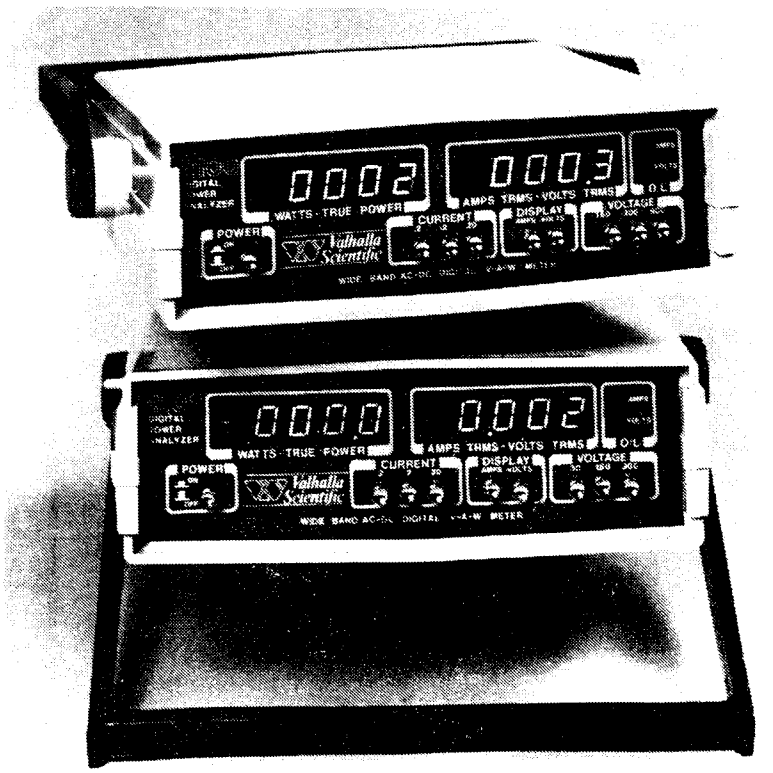
Valhalla Scientific, Inc.

2100/2101
Digital Power Analyzer
Operation and Maintenance
Manual



VALHALLA SCIENTIFIC
9955 Mesa Rim Road
San Diego, CA 92121
(619)457-5576

Revised: 06/01/89

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 it's calibration measurements are traceable to the National Bureau of Standards to the extent allowed by NBS'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.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SPECIFICATIONS

DC/AC CURRENT (TRUE RMS)

Current Range: 0.2, 2, 20 Amperes.

DC Inputs: 0.5000, 5.000, 20.00 Amperes.

AC Inputs: 0.3500, 3.500, 20.00 Amperes.

Frequency Response: DC, 40 Hz to 20 KHz.

Crest Factor Response: 50:1 for minimum RMS input, linearly decreasing to 2.5:1 for full scale RMS input.

Peak Indicator: Illuminates at 2.5 times full scale.

Maximum Input: 35A peak, 20A DC or RMS; 100A DC or RMS for 16 milliseconds without damage.

Overrange: 150% of full scale for DC, up to maximum input.

DC/AC VOLTAGE (TRUE RMS)

Range: (Model 2100)150.00, 300.0, 600.0 VDC or True RMS.
(Model 2101) 30.00, 150.00, 300.0 VDC or True RMS.

Crest Factor Response: 50:1 for minimum RMS input, linearly decreasing to 2.5:1 for full scale RMS input.

Maximum Input: (Model 2100) 600V DC or RMS AC, 1500V peak.
(Model 2101) 300V DC or RMS AC, 750V peak.

Peak Indicator: Illuminates at 2.5 times full scale.

WATTS (TRUE POWER· EI COS φ)

MODEL 2100

VOLTAGE RANGE	CURRENT RANGE		
	.2A	2A	20A
150.00	30.00W	300.0W	3000W
300.00	60.00W	600.0W	6000W
600.00	120.00W	1200.0W	12000W

MODEL 2101

VOLTAGE RANGE	CURRENT RANGE		
	.2A	2A	20A
30.00	6.00W	60.0W	600.0W
150.00	30.00W	300.0W	600.0W
300.0	60.00W	600.0W	6000W

Power Factor: 0 to unity, lead or lag.

ACCURACY (V·A·W, 25°C ± 25°C)

DC, 40 Hz to 5 KHz: ± 0.25% of reading ± 6 digits.

5 KHz to 10 KHz: ± 0.5% of reading ± 0.5% of range.

10 KHz to 20 KHz (2 AMP Range Only): ± 1% of reading, ± 1% of range.

SPECIFICATIONS (Cont'd)

DISPLAYS:	Large, high intensity LED's.
MINIMUM INPUT:	5% of range for all true RMS responding converters.
OPERATING TEMPERATURE RANGE:	0°C to 50°C.
TEMPERATURE COEFFICIENT:	± 0.025% of range per °C from 0°C to 20°C and 30°C to 50°C.
CONVERSION RATE:	One conversion in approximately 300 milliseconds.
LOAD CONNECTION:	Four-terminal, heavy duty input jacks.
POWER REQUIRED:	115/230 VAC ± 10%, 50-60 Hz, 5 watts.
SIZE:	23.5 cm L x 21.6 cm W x 6.4 cm H (9.25" x 8.25" x 2.5").
WEIGHT:	2.3 kg (5 lbs) NET, 4.5 kg (10 lbs) shipping.

Specifications subject to change without notice.

12-06-88

2100/2101 Parts List

Parts List	Rev.	Title	Sheets
2100-600	T	P.C.B. Assy. - Main Bd.	2 of 6 3 of 6 4 of 6 5 of 6 6 of 6
2100-601	A	Display PCB Assy.	1 of 2
2100-400	N	Digital Wattmeter Final Assembly	1 of 4 2 of 4
2100-403	G	Final Assembly Main PCB	1 of 1
2100-404	F	Final Assmbly Main PC Board	1 of 1
2100-405	C	Option "Analog" Output	1 of 2

2100/2101 List of Drawings

Drawing No.	Rev.	Title	Sheets
2100-070	H	Schematic - Digital Wattmeter	1 of 2 2 of 2
2100-400	N	Rear Panel Assembly Dwg.	3 of 4
2100-400	N	Assembly - Model 2100/2101	4 of 4
2100-600	T	2100 & 2101 Main Bd. Assy.	1 of 6
2100-601	A	Display Board Assy. 2100/2101	2 of 2

SECTION I — GENERAL INFORMATION

1-1 DESCRIPTION

1-2 Valhalla Scientific Models 2100 and 2101 Digital Wattmeters are accurate, low-cost instruments to aid engineering, production test and quality assurance departments in the determination of product power consumption from DC and AC power lines. The instruments feature dual, independent digital displays. One display provides a continuous indication of True Power in Watts. The other display is switch selectable between Amperes (True RMS) and Volts (True RMS).

1-3 The Model 2100 and Model 2101 provide a fast and convenient method of determining product efficiency, power factor and true RMS current. Phase angle relationships may be calculated through utilization of the displayed digital data.

1-4 The Digital Wattmeters use a unique four-quadrant complex waveform analog multiplier to derive a DC signal equivalent to the integrated product of the instantaneous value of line voltage and current. The resultant wattage value is converted for presentation on a 4-1/2 digit display. Power ranging provides maximum resolution from 10 milliwatts to 12000 watts on the Model 2100 and from 1 milliwatt to 6000 watts on the Model 2101. True RMS current from 100 microamperes (max resolution) through 19.99 amperes with a crest factor of 2.5:1 may be monitored by selecting the current display with the front panel switch. True RMS voltage from 7.5 volts to 600 volts may be monitored on the Model 2100 by selecting the voltage display. On the 2101, the range is from 1.5 volts to 300 volts. Four binding posts on the rear panel provide convenient means of making the measured line and load connections.

1-5 The Digital Wattmeters are designed to operate from selectable 115/230V AC power. The loads may be operated from power sources up to 600 volts on the Model 2100 and up to 300 volts on the Model 2101. These sources may be independent of instrument power and may be DC, or AC from 40 Hz to 20 KHz. Peak voltage limitation is 1500 volts for the Model 2100 and 750 volts for the Model 2101. There are three selectable current display ranges identified on the front panel as .2, 2 and 20 amperes. DC current may be displayed up to 0.5000, 5.000 and 20.00 amperes. AC sinewave current may be displayed up to 0.3500, 3.500 and 20.00 amperes. Voltage display ranges are also selectable in three steps; 150.00, 300.0 and 600.0 on the Model 2100 and 30.00, 150.00 and 600.0 on the Model 2101

1-6 ACCESSORIES

1-7 The Digital Wattmeters are shipped from the factory with a detachable power cord and an instruction manual.

1-8 RACK MOUNT- OPTION 'R'

1-9 The Model 2100 or Model 2101 may be purchased with an Option 'R' rack mount adapter for use in rack mount applications.

SECTION II — INSTALLATION

2-1 INTRODUCTION

2-2 This section of the manual contains information for receiving inspection and installation of the Model 2100 and Model 2101 Digital Wattmeters.

2-3 INITIAL INSPECTION

2-4 If the external shipping container shows evidence of in-transit damage, such damage should be immediately brought to the attention of the carrier and such damage noted on the bill of lading.

2-5 Unpack the instrument and retain the shipping container until the instrument has been inspected for possible damage in shipment. If in-shipment damage is observed, notify the carrier and obtain his authorization for repairs before returning the instrument to the factory. Where the external shipping container has shown evidence of damage in transit, but the instrument shows no external damage, it may be advisable to check the performance of the unit using the adjustment procedure of Section V as a guide to determine that the instrument has not incurred hidden damage.

2-6 POWER REQUIREMENTS

2-7 The instrument is shipped from the factory for operation from 115 or 230 volts AC 50/60 Hz. The internal operating input voltage range is selectable with a rear panel switch. When 115V is selected, the unit will operate at line voltages of 103 to 130 volts. When 230V is selected, the unit will operate at line voltages of 206 to 260 volts.

2-8 INSTALLATION

2-9 If the Model 2100 or Model 2101 is to be used in the bench top configuration, installation requires only that the line cord be connected to the wall receptacle and its other end inserted in the rear panel connector. A rear panel mounted fuse provides protection for the internal circuits.

2-10 If the unit is to be installed in a rack, assemble the Wattmeter into the rack mount adapter using the instructions included with the option. Then it is only necessary to locate the unit in the rack, install the screws that attach it and make the power source and load connections. The unit should be operated only in areas where the ambient temperature does not exceed 50°C. If the internal temperature of the rack mount, in which the unit is installed, will exceed this temperature limit, forced air cooling should be employed to maintain the ambient air at or below the 50°C limit.

SECTION III — OPERATION

3-1 INTRODUCTION

3-2 This section of the manual contains complete operating instructions for the Model 2100 and Model 2101 Digital Wattmeters.

3-3 FRONT PANEL CONTROLS AND INDICATORS

3-4 There are nine push-button controls on the front panel. Their functions are detailed in the following paragraphs.

3-5 POWER PUSH BUTTON

3-6 Power is applied to the unit by pressing the POWER push button. Application of power is indicated by lighting of the power and voltage/current digital displays. The first depression locks the push button in its ON position and applies power to the unit. When it is depressed a second time, it returns to its outer position and disconnects power from the unit.

3-7 AMPS/VOLTS DISPLAY SELECTORS

3-8 Display of amperes or volts on the righthand display is selected by depressing either the AMPS or VOLTS push button. The button remains in its depressed position until released by depressing the other button.

3-9 CURRENT RANGE SELECTORS

3-10 There are three current range selections that are made with the CURRENT push buttons. The push buttons are labeled .2, 2 and 20. The maximum current reading that may be displayed in each range is approximately .3500, 3.500 and 20.00, respectively. The selected push button remains locked in its depressed position until released by depressing another button in the CURRENT group.

3-11 VOLTAGE RANGE SELECTORS

3-12 There are three voltage range selections that are made with the VOLTAGE push buttons. The push buttons on the Model 2100 are labeled 150, 300 and 600. Those of the Model 2101 are labeled 30, 150 and 300. The maximum voltage that may be displayed in each range of the Model 2100 is 199.99, approximately 500.0 and 600.0, respectively. On the Model 2101 the voltages are approximately 50.00, 199.99 and 300.0. The selected push button remains locked in its depressed position until released by depressing another button in the VOLTAGE group.

3-13 PEAK- AMP OVERLOAD INDICATOR

3-14 If the peak or steady-state current to the measured load is greater than 250% of the range selected with the CURRENT push button, the PEAK AMP O/L indicator will be illuminated. Selecting the proper range or reducing the current to the load will extinguish the indicator. Do not rely on current or power indications if the indicator is illuminated.

3-15 PEAK- VOLT OVERLOAD INDICATOR

3-16 If the peak or steady-state voltage applied to the rear panel connectors is greater than 250% of the range selected with the VOLTAGE push button, the PEAK VOLT O/L indicator will be illuminated. Selecting the proper range or reducing the voltage will extinguish the LED. Do not rely on voltage and power indications if the indicator is illuminated.

3-17 VOLTS/AMPS DISPLAY

3-18 When VOLTS is selected, the righthand digital display will show the voltage applied to the rear panel connectors. Resolution is 0.01 volts when the 30 volt range (Model 2101 only) or 150 volt range is selected and the 0.1 volt resolution when the 300 volt range or 600 volt range (Model 2100 only) is selected. When AMPS is selected, the current supplied to the load will be displayed with resolution of 0.0001 ampere when the .2 ampere range is selected, 0.001 ampere when the 2 ampere range is selected and 0.01 ampere when the 20 ampere range is selected. The display will blink if the voltage or current is greater than that required for a display of 19999 (decimal omitted).

3-19 WATTMETER

3-20 The power dissipated in the load is indicated on the lefthand display. To obtain a valid

display of power (wattage) requires that the peak voltage and current to the load are within 250% of the voltage and current ranges selected with the front panel push buttons. If voltage or current exceed those levels, the respective PEAK indicator will be illuminated. These peak indications occur independently of whether AMPS or VOLTS has been selected for the righthand display. The correct action in either case is to select a higher range or, if the highest range has been selected and the PEAK indicator is still on, the voltage applied to and/or the current through the instrument must be reduced. This may require the use of external voltage dividers and/or current shunts. If external dividers or shunts are used, the power display will be a fraction of the actual load power. Simple ratio calculations will then reveal the power actually delivered to the load.

3-21 To obtain power readings with maximum resolution, select increasingly lower ranges of current and voltage until the PEAK indicators illuminate, then select the next highest range. Selecting current and/or voltage ranges shifts the decimal point within the power display. If the current and voltage to the load are within the current and voltage range of the instrument, the power reading will be accurate.

3-22 Under certain conditions, where complex waveforms are applied to the instrument and load, it may be necessary to select a current and/or voltage range that is well above the true RMS value indicated on the display in order to extinguish the PEAK indicator. This will reduce the resolution of the wattmeter reading, but is necessary for reading accuracy. The display will blink if the load power is greater than that required for a display of 19999 (decimal omitted).

3-23 REAR PANEL CONNECTIONS

3-24 The locations of the rear panel connections are shown in Figure 3-1. The function of the 115V/230V switch and power cord receptacle were covered in Section II. It is important to connect the load in accordance with the L (line) and N (neutral) indications on the rear panel if accurate measurements are to result.

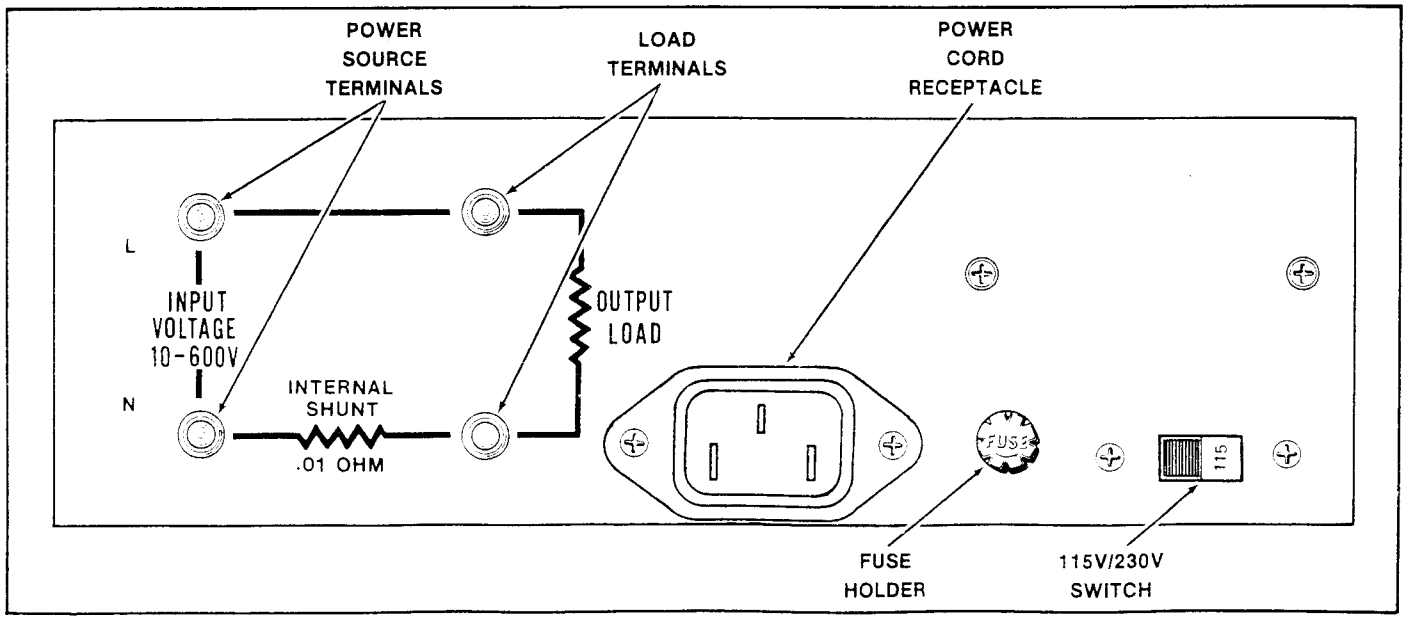


Figure 3-1. Rear Panel Connections.

SECTION IV — THEORY OF OPERATION

4-1 GENERAL

4-2 This section of the manual describes operation of the circuits of the Digital Wattmeters. A functional description is referenced to the block diagram of Figure 4-1 and is intended to assist the user in gaining a general understanding of instrument operation. The circuit descriptions are of a more detailed nature and are intended to acquaint the user with circuit operation to the degree necessary for logical troubleshooting. The information contained in this section, together with that of Section V, will provide the background necessary for maintenance of the instruments.

4-3 FUNCTIONAL DESCRIPTION

4-4 A block diagram of the Digital Wattmeters is shown in Figure 4-1. Power for the load under test is connected to one set of rear panel terminals and passes through the instrument to a second set of terminals to which the external load under test is connected. A 0.01 ohm current shunt is installed between one input terminal and one output terminal. The inputs to the voltage amplifier are connected to both power line terminals. The inputs to the three-stage current amplifier are connected across the current shunt.

4-5 The voltage amplifier gain is controlled by the voltage range switch so that it has a full-scale 5-volt output at the selected range. The gains of the three stages of the current amplifier are 25, 10 and 10, respectively. The outputs of each current amplifier stage are individually selected by the current range switch for the .2, 2 and 20 ampere ranges.

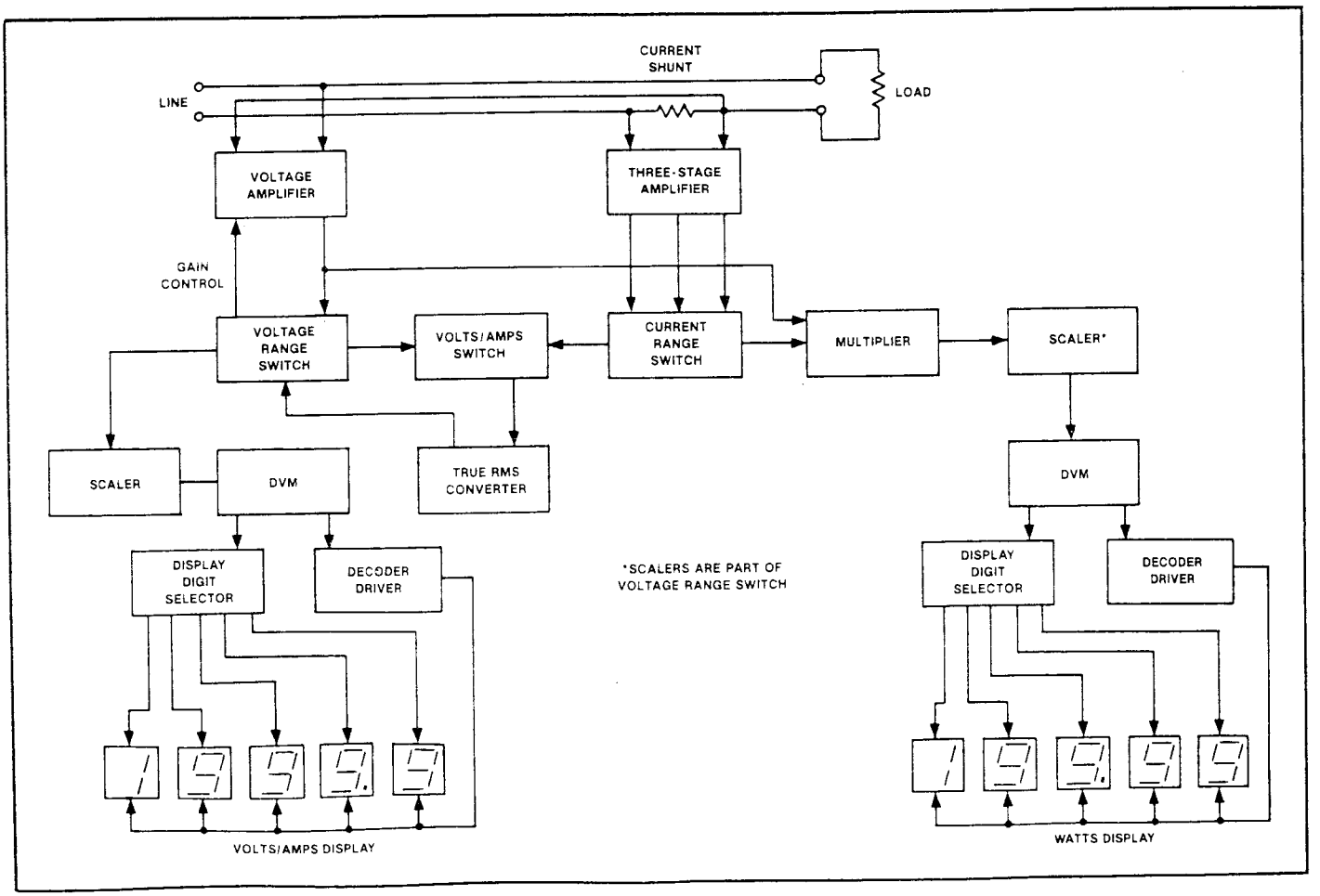


Figure 4-1. Block Diagram.

4-6 The signal applied to the true RMS converter is determined by the position of the amps/volts selector switch. Since the 5-volt full-scale output of the voltage amplifier is the same for the three ranges, the output of the RMS converter will be passed through the scaler when the voltage amplifier output is selected. The scale factor is controlled by the voltage range switch, which selects the correct voltage to be applied to the RMS converter. If a current amplifier output is selected, scaling is not required. However, the current range switch will place the decimal point of the display in the proper position for the selected range.

4-7 The DVM is a true dual slope, integrating digital voltmeter. The full-scale voltage applied to its input is 0.2 volts in the current ranges and 1.5, 0.3 and 0.6 volts in the three voltage ranges of the Model 2100 and 0.3, 1.5 and 0.3 volts for the ranges of the Model 2101. The voltage measured by the DVM is latched to its internal registers at the end of the measurement cycle. During the time of the next input measurement, each digit of the previously measured voltage is sequentially applied to the inputs of the decoder/driver. While the decoded data is present at the output of the decoder/driver, the display digit selector energizes the appropriate display digit. Thus, the display is multiplexed from a single BCD output of the DVM and at such a rate that it appears to be continuously illuminated.

4-8 The output of the voltage amplifier and the output of the current amplifier stage selected with the current range switch are applied to individual inputs of the power converter which is a multiplier circuit. The output of the power converter is passed through a scaler which is controlled by the voltage range switch. Again, scaling is necessary since the full-scale output of the voltage amplifier is the same on all ranges. The DVM which follows the scaler is identical to that used for the amps/volts display. However, its decimal point has only two positions and these are controlled by the voltage range switch.

4-9 CIRCUIT DESCRIPTIONS

4-10 To supplement the overview provided by the preceding functional description, this section describes the operation of each circuit. The reference designators used in this section are those of the schematic diagram of the Model 2100, Figure 5-5. The schematic of the Model 2101, shown in Figure 5-6, is slightly different, but the principles are the same. The individual circuits of a multiple-circuit device are identified by the device designator followed by a suffix number corresponding to the output pin number. For example, the amplifier of IC7 that has its output connected to pin 1 is identified as IC7-1.

4-11 POWER SUPPLY

4-12 The power supply schematic is located in the lower left area of Figure 5-5. S1 is the front panel push button switch that connects one side of the power line to one end of the primary windings of transformer T1. The other end of the primary windings is permanently connected to the other side of the line. T1 has two primary windings that are connected in parallel by S10 for operation on 115 volts and in series for operation on 230 volts.

4-13 The voltage across one secondary winding of T1 is rectified by D1 and D3 and filtered by C18 to provide + 5 volts to the display driver transistors TR1 through TR5 and TR8 through TR12, and to IC21. The other secondary is rectified by D6 and D7 to provide a positive DC input to voltage regulator IC11 which develops + 15 volts at its output. The same secondary is also rectified by D4 and D5 to provide the negative DC input to voltage regulator IC12 which develops – 15 volts at its output. These voltages power the devices that are not connected to the + 5-volt supply.

4-14 It should be noted that the neutral input terminal is connected to the internal common bus (ground). T1 provides isolation between the common bus and the power line. The plastic case and other insulators isolate the operator from the input terminals. However, when the unit is opened for service, personnel should verify that the neutral terminal is at the same potential as the power line ground. If it is connected to a high potential, serious injury could befall personnel if they come in contact with the internal circuits. This precautionary note is repeated in the maintenance section of this manual, but with greater emphasis.

4-15 VOLTAGE AMPLIFIER AND SCALING

4-16 The neutral line of the input (measured) voltage source is connected to the common internal bus (ground). The other line is connected to the input of the voltmeter amplifier circuit through a 600K ohm resistor, R1, on the rear panel assembly.

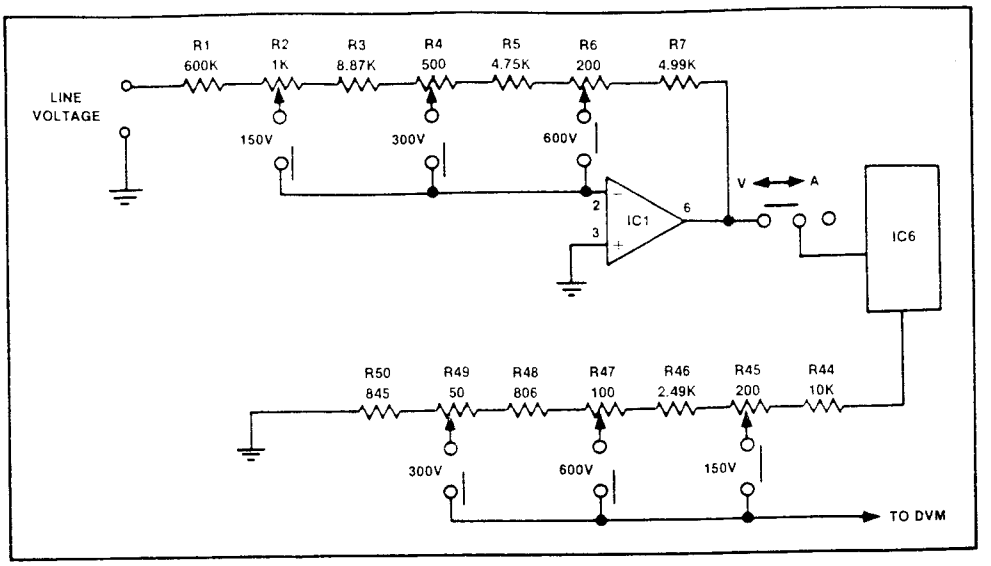


Figure 4-2. Simplified Circuit Diagram, Voltage Amplifier, Model 2100.

Refer to Figure 4-2. This is a simplified diagram of the circuit of operational amplifier IC1 and RMS voltage converter IC3. The three switches connected to the input of IC1 are sections of the voltage range selector. The number adjacent to each switch indicates the selected range for which it is closed. The gain of IC1 is determined by the closed section of the switch which selects the resistance value for the feedback loop of IC1. R2, R4 and R6 provide fine adjustments of gain in each range. The output of IC1 for a full-scale input (150, 300 or 600 volts) is 5 volts. R8 provides the offset adjustment for IC1.

4-17 The output of IC1 passes through another switch, S5B, which selects the output of the voltage or current amplifiers as an input to IC6. When the VOLTS mode is selected, the output of IC6 is a DC voltage directly proportional to the RMS value of the input voltage and will be 5 volts full-scale. It appears across the voltage divider comprised of R44 through R50. The switches connected to the arms of the potentiometers in this voltage divider are other sections of the range switch that close simultaneously with those in the feedback circuit of IC1. The output of IC6 is scaled down through the divider to 0.6 volts for the 600 volt range, 0.3 volts for the 300 volt range and 1.5 volts for the 150 volt range with the potentiometers providing the fine calibration adjustments.

4-18 CURRENT AMPLIFIERS AND SCALING

4-19 The source of the signal for the current meter is a 0.01 ohm shunt resistor, R61, through

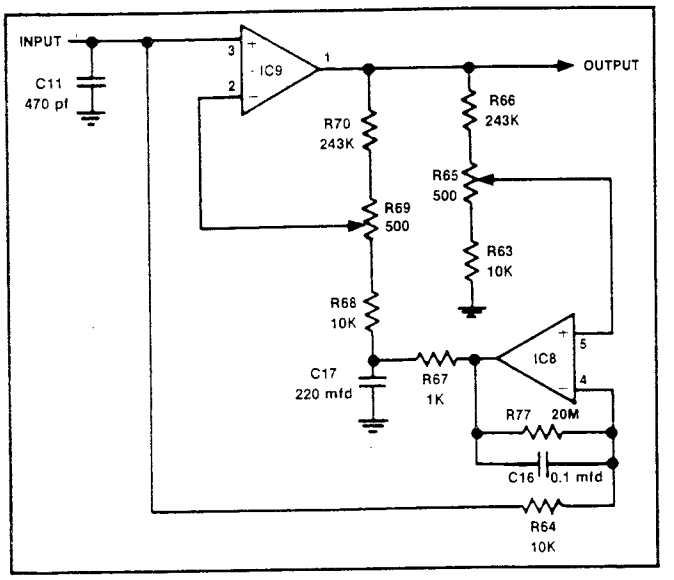


Figure 4-3. Simplified Circuit Diagram, Current Input Amplifier.

which the load current flows. The resistance of R61 is very low so as to have minimal effect on the voltage applied to the load. Therefore, the signal developed across R61 must be greatly amplified, especially in the lowest current range. The current signal amplifiers are shown in Figure 5-5. A simplified diagram of the input current amplifier is shown in Figure 4-3. The minimum full-scale voltage developed across R61 is only 2 millivolts. Therefore, the input amplifier must remain stable at DC and from 40 Hz through 5 KHz. Operational amplifier IC9-1 and chopper-stabilized amplifier

IC8 operate in concert to achieve the required stability.

4-20 Any offset appearing at the output of IC9-1 is reduced by a factor of 25 at the arm of R65 where it is applied to the non-inverting input of IC8. Thus, a differential exists between the two inputs of IC8. An offset is then produced at the output of IC8 that places a charge on C17 of a polarity that drives the output of IC9-1 toward zero. The gain of IC8 is 200 and its output is integrated by R67 and C17 which eliminates any tendency toward oscillation. Therefore, the system finally finds a point of equilibrium where the offset at IC9-1 has been reduced to a negligible level.

4-21 IC9-1 has a gain of 25 and the amplifiers that follow, IC9-7 and IC10-6, have a constant gain of 10 when properly adjusted with R74 and R85. The outputs of IC9-1, IC9-7 and IC10-6 are each connected to one contact of the CURRENT switch. The other contact is connected to its counterparts so that the selected output is applied to the true RMS converter, IC6, when AMPS is selected with the VOLTS/TRUE RMS/AMPS. A 200 millivolt input to IC9-1 will produce a level at its output of 5 volts. A 20 millivolt input will produce 5 volts at the output of IC9-7 and 2 millivolts will produce 5 volts at the output of IC10-6. Thus, the full-scale voltage applied to the true RMS converter in any range is 5 volts.

4-22 The output of the true RMS converter appears across the divider comprised of R51, R52 and R53. The potential at the arm of R52 is 200 millivolts and is applied to the amps/volts DVM, IC20, through a section of the VOLTS/TRUE RMS/AMPS switch when AMPS is selected.

4-23 PEAK DETECTOR/INDICATORS

4-24 When the voltage applied to the rear panel terminals exceeds the selected voltage range, the peak voltage indicator is caused to light. This signals that the displayed voltage and power value may not be accurate. An identical circuit provides a visual signal when the current to the load exceeds the selected current range. The peak detectors provide their visual signals irrespective of whether AMPS or VOLTS has been selected for display.

4-25 The voltage peak detector is comprised of comparators IC2-1, IC2-2 and IC2-13. Their circuit is shown in the upper area of Figure 5-5. The reference voltage at the inverting input of IC2-1 is at -12 volts, which is derived from the divider comprised of R11 and R12. The non-inverting input is connected to the output of the voltage amplifier, IC1-6. The non-inverting input of IC2-2 is at $+12$ volts which is derived from the divider comprised of R9 and R10. Its inverting input is also connected to the output of IC1-6. With zero volts applied to the input, the outputs of both comparators are high ($+15$ volts). Since the inverting input of IC2-13 is at ground potential, its output will be high, back-biasing voltage peak indicator DS2 and holding it out of conduction.

4-26 When the input voltage (either peak or steady-state) exceeds $+12$ volts, the output of IC2-1 will transition to -15 volts, causing the output of IC2-13 to transition to -15 volts, turning on DS2. When the input voltage exceeds -12 volts, the output of IC2-2 and IC2-13 will transition to -15 volts to turn on DS2. An integrating capacitor, C1 holds the output of IC2-13 at a low state between peaks so that DS2 is continuously illuminated until the input to IC2-13 is increased above its transition level.

4-27 An identical circuit for the current peak detector/indicator is comprised of IC7-1, IC7-2, IC7-13 and associated components. The input to this detector is from the CURRENT range switch which connects it to the output of the selected current signal amplifier.

4-28 DIGITAL VOLTMETERS

4-29 There are two near-identical digital voltmeter (DVM) circuits. One, shown in the lower right area of Figure 5-5, drives the AMPS/VOLTS display. The other, shown in the upper right area, drives the WATTS display. Most of the amps/volts DVM circuitry is contained in two special devices, IC19 and IC20, which comprise a dual-slope integrating voltmeter. The analog circuits are contained in IC19 and the digital circuits in IC20. The circuit of the watts DVM is comprised of IC17 and IC16 and associated components. Only the circuit of IC19 and IC20 is discussed in the following paragraphs.

4-30 A dual-slope integrating voltmeter has three cycles. Timing of these cycles is controlled by a crystal oscillator, IC21, which operates at 100 KHz. The first cycle is auto-zero which nulls out any offsets. The next integrates the input for a precise time (10,000 counts of the oscillator). In the pro-

cess, it charges a capacitor to a level proportional to the input voltage. In the third cycle, a fixed level reference voltage of reverse polarity is applied to the integrator. The time required for the integrator to discharge its capacitor back to zero in this cycle is determined by counting the oscillator pulses. This count is an accurate measurement of the input voltage. The reference cycle count is displayed as the measured voltage.

4-31 Auto Zero

4-32 IC19 contains an integrator and a comparator. During the auto-zero cycle, a switch internal to IC20, which is connected between its pins 16 and 17, connects the output of the comparator at pin 2 of IC19 to the input of the integrator at pin 12 of IC19. This charges auto-zero capacitor C33. The auto-zero cycle time is sufficient to completely charge the capacitor and zero the output of the integrator. The capacitor will hold its charge during the next two periods. The input reference capacitor, C34, is also charged to a reference level during this period.

4-33 Input Integration

4-34 The output of true RMS converter IC6 is connected to pin 10 of IC20 through a scaling voltage divider that is part of the voltage range switch. During the input integration period, a switch internal to IC20 connects pin 10 to pin 9 and to the input of the integrator of IC19. C32 is the integrator capacitor. At the end of the input integration period, C32 is charged to a level proportional to the input voltage. At the same time, the polarity of the input is latched in IC20.

4-35 Reference Integration

4-36 At the beginning of the second integration period, the switches in IC20 will select the reference voltage at its pin 7. This reference is obtained from pin 6 of IC16, in the watts DVM circuit, through R98, R99 and R107. R107 provides a fine adjustment of the reference input. The reference is applied to the integrator to return its output to zero. During this integration period, the crystal oscillator drives a multi-stage counter. When the integrator output crosses zero, counting is terminated. The number of counts required to integrate the reference to zero, which is stored in the counter, is precisely proportional to the input voltage.

4-37 Amps/Volts Display

4-38 The reference integration counts, which are accumulated in an internal counter of IC20, are latched into a multiplexer, also internal to IC20, at the end of the count period. During the next series of auto-zero and integration periods, each digit of the counts latched into the multiplexer are sequentially placed on the BCD outputs of IC20 and on the inputs of decoder/driver IC18. While the most significant digit data is applied to IC18, transistor TR8 is turned on by IC20 to provide the anode voltage for DS8. When the next digit data is applied to IC18, TR8 is turned off and TR9 is turned on to provide the anode voltage for DS9. The sequence is continued for TR10/DS10, TR11/DS11 and TR12/DS12 and then repeated. The repetition rate is fairly high so that all digits appear to be continuously illuminated.

4-39 Decimal Point Positioning

4-40 The decimal points in the AMPS/VOLTS display are positioned by the VOLTAGE switch when the VOLTS function is selected. Pin 6 of the display device is the decimal input. In the 150-volt range, pin 6 of DS10 is grounded through contacts of the CURRENT switch so that the resolution is 0.01 volts. In the 300- and 600-volt ranges, pin 6 of DS11 is grounded and the resolution is 0.1 volts. When the AMPS function and the 0.2 range are selected, pin 6 of DS9 is grounded and the reading resolution is 0.0001 amperes. Pin 6 of DS10 is grounded in the 2 ampere range for a display resolution of 0.001 amperes. For the 20 ampere range, display resolution is 0.01 amperes, since pin 6 of DS11 is grounded. Note that the path to ground is through the switch and 100-ohm resistor R54.

4-41 The decimal points of the watts display are controlled only by the CURRENT range switch. Pin 6 of DS6 is grounded in the .2 ampere range for a display resolution of 0.01 watts. In the 2 ampere range, pin 6 of DS7 is grounded for resolution of 0.1 watts. No decimal point is displayed in the 20 ampere range. Note that the watts display decimal points are grounded through the current switch and 100-ohm resistor R87.

4-42 ANALOG MULTIPLIER

4-43 Analog multiplier IC3 receives the output of voltage amplifier IC1-6 and the output of either IC9-1, IC9-7 or IC10-6, depending on the selected current range.

4-44 The output current from IC3 is proportional to the product of the signals at its two inputs. This output current is converted to a voltage by IC4-6.

4-45 The analog multiplier (IC3) is direct coupled and is, therefore, subject to DC shift at its output due to temperature changes. To correct for this shift, an auto zero circuit is used. It consists of IC5, the switches of IC13 and IC14 and associated components. The switch drivers are shown in the upper right area of Figure 5-5. Each of the eight switch drivers is identified by an alpha character. The switch sections are shown in a manner that simplifies the diagram and facilitates the understanding of circuit operation. Each switch section in the main part of the diagram is identified with the same alpha character as its driver. The circuit switches the two inputs to the multiplier to zero and measures the offset voltage output at IC4-6. IC5 amplifies the offset voltage and charges C4 to a voltage that will drive IC4-6 to zero. The inputs to the multiplier are then switched back to the signal source. This sequence occurs during every auto-zero cycle.

4-46 MODEL 2101 CIRCUIT

4-47 The Model 2100 and Model 2101 circuits are nearly identical and are assembled on identical circuit boards. The principal differences between them are 1) Some resistors installed in the Model 2100 are not installed in the 2101, 2) The values of a number resistors are different, 3) There are some minor switch wiring changes and 4) NAND gates IC22 and IC23 are installed only in the Model 2101. The resistor and wiring changes do not require detailed descriptions. The purpose of IC22 and IC23, which are shown in Figure 5-6, is to control the display decimal points. Note that the decimal point of DS5 is used in the Model 2101 to increase the resolution of the display in the lowest current and power ranges. This requires that the decimal point illumination of the display be controlled by the VOLTAGE and AMPS range switches. This is accomplished through the NAND gates of IC22 and IC23.

SECTION V MAINTENANCE

5-1 INTRODUCTION

5-2 This section provides maintenance information for the Model 2100 and Model 2101 Digital Wattmeters. Included are a recommended test equipment list and calibration procedures.

5-3 RECOMMENDED TEST EQUIPMENT

5-4-1 Reference DC Voltage Standard (Valhalla Scientific Model 2701B or equivalent). Two required.
5-4-2 Reference AC Voltage Standard (Valhalla Scientific Model 2703 and 2705 Wattmeter Calibration System or equivalent). One required.
5-4-3 Reference AC-DC Current Calibrator (Valhalla 2500E or equivalent). One required.

5-5 CALIBRATION PROCEDURES

5-6 The following procedures should be performed at routine intervals to insure that the Digital Wattmeters remain within specified limits. In addition, calibration should be performed whenever repairs have been completed involving accuracy-determining components.

5-7 Remove the top cover from the unit to gain access to the internal adjustments.

5-8 Apply power to the Digital Wattmeter and to the test equipment, and allow approximately thirty minutes for stabilization.

5-9 MODEL 2100 PROCEDURE

5-10 The following procedure applies only to the Model 2100. Refer to paragraph 5-21 for the Model 2101 procedure.

5-11 Connect the positive terminal of the DVM to pin 7 of IC20 and the negative terminal to analog ground. Adjust R100 if necessary for a DVM reading of +1.000 Volts.

5-12 Connect the positive terminal of the DVM to pin 7 of IC17 and the negative terminal to analog ground. Adjust R107 if necessary for a DVM reading of +1.000 volts.

CAUTION

The neutral input terminal is connected to the internal common bus (ground). Transformer T1 provides isolation between the common bus and the power line, and the plastic case and other insulators isolate the operator from the input terminals when the cover is in place. However, when the unit is opened for service, verify that the neutral terminal is at the same potential as the power line ground. If connected to a high potential and internal circuitry is contacted, SERIOUS INJURY MAY RESULT.

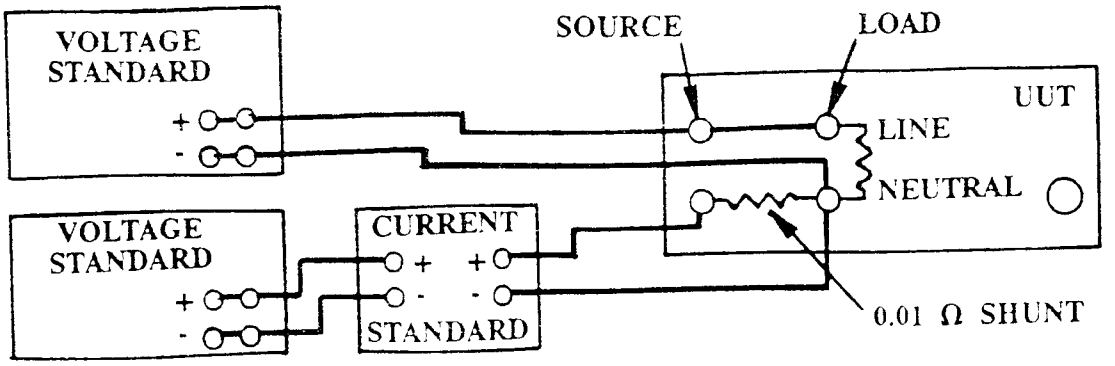


Figure 5-1. Calibration Equipment Connections

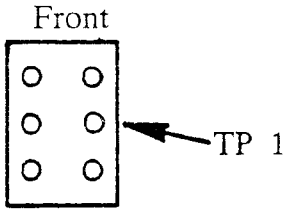
Table 5-1. Model 2100 Voltage Adjustments

	Range	DC Voltage Calibrator Output	Adjust	TP1 DVM Reading	Adjust	2100 Display Reading
1.	150	10.00 VDC	-	-	R8*	10.00
2.	150	150.00 VDC	R2	-5.000 VDC	R45	150.00
3.	300	300.00 VDC	R4	-5.000 VDC	R49	300.00
4.	600	600.00 VDC	R6	-5.000 VDC	R47	600.00
5.	150	150.00 VDC	Reduce for Current Range Calibrations			

* Alternate input polarity and adjust R8 for the same reading at both polarities.

5-13 Connect the 2100 to Reference Standards per Table 5-1. Perform the adjustments listed in Table 5-1. Also note location of TP 1 in Figure 5-1, Select Volts Display.

5-14 Perform the adjustments in Table 5-2. Select the Amps display.



Switch S5 (Amps)
Figure 5-2. TP 1 Location

Table 5-2. Model 2100 Current Adjustments

	Range	DC Current Calibration Output	Adjust	2100 Current Display
1.	20A	10.0000 ADC	R65	-2.500 at TP 1
2.	20A	10.0000 ADC	R52	Adjust R52 for 10.00 reading on display.
3.	2A	1.0000 ADC	R71	Alternate + and - polarity and balance for same reading on display.
4.	2A	1.0000 ADC	R74	1.000
5.	0.2A	0.10000 ADC	R83	Alternate + and - polarity and balance for same reading on display.
6.	0.2A	0.10000 ADC	R85	.1000

5-15 Select the 2 Amp, 600 volt range. Apply 1 Amp and reduce the input voltage to zero. Alternate the input current polarity and adjust R29 for the same reading at both polarities. Adjust R43 for 000.0 on the Watts display (300 volt range on the 2101).

5-16 Reduce the input current to zero (600 volt range). Apply 150 volts, alternate the input voltage polarity, and adjust R28 for the same reading at

both polarities. The balance reading should be ± 3 digits from 000.0. If reading is not within the specified limits, adjust R43 for a reading of 000.0, then repeat step 5-15.

5-17 Select the 1 Amp range and the 600 volt range. Apply 1 amp and 600 volts to the 2100. Adjust R36 for a reading of 600.0 on the Watts display. Reverse the current and volts polarity and adjust R36 for the same reading at both polarities.

5-18 Reduce the input voltage to 150 VDC (600 volt range) and verify linearity.

5-19 Select the 300 volt range and increase the input voltage to 300.0 volts. Adjust R34 for 300.0 on the Watts display. Reverse the input voltage and current polarity, and adjust R34 for a balance between both polarities.

5-20 Reduce the input voltage to 150 VDC and select the 150 volt range on the 2100. Adjust R32 for 150.0 on the watts display. Reverse the input voltage and current polarity, and adjust R32 for a balance between both polarities.

5-21 Replace the DC voltage standards illustrated in Figure 5-1 with the AC Wattmeter Calibration System (Valhalla 2703 Master, 2705 Slave). Select the 150 watt and the 20 Amp ranges.

5-22 Apply 150 volts AC and 10 amps AC (100 Hz) with a zero phase difference. Adjust R69 for 10.00 on the current display.

5-23 Verify that all volts, current, and watts ranges are within specifications. If the 2703/2705 Wattmeter Calibration System is used, verify the power factor response at 90, 120, 180 and 240.

5-24 MODEL 2101 CALIBRATION PROCEDURE

5-25 The Model 2101 is calibrated the same as the 2100 with the following exceptions:

5-25-1 Table 5-3 is substituted for Table 5-1.

5-25-2 Paragraph 5-17 is deleted.

5-26 Verify 30 watts full scale (1 amp = 30.00 volts).

Table 5-3. Model 2101 Voltage Adjustments

	Range	DC Voltage Calibrator Output	Adjust	TP1 DVM Reading	Adjust	2100 Display Reading
1.	150	10.00 VDC	-	-	R8*	10.00
2.	30	30.00 VDC	R2	-5.000 VDC	-	-
3.	150	150.00 VDC	R4	-5.000 VDC	R45*	150.00
4.	300	300.00 VDC	R6	-5.000 VDC	R49+*	300.00
5.	150	150.00 VDC	Reduce for Current Range Calibrations			

* Alternate input polarity and adjust for the same reading at both polarities.
\+ The 30 volt and 300 volt ranges are adjusted using R49.

USING THE 2100 DIGITAL POWER ANALYZER WITH CURRENT AND POTENTIAL TRANSFORMERS

The current and voltage ranges of the 2100 may be extended using current and potential transformers. Current Transformers (CT's) are used to extend the current range of the 2100. CT's are available in many division ratios eg. 1000:1, 100:1, 10:1, 1:1. When using a CT with the 2100 the operator must multiply the current and power readings by the ratio of the CT used. The bandwidth and ratio accuracy of the CT will affect the overall current and power measurement accuracy. The CT connections are shown in figure 1.

Potential Transformers (PT's) are used to extend the voltage range of the 2100. PT's are available in many division ratios eg. 10:1, 100:1, 1000:1. When using a PT with the 2100 the operator must multiply the voltage and power readings by the ratio of the PT used. The bandwidth and ratio accuracy of the PT will affect the overall voltage and power measurement accuracy. The PT connections are shown in figure 2.

When measuring high voltages with the 2100 do not exceed the 1500 volt common mode specification. Use both a CT and PT to isolate the 2100 from the high voltage source. The PT-CT connections are shown in figure 3.

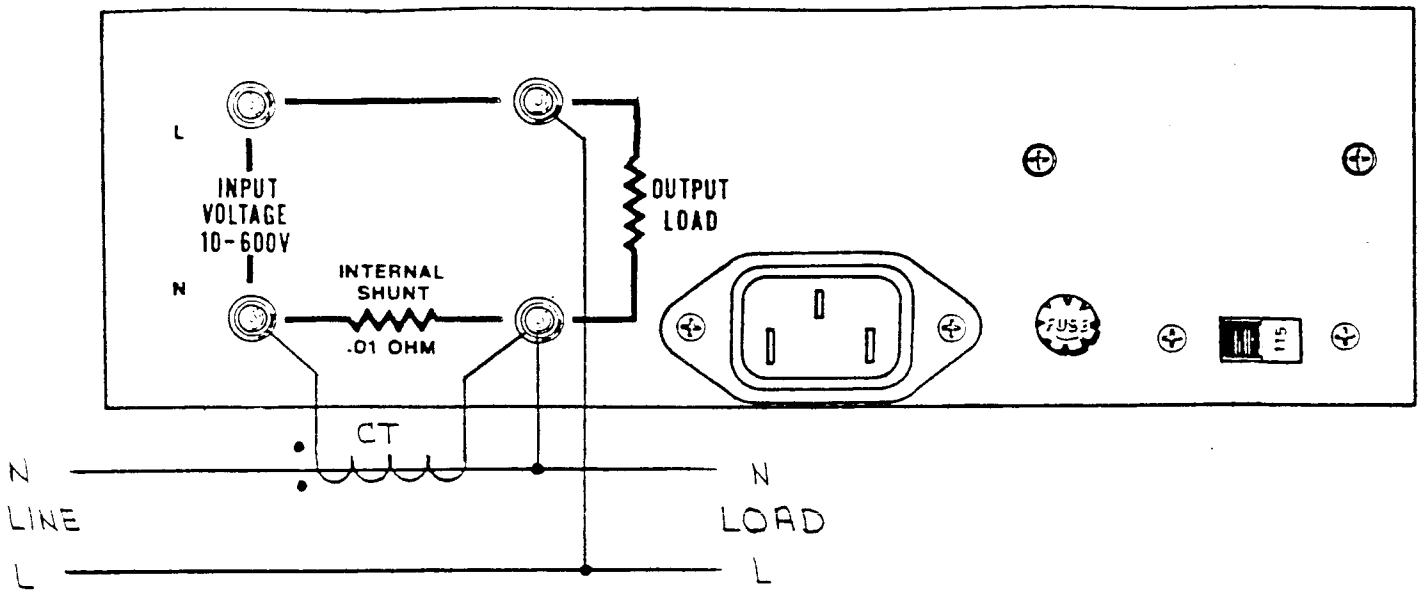


FIGURE 1 CT CONNECTIONS

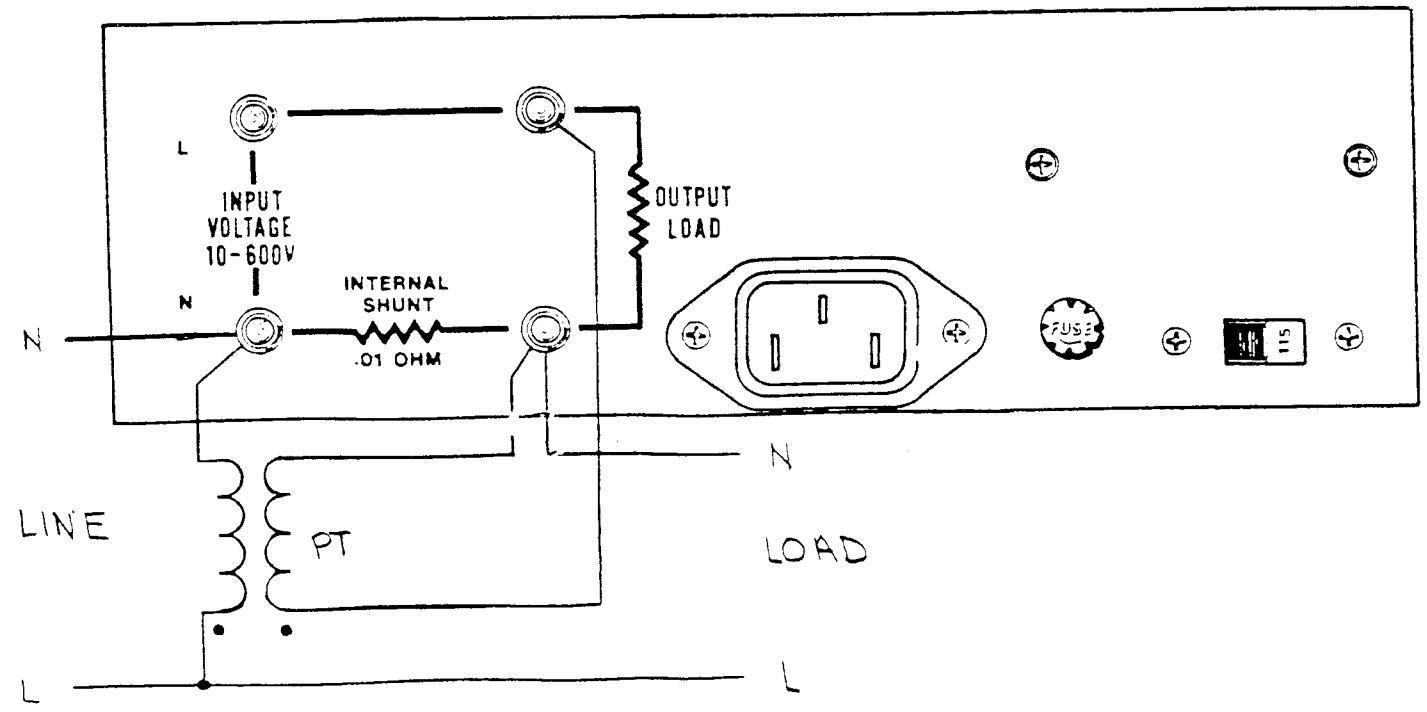


FIGURE 2 PT CONNECTIONS

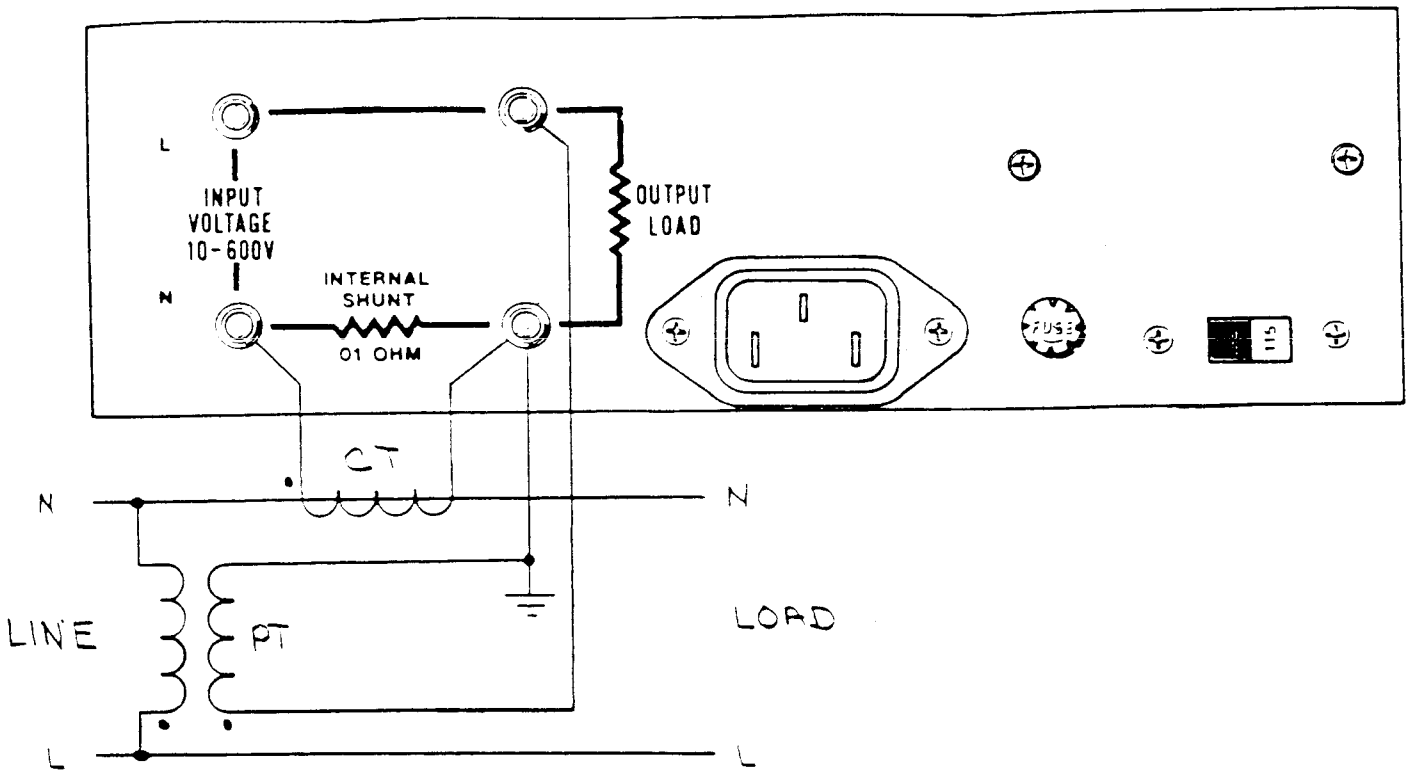


FIGURE 3 CT-PT CONNECTIONS

REF.DES.	STOCK #	QUANTITY A T N	DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
4	90-04200	2	#4-40 x 3/8" Phil Pan Black		
6	80-01222	96	22awg Wire, Red PVC		
7	80-01422	96	22awg Wire, Yellow PVC		
8	70-00002	24	1/8" Black Shrink Tubing		
J6	05-10257	1	Connector, female, 25 way, D	Cannon DBE25S	

Valhalla Scientific Inc.

PARTS LIST

PCB ASSY- MAIN BD | MODEL 2100/2101 | DWG NO 2100-600 | REV T

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
24	IC1,4,5,10	3-30090	OP. AMP		LF356N	4					
25	IC2,7	3-30133	QUAD COMPARATOR		LM339N	2					
26	IC3	3-30091	MULTIPLIER		RC4200ANB	1					
27	IC6	3-30045	RMS CONVERTER		AD536JH	1					
28	IC8	3-30111	OP. AMP		ICL7650	1					
29	IC9	3-30134	OP. AMP		NE5532N	1					
30	IC11	3-30036	+15V REGULATOR		78M15C	1					
31	IC12	3-30037	-15V REGULATOR		79M15C	1					
32	IC13,14	3-30144	QUAD SWITCH, LF13333N		LF13333N	2					
33	IC15,18	3-30106	BCD TO 7 DECODER		74LS47N	2					
34	IC16,19	3-30113	ANALOG VOLTMETER		ICL8068ACPD	2					
35	IC17,20	3-30114	DIGITAL VOLTMETER		ICL7107C035CPI	2					
36	IC21	5-02007	OSCILLATOR, 100KHZ		PX01000KHZ-A	1					
37											
38											
39											
40	R65,69	1-50029	POT, 500Ω		68WR-500	2					
41	R45	1-50037	POT, 200Ω		68WR-200	1					
42	R8,28,29,43,71,83,117	1-50028	POT, 50K		68WR-50K	7					
43	R32,34,49,52,62,74,85	1-50033	POT, 50Ω		68WR-50	7					
44	R100,107	1-50014	POT, 100Ω		68WR-100	2					
45	R39	1-50012	POT, 10KΩ		68WR-10K	1					
46	R35	1-10066	1.5K, 1%, 1/4W, METAL FILM		RN60C1501F	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	PCB ASSY- MAIN BD.	MODEL 2100/2101	DWG NO 2100-600	REV T

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
47	R9,12,55,58	1-01047	RES., 2.4K, 1/4W, 5%		RC07GF242J	4					
48	R10,11,56,57,64, 67,94,103	1-01061	RES., 10K, 1/4W, 5%		RC07GF103J	8					
49	R13,59,95,104	1-01085	RES., 200K, 1/4W, 5%		RC07GF204J	4					
50	R14,60	1-01054	RES., 5.1K, 1/4W, 5%		RC07GF512J	2					
51	R15-21,30	1-10049	RES., 100K, .1%		RN60C1003B	8					
52	R22,23,93,102	1-01073	RES., 47K, 1/4W, 5%		RC07GF473J	4					
53	R24,25	1-01083	RES., 150K, 1/4W, 5%		RC07GF154J	2					
54	R26,27,41,78-81, 89,90	1-01041	RES., 1K, 1/4W, 5%		RC07GF102J	9					
55	R31	1-10140	RES., 768Ω, 1%		RN60C7680F	1					
56	R33	1-10131	RES., 750Ω, 1%		RN60C7500F	1					
57	R38	1-10150	RES., 68.1K, 1%		RN60C6812F	1					
58	R40	1-01100	RES., 1M, 1/4W, 5%		RC07GF105J	1					
59	R42	1-01081	RES., 100K, 1/4W, 5%		RC07GF104J	1					
60	R 63,68	1-10008	RES., 10K, 1%		RN60C1002F	2					
61	R46	1-10083	RES., 2.49K, 1%		RN60C2491F	1					
62	R48	1-10127	RES., 806Ω, 1%		RN60C8060F	1					
63	R50	1-10133	RES., 845Ω, 1%		RN60C8450F	1					
64	R51	1-10224	RES., 24.3K, 1%		RN60C2432F	1					
65	R53,75,84	1-10001	RES., 1K, 1%		RN60C1001F	3					
66	R66,70	1-10015	RES., 243K, 1%		RN60C2433F	2					
67	R72,82	1-01040	RES., 910Ω, 1/4W, 5%		RC07GF911J	2					
68	R74,86	1-10017	RES., 9.09K, 1%		RN60C9091F	2					
69	R77	1-01123	RES., 20M, 1/4W, 5%		RC07GF206J	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	PCB ASSY-MAIN BD	MODEL 2100/2101	DWG NO 2100-600	REV T

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
70	R54, 87, 91	1-01021	RES., 100Ω, 1/4 W, 5%		RC07GF101J	3					
71	R92	1-01053	RES., 4.7K, 1/4W, 5%		RC07GF472J	1					
72	R96, 105	1-01070	RES., 33K, 1/4 W, 5%		RC07GF333J	2					
73	R88, 97, 106	1-01086	RES, 220K, 1/4 W, 5%		RC07GF224J	3					
74	R98	1-10193	453, 1%, 1/4W		RN60C453OF	1					
75	R99		RES., 0-1K, 1%		RN60C	1					FAC. SEL.
76	R101, 108	1-10078	RES., 2K, 1%		RN60C2001F	2					
77	R73	1-01102	RES., 1.5M, 1/4 W, 5%		RC07GF155J	1					
78	R118	1-01093	470K, 5%, 1/4W, CARBON FILM		RC07GF474J	1					ECR#1076
79	RN1, 2	1-40002	RES. NETWORK, 100Ω		316B-101	2					
80	R119	1-10085	249, 1% 1/4W, METAL FILM		RN60C2490F	1					ECR#1076
81	R44	1-10099	RES. 10.2K. 1%		RN60C1022F	1					
82											
83											
84											
85											
86											
87											
88											
89											
90											
91											
92											

NOTES:

Valhalla Scientific Inc.

PARTS LIST

PCB ASSY-MAIN 5D | MODEL 2100/2101 | DWG NO 2100-600 | REV T

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
93											
94											
95	S1	5-03003	SWITCH, DPDT, LATCHING			1					
96	S2-9	5-03058	SWITCH, MULTIPLE STATION		2KB1026000XXX	1					
97	——	——	PUSH BUTTON, SILVER	——	SUPPLIED W/SWITCH	9					
98											
99											
100	TR1-5, 7-13	3-10013	TRANSISTOR, NPN		2N4401	12					
101	TR6	3-10010	TRANSISTOR, PNP		2N4402	1					
102											
103		5-10007	TERMINAL		2014A	1					
104											
105		4-10334	SHIELD, PCB		2100-212	1					
106										NOV 11	1988
107		5-10276	SPACER, 1/4 HEX, 1/2 LG		4016	3					
108		5-10086	GND. LUG		1412-6	1					
109		5-10657	CONNECTOR SPACER .30 ID x .125 OD	BIVAR	939-065	16					
110			SCREW, PAN PHIL		6-32 X 5/16	3					
111											
112			22 AWG, BLK, 3"			3"					
113											
114											
115											

SHT 6 OF 6

NOTES:

Valhalla Scientific Inc.	PARTS LIST	Display PCB Assy.	MODEL 2100/2101	DWG NO 2100-601	REV A

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY. I	QTY. N	I	N		REMARKS
1											
2	1 ea,	4-30071	Display PCB	53504	2100-701	1					
3											
4	DS1, 2	5-01011	LED, Red, Large	28480	5082-4655	2					
5	DS3, 8	5-01020	Display, High Eff., ±1	28480	5082-7656	2					
6	DS4-7, 9-12	5-01010	Display-High Eff.,7seg.	28480	5082-7650	8					

NOTES:

Federal Supply Codes for Manufacturers (cont.)

18612
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18720
R.C.A.
Mountaintop, Pennsylvania

18927
GTE Sylvania Inc.
Titusville, Pennsylvania

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23936
Pamotor Div.
Burlingham, California

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Slatersville, Rhode Island

25684
Victoreen Instrument Co., Inc.
Oak Lawn, Illinois

27014
National Semiconductor Corp.
Santa Clara, California

27556
IMB Electronic Products
Santa Fe Springs, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
St. Paul, Minnesota

28480
Hewlett Packard Co.
Palo Alto, California

29083
Monsanto Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

30983
Electra/Midland
San Diego, California

32539
Mura Corp.
Great Neck, New York

32897
Erie Technological Products, Inc.
Carlisle, Pennsylvania

32997
Bourns Inc.
Riverside, California

33173
General Electric Co.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

43543
Nytronics Inc.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

53504
Valhalla Scientific, Inc.
San Diego, California

54294
Cutler-Hammer Inc.
Selma, North Carolina

55026
Simpson Electric Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

65092
Weston Instruments Inc.
Newark, New Jersey

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71279
Cambridge Thermionic Corp.
Cambridge, Massachusetts

71400
Bussmann Mfg.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Brooklyn, New York

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73445
Amperex Electronic Corp.
Hicksville, New York

73734
Federal Screw Products, Inc.
Chicago, Illinois

73899
JFD Electronics Co.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74276
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76055
Mallory Controls
Frankfort, Indiana

76493
J.W. Miller Company
Los Angeles, California

76854
Oak Industries Inc.
Crystal Lake, Illinois

77342
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp.
Cleveland, Ohio

80031
Electro-Midland Corp.
Mepco Div.
Norristown, New Jersey

56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc. Instrument Div.
Riverside, California

81073
Grayhill Inc.
La Grange, Illinois

Federal Supply Codes for Manufacturers (cont.)

81[illegible]
Triad Transformer Corp
Venice, California

81312
Winchester Electronics
Div. of Litton Industries Inc
Oakville, Connecticut

81483
International Rectifier Corp
Los Angeles, California

81741
Chicago Lock Co
Chicago, Illinois

82389
Switchcraft Inc
Chicago, Illinois

82877
Rotron Inc
Woodstock, New York

82879
ITT Royal Electric Div
Pawtucket, Rhode Island

83003
Varo Inc
Garland, Texas

83298
Bendix Corp
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83594
Burroughs Corp
Plainfield, New Jersey

83740
Union Carbide Corp
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
Ogallala, Nebraska

84613
Fuse Indicator Corp
Rockville, Maryland

84682
Essex International Inc
Peabody, Massachusetts

86684
Radio Corp. of America
Harrison, New Jersey

86928
Gould Inc
Trenton, New Jersey

88245
Litton Systems Inc
Usecs Div
Van Nuys, California

88418
Sprague Dubilier Electronic Div
Formerly Varian, North Carolina

89730
G E Co
Newark, New Jersey

90201
Mallory Capacitor Co
Indianapolis, Indiana

56365
Square D Co
Chicago, Illinois

90303
Mallory Battery Co
Tarrytown, New York

91094
Essex International Inc.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91506
Augat Inc
Attleboro, Massachusetts

91637
Dale Electronics Inc
Columbus, Nebraska

91662
Elco Corp
Willow Grove, Pennsylvania

71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices Inc
Edgewater, New Jersey

91833
Keystone Electronics Corp
New York, New York

91929
Honeywell Inc
Micro Switch Div
Freeport, Illinois

92194
Alpha Wire Corp
Elizabeth, New Jersey

93332
Sylvania Electric Products
Woburn, Massachusetts

94988
Wagner Electric Corp
Tung-Sol Div
Newark, New Jersey

95146
Alco Electronic Products Inc
Lawrence, Massachusetts

95275
Vitramon Inc
Bridgeport, Connecticut

95303
RCA Corp
Receiving Tube Div
[illegible]

95345
Gordos Corp
Bloomfield, New Jersey

95712
Bendix Corp
Franklin, Indiana

97913
Industrial Electronic
Hardware Corp
New York, New York

97945
Penwalt Corp
SS White Industrial Products Div
Piscataway, New Jersey

98078
Maico A. Microdot Co., Inc
Connector & Cable Div
Pasadena, California

98291
Sealectro Corp
Mamaroneck, New York

98388
Roya Industries
Products Div
San Diego, California

98978
IERC
Burbank, California

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect
Burbank, California

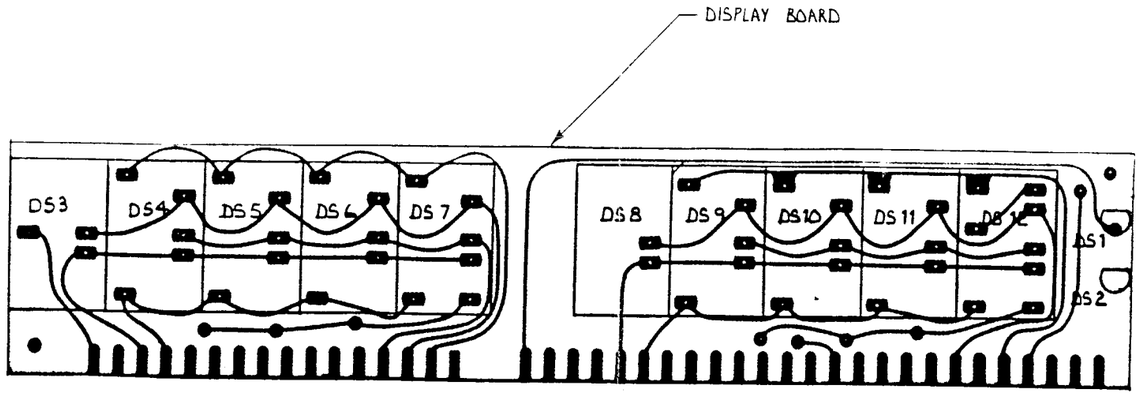
99392
STN
Oakland, California

99515
ITT Jennings Monrovia Plant
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp
Lansdowne, Pennsylvania

99848
Centralab Semiconductor
El Monte, California

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	A			



CLAD SHOWN IS NEARSIDE

DASH NO	QTY REQD	NEXT ASSEMBLY	USED ON
	1	2100-600	2101
	1	2100-600	2100

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

BREAK ALL SHARP CORNERS AND EDGES. MACH SURFACES 64 ✓

MATERIAL

FINISH

DRAWN CRE 4/27/83
CHECKED pm 4/28/83
APPR
STK NO

Valhalla Scientific Inc.
SAN DIEGO, CA

DISPLAY BOARD ASSY. 2100/2101

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
2:1	53504	C	2100-601	A

SHEET 2 OF 2

2100-601 A

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	.	SEE SHT 4 OF 4		

SEE PARTS LIST 2100-405 {
SCREW 4-40 (4)
CONNECTOR 25 PIN (3)
(MOUNT CONNECTOR WITH PINS 1 THRU 13 UP)

(OPTION "DMX" ONLY)

J6

E1
R1
(16)
REMOVE INSULATOR SUPPLIED WITH BINDING POST (27) REPLACE WITH ITEM (26) 2 PL
BINDING POST

5 PL { (18) 6-32 (19) WASHER (20) NUT

NUT (20)
SOLDER LUG (23)
SCREW 6-32 (18)

(30) HOLE PLUG

E16 LOAD
E17 LINE

GROMMET (25)

E1 (LEAD OF R1)

T1

1 2 3 4

B

GRN

J5

BLK

A C B

F1

WHT

S2

6 5 4

1 2 3

TWISTED PAIR TO S1 ON PCB (12")

WHT BLK

E6 E7

ON PCB 2100-700

BINDING POST 2PL (13)

E14 LOAD

E15 NEU

REAR PANEL

SHIELD (7)

TO SHUNT

TO SHUNT

#8 WASHER (28)

TO E2

(36)

TRANSF LEADS

1. WHT/BLK
2. WHT
3. BLK/WHT
4. BLK

MATERIAL	DRAWN RFG	6/19/81	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA
	CHECKED		
	APPR.		
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT, VALHALLA SCIENTIFIC INC RESERVES ALL PATENT, SALE, PROPRIETARY, DESIGN, MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO		REAR PANEL ASSEMBLY DWG.
	SCALE NONE	CODE IDENT NO. 53504	SIZE B	DRAWING NO. 2100-400	REV. N
	SHEET 3 OF 4				

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
		SEE SHT. 1		

POWER CONNECTIONS

IC No.	+15V	-15V	▽	+5V	▽D
13,14	12	5	4		
15,18				16,3	8
16	7,8	1	5		
19	8	1	5	11	
17,20		6	11		15

WATTS-TRUE POWER

AMPS TRMS-VOLTS TRMS

IC14 LF13333

IC13 LF13333

DS1 DS2 DS3 DS4 DS5 DS6 DS7 DS8 DS9 DS10 DS11 DS12

RN1 100

RN2 100

IC15 74LS47

IC18 74LS47

IC17 7103

IC20 7103

IC16 8068

IC19 8068

IC21 AE404

TR1 2N4401 (5)

TR2

TR3

TR4

TR5

TR6 2N4402

TR7 2N4401

TR8 2N4401 (6)

TR9

TR10

TR11

TR12

TR13

D8 D9 D10 IN4148(S)

D11 D12 D13

R88 470K

R89 1K

R90 1K

R91 100

R92 47K

R93 47K

R94 10K

R95 100K

R96 33K

R97 220K

R98 453 1% SEL

R99 SEL 1%

R100 100

R101 2K 1%

R102 47K

R103 10K

R104 100K

R105 33K

R106 220K

R107 100

R108 2K 1%

C23 1μ

C24 .01μ

C25 .1μ

C26 .22μ

C27 4.7μ

C28 10μ

C29 10μ

C30 330P

C31 .1μ

C32 .22μ

C33 4.7μ

C34 10μ

C35 10μ

C36 .01μ

+5V -15V 100KHZ

NOTE: DISPLAYS (DS1-12) ARE MOUNTED ON PCB 2100-701.

PCB 2100-700A

MATERIAL	DRAWN	Valhalla Scientific Inc.	
	CHECKED	SAN DIEGO, CALIFORNIA	
	APPR		
FINISH		SCHEMATIC- DIGITAL WATTMETER	
	SCALE ~	CODE IDENT NO. 53504	SIZE D
	SHEET 2 OF 2	DRAWING NO. 2100-070	REV H

	LTR	DESCRIPTION	DATE	APPROVED
	B	REVISED & REDRAWN	1-26-82	
	C	ECO 48 BM 4-15-83		
398	D	ADD C16. CHG R17 TO 10K, 1%	4-24-84	R
685	E	ADDED C16 TO SILKSCREEN DPM	4-24-85	DM
858	F	CHANGED R98 AND R51 MAS	4/18/86	
1038	G	CHANGED R17 TO 100K AND C27+C33 TO 4.7u DGL	7/21/87	
1076	H	CHANGED R67 TO 10K, ADDED R117-119 DGL	1/28/88	

POWER CONNECTIONS			
I.C. NO.	+15V	-15V	COM
1, 4, 5, 10	7	4	
2, 7	3	12	6
3		3	4
9	8		

MATERIAL	DRAWN Rick 1/82
	CHECKED DM 2/82
FINISH	APPR [illegible] 1/85

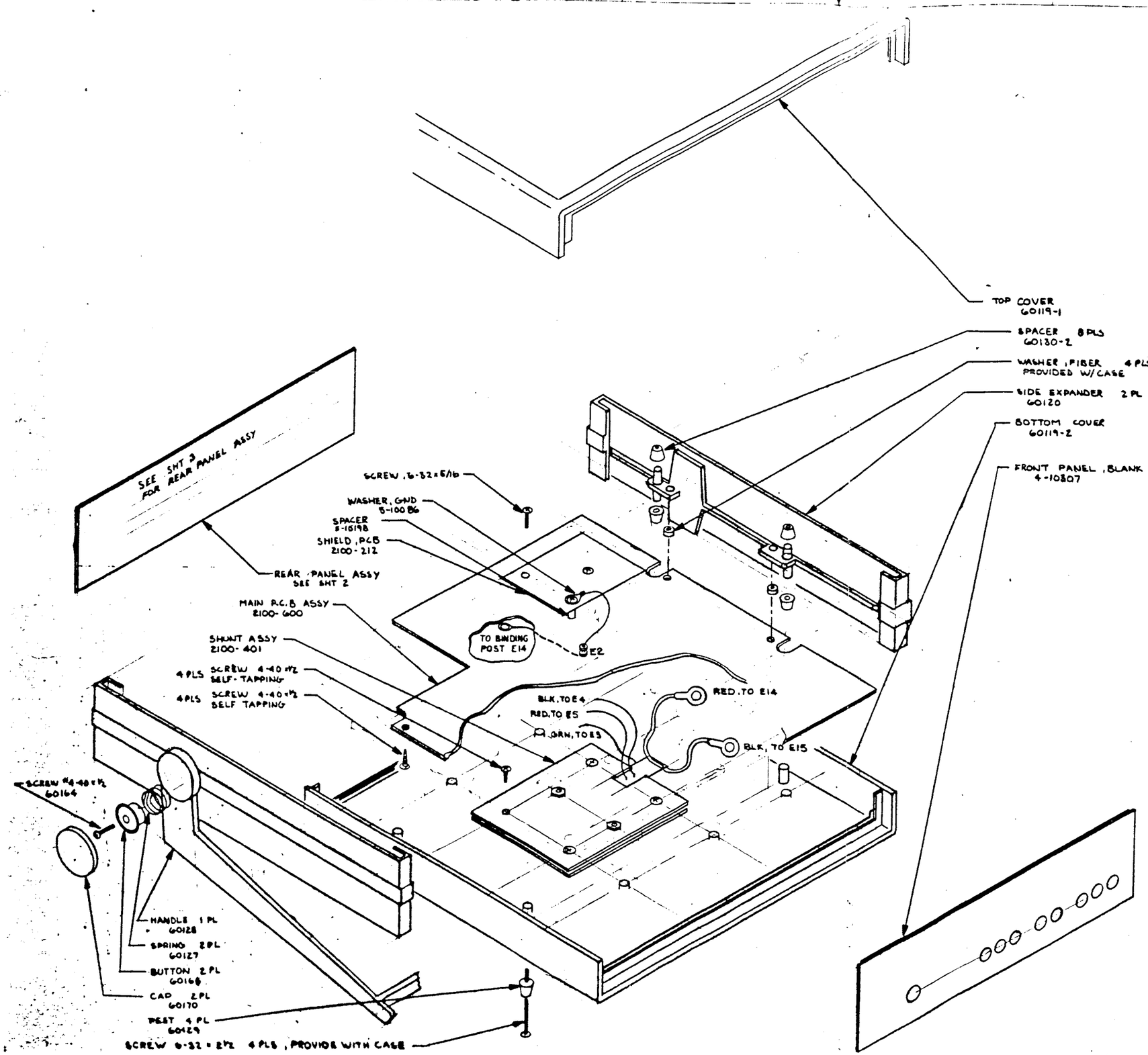
Valhalla Scientific Inc.
SAN DIEGO, CALIFORNIA

SCHEMATIC - DIGITAL WATTMETER

SCALE	CODE IDENT NO	SIZE	DRAWING NO	REV
	53504	D	2100-070	H

SHEET 1 OF 2

ECO	LTR	DESCRIPTION	DATE	APPROVED
20	A			
48	C	RM 6-83		
124	D	W.P.W.	9-15-83	
223	E	CRE	1-26-84	
312	F	PARTS LIST CHANGE RDN	3-12-84	
460	H	REV. LEVEL CHANGE ONLY	6-14-84	
571	J	CHG P/L ITEM 27 RDN	10-8-84	
576	K	CHANGED PARTS LIST, ITEM 27 RDN	11-27-84	
652	L	CHANGED PARTS LIST ITEM 26 DPM	2-8-85	
985	M	MADE PARTS LIST CHANGE MAB	7-21-87	
1129	N	UPDATED TO CALL OUT CORRECT SPACER	5-31-88	CRE



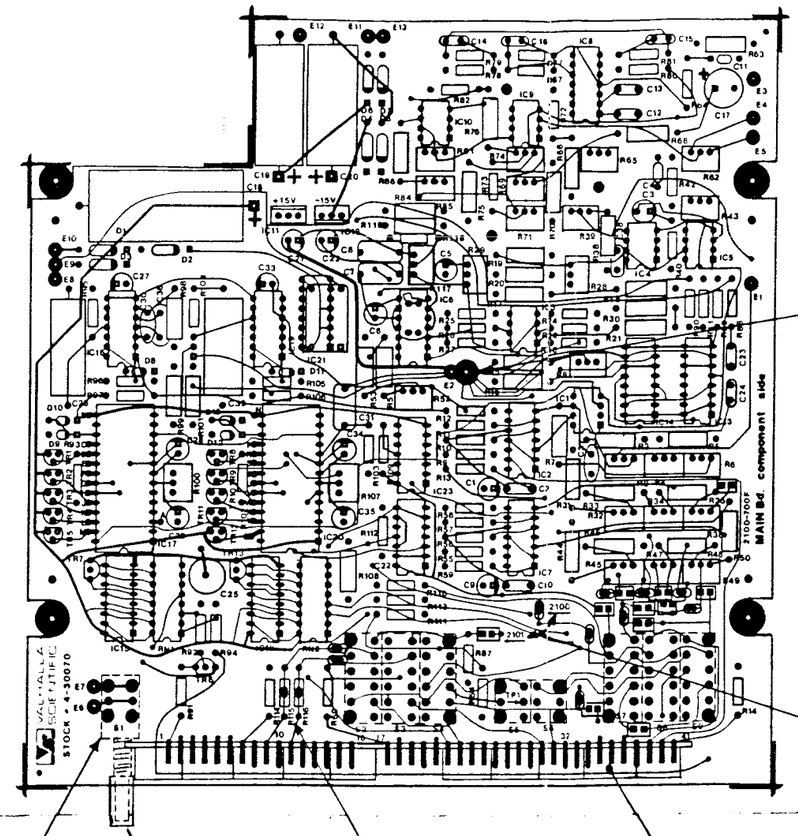
NOTES:

1. FOR SCHEMATIC SEE 2100-070 SHTS 1 AND 2.
2. FOR PARTS LIST SEE SHTS 1 AND 2 OF 2100-400.
3. FOR FINAL PARTS PLACEMENT ON 2100 SEE 300-403.
4. FOR FINAL PARTS PLACEMENT ON 2101 SEE 2100-404.

MATERIAL	DRAWN R M 6/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA	
FINISH	CHECKED RM 6-83	ASSEMBLY - MODEL 2100/2101	
	APPR. PWJ 6/83		
	SCALE NONE	CODE IDENT NO 53504 / SIZE D / DRAWING NO 2100-400	REV N
	SHEET 1 OF 4		

8 7 6 5 4 3 2 1

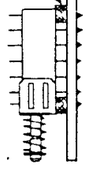
REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
0138	G	REDRAWN INCORPORATED E.C.O. 0138 AND ALL PREVIOUS REVISIONS CRE	1/29/84	PL
399	H	PARTS LIST CHANGE. R.D.N.	3-27-83	PL
398	J	ADD C16, CHG R17 TO 10K, .1%	4-24-84	PL
453	L	CHG. R67, R17 & C16	5-16-84	R
454	M	REDRAW P/L	5-18-84	PL
553	N	P/L CHANGE R	8-16-84	R
685	O	ADDED C16 DPM	4-2485	JM
858	P	CHANGE R98 AND 51 RDN	4-9-86	JM
909	Q	UPDATED - DELETE SOCKET XIC21 MAS	12-17-86	JM
1038	R	ADDED SPACERS UNDER SWITCHES DGL	7/21/87	JM
1076	S	ADDED R35 TO P/L, PCB CHANGE DGL	1/28/88	CRE
1139	T	CHANGED VALUE OF R 44 GWM	8/3/88	CRE



(100) TERMINAL

FOR 2100 SOLDER BRIDGES MARKED ⬭ 12 PL.
FOR 2101 SOLDER BRIDGES MARKED ▭ 11 PL.

INSTALL SPACERS ON CORNER PINS OF SWITCHES (16 PL)



S1-S9 ARE MOUNTED ON THE FARSIDE OF THE BOARD.

FOR 2100 USE SOLDER BRIDGES
FOR 2101 USE R115 + R116

(3) DISPLAY BD. ASSY.

(93) SILVER BUTTONS SUPPLIED WITH SWITCH 9 PL.

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

DRAWN CRE	1-24-84
CHECKED PL	1-24-84
APPR PL	1-24-84
STK NO	

Valhalla Scientific Inc.
SAN DIEGO, CA

2100 + 2101 MAIN BD. ASSY.

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
1:1	53504	C	2100-600	T

SHEET 1 OF 6

Valhalla Scientific Inc.	PARTS LIST	FINAL ASSEMBLY MAIN PCB	MODEL 2100	DWG NO 2100-403	REV G

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
1											
2											
3	R36, 47	1-50014	POT, 100Ω		68WR100	2					FOR R107.
4	R109-113	———	NOT USED	———	———						
5											
6	IC22, 23	———	NOT USED	———	———						
7											
8		4-10490	FRONT PANEL, SCREENED		2100-100		1				MADE FROM: 4-10307
9											
10	R2	1-50013	POT, 1K		68WR-1K	1					
11	R3	1-10141	RES, 8.87K, 1%		RN60C8871F	1					
12	R4	1-50029	POT, 500Ω		68WR-500	1					
13	R5	1-10142	RES, 4.75K, 1%		RN60C4751F	1					
14	R6	1-50037	POT, 200Ω		68WR-200	1					
15	R7	1-10061	RES, 4.99K, 1%		RN60C4991F	1					
16											
17											
18											
19											
20											
21											
22											
23											

NOTES: SOLDER ALL JOINTS MARKED ◯ 2100

SHT 1 OF 1

40

NOTES: FOR 2100 FINAL ASSY P.L. SEE 2100-403
FOR 2101 FINAL ASSY P.C.L. SEE 2100-404

SHT 2 OF 2

Valhalla Scientific Inc.

PARTS LIST

DIGITAL WATTMETER FINAL ASSEMBLY | MODEL 2100/2101 | DWG NO 2100-400 | REV N 1

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	QTY I	QTY N	REMARKS
1		F/G	PCB ASSY MAIN	53504	2100-600	1				
2		F/G	SHUNT ASSY .01Ω	53504	2100-401	1				
3										
4										
5		4-10397	REAR PANEL	53504	2100-213	1				
6		4-10130	CASE	LA FRANCE	CH-250 BEIGE	1				
7		4-10309	INPUT SHIELD	53504	2100-210	1				
8		4-10285	SHORTING STRAP	53504	2100-207	1				
9	J5	5-10063	AC RECEPTACLE	82389	EAC-301	1				
10	XF1	5-10018	FUSE HOLDER	75915	342004A	1				
11	F1	5-04010	FUSE .25A SB	75915	3AG .25A SB	1				
12	S2	5-03017	SWITCH 115/230	82389	46256LFR	1				
13	J1-J4	5-10020	BINDING POST w/2 NUTS	83330	257 BLACK	2				
14	T1	4-29038	TRANSFORMER	53504	2100-010	1				
15		5-10198	SPACERS FIBER	83330	8880	4				
16		5-10450	SOLDER LUG #10	83330	1410-10	1				
17			SCREW, PHIL PAN, CAD		#4x1/2 SELF-TAPPING	8				
18			SCREW, PHIL PAN, BLK		6-32x3/8	6				
19			WASHER, SPLIT LOCK		#6	5				
20			NUT, RADIO HEX		6-32	6				
21		5-10067	POWER CORD	ELECTRO-CORD	E1015	1				
22	R1	1-10089	RES. 600K	CADDOCK	MG714-600K	1				
23		5-10086	SOLDER LUG #6	SMITH	1412-6	1				

NOTES:

ECO 571 10-8-84

FOR SHTS 3 & 4 SEE ASSY. DWGS

SHT 1 OF 4

cc																							
23																							

NOTES: SOLDER ALL JOINTS MARKED ☐ 2101

SHT 1 OF 1