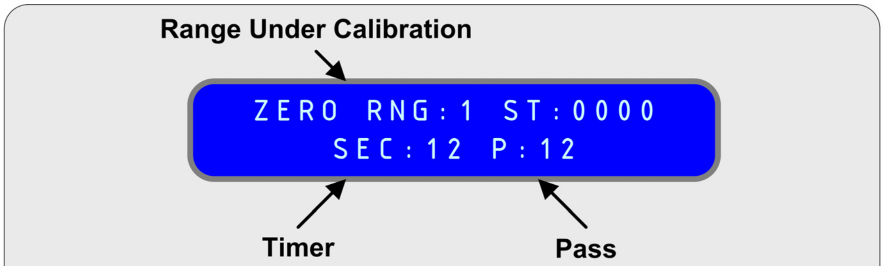
8.4.1.1 Sense Calibration

Step 1. Press the **FUNC** key followed by the **CAL** key. The screen will display the following message:

Step 2. Press the **CAL** key. The screen will display the following message:

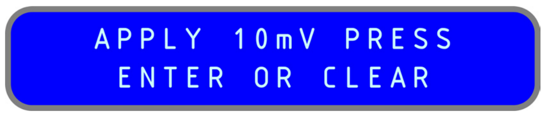


Step 3. Apply a short between the Sense Hi and the Sense Lo binding post. Once the short is applied, press the **ENTER** key. The ohmmeter will perform the zero calibration for all ranges. If the **CLEAR** key is pressed, the display will return to the previous screen. While the instrument is zeroing the screen will display the following:

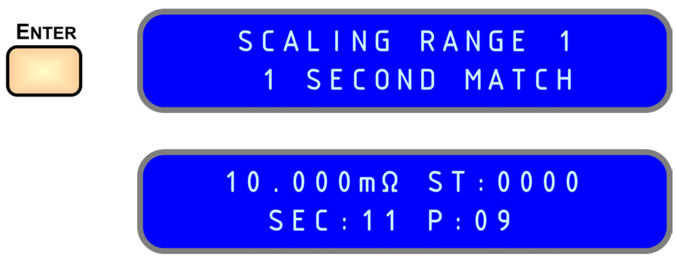


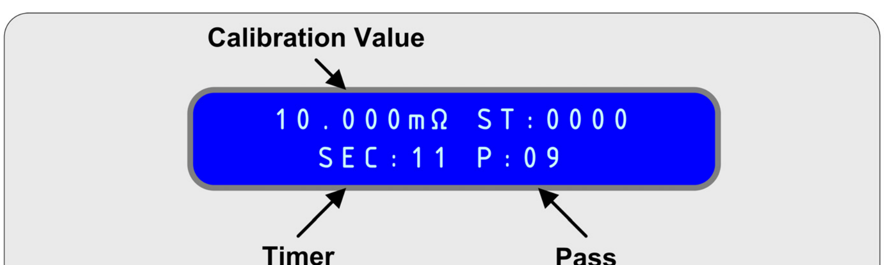
Pass indicates the number of passing values that have been measured. 15 passing values must be measured before the timer reaches its 100 seconds limit for the calibration to pass.

When the instrument has completed the zero cal for all the ranges, the screen will prompt the following message:



Step 4. Apply 10mV using the voltage standard and press **ENTER** to start the 20mΩ range voltage calibration. Press the **CLEAR** key if you wish to return to the zero cal.





Pass indicates the number of passing values that have been measured. 15 passing values must be measured before the timer reaches its 100 seconds limit for the calibration to pass.

When the instrument has completed the 10mV cal, the screen will prompt the following message:

```
APPLY 300mV PRESS
ENTER OR CLEAR
```

Step 5. Apply 300mV using the voltage standard and press **ENTER** to start the range voltage calibration. Press the **CLEAR** button if you wish to return to the previous screen.

ENTER

```
SCALING RANGE 2
1 SECOND MATCH
```

```
0.30000Ω ST:0000
SEC:11 P:09
```

This step will perform the voltage calibration from 200mΩ range to the 20kΩ range. When the instrument has completed the 300mV cal, the screen will prompt the following message:

```
SAVE CAL VALUES?
PRESS ENTER OR CLEAR
```

Step 6. Press **ENTER** to save the cal values or **CLEAR** to return to the 300mV cal.

ENTER

```
CALIBRATION COMPLETE
PRESS ENTER OR TCM
```

Step 7. Press **ENTER** to complete the calibration. The screen will display:

ENTER

```
SAVING NEW SETUP
DATA IN NOVRAM
```

Sense calibration is now completed.

8.4.1.2 Source Calibration

Step 1. Short the SENSE HI and SENSE LO using a jumper.

Step 2. Connect the digital voltmeter to the main board as follows:
DVM negative input to TP9
DVM positive input to TP10

Step 3. Adjust RV1 for a DVM reading of -1.0000V.

Step 4. Remove the DVM connection and the jumper.

Step 5. Select the .2Ω range.

Step 6. Connect the 4176 to a .1Ω standard resistor.

Step 7. Adjust RV2 for a display reading equal to the value of the load.

Step 8. Select the 2Ω range.

Step 9. Connect the 4176 to a 1Ω standard resistor

Step 10. Adjust RV3 for a display reading equal to the value of the load.

Step 11. Select the 20Ω range.

Step 12. Connect the 4176 to a 10Ω standard resistor

Step 13. Adjust RV4 for a display reading equal to the value of the load.

Step 14. Select the 200Ω range.

Step 15. Connect the 4176 to a 100Ω standard resistor

Step 16. Adjust RV5 for a display reading equal to the value of the load.

Step 17. Select the 2kΩ range.

Step 18. Connect the 4176 to a 1kΩ standard resistor

Step 19. Adjust RV6 for a display reading equal to the value of the load.

Step 20. Select the 20kΩ range.

Step 21. Connect the 4176 to a 10kΩ standard resistor

Step 22. Adjust RV7 for a display reading equal to the value of the load.

Step 23. Reset the 4176 from the front panel **RESET** button or by turning off the power switch and rebooting.

Step 24. End of Souse Calibration.

8.4.1.3 Final Adjustments

Step 1. Select the 20mΩ range.

Step 2. Connect the 4176 to a 10mΩ standard resistor.

Step 3. Press **FUNC** key followed by the **CAL** key.

Step 4. Press the **CAL** key again to enter the ohms cal mode.

Step 5. Press the **FUNC** key to skip zero volts cal.

Step 6. The screen should display:

```
APPLY 10mV PRESS
 ENTER OR CLEAR
```

Step 7. Press **ENTER** to continue.

Step 8. Once the 10mV cal is complete, the screen will display:

```
APPLY 300mV PRESS
  ENTER OR CLEAR
```

Step 9. Press the **FUNC** key to skip. The screen should display:

```
  SAVE CAL VALUES?
PRESS ENTER OR CLEAR
```

Step 10. Press **ENTER** to save the cal values.

Step 11. Press **ENTER** to complete the calibration.

8.4.2 Periodic Maintenance

The 4176 ohmmeter does not require any periodic maintenance other than an occasional cleaning of the exterior surfaces of the product and routine performance of the calibration procedure. Loose dirt or dust which may have collected on the exterior surface of the ohmmeter may be removed with a soft cloth or brush. Any remaining dirt may be removed with a soft cloth dampened in a mild soap and water solution.

Do not use abrasive cleaners on the ohmmeter!

The front panel may be cleaned with a soft cloth and a "Windex" type cleaner if required.

Do not use petroleum based cleaners on the front panel.

If required, the interior of the product may be cleaned out by blowing with dry compressed air. If the product has become heavily soiled with dirt or other contaminants it is recommended that the unit be completely overhauled.

Contact Valhalla Scientific Calibration Center for details.

Valhalla Scientific, Inc.
Calibration Center
8318 Miramar Mall
San Diego Ca, 92121
Phone: 858/457-5576
Fax: 858/457-0127
e-mail: valhalla@valhallascientific.com

Chapter 9 SPECIAL PROCEDURES

9.1 Noisy Readings

In general, noisy readings are caused by poor connections either to the input terminals or to the test load. If noisy readings are encountered, check these connections first.

9.2 Inductive Loads

The measurement of highly inductive loads (such as large transformers) may also yield noisy readings. This is due to the very high impedance to line voltage exhibited by the load causing an excessive amount of noise pick-up. This effect can be significantly reduced by using fully shielded cables. It may also be helpful (and will cause the settling time to be reduced) if the unused windings on transformers being tested can be short-circuited during the measurement. This will significantly reduce the inductance of the winding under test and will also prevent these windings from producing dangerous voltages during connection and disconnection of the ohmmeter.

Chapter 10 THEORY OF OPERATION

Apparent malfunctions are often the result of misinterpretation of specifications or due to an incomplete understanding of the instrument. **A thorough review of the operating instructions for this instrument is recommended prior to any component replacement.** Check to be sure that cables and other test equipment are in good working order before attempting to troubleshoot the ohmmeter.

The following guidelines have been established to help solve the problems that cannot be eliminated by reviewing the operating instructions.

10.1 Localizing the Problem

The key to successful troubleshooting is to localize the problem as much as possible before trying to pin the problem down to a specific component. Certain questions should be asked such as "Does the problem occur on all ranges or on a specific range only?" The power supplies are also one of the first things that should be checked.

As it is not possible to anticipate all failure modes of the ohmmeter, servicing personnel should become familiar with this chapter of the manual to gain a complete understanding of the internal workings of this instrument.

10.2 Component Replacement

If the problem has been identified as a faulty component, the accuracy of the ohmmeter can be maintained only if the following precautions are taken:

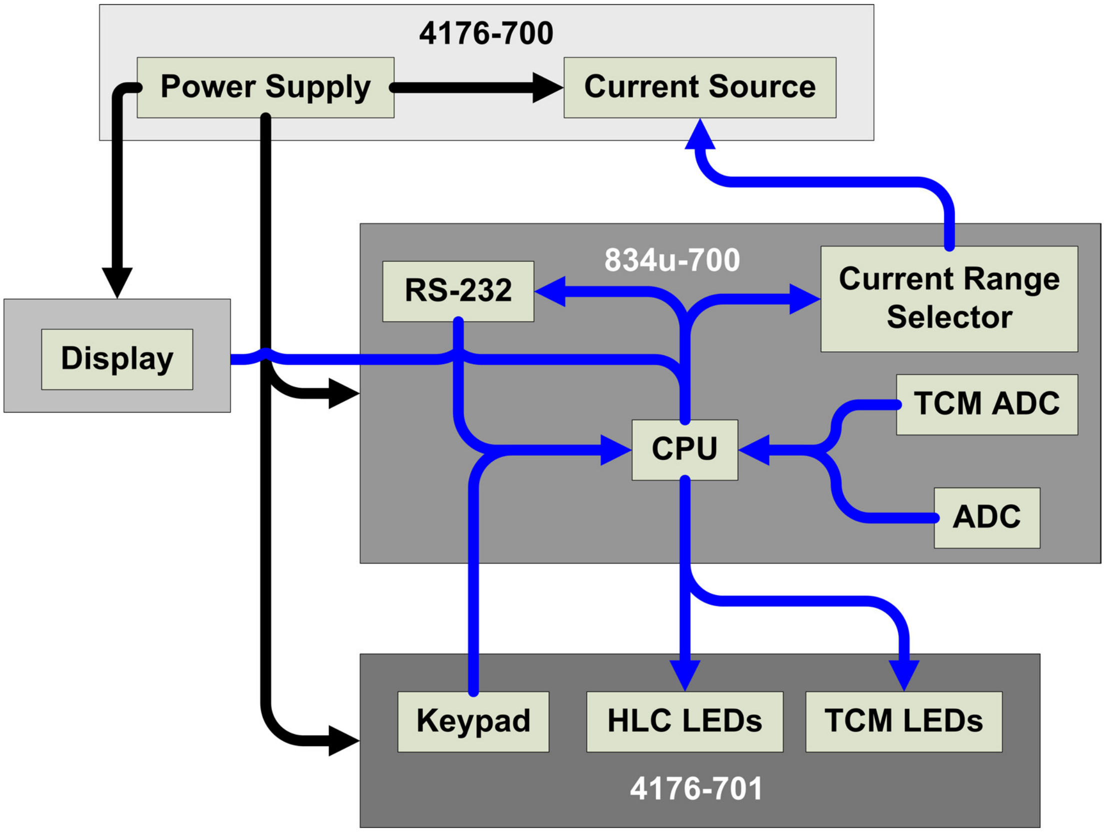
- Use only the specified replacement component or its exact equivalent. Spare parts can be ordered from your nearest Valhalla Scientific Service Center or from the factory directly by referring to the Valhalla Stock Number listed in the Parts Lists section at the back of this manual.

- Use only 63/37 grade rosin core electronic grade solder with a 50W or lower maximum power soldering iron.

- When soldering, heat the terminal of the component, not the solder. Apply solder smoothly and evenly. Do not move the component until the solder has cooled. Bad solder joints can cause additional problems!

- Static sensitive parts require special handling procedures. Always treat an unknown part as if it were static sensitive.

10.3 General Circuit Descriptions



The ohmmeter may be divided into four separate parts.

4176 Main Board (4176-700) – This portion of the ohmmeter contains the power supply and the constant current source.

> Power Supply – This section converts the AC line power into the DC levels necessary to power the ohmmeter's circuitry.

> Constant Current Source - This section of the main board provides a stable test current that is passed through the load to develop a voltage across it. The value of this current for each range is indicated on the front panel of the instrument.

Micro-Controller Board (834u-700) –This is the central processing unit of the ohmmeter. The analog to digital conversion, the range selection, LED indicator selection and all other decision making processes occur in this portion of the instrument.

> ADC – The micro-controller's analog to digital converters sense the voltage drop across the load.

> TCM ADC - The micro-controller's analog to digital converter sense the voltage across the temperature sensor (Omni Compensator).

CPU – The micro-controller processes the data received by the ADC's and sends a ohms reading to the display. Also from the data received from the keypad, the micro-controller selects the current range, activates the LEDs and sends data out from the rs-232 port.

Current Range Selector – The current range selection occurs within the micro-controller. According to the data received from the keypad, a signal is sent to activate the appropriate relay on the current source circuitry.

RS-232 – The RS-232 data is also sent and received by the micro-controller.

Display – This is the visual interface to the user. The display receives its data directly from the micro-controller.

Keypad Board (4176-701) – This section of the ohmmeter contains the keypad and the LED indicators for the TCM and HLC function.

Keypad – The keypad is used to send commands to the micro controller.

HLC LEDs – These LEDs indicate the result of the HLC comparison.

TCM LEDs – These LEDs indicate the status of the temperature compensation mode.

10.4 Troubleshooting

Use the following guidelines to determine in which circuitry that fault originates:

- If the fault occurs on one range only then the fault is probably in the current source section. Connect the source binding post to an ammeter that can measure up to 1Amp and has a resolution of at least 1µA. Switch through the ranges and check the value of the test current. If any given range does not output current, check the relay for that specific range, or check if one of the range resistors is open. If the value of the test current is outside of the specified tolerance, check the potentiometer for that specific range.

- If the fault is display related (e.g., missing segments, non-numeric data, etc.), the first thing to do is reboot the instrument. If the problem persists, most likely the fault can be traced to the display it self, the display cable or the micro-controller board.

- If the fault occurs on all ranges, you should verify that the micro-controller's ADC is working correctly. Select the 20mΩ range and apply 10mV to the sense terminal. The display should read 10.000mΩ. Select the 100mΩ range and apply

100mV to the sense terminals. The display should read 100.00mΩ. Is these values are not displayed, try recalibrating the instrument.

10.5 Current Source Detailed Circuit Descriptions

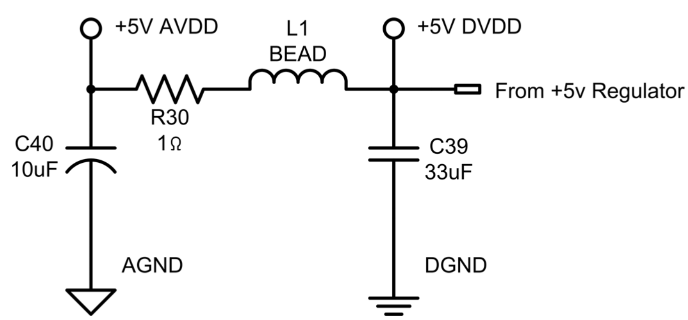
This series of paragraphs detail the actual operation of the above mentioned circuits, and are provide to aid the technician in troubleshooting to component level. A basic knowledge of electronics is assumed. The technician should refer to the schematics in chapter 13 of this manual.

10.5.1 Power Supplies

The ohmmeter uses several supplies to power the current source, the micro-controller and the remaining circuitry. All of these supplies are similar in design. A secondary winding of the transformer (T1) provides the basic AC voltage from which the DC supply will be produced. This AC voltage is rectified using diodes, filtered using electrolytic and tantalum capacitors, and in some cases regulated using a standard three-pin regulator.
The levels supplied are the following:

±15V and AGND (analog ground)
±8V and 0V (current source ground)
+5V DVDD (digital 5 volt supply) and DGND (digital ground)
+5V AVDD (analog 5 volt supply) and AGND (analog ground)

AVDD and DVDD are regulated by a precision 5 volt regulator and isolated from each other as shown below.



The complete power supply circuitry is shown on schematic 4176-070 sheet 1.

10.5.2 Constant-Current Source

The constant-current source provides the stable current necessary to generate the precise voltage drop across the load. The design of the current source compensates for all series resistance (within compliance voltage limits) to overcome the effects of test lead and contact resistances. The complete current source circuitry is shown on drawing 4176-700 sheet 2.

10.5.2.1 Reference Generator

As a stable and accurate reference, the current source circuitry uses a +6.95VDC regulator (U23). The voltage level of the regulator can be checked by measuring the voltage across TP8 and TP9.

10.5.2.2 Reference Inverter Stage

U24 and its associated components form an amplifier stage having a gain of -.144. This stage is used to convert the +6.95 VDC reference voltage to the negative 1 volt reference required by the current source. This voltage level can by checked by measuring the voltage across TP10 and TP9.

10.5.2.3 Differential Amplifier

U25 and its associated components form a unity gain differential amplifier. The output of the Reference Inverter stage (V_{REF}) and the output of the Output Amplifier (V_{OUT}) form the inputs to this amplifier. The output voltage from this amplifier is thus given by:

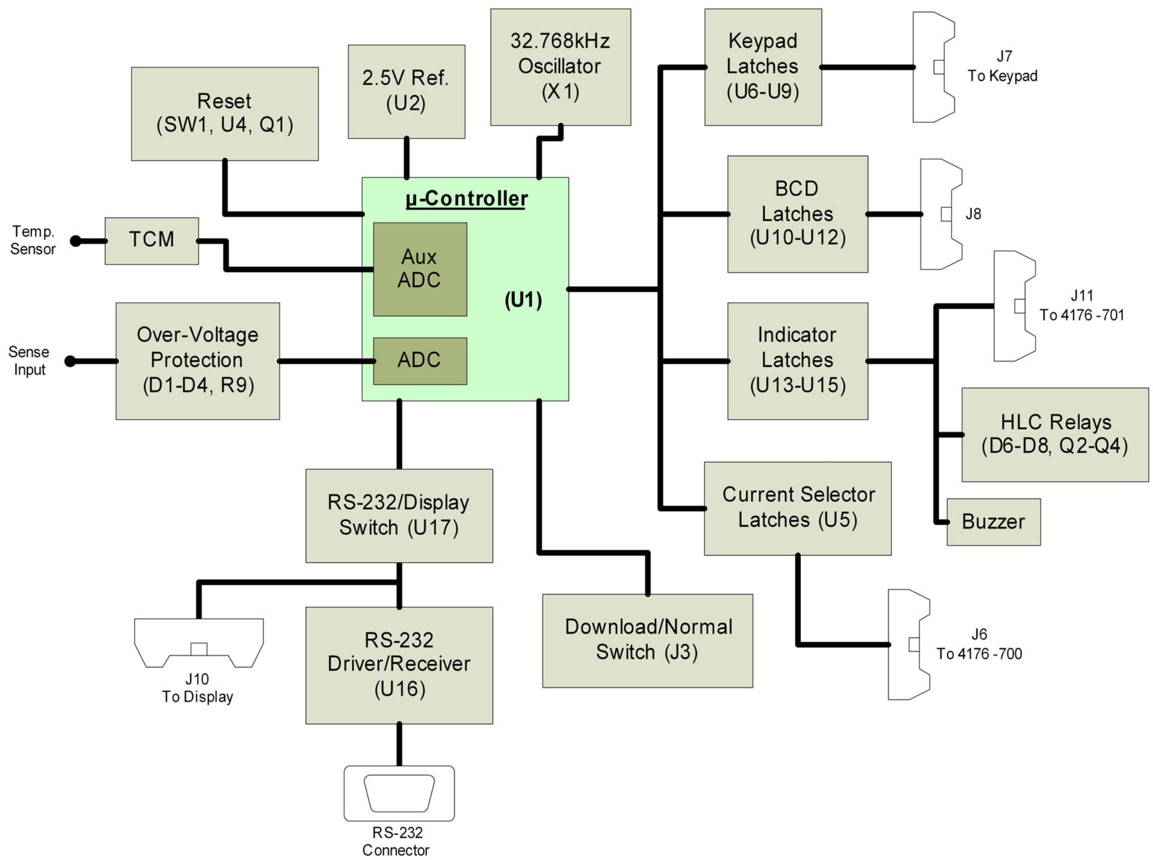
$$Diff\ Amp\ Output = V_{OUT} - V_{REF}$$

10.5.2.4 Output Amplifier

U26, Q6, Q7, the range resistors R50 through R58, and the potentiometers RV2 through RV7, combine to form the output amplifier of the current source. The range resistors and potentiometers determine the value of the output current. The voltage drop across these resistors (V_{OUT}) is used as an input to the Differential Amplifier to provide error correction and to compensate for varying loads.

10.6 Micro-Controller Board Detailed Circuit Descriptions

Complete circuitry is shown on schematic 834u-070 sheet 1 thru 7.



10.6.1 Micro-Controller

The micro-controller executes the analog to digital conversion on the voltage across the load. Also all other processes, such as range selection, HLC relay switching, LEDs activation and so on.
Refer to schematic 834u-070 sheet 1.

10.6.2 Over-Voltage Protection

The resistor R9 and diode D1 thru D4, form the Over-Voltage protection circuitry. This block limits the input voltage to only ±7V if an extreme overload occurs.
Refer to schematic 834u-070 sheet 1.

10.6.3 TCM

The zener diode D5 and its associated components create a +1.2V reference. This voltage level plus AVDD are used to power the temperature compensator if attached.
Refer to schematic 834u-070 sheet 1.

10.6.4 Reset

U4, SW1 and Q1 form the reset circuitry for the micro-controller and the display. To reset, press SW1.
Refer to schematic 834u-070 sheet 1.

10.6.5 2.5V Reference

U2 is a precision 2.5V reference used by the micro-controller during the analog to digital conversion.
Refer to schematic 834u-070 sheet 1.

10.6.6 Download/Normal Switch

J4 is the switch that allows the download of the instruments firmware.
Refer to schematic 834u-070 sheet 1.

10.6.7 RS-232/Display Switch and RS 232 Driver/Receiver

U17 is a digital switch that allows the micro-controller to send data to the display or to the RS-232 port.
U16 is a RS-232 Driver Receiver. This component converts data to the RS-232 level.
Refer to schematic 834u-070 sheet 6.