4176

Programmable Micro-Ohmmeter

Operation Manual

Rev. 62-1

VALHALLA
SCIENTIFIC

VALHALLA SCIENTIFIC INC. CERTIFICATION

Valhalla Scientific, Inc. certifies that this instrument was thoroughly tested and 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 Nation Institute of Standards and Technology to the extent allowed by NIST's calibration facility.

Due to continuing product refinement and due to possible parts manufacturer changes, Valhalla Scientific, Inc. reserve 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.

We will repair the instrument during the warranty period provided it is returned to Valhalla Scientific, Inc. 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.

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

SUPPORT

For repair and calibration services, call 800-548-9806 or visit valhallascientific.com.
Email support available at support@valhallascientific.com

4176 Programmable Digital Micro-Ohmmeter User Manual
Revision 62-1 (2021)
Copyright © 2021 Valhalla Scientific, Inc. All rights reserved

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 greater 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.

Table of Contents

1. General Information

Instrument Description

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 programmable temperature compensation, hi-lo comparison, and remote interface.

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

Instrument Identification

Valhalla Scientific instruments are identified by a two-part serial number. The Serial Tag is located on the rear or bottom of the instrument. The number is in a form of 62-0000. The first two digits, called the serial number prefix, indicate the model. It changes only when a change is made to the instrument. The last 4 digits, called the serial number suffix, are unique for each individual unit.

Be sure to include the entire serial number, both prefix and suffix, in any correspondence about your instrument.

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.

2. Unpacking and Installing

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, 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.

Setting the Line Voltage

The line voltage selection is preconfigured according to the country to which it is shipped or as specified by the customer.

To change this setting, follow the steps below:

1. Remove the power cord from the instrument.
2. With a small flat head screwdriver, slide the "Line Voltage Selector" switch to the appropriate position.
3. Replace the line power fuse accordingly.

Fuse Selection

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

- 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.

<div align="center">

115V – 105Vac to 125Vac

230V – 210Vac to 250Vac

</div>

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

<div align="center">

115Vac = 0.500 Amp Fuse Blo Slo

230Vac = 0.250 Amp Fuse Blo Slo

</div>
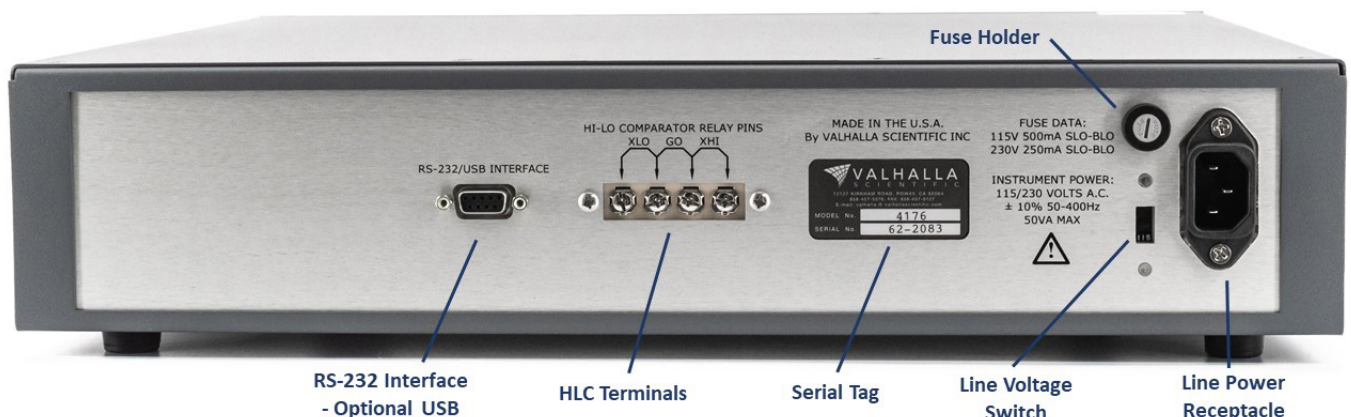
Bench Use

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.

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 (see Figure 1). The kit is listed under accessories as *RX-3*.

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 using trays or slides. If it is to be transported while mounted in a rack, it should be supported 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.

Figure 1 – Rack Mount Adapter RX-3

3. Specifications

This section contains accuracy and operational specifications for the Model 4176. The accuracy specifications are valid for a period of one year from the date of calibration at a temperature of 15°C to 35°C. Outside this range, the temperature coefficient specification applies.

Standard Measurement Mode Specifications

#	Range	Test Voltage	Full Scale	Resolution	Current Source[1]	Accuracy[2] (±% of Reading ± Ω)	Temperature Coefficient[3]
1	20mΩ	20mV	20.000mΩ	1µΩ	1A	± (0.02% + 0.004mΩ)	±20ppm/°C
2	200mΩ	200mV	200.00mΩ	10µΩ	1A	± (0.02% + 0.04mΩ)	±20ppm/°C
3	2Ω	200mV	2.0000Ω	100µΩ	100mA	± (0.02% + 0.0004Ω)	±20ppm/°C
4	20Ω	200mV	20.000Ω	1mΩ	10mA	± (0.02% + 0.004Ω)	±20ppm/°C
5	200Ω	200mV	200.00Ω	10mΩ	1mA	± (0.02% + 0.04Ω)	±20ppm/°C
6	2kΩ	200mV	2.0000kΩ	100mΩ	100µA	± (0.02% + 0.0004kΩ)	±20ppm/°C
7	20kΩ	200mV	20.000kΩ	1Ω	10µA	± (0.02% + 0.004kmΩ)	±20ppm/°C

Table 1 - Ranges Parameters and Accuracies

Temperature Compensator Mode Specifications

#	Range	Accuracy
1	20mΩ	± (0.02% of Reading + 0.007mΩ + 0.001% of ΔT)
2	200mΩ	± (0.02% of Reading + 0.07mΩ + 0.001% of ΔT)
3	2Ω	± (0.02% of Reading + 0.0007Ω + 0.001% of ΔT)
4	20Ω	± (0.02% of Reading + 0.007Ω + 0.001% of ΔT)
5	200Ω	± (0.02% of Reading + 0.07Ω + 0.001% of ΔT)
6	2kΩ	± (0.02% of Reading + 0.0007kΩ + 0.001% of ΔT)
7	20kΩ	± (0.02% of Reading + 0.007kΩ + 0.001% of ΔT)

ΔT is the absolute value of the differential between the ambient temperature in °C and 25°C.

[1] Current Source is ±1% absolute accuracy.
[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 5°C to 21°C and 29°C to 50°C.

General Specifications

Display: .... 5 Digit / Multi Section VFD 140px x 16px

Overload Limit:

20mΩ Range ....99.95% of Range

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

Overload Indication: ....Display flashes "OVERLOAD"

Terminal Configuration: .... Four-wire Kelvin

ADC Conversion Rate: ....45 conversions / second

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

Test Current Polarity:.. Positive (flows high to low)

Compliance Voltage (Normal Mode): ....5 VDC nominal

Settling Time:... 300 milliseconds

Environmental

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

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

Humidity: .... 80% RH at 40°C non-condensing

Power Requirements

Power Supply Voltage: .... 105-125 or 210-250 VAC

Power Supply Frequency: ....50 - 60 Hz

Power Supply Consumption: ....25VA Maximum

Physical

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

Weight: ....4.7Kg (10.4 lbs.) Net; 7Kg (15 lbs.) Shipping

4. Getting Started

Introduction

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

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.
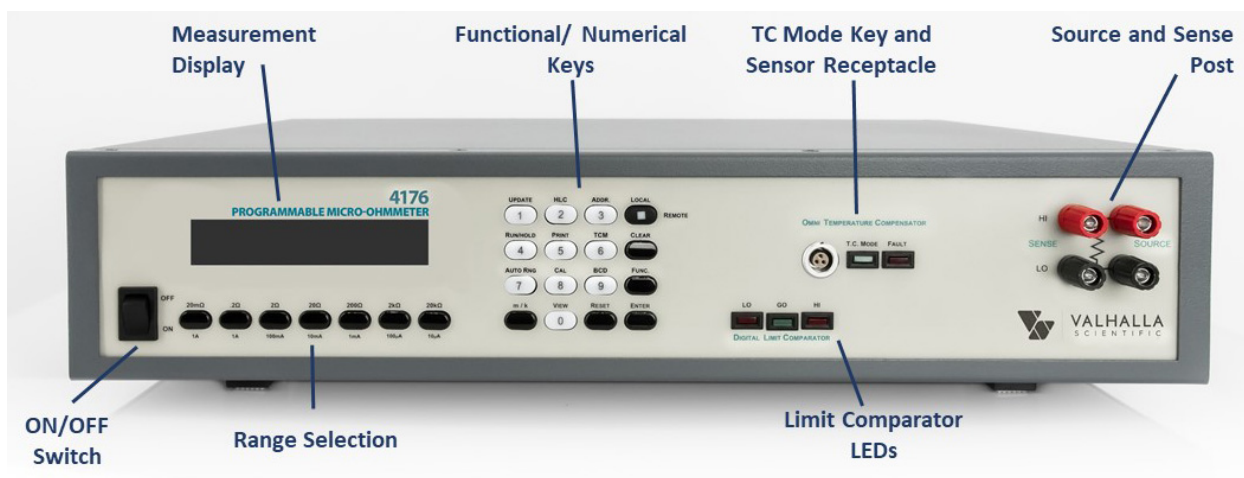
Power Switch

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.

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. If the auto range function is on, this section of the display will alternate between the automatically selected range value 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.

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

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.

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

Function/Numerical Keys

There are sixteen Function/Numerical keys used to trigger the standard and/or optional ohmmeter functions and for data entry. Table 2 lists a brief description of each key and its uses. The Function/Numerical keys will be further described throughout this manual.

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 were active.	./±

Table 2 - Function/Numerical Keys

TCM Receptacle and LEDs

This portion of the front panel is utilized only during temperature compensated type measurements (TCM). See the Temperature Compensated Measurement Mode section of the manual for more details about the function.

Critical to this measurement mode is precise temperature sensing, which requires 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[1], can be inserted only in the proper mating position. A red dot on the Omni Compensator and a red tab on the receptacle are meant to guide you in the insertion of the connector in the 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.

---

[1] The Omni Compensator is an optional accessory to the 4176.

HLC LEDs

This portion of the front panel is designed to give the user a visual indication of the HLC results. HLC mode is described in detail in the Measurement Modes and Functions section of this manual. 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 set by the user. The red LED, labeled "ExceedLO", is on if the measured resistance value is less than the lower limit. The red LED, labeled "ExceedHI", is on if the measured resistance value is greater than the upper limit. Only one LED can be on at a time, if more than one LED is on for any length of time, it is recommended that you contact the Valhalla Scientific Tech Support Team.

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 its remote interface port. If the LED is off, the ohmmeter is in local state and will receive commands only from the front panel keys.

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 resistance of the current carrying leads. Chapter 5 will illustrate how the 4-wire principle is used to eliminate lead, wire, and contact resistances as potential error sources.

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 that are not described in this section, please refer to any available addendum that references the particularities of your model.
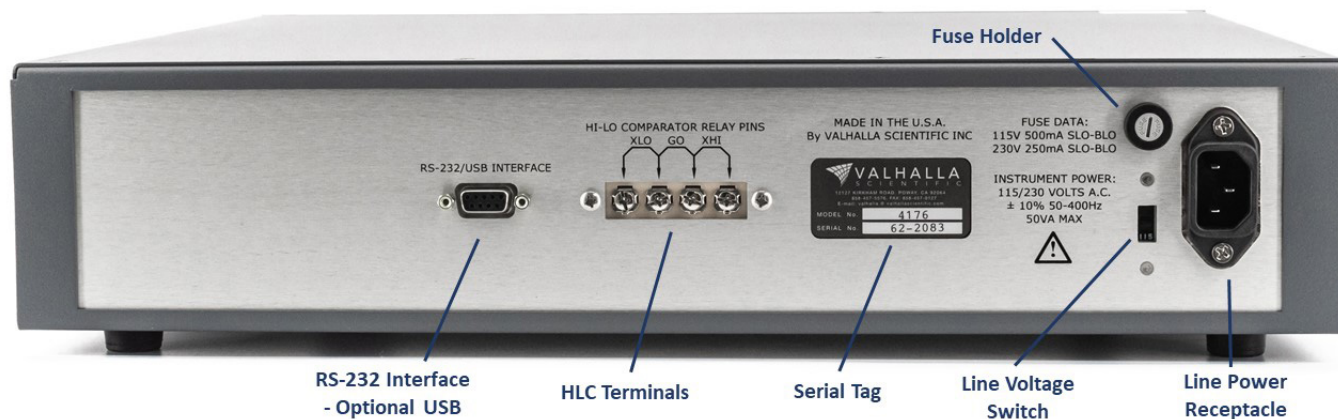
Line Voltage Switch

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 critical 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!

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; see chapter 7 Remote Interface for connector pin assignment.

Fuse Holder

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

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

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

WARNING: Replace blown fuses with their exact equivalent only!

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.

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 wire or spade lugs.
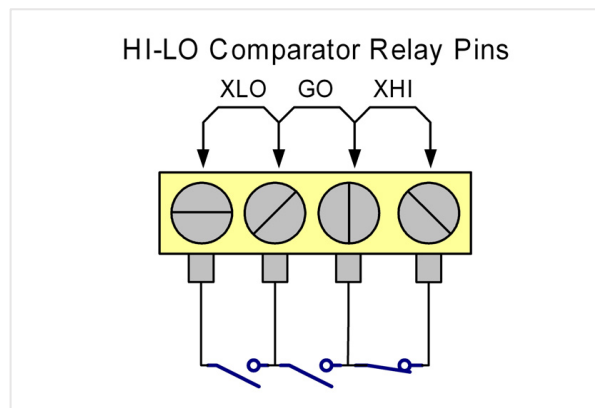
Contacts are rated at 100 volts, 100mA. The truth table of the contacts is listed below. The Ω's symbol represents the load measured value; UL is the upper limit and LL is the lower limit set by the user.

HLC State	HLC Result	XLO	Go	XHI
ON	LL≤Ω≤UL	OPEN	CLOSED	OPEN
ON	Ω<LL	CLOSED	OPEN	OPEN
ON	Ω>UL	OPEN	OPEN	CLOSED
OFF	LL≤Ω≤UL	OPEN	OPEN	OPEN
OFF	Ω<LL	OPEN	OPEN	OPEN
OFF	Ω>UL	OPEN	OPEN	OPEN

Table 3 - HLC Truth Table

Applying Power

Before applying power, please refer to chapter 2.

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.

Power-On Default Settings

Once you have turned on the ohmmeter, it will start its power-on routine. On the display you should see the following messages:

When the power-on routine is finished, the ohmmeter will beep in a pattern.

By design, in 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.

Functions	Settings
Standard Measurement Mode	ON
Range	20kΩ
Auto-Range (Automatic Range Selection)	ON
TCM (Temperature Compensation Mode)	OFF
HLC (Hi-Lo Comparator Mode)	OFF
PIM (Printer/Log Mode)	OFF

Table 4 - Power-On Default Settings

Connecting a Load to the 4176

The first step in using the ohmmeter is to connect to a load. Valhalla Scientific, Inc. offers several 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 and to ensure that the marked side of each banana jack is connected to the Source terminals.

Lead 1 - Connect between SENSE HI and SOURCE HI, with the ground marker on the source side.

Lead 2 - Connect between SENSE LO and SOURCE LO, with the ground marker 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.

The most common termination is <u>alligator type clips</u>. 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.

For flat surfaces, you can choose 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.

For hard-to-reach surfaces, Valhalla Scientific offers two 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.

See chapter 5 for a full list of lead sets and accessories for your 4176.

Range Selection

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

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.

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.

5. Measurement 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.

Standard Measurement Mode

The 4176 powers on in the standard measurement mode. In this mode, the instrument simply measures 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.
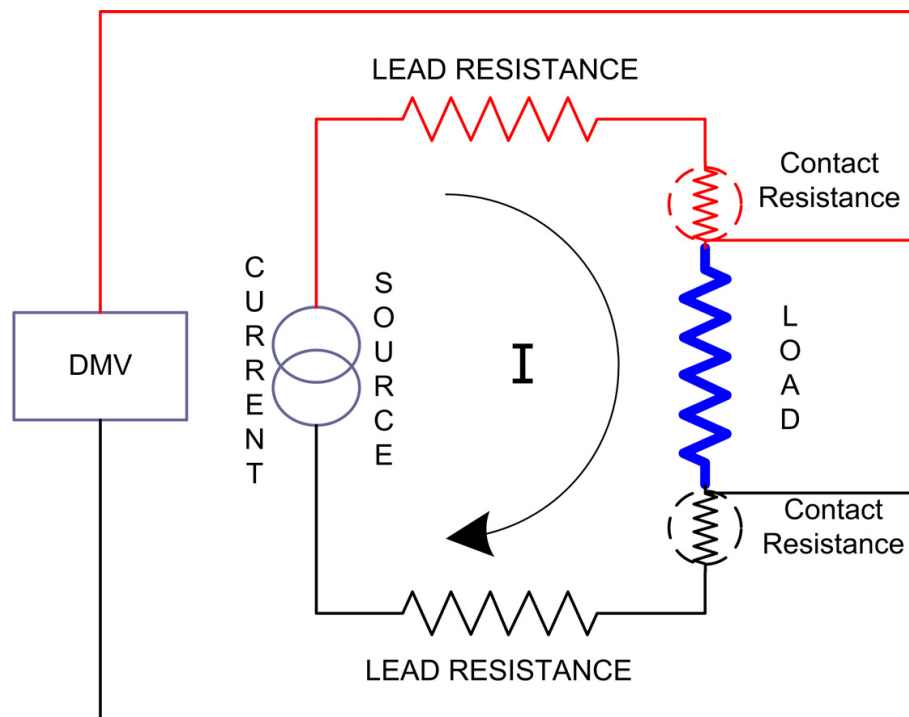
The figure above illustrates how the 4-wire principle is used to eliminate lead, wire, and contact resistances as potential error sources. The internal current source inherently overcomes all series resistance (within compliance voltage limits) and delivers a precise constant current. The internal high-impedance 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.

"TCM" - Temperature Compensated Measurement Mode

Valhalla engineers are pioneers in the technology of accurate measuring devices using recognized formulas that compensate for measurement inaccuracies because 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, senses the ambient temperature and automatically 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:

$$\frac{R - R_0}{R_0} = \alpha(T - T_0) \quad OR \quad R = R_0[1 + \alpha(T - T_0)]$$

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 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 us 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:

$$R_C = \frac{1}{1 + 0.003931(22.5 - 20)} = 0.9903\Omega$$

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

Omni Compensator

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 later in this chapter.

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".

TCS – Temperature Compensator Setup

As describe earlier in this chapter, the 4176 needs to reference a temperature coefficient and a temperature reference to calculate the compensated value. Stored in the instrument's 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	3931 ppmΩ/°C	20°C
Copper	CU25	3931 ppmΩ/°C	25°C
Aluminum	AL20	4030 ppmΩ/°C	20°C
Aluminum	AL25	4030 ppmΩ/°C	25°C
Gold	AG20	3000 ppmΩ/°C	20°C
Gold	AG25	3000 ppmΩ/°C	25°C

The following procedure illustrates how to select one if these configurations 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.

Press "**FUNC. + TCM + 1"** to bring up the first selection screen.

Screen	Instruction
`1.CU20  2.CU25  3.AL20` `FUNC:NEXT`	Press the number associated with one of the configurations, and press "**ENTER**" or go to the next selection screen by pressing **"FUNC."**
`1.CU20  2.CU25  3.AL20` `FUNC:NEXT`	Press the number associated with one of the configurations, and press "**ENTER**" or go to the next selection screen by pressing **"FUNC.".** (Press **"CLEAR"** to return to the previous screen.)
`7.CUSTOMIZE` `CLEAR:PREV`	Press **"7 + ENTER"** to enter the custom configuration screen. (Press "**CLEAR**" to return to the previous screen.)
`INPUT  TEMP.  COEFF` `.00_____PPM/°C`	Using the numeric keys input a value for the temperature coefficient. (Use **"CLEAR"** as a backspace to correct errors.) Press **"ENTER"** to confirm the value.
`INPUT  REF.  TEMP` `…….…°C`	Using the numeric keys input a value for the reference temperature. (Use **"CLEAR"** as a backspace to correct errors.) Press **"ENTER"** to confirm the value. The screen will display the values entered.
`STORING  NEW  SETUP` `DATA  IN  NOVRAM`	Press **"ENTER"** to confirm the values or **"CLEAR"** to return to the previous screen. The screen will display a brief message and the instrument will return to the standard measurement mode.

TCC – Temperature Compensator Calibration

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

Verify that the instrument is in a temperature-controlled area.

Press "**FUNC. + TCM + 2**" to initiate the process.

```
CONNECT THE SENSOR
AND PRESS ENTER
```

Connect the Omni Compensator to the TCM receptacle on the front panel of the Ohmmeter.

Allow the Omni Compensator to reach ambient temperature. (Wait 5 to 10 minute before proceeding.)

Press "**ENTER**" to continue.

```
INPUT AMBIENT TEMP
…….…°C
```

Using the numeric keys input a value for the ambient temperature. (Use "Clear" as a backspace to correct errors.)

Press "**ENTER**" to confirm the value.

```
STORING NEW SETUP
DATA IN NOVRAM
```

Press "**ENTER**" to confirm the value or "**CLEAR**" to return to the previous screen.

Once the calibration values are stored, press "**TCM**" and verify that the temperature displayed matches the ambient temperature. If the values do not match, repeat the procedure.

"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 drastically reduced while significantly increasing 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 the measured resistance is within these limits, the GREEN indicator will remain illuminated, indicating a within tolerance condition. If either RED indicator is illuminated, that respective limit has been exceeded and the test sample should be rejected.
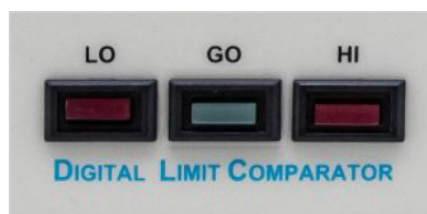
HLC Relay Terminal

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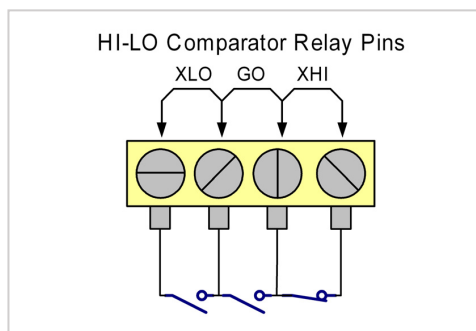
The HLC relay terminal is internally wired to three relays which are active only when the HLC mode is selected. According to the result of the comparison, one of the relays will have its contacts closed while the remaining two relays will have contacts open. The standard "relay contact closure" feature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

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	X	OPEN	OPEN	OPEN
OFF	X	OPEN	OPEN	OPEN
OFF	X	OPEN	OPEN	OPEN

Setting the Limits

Each range has a different set of limits that can be programmed by the user. Table 5 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.

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.

Press **"Func. + HLC"** to bring-up the first input screen.

```
INPUT HLC MAX VALUE
  …… . …… … m Ω
```

Using the numeric keys input a value for the upper limit. (Use **"CLEAR"** as a backspace to correct errors.)

Press **"ENTER"** to continue.

```
INPUT HLC MIN VALUE
  …… . …… … m Ω
```

Using the numeric keys input a value for the lower limit. (Use **"CLEAR"** as a backspace to correct errors.)

Press **"ENTER"** to continue.

```
STORING NEW SETUP
DATA IN NOVRAM
```

The screen will display a brief message and the instrument will return to the standard measurement mode.

HLC ON

To start working with the HLC mode, simply select the correct range for your load and press the **"HLC"**. The screen will briefly display "HLC ON". The instrument will also perform an LED check-sequence. Make sure that all three of the HLC LEDs illuminate. After the LED check-sequence, only one of the three HLC LEDs will remain illuminated.

It is always good practice to check if the limits set for the range in use meet your specifications. To view the set limits:

press **"VIEW+ HLC"**

```
MAX  =  ##.###mΩ
MIN  =  ##.###mΩ
```

The screen will display both the upper and lower limit set for that range.

Update Function

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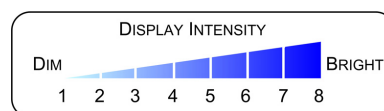
Display Update Rate

The display update rate indicates the time interval in-between every display update. Table 6 lists these values and the equivalent in updates per second.

Table 6 – 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

Display Intensity

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.

Setting the Display Update Rate and Intensity

To change the display update rate and the display intensity:

Press **"FUNC. + UPDATE"**

```
DISPLAY UPDATE RATE
 .1s  .2s  .3s  .4s  .5s
```

Select an update rate using the numerical keys from 1 thru 5 and press **"ENTER"**.

```
DISPLAY INTENSITY
 1  2  3  4  5  6  7  8
```

Select an intensity level using the numerical keys from 1 thru 8 and press **"ENTER"**.
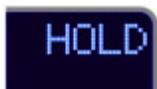
```
STORING NEW SETUP
DATA IN NOVRAM
```

The screen will display a brief message. The values are stored in memory and the instrument automatically returns to the previous mode.
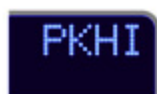
Run/Hold Function

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

RUN/HOLD

When configured for Run/Hold, pressing the **"Run/Hold"** key will freeze the readings on the display. The function window displays "HOLD". To exit the hold state, press **"Run/Hold"** again, the function window displays "RUN".

RUN/PKHI

When configured for Run/PeakHi, 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. The function window displays "PKHI". To exit the PKHI state, press **"Run/Hold"** again, the function window displays "RUN".

RUN/PKLO

When configured for Run/PeakLo, pressing the **"Run/Hold"** key will activate the Peak-Lo state, the readings on the display will only decrease therefore showing the lowest value measured. The function window displays "PKLO". To exit the PKLO state, press **"Run/Hold"** again, the function window displays "RUN".

Configuring the Run/Hold Function

To configure the Run/Hold function:

Press **"Func. + Run/Hold"**

> RUN/HOLD ACTION
> 1:HOLD 2:PKHI 3:PKLO

Select one of the three options by pressing keys 1, 2, or 3 and press **"Enter"**.

> STORING NEW SETUP
> DATA IN NOVRAM

The screen will display a brief message, the selection is stored in memory and the instrument automatically returns to the previous mode.

Print/Log Function

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

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

PRINT

When configured for Print, pressing the **"PRINT"** key transmits one reading as it is displayed on the ohmmeter's screen.

LOG

When configured for Log, pressing the **"PRINT"** key continuously transmits the measurements at a rate equal to the display update rate. Pressing the print key once again will terminate the transmission. The measurements are transmitted in the same format in which they are displayed on the ohmmeter's screen.

LOG2

When configured for Log, pressing the **"PRINT"** key continuously transmits the measurements at a rate equal to the display update rate[1]. Pressing the print key once again will terminate the transmission. The measurements are transmitted in engineering format.

For example:

$$10.000 k\Omega = 1.00E + 04$$

Configuring the Print button function

To configure the Print/Log function:

<div align="center">

Press **"FUNC. + PRINT"**

</div>

PRINT BUTTON MODE
1 : PRINT   2 : LOG   3 : LOG2

Select one of the three options by pressing keys 1, 2, or 3 and press **"ENTER"**.

The screen will display a brief message, the selection is stored in memory and the instrument automatically returns to the previous mode.

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.

Using the View function

Press **"VIEW"** followed by one of the following keys:

```
DISPLAY RATE: ###ms
INTENSITY LEVEL: #
```

UPDATE - The screen shows the display update rate and intensity settings.

```
MAX = 22.222mΩ
MIN = 11.111mΩ
```

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.

```
RUN/HOLD KEY
ACTION: PKHI
```

RUN/HOLD – The screen will display the configuration of the "**RUN/HOLD**" key.

```
PRINT MODE SET
TO PRINT
```

PRINT – The screen will display the configuration of the "**PRINT/LOG**" feature.

```
T.COEF. = 3931PPM/°C
REF. TEMP. = 20.00°C
```

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

```
AUTO-RANGING: OFF
STATIC RANGE: X1
```

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

```
LAST CALIBRATION
DATE: 03-23-04
```

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

To exit the view function press **"VIEW"**.

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 than 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.

Enabling SafeMode

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

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.

6. Optional Features and Accessories

The 4176 Micro-Ohmmeter are shipped with a detachable power cord as standard equipment. This section lists several items that may be desirable for special applications.
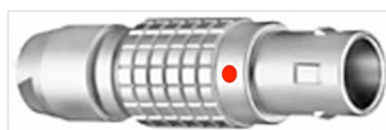
Options

USB

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

Accessories

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.

Option RX-3: Rack Mount Adapter

The 4176 Micro-Ohmmeter may be mounted in a standard 19" equipment rack using a set of optional rack ears. Option RX-3 comes with all the necessary hardware for installation and mounting.

Test Leads

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

Alligator Clip Type Leads

K: Kelvin Lead Set

"K" is a shielded, 4-wire Kelvin cable set, 48 inches in length terminated in gold plated alligator clips *(KCS)*. Option "K" is the recommended general purpose lead set for most applications. *Figure 2.*

KCS: Gold-Plated Clips

"KCS" are gold-plated alligator clips used on the "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 10A.

Figure 2 – K: Kelvin 4-Wire Lead Set

C: Banana-to-Clip Cable

"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.

KK: Heavy-Duty Lead Set

"KK" is a 4-wire Kelvin cable set, 48-inches in length terminated in heavy-duty gold-plated clamps. *Figure 3*.

JAWS: Gold-Plated Clamps

"JAWS" are gold-plated heavy-duty clamps. Clamps open to 2 inches for connection to large motors, bushings, etc.

Figure 3 - KK: Kelvin 4-Wire Lead Set

Needle Type Probes

MP-1: Kelvin Micro-Probes

"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.

MP-2: Kelvin Mini-Probes

"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.

MP-S: Single Pointed Probe Set

"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).

Surface Probes

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. *Figure 11*

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.
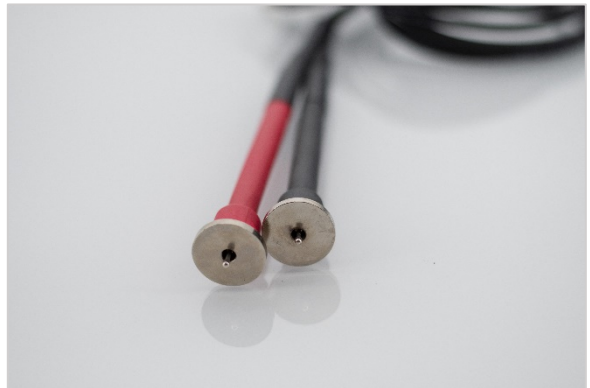
Figure 4 - MP-4 Surface Probe

Other Lead Sets

BBL: Banana-to-Banana Cable

"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.

SL-48: Low Thermal Leads

"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.

7. Remote Operations

RS-232 Interface

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 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.

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 7 shows the 9-pin connector (Female) with its pin number assignments. 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 15 meters 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 both sides of cable, and the internal connection lines meet the demands of the instrument.

Table 7 –
RS-232 Connector
Pin Configuration
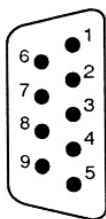
Pin #	Pin Function
1	Not Connected
2	Receive Data (RxD) (input)
3	Transmit Data (TxD) (output)
4	Not Connected
5	Signal Ground (GND)
6	Not Connected
7	Not Connected
8	Not Connected
9	Not Connected

Connecting to a Computer

A personal computer with a COM port is essential to operate the 4176 via RS232 interface.

The connections between the 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.

Checking Connections

If you want to test whether the RS232 connection is working or not, you can send a command from the 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 4176,1.81,0"

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

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.

COMMANDS AND SYNTAX

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.

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.

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.

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

Example:

RANGE 4; HLCHI 14.999<LF>

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

DETAILS OF COMMAND REFERENCE
Each command in this section 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.

COMMAND INDEX

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 - Suppress Alarms
2 - Suppress 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 - Suppress Alarms
2 - Suppress 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 / 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 / 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 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 1Ω in the 3Ω range and 100.00 for 100mΩ in the 100mΩ range, and 00.500 for .5kΩ in the 20kΩ 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 1Ω in the 2Ω range and 100.00 for 100mΩ in the 200mΩ 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 1Ω in the 1Ω range, 100.00 for 100mΩ in the 100mΩ range, 1.000 for 1k in the 1kΩ 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 1Ω in the 1Ω range and 100.00m for 100mΩ in the 100mΩ range, 1.0000k for 1kΩ in the 1kΩ 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 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) : "

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		

Power-on default = 0

Usage: Keys are polled every 25ms in a timer interrupt. This routine changes the 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   (synonymous 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?
2 – ATOD1?
3 – RDNG?
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?

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

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 20.000Ω 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   <2kΩ)
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 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.

8. Routine Maintenance

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.

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.
3. Four wire test lead set.
4. Precision Digital Voltmeter.

Pre-Calibration Procedure

The calibration adjustments are accessed by removing the top cover of the instrument. Leave the cover in place as much as possible. After each adjustment is made, the cover should be replaced, and the instrument allowed to stabilize.

Dangerous AC line voltages exist inside the instrument. Use caution when adjusting.

Avoid contact with these voltages.

4176 Calibration Procedure

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 potentiometers located on the 4176 main board. All three calibrations must be performed for a complete calibration of the 4176.

Sense Calibration

I. Press the **"FUNC. + CAL"**.

```
CAL KEY:  OHMS CAL
TCM KEY:  TCM CAL
```

II. Press **"CAL"** to choose the standard calibration.

```
APPLY ZERO VOLTS
PRESS ENTER OR CLEAR
```

III. Apply a short between the Sense Hi and the Sense Lo binding post. Once the short is applied, press **"ENTER"**. The ohmmeter will perform the zero calibration for all ranges. Press **"CLEAR"** to return to the previous screen.

While zeroing the ranges, the screen will display the following information:

Pass indicates the number of passing values that have been measured. 15 passing values must be measured before the timer reaches the 100 second limit for a successful calibration.


```
ZERO 20mV   ADC:0000
      SEC:01   P:01
```
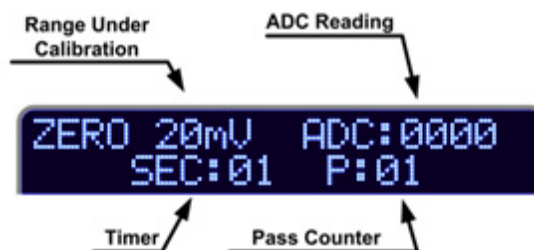
```
APPLY 10mV PRESS
ENTER OR CLEAR
```

IV. When prompted by the display, remove the short and apply 10mV to the sense terminals. Press **"ENTER"** to continue or **"CLEAR"** to return to the zero cal screen. While calibrating the ranges, the screen will display the following information.

```
10.000mΩ  ST:0000
   SEC:11  P:09
```

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

V. When prompted by the display, apply 300mV to the sense terminals. Press **"ENTER"** to continue or **"CLEAR"** to return to the 10mV cal screen. While calibrating the ranges, the screen will display the following information:

```
0.30000Ω  ST:0000
   SEC:11  P:09
```

VI. When prompted by the display, press **"ENTER"** to save the calibration values to memory, or press **"CLEAR"** to return to the 300mV calibration screen.

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

VII. When prompted by the display, press **"ENTER"** to exit the calibration mode, or press TCM to continue with the TCM Cal.

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

Source Calibration

1. Short SENSE HI and SENSE LO terminals using a jumper.
2. Connect the digital voltmeter to the main board as follows:
   DVM negative input to TP9
   DVM positive input to TP10
3. Adjust RV1 for a DVM reading of -1.0000V.
4. Remove the DVM connection and the jumper.
5. Select the .2Ω range.
6. Connect the 4176 to a .1Ω standard resistor.
7. Adjust RV2 for a display reading equal to the value of the load.
8. Select the 2Ω range.
9. Connect the 4176 to a 1Ω standard resistor.
10. Adjust RV3 for a display reading equal to the value of the load.
11. Select the 20Ω range.
12. Connect the 4176 to a 10Ω standard resistor.
13. Adjust RV4 for a display reading equal to the value of the load.
14. Select the 200Ω range.
15. Connect the 4176 to a 100Ω standard resistor.
16. Adjust RV5 for a display reading equal to the value of the load.
17. Select the 2kΩ range.
18. Connect the 4176 to a 1kΩ standard resistor.
19. Adjust RV6 for a display reading equal to the value of the load.

20. Select the 20kΩ range.
21. Connect the 4176 to a 10kΩ standard resistor.
22. Adjust RV7 for a display reading equal to the value of the load.
23. Reset the 4176 from the front panel RESET button or by turning off the power switch and rebooting.

End of Source Calibration.

Final Adjustments

1. Select the 20mΩ range.
2. Connect the 4176 to a 10mΩ standard resistor.
3. Press **FUNC** key followed by the **CAL** key.
4. Press the **CAL** key again to enter the ohms calibration mode.
5. Press the **FUNC** key to skip zero volts cal.
6. The screen should display:

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

7. Press **ENTER** to continue.
8. Once the 10mV calibration is complete, the screen will display:

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

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

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

10. Press **ENTER** to save the calibration values.
11. Press **ENTER** to complete the calibration.

TCM ADC Calibration

Remove the top cover of instrument.

I. Verify that the Omni Compensator (Temp. Sensor) is not connected to the ohmmeter. Press **"ENTER"** to continue. The instrument will perform the TCM Zero Cal. The screen will display the following information:

```
ZERO ADC:0000
SEC:01  P:01
```

```
APPLY 1.000V PRESS
ENTER OR CLEAR
```

II. When prompted by the display, apply 1V to TP1 and TP2 (follow polarity). Press **"ENTER"** to continue or **"CLEAR"** to return to the zero cal screen. While calibrating the full scale TCM, the screen will display the following information:

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

III. When prompted by the display, press **"ENTER"** to save the calibration values to memory, or press **"CLEAR"** to return to the TCM full scale cal screen.

```
CONNECT THE SENSOR
AND PRESS ENTER
```

IV. Connect an Omni Compensator to the TCM receptacle on the front panel.

V. Allow the sensor to settle for 2-3 minutes and press **"ENTER"**.

```
INPUT AMBIENT TEMP
…….…°C
```

VI. Using a precision thermometer, record the ambient temperature.

VII. Using the numerical keys, enter the ambient temperature recorded in the previous step. Press **"ENTER"** to continue.

VIII. Press **"ENTER"** to confirm the value or press **"CLEAR"** to return to the previous screen.

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

IX. When prompted by the display, press **"ENTER"** to save the TCM calibration values to memory, or press **"CLEAR"** to return to the previous screen.

Special Procedures

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.

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.

5. Addendum

Immediately following this page may be found any notices regarding manual changes, or operating instructions for the optional interfaces (if installed). Please refer to any applicable material before attempting to operate your ohmmeter. If no items follow this page, your manual is complete as printed.

For repair and calibration services, call 800-548-9806 or visit valhallascientific.com.
Email support available at support@valhallascientific.com

4176 Programmable Digital Micro-Ohmmeter User Manual
Revision 62-1 (2021)