Model 4014

Wide-Range Digital Ohmmeter

Operation Manual

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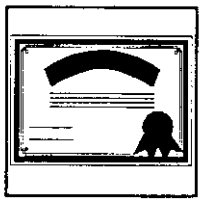
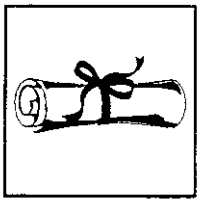
CERTIFICATION



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 National Institute of Standards and Technology to the extent allowed by NIST's calibration facility.

WARRANTY



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 or replace the instrument during the warranty period provided it is returned to Valhalla Scientific, Inc. freight prepaid. No other warranty is expressed or implied. We are not liable for consequential damages. Permission and a return authorization number 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 changes, Valhalla Scientific reserves the right to change any or all specifications without notice.

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SECTION I UNPACKING & INSTALLATION

1-1. Introduction

The Valhalla Scientific Model 4014 is a wide-range, highly accurate 4-wire digital ohmmeter. The 4014 combines affordability with features usually available only on instruments costing twice as much. The 4014 is capable of measuring resistances from 0.0001Ω resolution to 200MΩ full scale.

The 4014 is available with a variety of test leads and accessories. The 4014 may also be equipped with one of several data outputs such as binary-coded-decimal (BCD), or the recently added ports for **GPIB, RS232, or a Centronics compatible parallel printer.**

Please read this manual thoroughly and any accompanying addendums before using this instrument.

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 Section 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 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 to verify that the instrument has been set for the proper local AC line voltage and to verify that the proper fuse has been installed as follows: 105 to 125 VAC = ¼ Amp Slo-blo; 210 to 250 VAC = 0.125 Amp Slo-blo.

Note: These fuse values are doubled if any of the interfaces (IEEE, RS232C, or printer) have been installed. Refer to rear-panel markings.

On older models the AC line voltage is selected internally by the configuration of the jumpers on pads 9 through 12. Pads 9-10 and 11-12 are jumpered together for 115VAC operation. Pads 9&12 only are jumpered for 230VAC operation.

On newer models the AC line voltage is selected via a sliding switch mounted on the rear panel of the instrument. The appropriate fuse values remain the same.

1-4. Bench Use

The unit 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 Sections 4, 5 and 6 before attempting to operate the ohmmeter.

1-5. Rack Mounting

Optional brackets are available for mounting the ohmmeter in a standard 19" equipment rack. These are listed in Section 3. The size of the unit 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!**

SECTION II SPECIFICATIONS

2-1. General

The specifications for the Model 4014 Ohmmeter are listed in the following paragraphs. The specifications are valid for full 4-wire Kelvin measurements using a high-quality shielded lead set such as Valhalla Option "K-Gray". The accuracy specifications listed below are valid for a period of 1 year from the date of calibration following a minimum 30 minute warm-up period for ambient temperatures between 15°C and 35°C, and include the effects of line voltage variations within the usable range.

MODEL 4014 RANGES, RESOLUTIONS, AND ACCURACIES

Range	Resolution	Test Current	Full-Scale Voltage	Accuracy (% of reading)
2Ω	.0001Ω	100mA	200mV	±0.02% ±2 digits
20Ω	.001Ω	10mA	200mV	±0.02% ±2 digits
200Ω	.01Ω	1mA	200mV	±0.02% ±2 digits
2KΩ	.0001kΩ	100μA	200mV	±0.02% ±2 digits
20KΩ	.001kΩ	10μA	200mV	±0.02% ±2 digits
200KΩ	.01kΩ	1μA	200mV	±0.02% ±2 digits
2MΩ	.0001MΩ	1μA	2V	±0.02% ±5 digits
20MΩ	.001MΩ	100nA	2V	±0.1% ±15 digits
200MΩ	.01MΩ	10nA	2V	±1% ±150 digits

2-2. General Specifications

Display Type: . . . . . 4½ digit LED (20000 counts)

A-to-D Conversion Rate: . . . . . 400 milliseconds

Overrange: . . . . . 100% of range (19999 counts on display)

Overrange Indication: . . . . . Display flashes

Terminal Configuration: . . . . . Four-wire Kelvin

Temperature Coefficient: . . . . . ±0.002% /°C (0-15°C and 35-50°C)

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

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

Settling Time: . . . . . 300ms + 1 conversion to within ±0.1% (10% for MΩ ranges)

2-3. Environmental Requirements

Common Mode Rejection Ratio: . . . . . 60 db at DC to 60Hz.

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

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

Dimensions: . . . . . 15"(38cm)W x 10"(26cm)D x 3½"(9cm)H

Dimensions (serial# 5-1210 and higher): . . 17"(43cm)W x 11½"(29.5cm)D x 4"(10cm)H

Weights: . . . . . 11lbs(5kg) NET; 15lbs(7kg) SHIPPING

Weights (serial# 5-1210 and higher): . . . . . 12lbs(5.5kg) NET; 16lbs(7.5kg) SHIPPING

SECTION III OPTIONAL EQUIPMENT

3-1. General

The Model 4014 is 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.

3-2. Accessories and Options

Option 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. The outputs of Option BCD may be used to drive the Valhalla Model 1248 below. Also refer to section 7-2.

Model 1248: Dual-Limit Comparator

The Valhalla Model 1248 may be used in conjunction with the Model 4014 and Option BCD above. The Model 1248 is a dual-limit BCD comparator that interprets the display indications of the ohmmeter as either "HI", "LO" or "GO", based on a window that is set by the user. Relay contact closure is provided to trigger an alarm, counter, batch sorter or other device. The 1248 also reduces operator workload by allowing him to make an instant determination of the test results. The mating cable from the ohmmeter to the 1248 is 3' in length and designated as "IDC-2".

Options IEEE, RS232, and PAR

The Valhalla 4014 ohmmeter is now available with several of the industry's most popular remote interfaces. These include a GPIB IEEE-488.2 compatible interface, a serial RS232C interface, and a Centronics parallel printer interface for direct print-out capability. The interfaces are for data acquisition only and do not provide range or function control of the ohmmeter. The interfaces are available in any combination and may be used simultaneously.

Option R: Rack Mount Adapter

The Model 4014 may be mounted in a standard 19" equipment rack using these optional rack ears. The standard rack ears are designated as Option R1. The rack ears for ohmmeters with serial numbers 5-1210 and higher are designated as Option RX3.

3-3. Test Leads

This section details the different test lead sets available for use with the Model 4014 ohmmeter.

Option K-Gray: Kelvin Lead Set

Option "K-Gray" is a shielded, 4-wire Kelvin cable set, 48 inches in length terminated in "KCS" gold-plated clips. Option "K-Gray" is the recommended general purpose lead set for most applications, and is particularly recommended when using the 20MΩ and 200MΩ ranges to reduce noise.

Option KCS: Gold-Plated Clips

Option "KCS" are the gold-plated Kelvin clips used on the Option "K-Gray" 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.

Option JAWS: Gold-Plated Clamps

Option "JAWS" are the heavy-duty clamps used to terminate Option "KK" below.

Option KK: Heavy-Duty Lead Set

Option "KK" is a heavy-duty 4-wire Kelvin cable set, 48-inches in length terminated in "JAWS" clamps for connecting to large motors, bushings, bolts, etc. Opening is 2".

Option MP-1: Kelvin Micro-Probes

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

Option MP-2: Kelvin Mini-Probes

Option "MP-2" is a 48-inch shielded 4-wire cable set equipped with Kelvin Mini-Probes having spring-loaded stainless steel tips with 0.18" spacing.

Option MP-4/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 MP-4 target area is 1" in diameter. The MP-5 target area is .4" in diameter.

Option BBL: Banana-to-Banana Cable

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

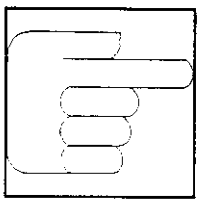
Option SL-48: Low Thermal Leads

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 the instrument.

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.

SECTION IV FRONT PANEL CONTROLS



4-1. General

This section outlines the use of each of the front panel controls and connectors. The user should also refer to Sections 5 and 6 for complete operating instructions.

4-2. POWER Switch

This "push-push" switch is used to alternately apply or disconnect the AC power source from the internal circuitry of the product.

4-3. Range Switches

These three switches are used to select the required resistance range, and are labeled "**Ω**", "**KΩ**", and "**MΩ**". The switches are interlocked such that only one switch may be selected (depressed) at any one time.

These switches work in conjunction with the sensitivity switches below. Use the range and resolution table of Section 2 to determine which setting will provide the greatest accuracy without exceeding its limit.

4-4. Sensitivity Switches

These three switches are used to select the sensitivity of the selected resistance range, and are labeled "**2**", "**20**", and "**200**". The switches are interlocked such that only one switch may be selected (depressed) at any one time.

These switches work in conjunction with the range switches above. Use the range and resolution table of Section 2 to determine which setting will provide the greatest accuracy without exceeding its limit.

4-5. VOLTAGE and CURRENT Terminals

The four terminals on the front panel provide full 4-wire Kelvin measurement capability. The CURRENT terminals provide the test current while the VOLTAGE terminals are used to monitor the voltage drop across the load. Refer to section 6-2.

4-6. ZERO Control

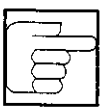
This potentiometer may be used to trim out any offset present on the display. Refer to section 6-4.

4-7. PRINT Switch

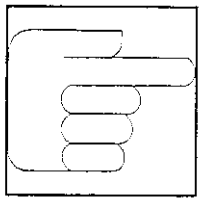
The PRINT switch is used by the optional parallel printer or serial RS232C interface to control data transfer. If the printer interface is installed, pressing this button will generate a print-out of the resistance measurement data. For the RS232C option (without printer), this will send one reading to the terminal. Please refer to the appropriate addendum in Section 11 of this manual for details on interface operation.

4-8. RESISTANCE Window

This 4½ (19999 counts) LED display presents the measured resistance value. The units of measure are determined by the setting of the Range switches, and are either ohms, kilo-ohms, or megohms. A flashing display indicates an overrange condition. In this situation the unit should be upranged to obtain a solid reading.



SECTION V REAR PANEL CONNECTORS



5-1. General

This section outlines the use of each of the rear panel controls and connectors. The user should also refer to Sections 4 and 6 for complete operating instructions.

5-2. Power Connector

The 3-prong power connector mounted on the rear panel of the product is for the application of AC power to the unit. Refer to section 1-3 for the available operating voltages and safety precautions.

5-3. Fuseholder

☞ This item is located internally on instruments manufactured with serial numbers lower than 5-1210.

This item is used to contain the main power fuse. Fuse values are listed below:

105VAC - 125VAC = ¼ amp slo-blo *
210VAC - 250VAC = .125 amp slo-blo *

Replace blown fuses with their exact equivalent only!

* Fuse values are doubled if the IEEE, RS232C or Printer interface has been installed. Refer to rear-panel markings.

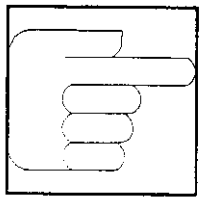
5-4. BCD Interface

This connector is provided on units fitted with Option "BCD" and may be used to interface with the Valhalla Model 1248 Comparator, or with other types of data acquisition equipment. The individual pin functions of this connector are shown in section 7-2.

5-5. Other Interfaces

The 4014 is now available with a choice of three common interfaces for remote data acquisition. These include GPIB (IEEE-488.2), RS232C, or a Centronics parallel printer interface. These interfaces are for data acquisition only, and do not allow remote range control of the ohmmeter. If your ohmmeter has been fitted with one of these optional interfaces, please refer to Section 11 for operating instructions.

SECTION VI MANUAL OPERATION



6-1. General

This section contains operating instructions for the Model 4014 Ohmmeter. The information contained in this section should be used along with the descriptions in Sections 4 and 5 to become completely familiar with the various methods of operation.

6-2. Connections

Connections to the ohmmeter are made via four binding posts on the front panel of the instrument. When using Valhalla test leads, the tabbed side of each banana jack is connected to the CURRENT terminals (see below). This ensures that current is carried in the largest conductor of the cable, and that the voltage input is shielded. Please refer to Figure 6-1 which details connections using Valhalla's Option K-Gray lead set.

NOTE: If the V_{HI} and I_{HI} terminals are not shorted together, the display will roll around and may or may not indicate an overrange. This is a characteristic of the voltmeter and does not indicate a fault in the instrument.

The 4-Wire configuration of all Valhalla ohmmeters 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 4-Wire ohmmeter 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.

Figure 6-2 illustrates how the 4-wire principle is used to eliminate 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.

6-3. Range and Sensitivity Switches

The resistance measurement range is set by a combination of the Range and Sensitivity switches. Refer to sections 4-3 and 4-4.

The Range switches are used to select the whether the displayed measurement will be read in ohms (**Ω**), kilo-ohms (**KΩ**), or megohms (**MΩ**).

The Sensitivity switches should be set according to the degree of accuracy and amount of display resolution required. Selecting a lower number increases the sensitivity, resolution, and accuracy. These switches, in combination with the Range switches, create the nine available resistance ranges of the Model 4014: **2Ω, 20Ω, 200Ω, 2KΩ, 20KΩ, 200KΩ, 2MΩ, 20MΩ** and **200MΩ**.

6-4. ZERO Adjustment

This adjustment may be performed at any time but does not need to be performed before each measurement. To make the adjustment, select the 200Ω range and connect the ohmmeter to the 0.1Ω resistor (provided). Adjust the front panel ZERO potentiometer for 000.10.

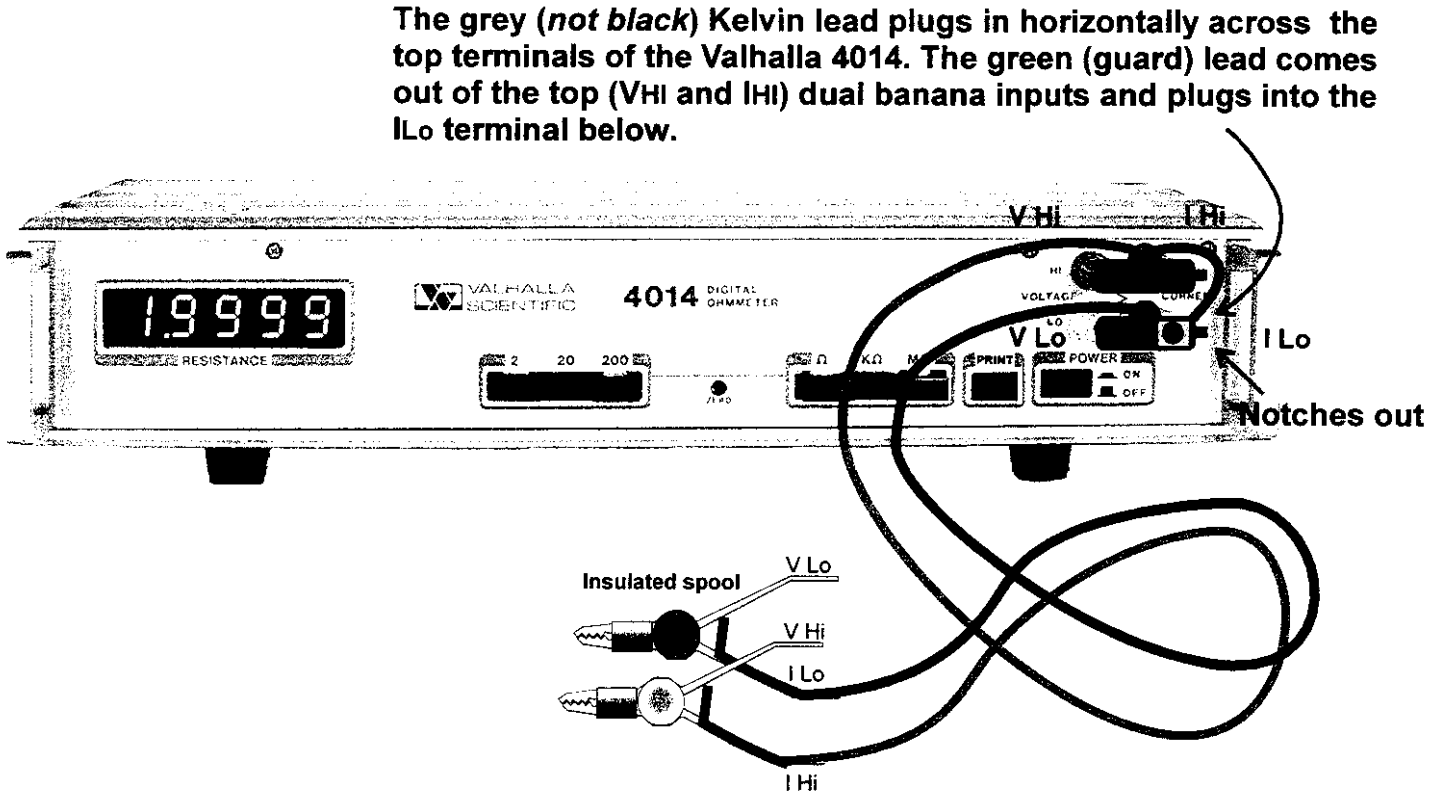


Figure 6-1. Ohmmeter Connections Using Option K-Gray

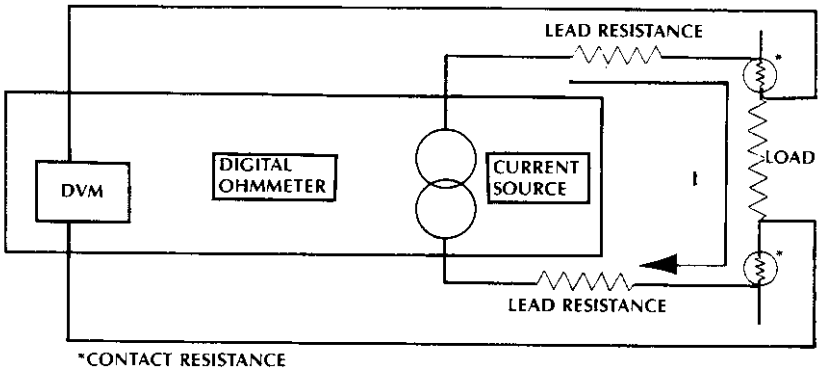
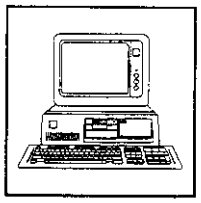


Figure 6-2. Error Sources in Resistance Measurements

SECTION VII INTERFACE OPERATION



7-1. General

The Model 4014 ohmmeter is now available with a choice of two data outputs. The standard output provides data in a binary-coded-decimal (BCD) format. The latest data output available is a parallel printer port for connecting directly to a Centronics compatible printer. Both interfaces are described below.

7-2. BCD Interface

Option BCD has a rear mounted 50 pin Amphenol connector providing data in a parallel binary-coded-decimal (BCD) format. The outputs are TTL compatible and may drive 1 LS load. The summary of pin functions is provided below and on the schematic number 2053-076 at the back of this manual.

Pin Number	Data
1	1
2	2
3	4
4	8
6	10
7	20
8	40
9	80
11	100
12	200
13	400
14	800
16	1000
17	2000
18	4000
19	8000
21	10000
22, 40	20000 (overrange)
26	+5 VDC supply
50	0 VDC common

35 End of Conversion on negative transition
(A high signifies "Busy")

45 Display Hold Line
(+5V or open = Run; 0V = Hold)

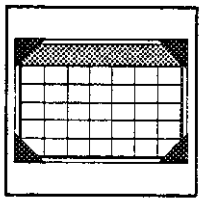
The BCD outputs are fully compatible with the Valhalla Model 1248 BCD Comparator. When connecting to the comparator using the standard IDC-2 interface cable, the end of the cable possessing the wire break-outs should be connected to the Model 1248.

7-3. Other Interfaces

The 4014 is now available with a choice of three common interfaces for remote data acquisition. These include GPIB (IEEE-488.2), RS232C, or a Centronics parallel printer interface. The printer interface may be configured to print labels, making it useful for component tagging.

These interfaces are for data acquisition only, and do not allow remote range control of the ohmmeter. If your ohmmeter has been fitted with one of these optional interfaces, please refer to Section 11 for operating instructions.

SECTION VIII ROUTINE MAINTENANCE



8-1. General

This section provides general maintenance information and a procedure for calibrating the ohmmeter. The Model 4014 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 routine calibration of the Model 4014:

Equipment	Required Performance
Precision Resistor	1Ω ±0.005% *
Precision Resistor	10Ω ±0.005% *
Precision Resistor	100Ω ±0.005% **
Precision Resistor	1KΩ ±0.005% **
Precision Resistor	10KΩ ±0.005% **
Precision Resistor	100KΩ ±0.005% **
Precision Resistor	1MΩ ±0.005% **
Precision Resistor	10MΩ ±0.01% **
Precision Resistor	100MΩ ±0.1% **

* May be replaced with Valhalla Model 2575A
** May be replaced with Valhalla Model 2724A

DC Voltage Standard: 0 to 0.1 volts, ±2μV (Valhalla Model 2701C)

High-quality shielded 4-terminal lead set such as Valhalla Option "K-Gray"

8-3. Calibration Procedure

The calibration adjustments are accessed by removing either the front or rear bezel and the top cover of the instrument. If the 4014 has been fitted with any of the interface options IEEE, RS232 or Printer, the interface PCB will cover the calibration adjustments. This board (which is blue in color) is installed with hinged standoffs to allow access to the adjustment potentiometers. Simply remove the black screw only (rear right corner), and the board may be flipped up. When finished with calibration, replace the black screw to hold the board in place.

The adjustment potentiometers are shown on the main board assembly drawing at the back of this manual. Leave the cover in place as much as possible. After each adjustment is made the cover should be replaced and the instrument allowed to restabilize.

8-3-1. Voltage Zero Adjustment

1) Connect the voltage standard (2701C) at 0 volts to the VOLTAGE HI and LO terminals.
2) Select the 2KΩ range.
3) Adjust the front panel ZERO potentiometer so that the display indicates 0.0000.

8-3-2. Voltage Fullscale Adjustment

1) Set the 2701C to output 100mV. The ohmmeter uses negative voltages therefore the VOLTAGE HI terminal should be negative with respect to the VOLTAGE LO terminal (select negative polarity).
2) Adjust RV101 on the replacement board for a display indication of 1.0000.
3) Remove all connections.

8-3-3. Current Zero Adjustment

1) Using the 4-wire test leads, connect the input terminals of the ohmmeter to the 1 ohm standard resistor and select the 2KΩ range.
2) Adjust the front panel ZERO potentiometer for a display indication of 0.0010 ohms ±1 digit.

8-3-4. Range Adjustments

The adjustments listed below should be performed *in the order shown* to calibrate the individual ranges. Allow extra settling time for the MΩ ranges. Also, movement in the test area must be kept to a minimum to prevent noise pickup at the inputs of the 4014. (This is especially important for the 20MΩ and 200MΩ ranges.)

Leave the covers in place as much as possible. After the cover is lifted to make the adjustment, replace it and allow the instrument to restabilize before proceeding.

1) **2Ω Range.** Connect the precision 1 ohm resistor to the Model 4014 input terminals. Adjust RV102, located on the replacement board, for an indication of 1.0000 ±1 digit on the front panel display. Warning! This adjustment affects <u>all</u> ranges.
2) **20Ω Range.** Connect the 10 ohm precision resistor to the input terminals and verify an indication of 10.000 ±3 digits on the front panel display (no adjustment).
3) **200Ω Range.** Connect the 100 ohm precision resistor to the input terminals and adjust RV78 for an indication of 100.00 ±1 digit on the front panel display.
4) **2KΩ Range.** Connect the 1KΩ precision resistor to the input terminals and adjust RV80 for an indication of 1.0000 ±1 digit on the front panel display.
5) **MΩ Ranges Zero Adjustment.** With the 1KΩ resistor still connected, select the 2MΩ Range. Adjust RV91 for an indication of 0.0010 ±1 digit on the front panel display.
6) **2MΩ Range.** Connect the 1MΩ precision resistor to the input terminals and adjust RV48 for an indication of 1.0000 ±3 digits on the front panel display.
7) **20MΩ Range.** Connect the 10MΩ precision resistor to the input terminals and adjust RV66 for an indication of 10.000 ±10 digits on the front panel display.
8) **200MΩ Range.** Connect the 100MΩ precision resistor to the input terminals and adjust RV54 for an indication of 100.00 ±100 digits on the front panel display.
9) **20KΩ Range.** Connect the 10KΩ precision resistor to the input terminals and adjust RV82 for an indication of 10.000 ±1 digit on the front panel display.
10) **200KΩ Range.** Connect the 100KΩ precision resistor to the input terminals and adjust RV84 for an indication of 100.00 on the front panel.

This concludes the calibration procedure for the Model 4014. ■

8-4. Periodic Maintenance

The Model 4014 ohmmeter does not require any periodic maintenance other than an occasional cleaning of the exterior surfaces 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!**

SECTION IX THEORY OF OPERATION

9-1. Troubleshooting

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.

If the ohmmeter exhibits problems that cannot be eliminated by reviewing the operating instructions, the following guidelines have been established to help solve the problem.

9-1-1. 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 section of the manual to gain a complete understanding of the internal workings of this instrument.

9-1-2. 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 part. Spare parts may 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.

9-2. General Circuit Descriptions

The ohmmeter may be easily thought of as consisting of two separate parts.

1) A constant-current source. This half of the ohmmeter 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 in Section 2 of this manual.

2) A digital voltmeter (analog-to-digital converter). The voltmeter senses the voltage drop across the load and translates this into the resistance reading on the display.

Use the following guidelines to determine whether the fault lies in the voltmeter or current source circuitry of the ohmmeter:

1) If the fault occurs on one range only then the fault is probably in the current source section.

2) If the fault is display related (e.g., missing segments, non-numeric data, etc.) then the fault is probably in the voltage measurement section.

3) If the fault occurs on all ranges, the voltmeter section may be verified as operational by applying a precise -100mV to the VOLTAGE terminals with the 4014 in any range except the MΩ ranges. The display should indicate 10000 counts no matter which resistance range is selected.

9-3. 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 at the back of this manual.

9-4. Power Supplies

The 4014 uses several different DC supplies, each of which is similar in structure. A transformer is used to step down the AC line voltage. Diodes are used to rectify this AC voltage to a DC level. Capacitors are used to smooth the voltage so that it may be regulated more easily. Standard three-terminal voltage regulators are used to provide a stable power source.

9-5. 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.

9-5-1. Reference Generator

The precise voltages required by the A-to-D convertor and the current source are provided by the zener reference IC106. IC106 and its associated components produce a nominal 6.95V. This voltage is attenuated by the resistors R111 through R115 and RV101 to provide the required 100mV DC reference voltage to the A-to-D convertor. RV102 is used to adjust the reference voltage to the current source.

9-5-2. Reference Invertor Stage

IC11 and its associated components form an amplifier stage having a gain of -1. This stage is used to convert the +1VDC reference voltage to a negative polarity.

9-5-3. Differential Amplifier

IC12 and its associated components form a unity gain differential amplifier. The output of the Reference Invertor 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 (V_{out}-V_{ref}).

9-5-4. Output Amplifier

IC13, Q18, Q19 and the range resistors R60 through R85 combine to form the output amplifier of the current source. The range resistors 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.

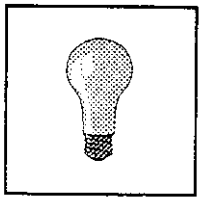
9-6. Analog-to-Digital Convertor

The A-to-D convertor is basically a high-impedance voltmeter that is used to measure the voltage drop across the unknown load. This voltage is converted to digital form to represent the resistance value of the load.

9-6-1. A-to-D Convertor

The A-to-D conversion is performed by the integrated circuit pair IC103-IC104 and their associated components. IC103 is the digital portion of the convertor and IC104 is the analog portion. The required reference voltage was discussed in Section 9-5-1 and is generated by IC106. IC102 is used to demultiplex the digital outputs of the convertor and to condition it for use by the display LEDs DS1-DS5.

SECTION X SPECIAL PROCEDURES



10-1. 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. It should also be noted that the MΩ ranges are susceptible to noise caused by movement in the test area. Noise pickup can be minimized by using a shielded lead set such as Valhalla Option "K-Gray". Movement in the test area should be kept to a minimum when using the MΩ ranges. Some other tips are noted below.

10-1-1. 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.

10-1-2. Drifting Displays

All Valhalla ohmmeters use a high impedance voltmeter as part of the resistance measurement process. This voltmeter is a highly accurate and stable 4½ digit analog-to-digital converter (A to D). Unless it is receiving a definite input signal, the output display of this A to D is ambiguous. The display may indicate a randomly wandering number, or it may flash indicating an overrange condition. This unpredictable display may make it seem to appear that the 4014 is experiencing some sort of malfunction. It is, in fact, just a characteristic of the voltmeter circuit and should not be mistaken for a fault in the instrument.

The display indications should be ignored unless there is a definite measurement being taken. If this wandering display is not acceptable, the ohmmeter can be made to indicate an overrange condition whenever the terminals are opened either by using a 4-wire Kelvin type lead set (Valhalla Option K-Gray) or by shorting the V_{HI} and I_{HI} terminals together.

The display should indicate a stable reading when the test leads are securely attached to the device under test. If the display appears to be erroneous when connected to a load, recheck the test leads for integrity and cleanliness. If all external items appear to be functioning properly, the problem may be the ohmmeter. In this case, please call the factory.

10-2. Connecting to Inductive Loads

The measurement of inductive loads (transformers, ballasts, coils, magnets, chokes, etc.) requires that special precautions be taken in order to ensure safety and maximize performance. Other than the noise considerations mentioned in 10-1-1 above, the following items should be noted:

1) Prior to connecting the unit to the load, select the highest range possible (200 MΩ).

2) Settling times for inductive loads are greater than those of resistive loads. A stable reading generally indicates that the inductor has been fully charged and an accurate measurement is being taken.

3) Prior to disconnecting the load, select the highest resistance range and wait for the display to show a stable reading indicating that the inductor has been discharged. This reduces the possibility of drawing and arc which may cause injury or damage the instrument.

SECTION XI MANUAL CHANGES

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.

ADDENDUM #9409

Effective Date: October 12, 1998

Subject: Valhalla Option "IEEE" Interface Operation

Applicability: Models 4100ATC, 4150ATC, 4165, 4165-1344, and 4014 fitted with optional GPIB Interface.

Content:

1. Description and Connections

Valhalla Option "IEEE" is an IEEE-488.2 compatible general-purpose interface (GPIB). This interface may be used for remote data acquisition only, and does not provide range or function control.

Connections to the GPIB are made using a standard GPIB cable. This cable (not provided) is available in one- or two-meter lengths from Valhalla Scientific. These cables are designated as Options GP-1 and GP-2. This standard cable is also available at most computer outlets.

The ohmmeter has been set at the factory for operation at address "18". If this address will not work within the constraints of your system, follow the steps below which describe changing the address.

1) Unplug the instrument from the AC line.
2) Remove the top rear bezel and the top cover. This will expose the interface board, which is blue in color.
3) The board is hinged for easy access. Remove the black #6 screw only, and the board will lift upward.
4) The address is determined by the setting of 8-position DIP switch "S1". Refer to Table 1 for setting the interface to a new address. The individual positions of S1 are numbered below each switch. Note that switches 1, 2 and 3 should always be left closed (down). Switches are selected by setting them open (up).
5) After setting the address, replace the board screw and covers. Power may now be applied. Note that whenever the address is changed, power must be cycled to place the new address in memory.

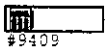


Table 1. Address Switch (S1) Coding								
S1 Marking	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Binary Code	closed	closed	closed	16	8	4	2	1

The address switch uses a standard "8-4-2-1" binary code. For the default setting of "18", switches #4 and #7 were selected (opened) because 16 + 2 = 18. To set the address to 25, for example, switches #4, #5 and #8 would be selected because 16 + 8 + 1 = 25.

Note that the switch coding allows selection of any address from 0 to 31. Certain addresses such as 0 and 31 may not be allowed in your system due to dedicated use by the system controller, disk-drive, printer, or other peripheral device. All devices on the bus must have their own unique address. Operating two devices at the same address will produce undefined results and is *not* recommended.

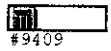
2. Sending Commands

The General-Purpose Interface Bus (GPIB) method of remote communication allows several instruments to be connected to the same line using a system of "addressed commands". For example to communicate with the Valhalla ohmmeter operating at address 18, the system controller first sends a universal message telling all devices on the bus, *except the one at address 18*, to ignore the following information until an end-of-command signal is received. After the end of the command has been detected, all devices resume listening for their address. In effect, only the device at address 18 received the data and responded accordingly.

The Command Set consists of a group of instructions that are recognized by a specific device. These instructions consist of universal commands (those which are recognized by all devices as specified by IEEE-488.2), and device-specific commands which are recognized only by a certain manufacturer or model number. The commands may further be divided into *standard commands* which do not require that a result be returned over the bus, or *queries* which always provide a result. Most of the commands used by the Valhalla ohmmeter are universal commands and queries.

Some commands are single words, but others consist of a root command followed by one or more variables, also called arguments. Arguments may be used to set-up multiple items such as the time and date using the clock setting command. For commands with multiple arguments such as TRIG and SETCLK, the root command must be separated from the first argument by a space.

Before devices may respond to data on the bus, they must have their remote function enabled. This is done by activating the REM (for remote) line on the bus. The REM line is enabled for all devices on the bus by executing a **REMOTE** 7 command in HP Basic, or by selecting remote in other systems. An addressed version of the statement, **REMOTE 718**, places only the device at address 18 into remote mode. The following sample program, given in HP Basic, describes the use of a query command.



☞ If you are using a language or software package other than HP Basic, consult the appropriate literature for the correct command syntax.

```
10    REMOTE 718          enables the device at address 18 to respond to instructions
20    DIM A$[100]         dimensions the variable A$ so that it may contain up to 100 characters
30    OUTPUT 718;"*IDN?"  this query is a universal command which asks that the device identify itself
40    WAIT .1             a delay of 100ms is recommended following issuance of a query
50    ENTER 718;A$        asks the device for the result of the query, and assigns it to the variable A$
60    PRINT A$            displays the result
70    END                 signals the end of the program
```

The result of this program is the display of the identification string for the ohmmeter which is:

VALHALLA SCIENTIFIC,<model#>,<serial#>,<firmware version>

Other commands in the Command Set may substituted for the *IDN? query above. If the command is not a query, the ENTER and PRINT statements should not be used. The ohmmeter Command Set is given in Section 3.

3. Ohmmeter Command Set for GPIB

This section describes the commands available for use with the ohmmeter. Note that all commands *must* be terminated with a _ (line-feed). Most new 488.2 compatible controllers automatically add a _ to terminate a command. Some older controllers such as pre-488.2 Hewlett Packard Basic systems may require the programmer to add a _ to the command line. A _ is ASCII character 10. Therefore, in HP Basic a _ would be added to line 30 of the sample program as shown: 30 OUTPUT 718;"*IDN?";CHR$(10)

A delay of 100ms is recommended following issuance of a query before soliciting a response. Also note that a 5 second delay will be encountered following a power-up or reset before the ohmmeter may respond over the bus.

***IDN? : Identification Query**

Syntax : *IDN?

Definition: This query instructs the ohmmeter to return a preset identification message to the controller. The response is in the format: VALHALLA SCIENTIFIC, Model#,Serial#,Firmware Version. (Models 4165 and 4165-1344 will indicate "4100ATC" in the *Model#* field.)

***OPT? : Device Options**

Syntax : *OPT?

Definition: This query instructs the ohmmeter to return a message listing any optional equipment that has been fitted.

Response: Option(s) : GPIB(IEEE488.2),PRINTER,RS232

***RST : Hardware Reset**

Syntax : *RST

Definition: The *RST command will reset the interface and all bus functions to their power-up conditions.

☞ A minimum 5 second delay must be allowed following issuance of this command.

***CAL? : Last Calibration Date**

Syntax : *CAL?

Definition: The instrument calibration date may be kept in non-volatile memory to be verified by the user. This date is set at the factory following full calibration.

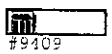
Response: MM-DD-YY <initials of technician>

TRIG : Take a Resistance Measurement (Full Command - Requires RS232 or Printer port)

Syntax : TRIG ➢port➣,➢strttime➣,➢interval➣,➢readings➣,➢stamp➣

Where:

➢port➣ is the location of the destination port: SERIAL or PRINTER
➢strttime➣ is the time to begin taking readings in the format HH:MM:SS or NOW to start immediately (24 hour format)
➢interval➣ is the amount of time in whole seconds to wait between readings and must be greater than 0 and less than 84,600 (24hrs)
➢readings➣ is the successive number of readings
➢stamp➣ to send date/time stamp with reading, 1=yes, 0=no.



The resistance reading is returned in scientific notation including five significant digits and an exponent (power of 10). This represents the value of resistance *in ohms*. For example, a

response of 1.2345e+2 would represent 1.2345 x 10^2 or 123.45 ohms. An overrange condition (flashing display on the ohmmeter) is indicated by all nines, and an exponent that exceeds the measurement capability of the ohmmeter. For example: 9.9999e+10

☞ This command may be used as an alarm clock type function to begin logging measurements at a specified time to either the serial port or to the printer (if installed). To stop, reset the interface or send the command again with "1" reading.

TRIG : Take a Resistance Measurement (Shortened Form for GPIB)

Syntax : TRIG

Definition: The query **TRIG** may be used by itself to trigger a single resistance reading via the GPIB bus. The ohmmeter waits until the next complete conversion, then returns that value. Allow a minimum 100ms delay following issuance of this shortened form before soliciting a response. Readings are updated following a TRIG query at the conversion rate of the ohmmeter which is 2.5 readings per second. See also the OHMS? query.

The resistance reading is returned in scientific notation including five significant digits and an exponent (power of 10). This represents the value of resistance *in ohms*. For example, a response of 1.2345e+2 would represent 1.2345 x 10^2 or 123.45 ohms. An overrange condition (flashing display on the ohmmeter) is indicated by all nines, and an exponent that exceeds the measurement capability of the ohmmeter. For example: 9.9999e+10

OHMS? : Resistance Measurement Query

Syntax : OHMS?

Definition: This query returns the present measured value of resistance. It differs from the TRIG query in that the reading is always available. Upon receipt of the OHMS? query, the interface will return whatever reading is present in its buffer. This has the effect of allowing more readings per second. This reading, however, is still only updated at the conversion rate of the ohmmeter which is 2.5 readings per second. This means that the same reading may be returned more than once. See also TRIG.

The resistance reading is returned in scientific notation including five significant digits and an exponent (power of 10). This represents the value of resistance *in ohms*. For example, a response of 1.2345e+2 would represent 1.2345 x 10^2 or 123.45 ohms. An overrange condition (flashing display on the ohmmeter) is indicated by all nines, and an exponent that exceeds the measurement capability of the ohmmeter. For example: 9.9999e+10

TIME? : Get the System Time

Syntax : TIME?

Definition: The interface includes an internal real-time clock. This query instructs the interface to send the present system time to the controller.

The TIME? query returns a string in the format hh:mm:ss <day of week> <month> <date>, <year>. For example, 06:45:15 Sunday May 2, 1993.

SETCLK : Set the Internal Clock

Syntax : SETCLK ➢hours➣,➢minutes➣,➢seconds➣,➢day➣,➢month➣,➢date➣,➢year➣

Where:

➢hours➣	is hours in 24-hr time, 0-23.
➢minutes➣	is the minutes, 0-59.
➢seconds➣	is the seconds, 0-59.
➢day➣	Sun=1, Mon=2, Tue=3, Wed=4, Thu=5, Fri=6, Sat=7
➢month➣	Jan=1, Feb=2, Mar=3, etc.
➢date➣	is the numeric day of the month, 1-31
➢year➣	is the year, 1992-9999.

***CLS : Clear the Status Registers**

Syntax: *CLS

Definition: This command clears any data from the buffers and any response bytes. It may be used clear unwanted responses to queries.

LABEL : Format the Print-out Style (Requires Option RS232C or PAR)

This command formats the arrangement of data that is sent upon pressing the PRINT/SEND button on the ohmmeter. If the parallel printer port has been installed, this command formats

the printout style. If the parallel printer port has *not* been installed, this command formats the data sent out the RS232C port.

Syntax: LABEL ➢test#➣,"➢banner➣",➢label size➣,➢time stamp➣,➢date stamp➣

Where:

➢test#➣ sets the starting point for the serializing test number counter. This may be any number from 1 to 999999. This number increments each time the "PRINT" or "SEND" button is pressed. The number is stored in non-volatile memory, and does not reset on power-up. Note: This number rolls-over to 0 after passing 999999.

➢banner➣ allows the user to install a banner such as the company name or product type as the first line of the print-out. The banner may be up to 30 characters in length. If no banner is desired, use a 0. Note: The banner must be alpha-numeric characters only (no punctuation), and should be enclosed in quotation marks otherwise spaces between words will be deleted.

➢label size➣ determines the number of line-feeds (_) to be sent after each label. By setting the proper number of line-feeds, the label size can be set for various sizes of pin-fed labels.

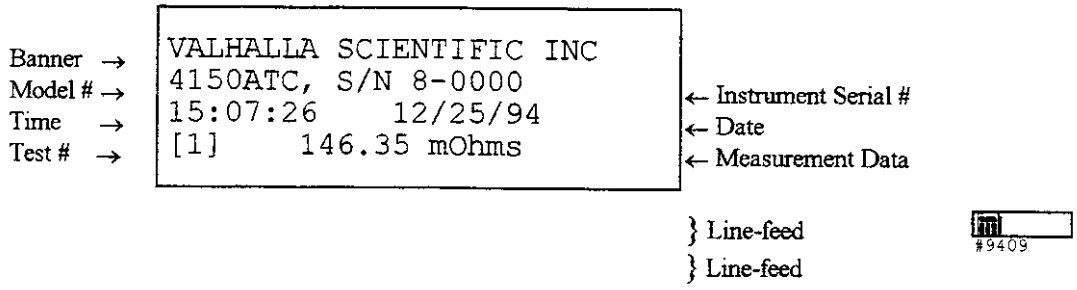
➢time stamp➣ determines if the present system time is to be included on the label. A "1" selects the time stamp. A "0" skips the time stamp.

➢date stamp➣ determines if the present system date is to be included on the label. A "1" selects the date stamp. A "0" skips the date stamp.

The following is a sample label including all fields of data. The command sent was

LABEL 1,"VALHALLA SCIENTIFIC INC",2,1,1

The first label will look like this:



The ohmmeter may also be set to generate a single line of data including only the measured resistance. This is done by sending the command: LABEL,0,0,0,0,0;
The resistance measurement will be followed by one _.

The test number may be set without changing other settings using a shortened form of the label command. Send the command:

LABEL #

where the "#" represents the desired starting number. This initial number may be any value from 0 to 999999, and will increment each time the PRINT or SEND button is pressed. Note that the counter rolls over to 0 after passing 999999.

☞ The full LABEL command stores settings in non-volatile RAM (E^2). A delay of several seconds may be encountered as the data is stored in memory.

End of Addendum #9409. ■

ADDENDUM #9408

Effective Date: October 12, 1998

Subject: Parallel Printer Interface (Option "PAR")

Applicability: Models 4100ATC, 4150ATC, 4165, 4165-1344, 4014, and 4300B fitted with optional printer interface.

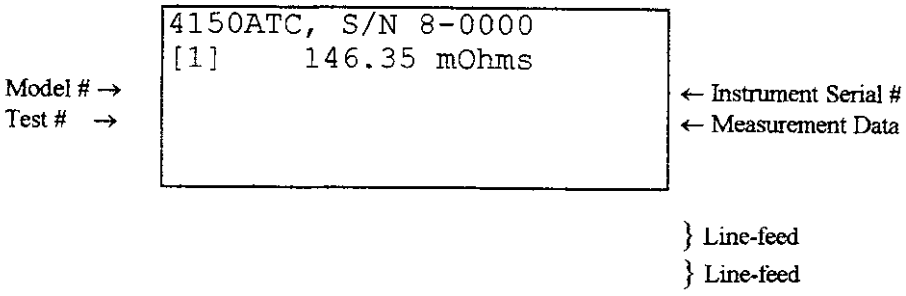
Content:

1. Description and Connections

Valhalla Option "PAR" allows direct print-out of the measured resistance data to a Centronics-compatible printer. Connections to the parallel printer interface are made on the rear of the ohmmeter and require a male DB25-pin connector. The other end of the cable should be a 36-pin Centronics-compatible parallel printer connector. This item is not provided but should have been supplied with the printer. If not, this cable is available at most computer supply outlets.

2. Generating a Print-out

After making connections apply power first to the printer, then to the ohmmeter. A printout may now be generated by pressing the button labeled "PRINT" or "SEND" on the front of the ohmmeter. Pressing this button generates one group of data, or "label". The label format has been configured at the factory to print on 3½" x 15/16" pin-fed labels (office standard E-4400). The basic label consists of 2 lines of data which are explained in the sample below.



The fields of the label provide information on the device used to perform the test (Model # and Serial #), as well as a test number and the actual measured data. The test number increments each time the button is pressed, and is a serializing-type number that does not reset on power up. Time and date stamps are also available, as well as custom headers. These items must be set via either the RS232 or IEEE-488 bus (see below).

Pressing the "PRINT" or "SEND" button generates a single label. The button must be released and pressed again to generate another label. Holding the button will *not* produce multiple labels. Labels may be sent at the rate of approximately 1 per second.

☞ Allow a 5 second delay following application of power to the ohmmeter before pressing the "PRINT" or "SEND" button.

This direct print-out feature has been installed with either interface Option "RS232" or "IEEE". The label style may be modified according to your preference by using the label set-up command. Refer to the associated literature for details on specific interface operation: Addendum #9405 for RS232, or Addendum #9409 for IEEE-488.2.

End of Addendum #9408. ■

ADDENDUM #9405

Effective Date: March 30, 2001

Subject: Valhalla Option "RS232" Interface Operation

Applicability: Models 4100ATC, 4150ATC, 4165, 4165-1344, 4014 and 4300B fitted with optional serial interface.

Content:

1. Description and Connections

Connections to the serial RS232C interface require a female DB9-pin connector (not provided). The RS232C port is configured as data terminal equipment (DTE) therefore a null-modem cable or adaptor is also required to interface to other DTE equipment such as computers and terminals. A "null-modem" cable or adapter reverses the roles of various data and control signals to make a DTE device appear as a DCE device or vice-versa. These items are available at most computer outlets.

Knowledge of the specific pin functions of Valhalla's serial connector may be necessary for certain applications. The connector is numbered inside the housing, next to the pins. The function of each pin is described below.

Pin #1: not used
Pin #2: Receive Data (RXDI)
Pin #3: Transmit Data (TXDO)
Pin #4: Data Terminal Ready (DTR)
Pin #5: Signal Ground (⊥)
Pin #6: Data Set Ready (DSR)
Pin #7: not used
Pin #8: Clear To Send (CTS)
Pin #9: not used

2. Sending Commands

Data may be exchanged with the ohmmeter using the following protocol:

Baud Rate: 9600	Stop Bits: 1
Parity: none	Handshaking: no
Word width: 8	

Notes:

The last character of each command must be a semi-colon (;). The ECHO feature must be set either to ON by sending a _ (carriage return), or OFF by sending a space immediately following power-up or reset. If the interface receives any other character before a _ or a space, it will require a reset by sending a tilde (~), or cycle power.

3. Command Set

The command set available for serial operations is given below. You will notice that some commands are single words, but others consist of a root command followed by one or more variables, also called arguments. Arguments may be used to set-up multiple items such as the time and date using the clock setting command. For commands with multiple arguments such as TRIG and SETCLK, the root command must be separated from the first argument by a space or comma.

"Query" commands, which usually end in a question mark, always provide a response to the query. Other commands are setup or instructional commands that do not provide a response. Note that each command *must* be terminated with a semi-colon (;) followed by a carriage-return (_). It is also recommended that a minimum 100ms delay be allowed following the _.

***IDN? : Identification String**

Syntax : *IDN?;

Definition: This query instructs the ohmmeter to return a preset identification message to the controller. (Models 4165 and 4165-1344 will indicate "4100ATC" in the *Model#* field.)

Identification string format: VALHALLA SCIENTIFIC,Model#,Serial#,Firmware Version

***OPT? : Device Options**

Syntax : *OPT?;

Definition: This query instructs the ohmmeter to return a message listing any optional equipment that has been fitted.

Response:

"Option(s) : GPIB(IEEE488.2),PRINTER,RS232"

***RST : Hardware Reset**

Syntax : *RST;

Definition: The *RST command will reset the interface to its power-up condition. If the interface is in a lockout mode, send a tilde (~) character alone to reset.

☞ A minimum 5 second delay must be allowed following issuance of this command.

***CAL? : Last Calibration Date**

Syntax : *CAL?;

Definition: The instrument calibration date may be kept in non-volatile memory to be read at any time. This date is set at the factory following full calibration, and is in the format:

MM-DD-YY <initials of technician>

ECHO : Turn Echo Feature On or Off

Syntax : ECHO,≻state≺;

Where:

≻state≺ is 1 for on and 0 for off

When using the RS232C port via a PC, the echo will be cumbersome in half-duplex mode and should be shut off using this command, or by a reset and sending a space.
(Space=ECHO OFF; _=ECHO ON)

TRIG : Take a Resistance Measurement

Syntax : TRIG,➢port≺,➢strttime≺,➢interval≺,➢readings≺,➢stamp≺;

Where:

➢port≺ is the location of the destination port: SERIAL or PRINTER
➢strttime≺ is the time to begin taking readings in the format HH:MM:SS or NOW to start immediately (24 hour format)
➢interval≺ is the amount of time in whole seconds to wait between readings and must be greater than 0 and less than 84,600 (24hrs)
➢readings≺ is the successive number of readings
➢stamp≺ to send date/time stamp with reading, 1=yes, 0=no.

The resistance reading is returned in scientific notation including five significant digits and an exponent (power of 10). This represents the value of resistance *in ohms*. For example, a response of 1.2345e+2 would represent 1.2345 x 10^2 or 123.45 ohms. An overrange condition (flashing display on the ohmmeter) is indicated by all nines, and an exponent that exceeds the measurement capability of the ohmmeter. For example: 9.9999e+10

This feature may be used as an alarm-clock function to begin taking measurements at a specified time. To stop, reset the interface (~), send the command again with "1" reading, or press the PRINT (or SEND) button.

The shortened query **TRIG;** may be used by itself to trigger a single reading. The ohmmeter waits until the next complete conversion, then returns that value. Readings are updated following a TRIG query at the conversion rate of the ohmmeter which is 2.5 readings per second. Pressing the PRINT (or SEND) button on the front of the ohmmeter duplicates the function of the TRIG command if the printer port has not been installed. This allows the RS232C port to be used with certain types of serial printers. Readings may be sent by pressing the PRINT/SEND button at a maximum rate of 1 per second. See also OHMS? and LABEL.

OHMS? : Resistance Query

Syntax : OHMS?;

Definition: This query returns the present measured value of resistance. It differs from the TRIG query in that the reading is always available. Upon receipt of the OHMS? query, the interface will return whatever reading is present in its buffer. This has the effect of allowing more readings per second. This reading, however, is still only updated at the conversion rate of the ohmmeter which is 2.5 readings per second. This means that the same reading may be returned more than once. See also TRIG.

The resistance reading is returned in scientific notation including five significant digits and an exponent (power of 10). This represents the value of resistance *in ohms*. For example,

a response of 1.2345e+2 would represent 1.2345 x 10^2 or 123.45 ohms. An overrange condition (flashing display on the ohmmeter) is indicated by all nines, and an exponent that exceeds the measurement capability of the ohmmeter. For example: 9.9999e+10

TIME? : Get the System Time

Syntax : TIME?;

Definition: The interface includes an internal real-time clock. This query instructs the interface to send the present system time to the controller. The TIME? query returns the time and date in the format-> 06:45:15 Sunday May 2, 1993.

SETCLK : Set the Internal Clock

Syntax : SETCLK,➢hours➣,➢minutes➣,➢seconds➣,➢day➣,➢month➣,➢date➣,➢year➣;

Where:

➢hours➣	is hours in 24-hr time, 0-23.
➢minutes➣	is the minutes, 0-59.
➢seconds➣	is the seconds, 0-59.
➢day➣	Sun=1, Mon=2, Tue=3, Wed=4, Thu=5, Fri=6, Sat=7
➢month➣	Jan=1, Feb=2, Mar=3, etc.
➢date➣	is the numeric day of the month, 1-31
➢year➣	is the year, 1992-9999.

LABEL : Format the Print-out Style

The LABEL command is used to configure the arrangement of data that is sent to either the parallel printer port or the RS232C port upon pressing the PRINT/SEND button on the ohmmeter. It allows the user to send information such as the time, date, identification, and test number.

Notes: **If the parallel printer port has been installed,** this command formats data sent to the printer. It does not affect the data sent to the RS232C terminal in response to a TRIG or OHMS? query. **If the the ohmmeter does *not* have the parallel printer port,** this command formats the data that is sent out the RS232C port as the result of pressing the PRINT/SEND button on the ohmmeter (see TRIG). This allows the RS232C port to be used with certain types of serial printers. The LABEL command does not affect the standard response to a TRIG or OHMS? query.

Syntax: LABEL,➢test#≺,"➢banner≺",➢label size≺,➢time stamp≺,➢date stamp≺;

Where:

➢test#≺ sets the starting point for the serializing test number counter. This may be any number from 1 to 999999. This number increments each time the "PRINT" or "SEND" button is pressed. The number is stored in non-volatile memory, and does not reset on power-up. Note: This number rolls-over to 0 after passing 999999.

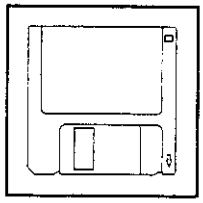
➢banner≺ allows the user to install a banner such as the company name or product type as the first line of the print-out. The banner may be up to 30 characters in length. If no banner is desired, use a 0. Note: The banner must be alpha-numeric characters only (no punctuation), and should be enclosed in quotation marks otherwise spaces between words will be deleted.

➢label size≺ determines the number of line-feeds (_) to be sent after each label. By setting the proper number of line-feeds, the label size can be set for various sizes of pin-fed labels.

➢time stamp≺ determines if the present system time is to be included on the label. A "1" selects the time stamp. A "0" skips the time stamp.

➢date stamp≺ determines if the present system date is to be included on the label. A "1" selects the date stamp. A "0" skips the date stamp.

SECTION XII PARTS LISTS



The following parts lists have been included in this manual:

4014-400	1 page	4014 Chassis Assembly
4014-602	4 pages	4014 Main Board Assembly
4014-601	1 page	4014 Display Board Assembly
4100-407	1 page	Option BCD Interface Assembly

REF.DES.	STOCK #	QUANTITY A	QUANTITY T	QUANTITY N	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
1	04-11030	1			4014 Front Panel (Screened)	DWG 4014-100 using 04-11005	
2	04-10333	4			Standard Bezel	DWG 2724-205	
3	04-10911		1		2790 Top & Bottom Cover	DWG 2790-228	
4	04-10460	2			2790 Side Rail	DWG 2790-206	
5	91-06006	14			#6-32 x 3/8" Phil Flat 82 Deg. S.S.		
6	92-06004		4		6-32 x 1/4" Phil Truss Head S.S.		
7	05-10808		2		Dual Tilting Feet (Plastic,Gray)	Elma Electronics 63-018S	
8	90-06006	6			#6-32 x 3/8" Phil Pan S.S.		
9	98-06000	6			#6 Flat Washer STD S.S.		
10	05-10361	2			Foot, hard, rubber, grey	ACC.Rubber 2095W-017-GREY	
11	04-11026	1			4100 Series Rear-Panel (Standard)	DWG 4100-220	
12	98-06002	6			#6 Internal Star Washer, S.S.		
13	90-06004	6			#6-32 x 1/4" Phil Pan S.S.		
14	05-10673	6			Standoff,1/4 Hex,1/4 Lg,#6,M-F,S.S.	Raf 4530-632-SS-0	
15	98-06001	10			#6 Split Lock Washer,STD,S.S.		
16	04-10346	2			2300/2575A/4100 Main bd. support bar	DWG 2300-214	
17	05-10018	1			Fuseholder, panel mount	Littlefuse 345061	
18	05-10166	1			Receptical, AC, filter	Corcom 6EF1	
19	91-06008	2			#6-32 x 1/2" Phil Flat 82 Deg. S.S.		
20	05-03017	1			Slide Switch,115/230V,2Pole	Switchcraft,4625LFR	
21	98-04001	2			#4 Split Lock Washer S.S.		
22	97-04001	2			#4-40 Radio Hex Nut S.S.		
23	04-11028		1		Bottom Cover	DWG 2790-229	
24	05-10001	2			Binding post, red	Superior BP21RC	
25	05-10002	2			Binding post, white	Superior BP21WTC	
29	70-00004	5			1/4" Black Shrink Tubing FP301	3M 3000250BK	
30	70-00002	3			1/8" Black Shrink Tubing FP301	3M 3000125BK	
31	80-02020	20			20awg Wire, Black TFE	M16878/4-BGE-0	
32	80-02120	10			20awg Wire, Brown TFE	M16878/4-BGE-1	
33	80-02920	13			20awg Wire, White TFE	M16878/4-BGE-9	
34	80-02820	10			20awg Wire, Gray TFE	M16878/4-BGE-8	
35	80-02520	5			20awg Wire, Green TFE	M16878/4-BGE-5	
37	05-04010	1			0.25A,Slo Blo Fuse	Littlefuse,313-.250	
A1	4014-600	1			4014 Main Board Assembly	Assembly 4014-600	

REF.DES.	STOCK #	QUANTITY A	T	N	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
1	05-10006	2			Chassis fastener, swage, 1/4sq, 4-40	Useco B1591B	
4	99-08000	4			#8 18-22awg Ring Lug (Red)	ELCOM B3651-169	
5	80-00014	6			14AWG Buss Wire	ANIXTER 1BB-1401	
6	70-11014	6			14awg TFE Sleeving		
7	98-06002	2			#6 Internal Star Washer, S.S.		
8	90-04006	2			#4-40 x 3/8" Phil Pan S.S.		
9	98-04002	2			#4 Internal Star Washer S.S.		
10	90-06007	2			#6-32 x 7/16" Phil Pan S.S.		
12	80-01022	10			22AWG Wire, Black PVC	M16878/1-BFE-0	
14	80-01222	14			22AWG Wire, Red PVC	M16878/1-BFE-2	
17	97-06001	1			#6-32 Hex Nut, Small Pattern, Stainless-Steel		
18	05-10073	8			Knob, black, rectangular	Centralab B304-BLK	
19	30-00155	1			4014 Display Board Assembly	ASSY 4014-601	
20	98-06000	2			#6 Flat Washer STD S.S.		
21	80-00022	3			22AWG Buss Wire	1BB-2201 ANIXTER	
A1	04-30297	1			4014 Main Board (Incorporated)	DWG 4014-702	
C11	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C12	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C13	02-40001	1			220uF 25V Aluminum Axial	Illinois 227TTA025M	
C14	02-40001	1			220uF 25V Aluminum Axial	Illinois 227TTA025M	
C15	02-10005	1			50pF 500V Ceramic disc	Illinois 500BCR050K	02-20002
C16	02-60002	1			0.1uF 250V Mylar	Illinois 104MSR250K	
C17	02-10002	1			500pF 100V Ceramic Disc	SPRAGUE 56AT50	
C18	02-40052	1			470uF 63V Aluminum Radial	Illinois 477RSM063M	
C19	02-40000	1			4700uF 16V Aluminum Axial	Illinois 478TTA016	
C20	02-10009	1			0.001uF 50V Ceramic Disc	NIC NCD102KIVX5P	
C21	02-90006	1			1uF 5% 50V Polycarbonate	IMB RA20105J	
C22	02-90005	1			0.1uF 5% 50V Polycarbonate	IMB RA7A104J	
C23	02-90000	1			0.005u 5% 50V Polycarbonate	IMB RA78502J	
C24	02-10006	1			0.01uF 50V Ceramic disc	Illinois 103GR050-Z	
C25	02-60001	1			0.22uF 100V Mylar	Illinois 224SHR100K75CE	
C26	02-30006	1			0.47uF 35V Tantalum Bead	TAP474K035SP	
C27	02-30008	1			6.8uF 10V Tantalum Bead		
C28	02-30006	1			0.47uF 35V Tantalum Bead	TAP474K035SP	
C29	02-30008	1			6.8uF 10V Tantalum Bead		
C104	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C105	02-90006	1			1uF 5% 50V Polycarbonate	IMB RA20105J	
C106	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C107	02-50000	1			0.22uF 10% 50V Polystyrene	IMB PA2A224K	
C108	02-40034	1			4700uF 10V Aluminum Radial	Illinois 478RMR010M	
C109	02-60002	1			0.1uF 250V Mylar	Illinois 104MSR250K	
C110	02-30006	1			0.47uF 35V Tantalum Bead	TAP474K035SP	
C111	02-30008	1			6.8uF 10V Tantalum Bead		
D3	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D4	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D5	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D6	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D7	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D8	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D9	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D10	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	

REF.DES.	STOCK #	QUANTITY A	QUANTITY T	QUANTITY N	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
D11	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D12	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D13	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D14	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D15	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D16	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D17	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D18	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D19	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D20	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D21	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D22	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D23	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D103	03-20048	1			Rectifier, Schottkey	Motorola 1N5818	
D105	03-20048	1			Rectifier, Schottkey	Motorola 1N5818	
D106	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D107	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D108	03-20000	1			Diode, general purpose	1N4148 or 1N914	
HIC109	05-10838	1			Heatsink, TO-220, Black Anodize	AAVID #576802B04000	
IC11	03-30013	1			Op-Amp,General Purpose,Uncompensated	LM301AH or LM301AN	
IC12	03-30017	1			Op-Amp,Uncompensated	LM308H	
IC13	03-30017	1			Op-Amp,Uncompensated	LM308H	
IC14	03-30015	1			Regulator,+12V,0.5A,TO202 or TO220	78M12CP	
IC15	03-30092	1			Regulator,-12V,0.5A,TO202 or TO220	79M12CP or LM320T-12	
IC16	03-30168	1			Regulator, +5V, 100mA, TO92	78L05ACLP	
IC17	03-30035	1			Regulator,-5V,0.5A,TO202 or TO220	79M05CP or LM320T-5.0	
IC102	03-30016	1			BCD to 7-Segment Decoder/LED Driver	7447AN	
IC103	03-30114		1		A to D convertor (digital portion)	Intersil ICL71C03ACPI or equiv.	
IC104	03-30113		1		A to D Convertor (analog portion)	Intersil ICL8068ACPD or equiv.	
IC105	05-02007	1			Programmable Osc.,8.3Hz-1MHz	Statek,PX01000KHzA	
IC106	03-30122	1			6.95V 1% Precision reference	National or Lin. Tech. LM399H or AH	
IC109	03-30638	1			Regulator, 1A, Low Dropout, +5V	National LM2940CT-5.0	
PL1	05-10898	1			Header, 12pin, 0.1"sp, Locking	Molex 22-11-2122	
PL2	05-10817	1			Header, 2 Pin, Straight, .1"sp, Gold, Locking	Molex 22-11-2022	
PL3	05-10313	1			Wafer, 10 way, gold, 0.56 lg	Molex 22-10-2101	
Q7	03-10003	1			NPN Darlington Transistor (TO92)	2N5172	
Q10	03-10003	1			NPN Darlington Transistor (TO92)	2N5172	
Q12	03-10003	1			NPN Darlington Transistor (TO92)	2N5172	
Q14	03-10003	1			NPN Darlington Transistor (TO92)	2N5172	
Q16	03-10003	1			NPN Darlington Transistor (TO92)	2N5172	
Q17	03-10004	1			P-Channel JFET	P1087E (selected)	
Q18	03-10000	1			N-Channel JFET	U1899E or PN4392	
Q19	03-10015	1			NPN Transistor (TO220)	MJE3439	
R30	01-01110	1			3.9M 5% 1/4W Carbon Film	RC07GF395J	
R49	01-10000			1	Factory Select Resistor	RN60C???	
R50	01-10000			1	Factory Select Resistor	RN60C???	
R51	01-20015	1			591.45K 0.05% 2ppm/C Wire Wound	Goldstar GS711-591K45-.05%-2PPM	
R52	01-20017	1			100K 0.05% 5ppm/C Wire Wound	Goldstar GS711-100K-.05%-5PPM	
R53	01-10017	1			9.09K 1% 50ppm/C 1/4W Metal Film	RN60C9091F	
R55	01-01081	1			100K 5% 1/4W Carbon Film	RC07GF104J	
R56	01-20017	1			100K 0.05% 5ppm/C Wire Wound	Goldstar GS711-100K-.05%-5PPM	

REF.DES.	STOCK #	QUANTITY A	QUANTITY T	QUANTITY N	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
R57	01-20017	1			100K 0.05% 5ppm/C Wire Wound	Goldstar GS711-100K-.05%-5PPM	
R58	01-20017	1			100K 0.05% 5ppm/C Wire Wound	Goldstar GS711-100K-.05%-5PPM	
R59	01-20017	1			100K 0.05% 5ppm/C Wire Wound	Goldstar GS711-100K-.05%-5PPM	
R60	01-01033	1			470 5% 1/4W Carbon Film	RC07GF471J	
R61	01-20006	1			90K 0.05% 5ppm/C Wire wound	Goldstar GS711-90K-.05%-5PPM	
R62	01-20014	1			10K 0.05% 5ppm/C Wire Wound	Goldstar GS805-10K-.05%-5PPM	
R63	01-01007	1			10 5% 1/4W Carbon Film	RC07GF100J	
R64	01-01081	1			100K 5% 1/4W Carbon Film	RC07GF104J	
R65	01-01038	1			750 5% 1/4W Carbon Film	RC07GF751J	
R67	01-01128	1			1000M 5% 1/4W Carbon Film	RC07GF108J	
R68	01-01045	1			2K 5% 1/4W Carbon Film	RC07GF202J	
R69	01-01081	1			100K 5% 1/4W Carbon Film	RC07GF104J	
R70	01-01053	1			4.7K 5% 1/4W Carbon Film	RC07GF472J	
R71	01-01033	1			470 5% 1/4W Carbon Film	RC07GF471J	
R72	01-01073	1			47K 5% 1/4W Carbon Film	RC07GF473J	
R73	01-01045	1			2K 5% 1/4W Carbon Film	RC07GF202J	
R74	01-01007	1			10 5% 1/4W Carbon Film	RC07GF100J	
R75	01-20020	1			10 0.01% 5ppm/C Wire Wound	Goldstar GS803-10R-.01%-5PPM	
R76	01-20019	1			90 0.01% 5ppm/C Wire Wound	Goldstar GS803-90R-.01%-5PPM	
R77	01-20012	1			897.25 0.05% 5ppm/C Wire Wound	Goldstar GS805-897R25-.05%-5PPM	
R79	01-20011	1			8.9725K 0.05% 5ppm/C Wire Wound	Goldstar GS805-8.9725K-.05%-5PPM	
R81	01-20010	1			89.725K 0.05% 5ppm/C Wire Wound	Goldstar GS805-89.725K-0.05%-5PPM	
R83	01-20009	1			897.25K 0.05% 5ppm/C Wire Wound	Goldstar GS805-897.25K-.05% 5PPM	
R85	01-10018	1			9M 1% 15ppm/C Film	Caddock TF050N-9M-1%-15PPM	
R88	01-01015	1			47 5% 1/4W Carbon Film	RC07GF470J	
R89	01-01015	1			47 5% 1/4W Carbon Film	RC07GF470J	
R90	01-01015	1			47 5% 1/4W Carbon Film	RC07GF470J	
R91	01-10052	1			10 1% 50ppm/C 1/4W Metal Film	RN60C10R0F	
R92	01-10000			1	Factory Select Resistor	RN60C???	
R93	01-10000			1	Factory Select Resistor	RN60C???	
R105	01-01021	1			100 5% 1/4W Carbon Film	RC07GF101J	
R106	01-01081	1			100K 5% 1/4W Carbon Film	RC07GF104J	
R107	01-01081	1			100K 5% 1/4W Carbon Film	RC07GF104J	
R108	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R109	01-01070	1			33K 5% 1/4W Carbon Film	RC07GF333J	
R110	01-01083	1			150K 5% 1/4W Carbon Film	RC07GF154J	
R111	01-10000			1	Factory Select Resistor	RN60C???	
R112	01-10269	1			66.5K 1% 50ppm/C 1/4W Metal Film	RN60C6652F	
R113	01-20002	1			9 0.05% 5ppm/C Wire Wound	Goldstar GS810-.05%-5PPM	
R114	01-01001	1			1.0 5% 1/4W Carbon Film	RC07GF1R0J	
R115	01-10000			1	Factory Select Resistor	RN60C???	
R116	01-10061	1			4.99K 1% 50ppm/C 1/4W Metal Film	RN60C4991F	
R117	01-01081	1			100K 5% 1/4W Carbon Film	RC07GF104J	
R119	01-20016	1			1K 0.05% 5ppm/C Wire Wound	Goldstar GS805-1K-.05%-5PPM	
RV31	01-50001	1			50K End Adjust (wide)	Beckman 89XR50K	
RV48	01-50000	1			100 Single Turn	CTS X201R101	
RV54	01-50015	1			2.5K Single Turn	CTS X201R252	
RV66	01-50028	1			50K Top Adjust	Beckman 68WR50K	
RV78	01-50018	1			10 Top Adjust	Beckman 68WR10ohm	
RV80	01-50033	1			50 Top Adjust	Beckman 68WR50ohm	
RV82	01-50029	1			500 Top Adjust	Beckman 68WR500ohm	

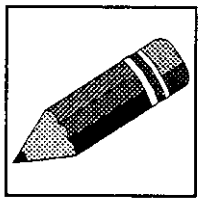
REF.DES.	STOCK #	QUANTITY A T N	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
RV84	01-50003	1	5K Single Turn	CTS X201R502	
RV91	01-50005	1	50K Single Turn	CTS X201R503	
RN201	01-40004	1	8 x 47 Network	A-B 316B-470	
RN202	01-40015	1	9 x 10K Network (SIP)	A-B 110A-103	
RV101	01-50000	1	100 Single Turn	CTS X201R101	
RV102	01-50003	1	5K Single Turn	CTS X201R502	
S1	05-03024	1	Switch,3Sta.,8Pole,Int-Lock	Centralab,78354-2	
S2	05-03025	1	Switch,3Sta.,6Pole,Int-Lock	Centralab,78354-1	
S3	05-03003	1	Switch, DPDT, Push-Push	Centralab 004184	
S4	05-03003	1	Switch, DPDT, Push-Push	Centralab 004184	
T2	04-20088	1	Power Transformer	DWG 4100-012	
TRT1	05-10007	1	Terminal, turret, swage	Useco 1300B-1	
X103	05-10295	1	Socket, dil, 28 pin	Burndy DILB28P-108	
X104	05-10041	1	Socket, dil, 14 pin	Burndy 8514-01	

PARTS LIST : 4014-601 REV D 4014 Display Board Assembly Page : 1

REF.DES.	STOCK #	QUANTITY A	QUANTITY T	QUANTITY N	DESCRIPTION	MANUFACTURING/PURCHASING DATA
19	04-30013	1			4014 Display Board	DWG 4014-701
21	80-00022	10			22awg Bus Wire	1BB-2201 ANIXTER
DS1	05-01010	1			Display,LED,Red,0-9	HP 5082-7650 Bin C, D or E
DS2	05-01010	1			Display,LED,Red,0-9	HP 5082-7650 Bin C, D or E
DS3	05-01010	1			Display,LED,Red,0-9	HP 5082-7650 Bin C, D or E
DS4	05-01010	1			Display,LED,Red,0-9	HP 5082-7650 Bin C, D or E
DS5	05-01010	1			Display,LED,Red,0-9	HP 5082-7650 Bin C, D or E

REF.DES.	STOCK #	QUANTITY A	QUANTITY T	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
1	80-03930	2		30awg Wire, White Kynar		
3	04-30155	1		2053A/4100 BCD Board	DWG 2053-706	
4	90-03008		2	#3-56 x 1/2" Phil Pan S.S.		
5	98-03000		2	#3 Flat Washer		
6	98-03001		2	#3 Split Lock Washer		
7	97-03000		2	#3-56 Hex Nut		
8	04-11027		1	4100 "BCD" Rear Panel	DWG 4100-221	
9	05-10340	12		Crimp Terminal,Gold,.10sp. housing, 22-30 AWG	Molex 08-55-0102	
11	80-01122	28		22awg Wire, Brown PVC	M16878/1-BFE-1	
12	80-01222	28		22awg Wire, Red PVC	M16878/1-BFE-2	
13	80-01322	28		22awg Wire, Orange PVC	M16878/1-BFE-3	
15	80-01522	28		22awg Wire, Green PVC	M16878/1-BFE-5	
16	80-01622	28		22awg Wire, Blue PVC	M16878/1-BFE-6	
17	80-01722	14		22AWG Wire, Violet PVC	M16878/1-BFE-7	
18	80-01822	14		22awg Wire, Gray PVC	M16878/1-BFE-8	
19	80-01922	14		22awg Wire, White PVC	M16878/1-BFE-9	
20	80-01022	14		22awg Wire, Black PVC	M16878/1-BFE-0	
C1	02-40029	1		100uF 25V Aluminum Radial	Illinois 107RMR025M	
C2	02-10014	1		0.1uF 50V Ceramic Disc	AVX SR205E104MAA00	
C3	02-10014	1		0.1uF 50V Ceramic Disc	AVX SR205E104MAA00	
C4	02-10014	1		0.1uF 50V Ceramic Disc	AVX SR205E104MAA00	
C5	02-10014	1		0.1uF 50V Ceramic Disc	AVX SR205E104MAA00	
C6	02-10014	1		0.1uF 50V Ceramic Disc	AVX SR205E104MAA00	
IC1	03-30039	1		Quad Latch (CMOS)	4042BE	
IC2	03-30039	1		Quad Latch (CMOS)	4042BE	
IC3	03-30039	1		Quad Latch (CMOS)	4042BE	
IC4	03-30039	1		Quad Latch (CMOS)	4042BE	
IC5	03-30039	1		Quad Latch (CMOS)	4042BE	
IC6	03-50088		1	4100 Series BCD Fixit PROM	DWG 4100-900 using 03-30418	
R1	01-01081	1		100K 5% 1/4W Carbon Film	RC07GF104J	
SK2	05-10012	1		Connector, 50-pin "D", Female with Bail	Amphenol 57-40500	
SK3	05-10498	1		Connector, housing, 12 way, 0.10 sp.	Molex 22-01-2121	
XIC6	05-10294	1		Socket, dil, 20 pin	Burndy DILB20P-108	

SECTION XIII DRAWINGS AND SCHEMATICS



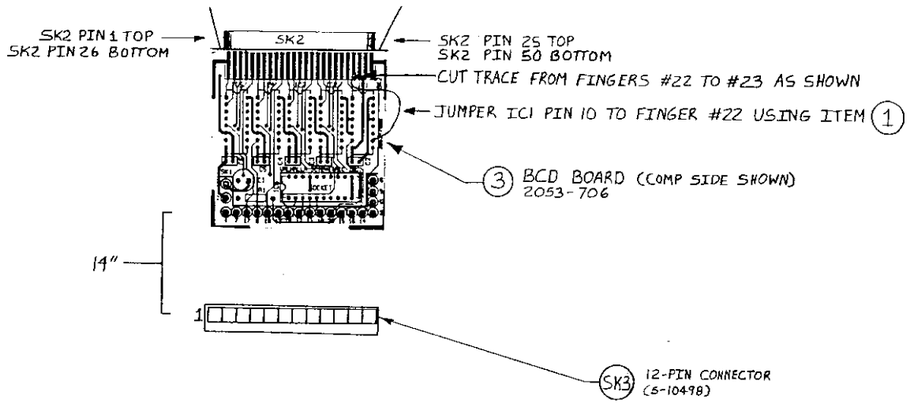
The following drawings have been included in this manual:

4014-400	1 page	4014 Chassis Assembly
4014-602	1 page	4014 Main Board Assembly
4014-601	1 page	4014 Display Board Assembly
4014-071	1 page	4014 Main Board Schematic
2053-076	1 page	Option BCD Interface Schematic
4100-407	1 page	Option BCD Interface Installation

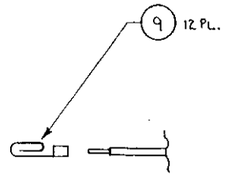
NOTES: (UNLESS OTHERWISE SPECIFIED)

1. FOR PCB AND INSTALLATION PARTS LIST, SEE 4100-407.
2. FOR SCHEMATIC SEE DWG 2053-076.

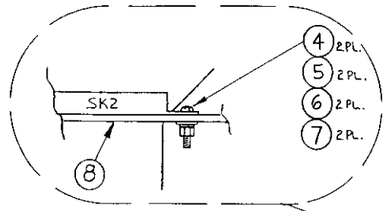
REVISIONS			
ECO	LTR	DESCRIPTION	DATE	APPROVED

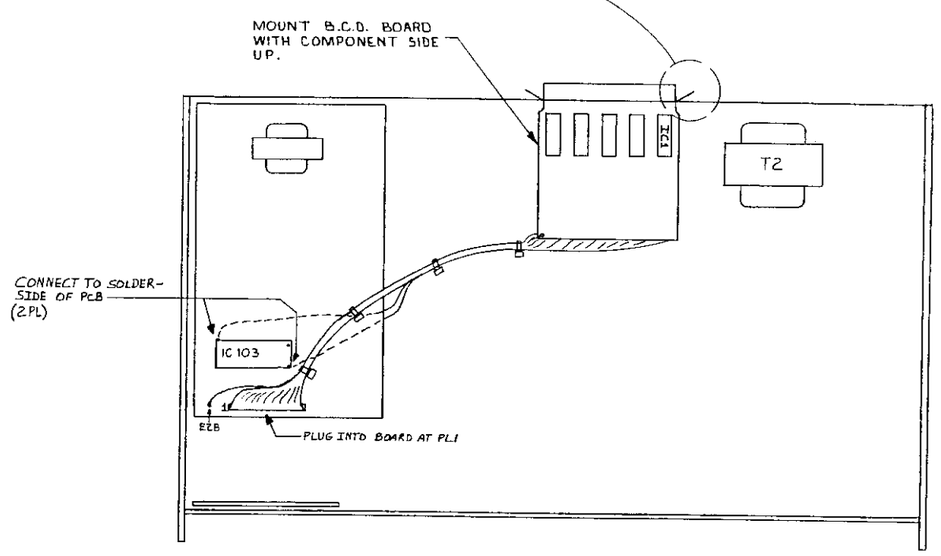


FROM	FUNCTION	TO SK1-	WIRE COLOR
SK3-1	5V	1	BROWN
SK3-2	B1	6	BLUE
SK3-3	B2	7	VIOLET
SK3-4	B4	8	GREY
SK3-5	B8	9	WHITE
SK3-6	D5	5	GREEN
SK3-7	D4	10	BLACK
SK3-8	D3	11	BROWN
SK3-9	D2	12	RED
SK3-10	D1	15	ORANGE
SK3-11	R/H	3	ORANGE
SK3-12	0V	2	RED
IC103, PIN 28	BUSY (EOC)	9	YELLOW
EPAD #28	STROBE	16	BLUE
IC103, PIN 14	OVERRANGE	15	GREEN



CRIMP AND SOLDER TERMINALS





DASH NO	QTY REQD	NEXT ASSEMBLY	USED ON

TOLERANCES
X = ± 30'
.XX = ± .03
.XXX = ± .010

BREAK ALL SHARP CORNERS AND EDGES, MACH SURFACES 64

MATERIAL

FINISH

Valhalla Scientific Inc.
SAN DIEGO, CA

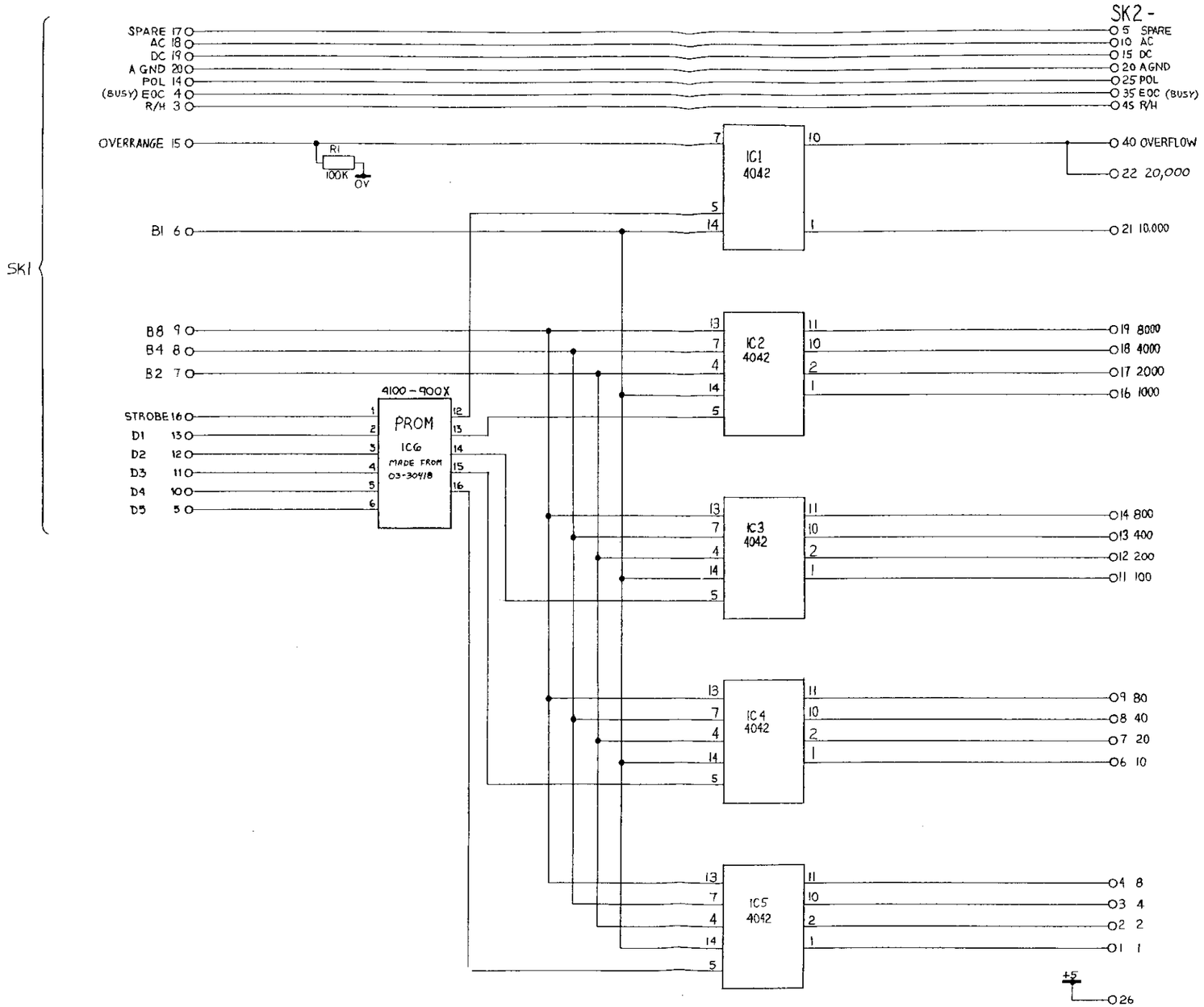
OPTION "B.C.D." ASSEMBLY

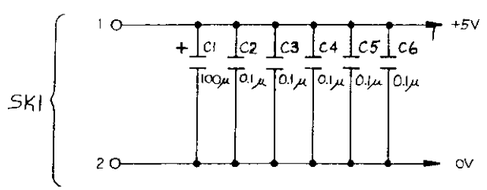
SCALE	SHEET	CODE IDENT	SIZE	DRAWING NO	REV
NONE	1 OF 2	53504	D	4100-407	D

4100-407

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED





POWER CONNECTIONS

DEVICE	+5V	0V
IC1	6,4,13,16	8
IC2	6,16	8
IC3	6,16	8
IC4	6,16	8
IC5	6,16	8
IC6	20	7,8,9,10,11,17,18,19

C1		C6	TOLERANCES	MATERIAL
IC1		IC5	X = ± 30'	
R1		R1	.XX = ± .03	
SK1	—	SK2	.XXX = ± .010	
			BREAK ALL SHARP CORNERS AND EDGES, MACH SURFACES 84 ✓	FINISH
FIRST USED	NOT USED	LAST USED		

Valhalla Scientific Inc.
SAN DIEGO, CA

STK NO

BCD SCHEMATIC
2053A / 4100ATC / 4150ATC / 4014

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
NONE	53504	D	2053-076	C

SHEET 1 OF 1

NOTES:

1. FOR PARTS LIST SEE 4014-802.
2. FOR PCB ASSEMBLY SEE DRAWING 4014-802.

HISTORY OF REVISIONS

ECO#	REV	DESCRIPTION OF CHANGE (S)	BY:	DATE	CHECKED
	A	RENUMBERED DRAWING / RELAYOUT PCB	TLC	04-18-86	EAL
1820	B	C23 VALUE. SWAP DS5-DS1 & DS4-DS2	TLC	03-10-88	

THESE PARTS LOCATED ON DISPLAY BOARD (DWG 4014-801)

THESE PARTS LOCATED ON REAR PANEL (DWG 4014-400)

ITEMS IN DASHED LINES ARE NOT LOCATED ON THE MAIN PCB. FOR REFERENCE ONLY.

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VALHALLA SCIENTIFIC, INC.
9255 MESA RIM ROAD
SAN DIEGO, CA 92121
(619) 457-5875

4014 MAIN BOARD SCHEMATIC

DRAWN BY: TIMOTHY L. COLVIN
CHECKED BY:
RELEASE DATE: March 15, 1986

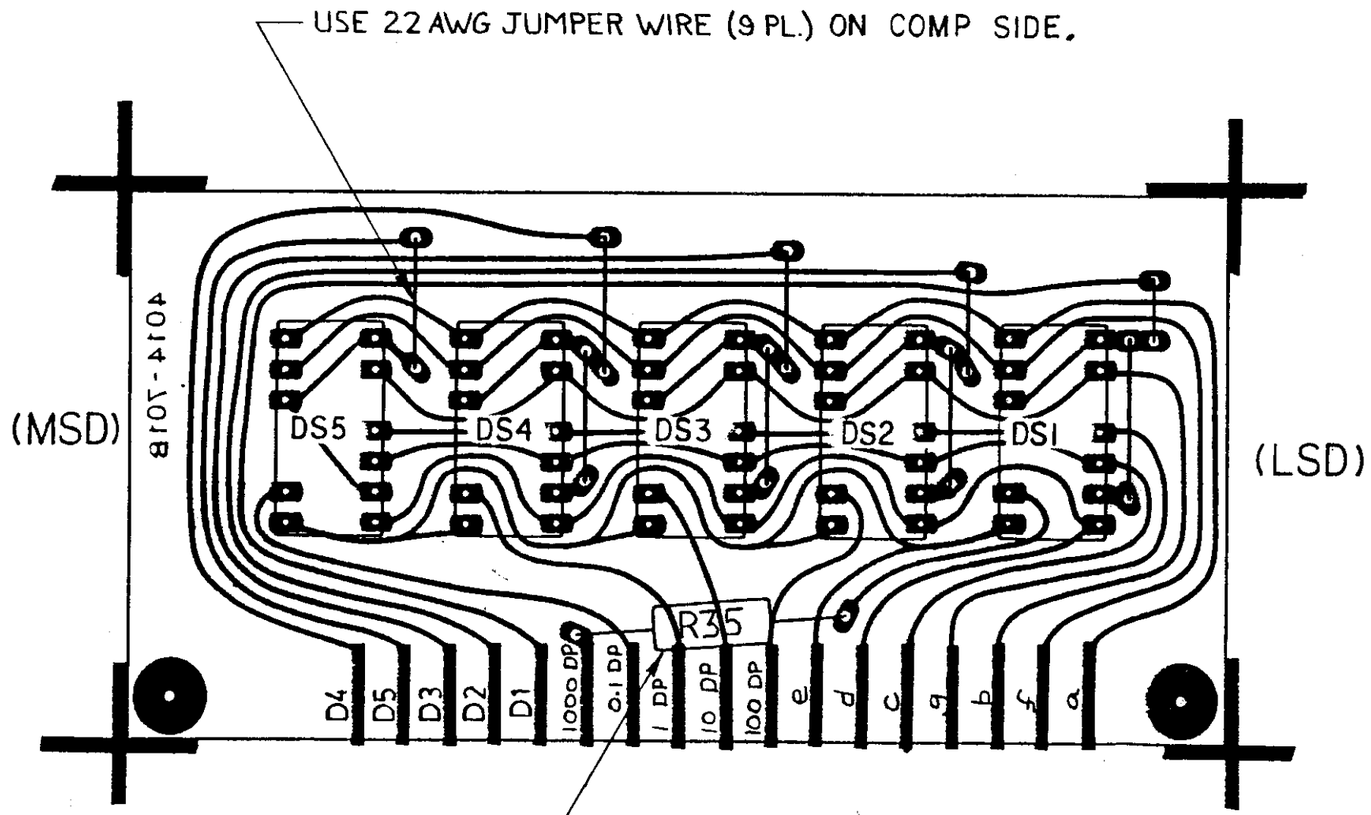
SIZE	CAGE CODE	DWG NO	REV
D		4014-072	B

SCALE | SHEET 1 OF 1

NOTES:

1. CLAD SHOWN IS SOLDER SIDE.

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED



Valhalla Scientific Inc.
SAN DIEGO, CA

DISPLAY BD ASSY

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
2:1	53504	B	4014-601	D

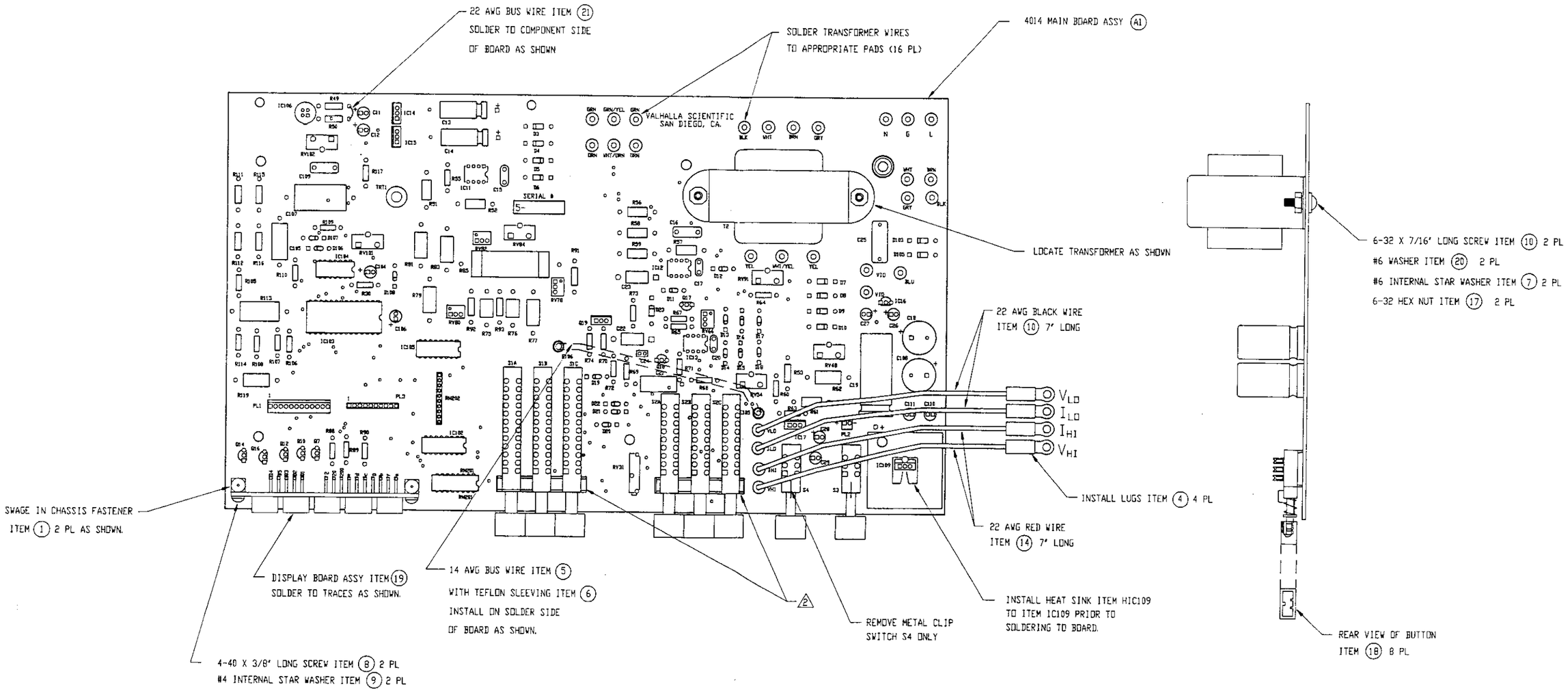
SHEET 1 OF 1

NOTES: Unless Otherwise Specified

1. FOR CHASSIS ASSEMBLY SEE 4014-400 DRAWING AND PARTS LIST.

2. ASSEMBLE SWITCHES WITH OPEN END OF METAL RETAINER FACING UPWARDS.

REVISIONS				
ECR#	LTR	DESCRIPTION OF CHANGE	DATE	APPROVED



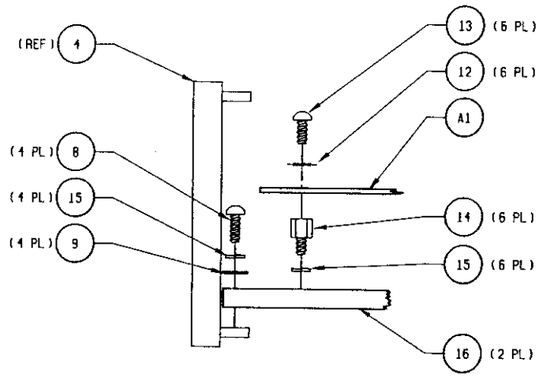
FINISH	MATERIAL		VALHALLA SCIENTIFIC 9955 MESA RIM RD. SAN DIEGO, CA 92121
SCALE: 1 : 1	STOCK NO. 30-00163	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC, INC. AND EXCEPT FOR GENERAL PURPOSES GRANTED TO THE UNITED STATES GOVERNMENT, IS NOT TO BE DISCLOSED OUTSIDE VALHALLA SCIENTIFIC, INC. NOR USED, IN WHOLE OR IN PART, FOR MANUFACTURING, SALE, OR PROCUREMENT WITHOUT THE WRITTEN CONSENT OF VALHALLA SCIENTIFIC, INC. THIS RESTRICTION DOES NOT LIMIT THE RIGHT TO USE INFORMATION OBTAINED FROM ANY SOURCE AS MAY BE PRIVILEGED UNDER THE CONSTITUTION OF THE UNITED STATES.	TITLE: 4014 MAIN BOARD ASSEMBLY
		SHEET 1 OF 1	DRAWING NO. 4014-602 REV: B

NOTES: Unless Otherwise Specified

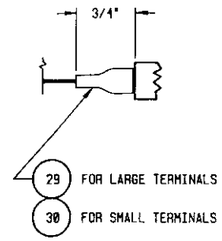
1. SEE SEPARATE PARTS LIST.

2. WIRES ARE TO BE TWISTED WITH 1 TO 2 TWISTS PER INCH.

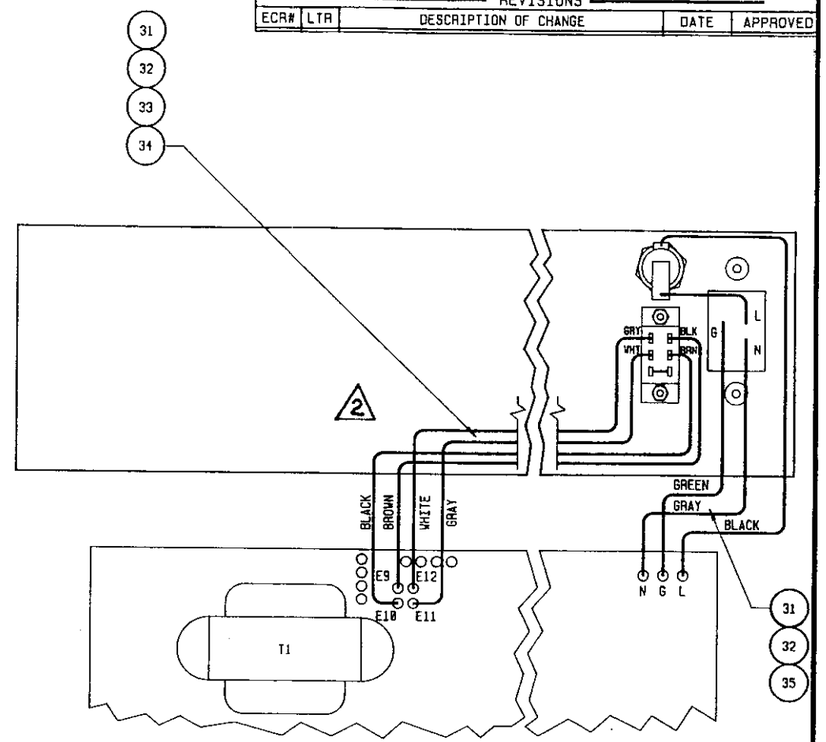
REVISIONS				
ECR#	LTR	DESCRIPTION OF CHANGE	DATE	APPROVED

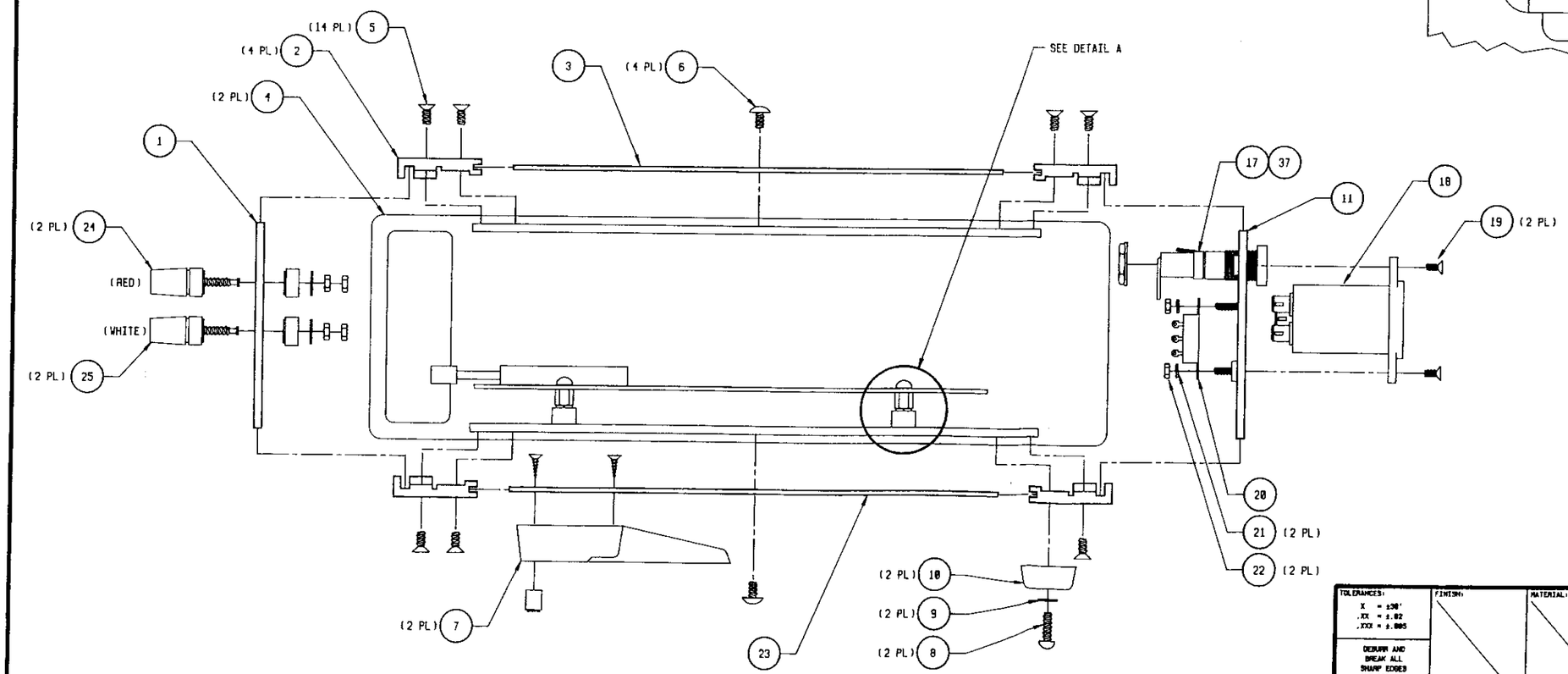


DETAIL A
FRONT VIEW OF BOARD MOUNTING

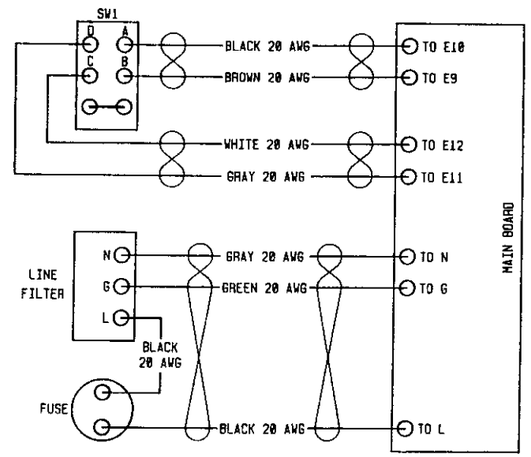


TERMINAL DETAIL
(TYPICAL 9 PL)





SIDE VIEW
SIDERAIL ITEM #4 NOT SHOWN



2 WIRING DIAGRAM

TOLERANCES: X = ±30' .XX = ±.02 .XXX = ±.005	FINISH:	MATERIAL:	VALHALLA SCIENTIFIC 9955 MESA RIM RD. SAN DIEGO, CA 92121
DEBURR AND BREAK ALL SHARP EDGES AND CORNERS			TITLE: ASSEMBLY- 4014 FINAL CHASSIS
MACHINED SURFACES ARE TO HAVE A FINISH OF	SCALE: 1 : 1	STOCK NO.	SHEET 1 OF 1 · DRAWING NO. 4014-400 · REV: