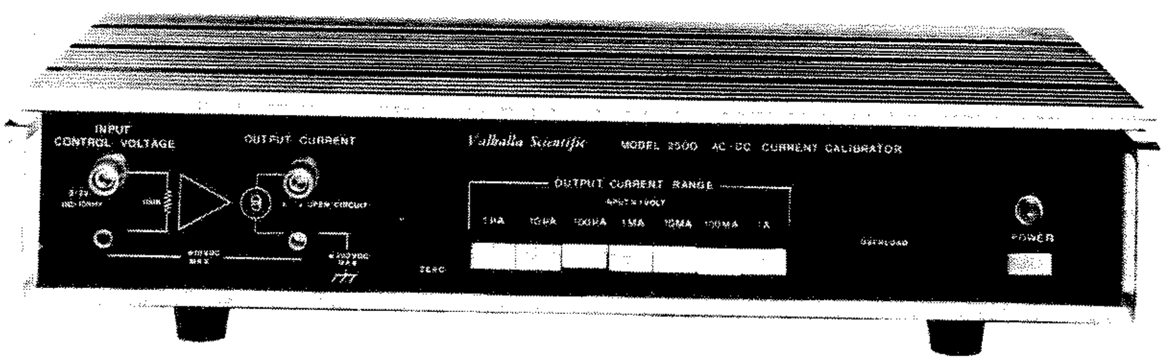
2500
AC-DC Current Calibrator

Operating and Maintenance Manual

CN 826



REVISED: 10/84

CERTIFICATION

Valhalla Scientific, Inc. certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. Valhalla Scientific, Inc. further certifies that its 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 repair returns. No liability will be accepted if returned without such permission.

SPECIFICATIONS

2500 AC-DC CURRENT CALIBRATOR

Specifications

Range	1μA	10μA	100μA	1MA	10mA	100mA	1A
Resolution	10pA	100pA	1nA	10nA	100nA	1μA	10μA

Dynamic Range: 0 to 200% of range, DC or RMS AC, up to Maximum rated output.
Fullscale: Fullscale = 200% of range.
Maximum Output Current: 2 amps DC or RMS AC.
DC Accuracy: (180 days 25°C ± 5°C) ± .01% of fullscale ± .01% of output.
AC Accuracy: (180 days 25°C ± 5°C) ± .01% of fullscale ± .05% of output to 1KHz. ± .05% of fullscale ± .05% of output to 10KHz. Add .05% of fullscale ± compliance voltage x Frequency (KHz).
1μA and 10μA range limited to 1KHz. 100μA range limited to 5KHz.

Input Impedance: 100 Kilo-ohms
Compliance Voltage: 10 volts DC or Peak AC. 7 volts DC or Peak AC above 100% of range.
Input/Output Ratio: 2.00000 volt input produces full scale output.
Maximum Input: 3 volts DC or RMS AC
Output Protection: Fuse protected at 3 amps
Input Common Mode Rejection Ratio: 60 dB @ linearly decreasing to 40dB @ maximum frequency.
Temperature Range: 0 to 50°C.
Temperature Coefficient: 1/10 of accuracy specification per °C.
Power: 115/230 VAC ± 10% 50-60Hz
Size: 299mm/9" L x 381mm/15" W x 64mm/2.5"H
Weight: 7 Kg/15 lbs. Net 9 Kg/20 lbs Shipping.
Duty Cycle: 25% at 2 Amperes, Increasing to 100% at 1 Ampere. (5 Minute Time Constant)

SECTION I

GENERAL INFORMATION

1-1 DESCRIPTION

1-2 The Valhalla Scientific Model 2500 AC-DC Current Calibrator is a complete wide range voltage-to-current convertor. This instrument will convert a precision input voltage to a proportional output current. If the input voltage is DC, the output current will have the polarity of the input voltage. If an AC signal is applied to the input terminals, the output current will have the frequency and phase of the applied input voltage. Seven current ranges, from one microampere to one ampere are selectable with the front panel range switch. The legends above each push-button indicate the current produced at the output terminals when one volt is applied to the input terminals.

1-3 The Model 2500 AC-DC Current Calibrator is housed in an extra heavy-duty aluminum case, ideally suited to the most rugged requirements.

1-4 ACCESSORIES

1-5 The Valhalla Scientific Model 2500 AC-DC Current Calibrator is shipped from the factory with detachable power cord and an instruction manual.

1-6 RACK MOUNT - OPTION R

1-7 The Model 2500 AC-DC Current Calibrator may be purchased with a rack mount adaptor, OPTION R, for mounting in a standard 19-inch rack.

SECTION II

INSTALLATION

2-1 INTRODUCTION

2-2 This section contains information for inspection and installation of the Model 2500 AC-DC Current Calibrator.

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 perform the calibration procedure of Section V to determine that the instrument has not incurred hidden damage.

2-6 POWER REQUIREMENTS

2-7 The Valhalla Model 2500 AC-DC Current Calibrator is normally shipped from the factory for operation from 105 to 125 volts AC at 50 to 400 Hz. To operate the instrument from 210 to 250 volts AC, requires reprograming of the power transformer primaries. This may be accomplished with the following procedure.

1. Remove the cover.
2. Locate the point on the vertical printed circuit board where the wires from the primary power plug connect to the printed circuit board. This is approximately 2.5 inches from the right end.
3. With a sharp instrument, make two cuts, approximately one-eighth-inch apart, on the clad of the vertical board between the points marked BRN and ORN. Peel the clad from the board between the two cuts.
4. Similarly, cut the clad between the points marked RED and YEL and remove the clad material between the two cuts.
5. Install a #22 AWG, or larger, jumper between the points marked RED and ORN.
6. Install a one-ampere fuse in the rear panel fuse holder. The unit is then ready to operate from 230 volt AC.

NOTE

The AC-DC Current Calibrator may be purchased from the factory preprogrammed to operate from 230 volts AC.

2-8 INSTALLATION

2-9 If the Model 2500 AC-DC Current Calibrator is to be used in the normal bench top configuration, installation requires only that the power cord be inserted into the mating connector on the rear panel of the instrument and that the other end of the cord be plugged into the wall receptacle. The instrument may then be connected to the precision reference input voltage and to the load to which current will be supplied.

2-10 The entire case of the AC-DC Current Calibrator is used as a heat sink for the output current transistors. Care should be exercised that the flow of air around the unit is not restricted, otherwise, internal temperatures may rise excessively, thereby shortening the life of internal components. When the instrument is installed in an equipment rack, caution should be exercised that there is free circulation of air around the instrument, and that the maximum ambient air temperature within the rack does not exceed 50° C. If the internal temperature of the rack rises above this limit, forced air cooling should be employed as necessary to reduce the ambient air temperature to 50°C or lower.

SECTION III

OPERATION

3-1 INTRODUCTION

3-2 This section of the manual contains the complete operating instructions for the Model 2500 AC-DC Current Calibrator.

3-3 INPUT VOLTAGE

3-4 The polarity and level of the input voltage determines the polarity and level of the output current. If the input voltage is zero, the output current will be zero. As the input voltage is increased, the output current will increase within the selected range. If the selected range is 1 MA, an input voltage of 1.0000 volts DC will produce an output current of 1.0000 MA. If the input is increased to 1.5000 volts DC, the output current will increase to 1.5000 MA. Similarly, if the 10 MA range is selected, the output currents will be 10.000 MA and 15.000 MA for inputs of 1.0000 volts DC and 1.5000 volts DC respectively. If the input voltage is of positive polarity, the output current will be of positive polarity. If the input voltage is of negative polarity, the output current will be of negative polarity. If an AC voltage is applied to the input terminals, the output current will have the amplitude, frequency and phase characteristics of the applied input voltage.

3-5 Maximum input voltage is 2 volts RMS AC or ± 2.8 volts DC. Although the accuracy specification does not define DC inputs higher than 2 volts DC, the unit is useable to inputs of 2.8 volts DC.

3-6 RANGE SWITCHING

3-7 Range switching is accomplished with a front panel, 7-station push-button switch. With this switch, the operator may select any one of the ranges of the instrument. The ranges are defined in decade increments of 1 MA, 10 MA, 100 MA, etc., based on a 1 volt input level. For example, if the 1 MA range is selected, and an input of 1 volt DC is applied, the output current will be 1 milliampere DC. If an input of 1 volt RMS AC is applied, the output will be 1 milliampere AC RMS.

3-8 OUTPUT CURRENT

3-9 As stated in previous paragraphs, the output current is proportional to the input voltage. Therefore, a 2 volt input will produce an output current which is 200% of the selected range (eg., if the 1 MA range is selected, the output current will be 2 MA). The effective output impedance of the current calibrator approaches infinity. Therefore, the output circuit will attempt to deliver the selected current into any load impedance applied to the output terminals. A 1 MA current output applied to a 1K ohm load impedance produces 1 volt across that load impedance. A 1 MA input current applied to a 2K ohm load impedance produces 2 volts, etc., until the output voltage reaches the ±10 volt DC or peak AC maximum compliance level. The 10 volts DC maximum compliance voltage corresponds to 7.07 volts RMS maximum compliance voltage for sine wave output currents.

3-10 ZERO ADJUSTMENT

3-11 A zero adjustment has been provided and is accessible through a hole in the front panel located to the left of the range switch. The instrument should be allowed a warm up period of one hour prior to making the zero adjustment. To make the zero adjustment, first short the input terminals together. Select the 1 MA range and connect a precision 1K ohm resistor and a digital volt meter (DVM) in parallel across the output terminals. If necessary, adjust the zero control until the DVM display is ± 100 microvolts DC or less.

3-12 OVERLOAD INDICATOR

3-13 An overload indicator is provided. It is an analog type warning system designed to inform the operator that the unit is being operated near or beyond the specification limits. There are two overload modes. The input overload indication occurs at approximately ±2.4 volts DC or 1.7 volts RMS AC. The output overload indication occurs at approximately ±7 volts DC or 5 volts RMS AC. As the input is increased, the overload indications will occur prior to the point where the specification limits are exceeded. It is, therefore, possible to have an overload indication when operating the instrument near one of its specification limits. When the overload indicator is illuminated, a careful check of the test setup should be made to verify proper operating conditions. Non-linear operating conditions are not necessarily encountered when an overload indication occurs, although input-output specifications may be exceeded.

3-14 APPLICATION INFORMATION

3-15 The application of a precision constant current source such as the Model 2500 AC-DC Current Calibrator requires a knowledge of potential outside error sources. The following paragraph outlines some of the more common error sources.

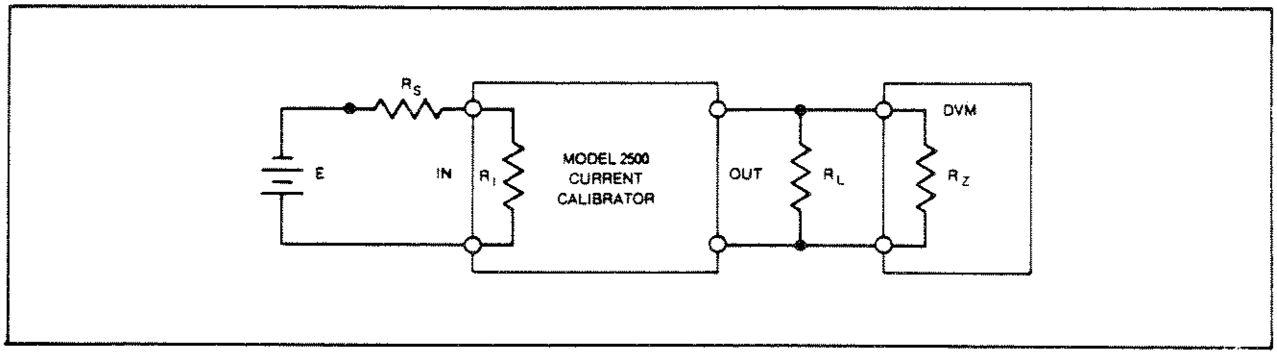


Figure 3-1. Block Diagram, DC Error Sources.

3-16 When measuring the DC current output of the AC-DC Current Calibrator, there are two primary potential error sources. The first occurs at the voltage input to the Current Calibrator. This error source is formed by the source impedance of the input voltage source, R_S, shown in Figure 3-1, forming a resistor divider with the 100K ohm input impedance of the Current Calibrator, R_I. To maintain the error at 0.01% or less, the ratio of R_I:R_S must be maintained at 10,000:1 or greater. Since R_I equals 100K ohms, the maximum impedance for R_S must be less than 10 ohms. The second potential error source occurs at the current output of the AC-DC Current Calibrator. This error source is the shunt impedance of the DVM, R_Z, shown in Figure 3-1, in parallel with the load impedance, R_L. To maintain the error at 0.01%, or , the ratio of R_Z:R_L must be maintained at 10,000:1 or greater. If the input impedance to the DVM is 10 megohms, the maximum shunt impedance, R_L, should not exceed 1K ohms. For a shunt impedance, R_L, of 1 megohm, the input impedance to the DVM, R_Z, must be at least 10,000 megohms.

3-17 In addition to the error sources outlined above, there are other error sources to be considered when measuring AC current. The most common of the AC error sources is cable capacitance, CC, shown in Figure 3-2. RG 58A/U cable, for example, has a capacitance of approximately 30 picofarads per foot. If the output of the Current Calibrator is connected to the load resistance through two feet of cable, the cable capacitance is 60 picofarads. If the output frequency is 10 KHz and R_L is 100K ohms, the effective load impedance is:

$$Z = \frac{R_L\left(\frac{1}{2\pi \cdot 10\,\text{KHz} \cdot 60\,\text{pf}}\right)}{\sqrt{R_L^2 + \left(\frac{1}{2\pi \cdot 10\,\text{KHz} \cdot 60\,\text{pf}}\right)}} = 92.98\,\text{K}\Omega$$

3-18 The effective error due to shunt capacitance, CC, in this case is 7.02%. As shown in equation 3-1, shunt capacitance versus load impedance is a square-law function. Reducing the load impedance by a factor of 10 (100K ohms to 10K ohms) will reduce the error by 100 to 1, 7% to .07%. Another potential error source is inductance (L) in series with the load resistor, R_L. If the load resistance is 1 ohm and the series inductance is 5 microhenries, the effective load impedance at 10 KHz is:

$$Z = \sqrt{R_L^2 + (2\pi \cdot 10\,\text{KHz} \cdot 5\mu\text{H})^2} = 1.0481\Omega$$

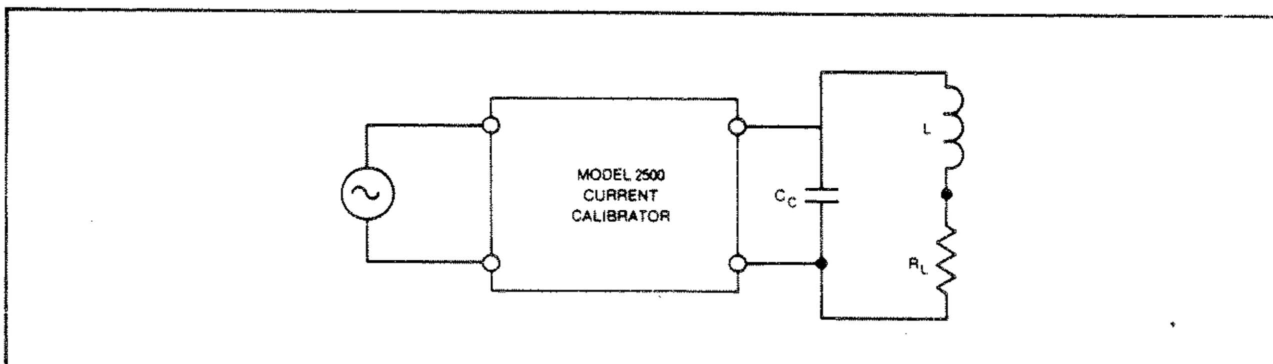


Figure 3-2. Block Diagram, AC Error Sources.

3-19 The effective error in load impedance caused by series inductance is, in this case, 4.81%. A precise current output from the Current Calibrator of 1.0000 amperes RMS at 10 KHz, when applied to this load will produce a voltage drop of 1.0481 volts RMS. In actual practice, series inductance becomes a problem only for shunt impedances of less than 5 ohms at frequencies of 10 KHz. The series inductance of most of the commercially available lab-standard type 1 ohm resistors is not low enough to produce accurate results when the output current is 1 ampere at 10 KHz. Special non-inductive precision current shunts are required.

SECTION IV

THEORY OF OPERATION

4-1 GENERAL

4-2 This section of the manual provides a description of the circuits of the Model 2500 AC-DC Current Calibrator. The circuit descriptions are referenced to the schematic diagram, Figure 5-5.

4-3 POWER SUPPLY

4-4 The circuits of the Model 2500 AC-DC Current Calibrator require +14 volts DC and —14 volts DC. These voltages are furnished by a bridge rectifier consisting of diodes CR16 through CR23 and series regulators Q1 and Q2. Zener diode CR4 provides the voltage reference level for the +14 volt series regulator Q1. CR5 provides the reference for the —14 volt series regulator Q2.

4-5 VOLTAGE TO CURRENT CONVERTER (TRANSCONDUCTANCE AMPLIFIER)*

4-6 A simplified diagram of the voltage to current converter is shown in Figure 4-1. The first amplifier operates at unity gain by virtue of the operational feedback loop provided by R7. The output of the first amplifier drives the inverting input of the second amplifier which operates open loop and, therefore, at very high gain. The output of the second amplifier provides a potentiometric feedback to the non-inverting input of the first amplifier. The system operates to maintain the output of the first amplifier, and the inverting input of the second amplifier, at approximately the same potential as that applied to the non-inverting input of the second amplifier. Very small differences between the two inputs of the second amplifier are sufficient to drive it to full scale output.

* Patent Pending

4-7 Assume that the output terminal is grounded and a 1 volt DC potential is applied to the input with the red input terminal positive. To equalize the inputs to the second amplifier, the first amplifier output must be driven to zero. This will be accomplished when the voltage drop across each of the four resistors (R5, R6, R7 and R16) is 0.25 volts. This condition will be satisfied when the output of the second amplifier is at +1 volt. The inputs to the first amplifier will both be at 0.25 volts and, since they are equalized, the output will be zero. (Offset, of course, a very small amount to drive the output of the second amplifier to +1 volt). +1 volt at the output of the second amplifier will cause 1 milliampere to flow through the 1K series resistor, R_S. Any tendency toward increasing the output voltage of the second amplifier is immediately compensated for through the feedback from its output to the non-inverting input of the first amplifier. Note that the sum of the voltages across the four resistors equals the voltage applied to the input terminals.

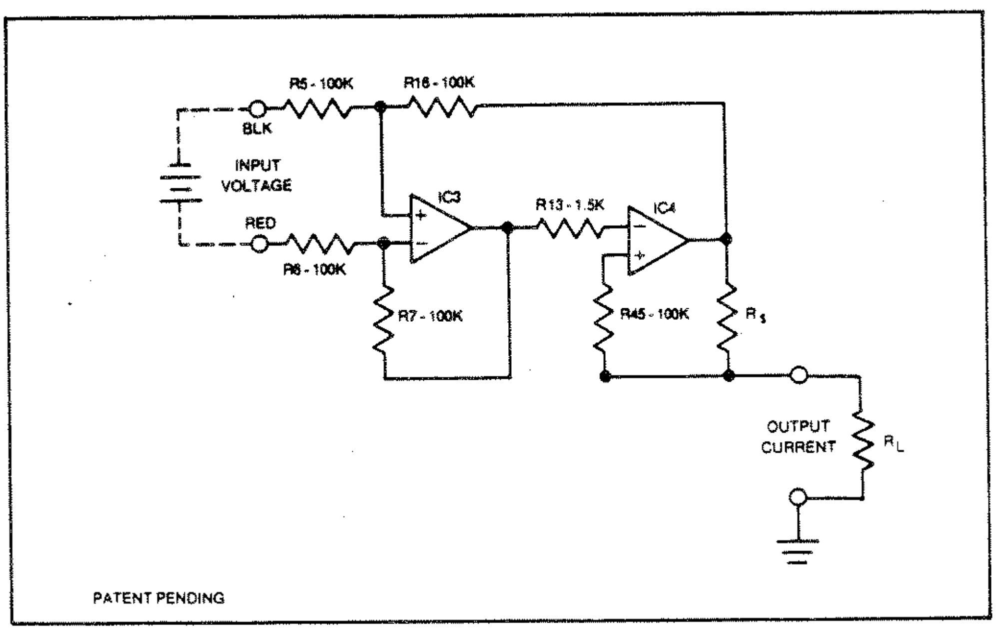


Figure 4-1. Simplified Circuit Diagram, Voltage/Current Converter.

4-8 Consider the conditions that are obtained when the ground is removed from the output terminal and a 1K resistor connected between the output terminal and ground. The reference level to the non-inverting input of the second amplifier will now be at some point above ground due to the current flowing through the load resistor, R_L. This will drive the output of the second amplifier in a positive direction and a point of stability will be reached when the output of the first amplifier is equal to the level applied to the non-inverting input of the second amplifier. Again, this condition will obtain when the voltage drop across each of the four resistors in the loop is equal to 0.25 volts. This will require that the output of the first amplifier be driven to +1 volt and the output of the second amplifier to +2 volts. Two volts across the series combination of R_S and R_L will produce one milliampere of current. Thus, although the resistance across the output terminals has been increased from zero to 1,000 ohms, the current flowing across the output terminals remains at one milliampere for both conditions. Note that the voltage difference between the output of the first amplifier and the output of the second amplifier is always equal to the voltage applied to the input terminals of the system. If the input signal were increased to +2 volts DC, the potential difference between the output of the first amplifier and the output of the second amplifier would increase to 2 volts and the voltage drop across the four resistors, to achieve equilibrium, would be 0.5 volts. If a 1K resistor is connected across the output terminals, the output of the second amplifier would be increased to +4 volts and the current through the series combination of R_S and R_L would increase to 2 milliamperes. Thus, the output current would be maintained proportional to the input voltage.

4-9 Since the system tends to maintain a voltage at the output of the second amplifier proportional to the input voltage, selecting different values of R_S with the front panel range switch will result in different current levels through R_S and the output load. The second amplifier is comprised of a high gain amplifier integrated circuit followed by a transistorized current amplifier in a "totem pole" arrangement. This provides positive and negative current outputs and and has the capacity to deliver up to 2 amperes to the load. The current amplifier is shown in the schematic diagram, Figure 5-5. Q3 and Q4 operate as constant current sources to bias Q5 and Q6. R54, which is connected to the non-inverting input of IC3, provides a fine adjustment for the overall gain of the voltage to current converter. R8 provides an adjustment to compensate for the offset of IC3.

4-10 OVERLOAD INDICATOR

4-11 The overload indicator circuit is shown in Figure 4-2. It operates in two modes: input overload and output overload. In the input overload mode, the input voltage is applied to the inputs of IC1 through R1 and R3. IC1 operates as a differential operational amplifier with unity gain. The output of IC1 drives the inverting input of IC2, which also operates at unity gain. The output of IC1 will go positive with a negative input voltage and the output of IC2 will go positive with a positive input voltage. When the input voltage, ±DC or peak AC, exceeds approximately 2.4 volts, Q9 will be turned on to illuminate the overload indicator, DS1. Q9 will be turned on, and DS1 illuminated, when the output voltage exceeds the threshold of CR14 and the drop across CR15 which approximates +7 volts DC or peak AC. Q9 will also be turned on in the overload mode when the output goes

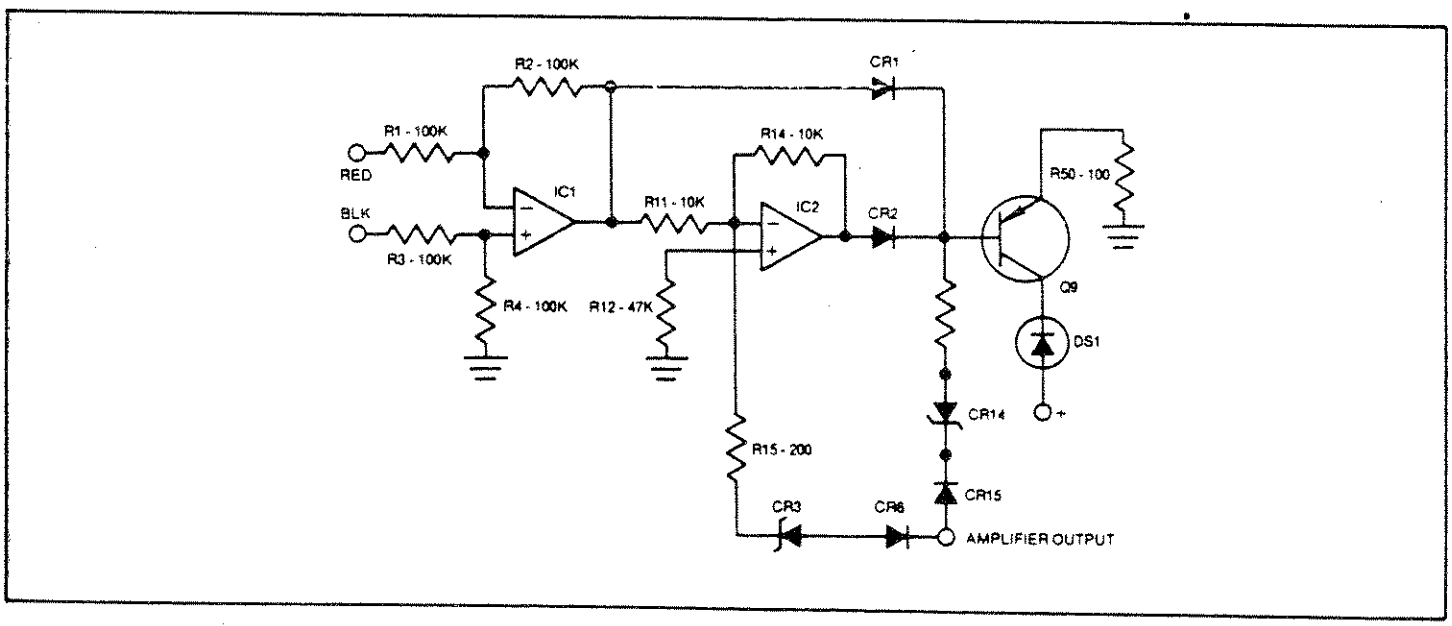


Figure 4-2. Simplified Circuit Diagram, Overload Indicator.

negative and exceeds the threshold of zener diode CR3 and the drop across CR6 which will occur at approximately —7 volts DC or peak AC. CR3 is connected the inverting input of IC2 to drive the output of IC2 positive and turn on Q9 through CR2.

4-12 RANGE SELECTION

4-13 Range selection is accomplished with a 7-station, push-button, interlocking switch assembly which inserts different values of resistance for R_S, shown in Figure 4-1, for each range. Calibration potentiometers, in the resistor matrix connected to the push-button assembly, permit precise adjustment of output current for a given input voltage. The adjustments of these potentiometers are covered in the calibration procedure of Section 5.

SECTION V

MAINTENANCE

5-1 INTRODUCTION

5-2 This section contains information necessary for the maintenance of the Model 2500 AC-DC Current Calibrator. Included are a list of required test equipment, calibration procedures and a troubleshooting guide.

5-3 REQUIRED TEST EQUIPMENT

DC Voltage Standard
0 to 1 Volt DC
±0.003% Accuracy

5 Digit DVM
±0.003% Accuracy
10 Megohms Input Impedance on 1V DC Range

Precision DC Shunt Resistors
1.0000 Ohms, ±0.003%
10.000 Ohms, ±0.003%
100.00 Ohms, ±0.003%
1.0000K Ohms, ±0.003%
10.000K Ohms, ±0.003%
100.00K Ohms, ±0.003%
1.0000M Ohms, ±0.003%

DC Nullmeter
10 Microvolts Sensitivity

5-4 If the AC Frequency Response Test of Paragraph 5-29 is to be conducted, the following items of AC test equipment will be required.

Thermal Transfer System
Fluke Model 540, or equivalent, with current shunts for 1A, 0.1A, and 0.01A.

AC Voltmeter
Hewlett Packard 3450A001, or equivalent.

AC Voltage Standard
Optimation Model 126, or equivalent.

High Impedance AC Amplifier
Valhalla Scientific Model 2009, or equivalent.

AC Shunts
1.0000K Ohms, ±0.005%
10.000K Ohms, ±0.005%
100.00K Ohms, ±0.005%

5-5 CALIBRATION PROCEDURE

5-6 The following procedure should be performed on a routine basis to insure that the instrument remains within its specified accuracy. The calibration procedure should be performed after repairs are made on any of the accuracy determining components. Apply AC power and allow one hour for the instrument to stabilize.

5-7 1 AMPERE RANGE

5-8 Connect the equipment as shown in the diagram of Figure 5-1 using a 1.0000 ohm resistor for R_L and a 9 ohm resistor for R_S. Set the DC Voltage Standard to zero volts DC. Select the 1A range on the Model 2500 and adjust the front panel ZERO control for an indication on the DC Nullmeter of ±100 microvolts or less.

5-9 Set the DC Voltage Standard for 1.00 volts DC. Adjust R48 for an indication on the Nullmeter of ±100 microvolts, or less. Open and close the switch across R_S. The output voltage displayed on the DVM should change from 1 volt to 10 volts.

NOTE

If the DC Nullmeter reads less than ±200 microvolts at both positions of the switch, proceed to paragraph 5-11. If not, proceed to paragraph 5-10.

5-10 Open and close the switch across R_S and observe the direction and magnitude of change indicated on the Nullmeter. Adjust R54 for a Nullmeter reading change of less than ±100 microvolts between the open and closed positions of the switch. The total offset of the output generated by adjusting R54 can be ignored. Only the change in the reading between switch positions is of importance at this point. After adjusting R54, return to paragraph 5-8 and repeat the steps of paragraphs 5-8 and 5-9.

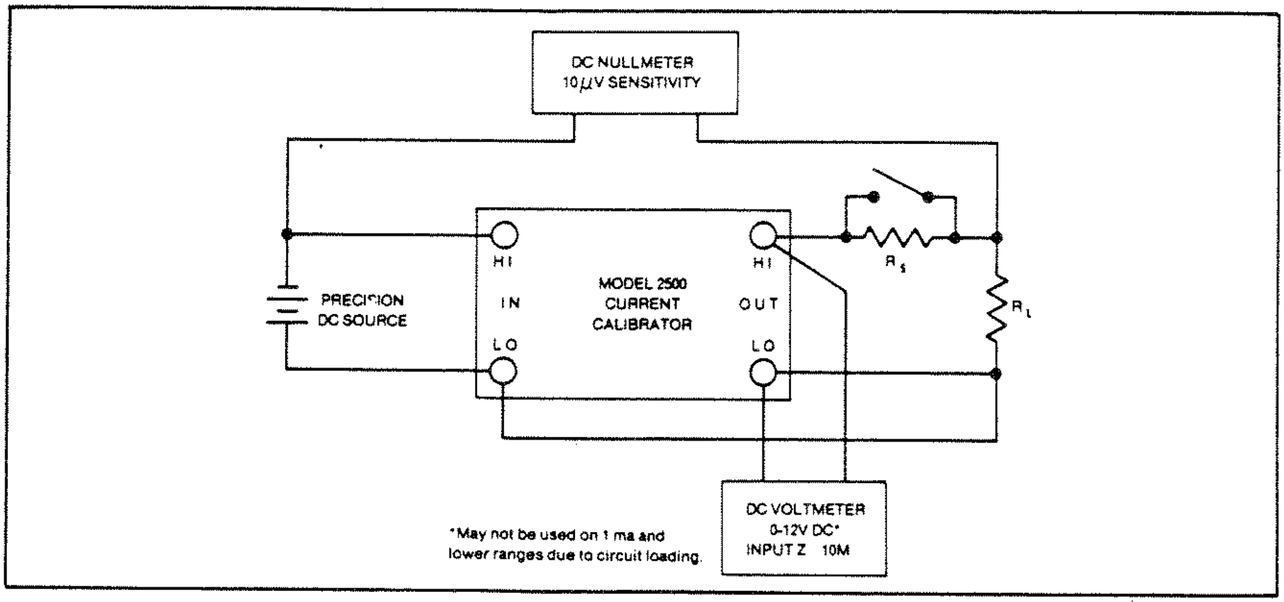


Figure 5-1. Equipment Connections, DC Calibration.

5-11 100 MILLIAMPERE RANGE

5-12 Connect a 10.000 ohm resistor for R_L and a 90 ohm resistor for R_S. Select the 100MA range and set the DC Voltage Standard to zero volts DC. Check for an indication of less than ±100 microvolts on the Nullmeter. Adjust the front panel ZERO control, if required.

5-13 Set the DC Voltage Standard to 1 Volt DC. Adjust R47 for an indication on the Nullmeter of less than ±200 microvolts with the switch both open and closed. The output compliance voltage need not be monitored during the remainder of the calibration procedure. The DVM will generate loading errors if it is connected during the remainder of the calibration procedure.

5-14 10 MILLIAMPERE RANGE

5-15 Select the 10MA range and connect a 100.00 ohm resistor for R_L and a 900 ohm resistor for R_S. Set the DC Voltage Standard for zero volts DC. Check for an indication on the Nullmeter of less than ±100 microvolts. Adjust the front panel ZERO control, if required.

5-16 Set the DC Voltage Standard to 1 volt DC. Adjust R46 for an indication on the Nullmeter of less than ±200 microvolts with and without the switch shorting R_S.

5-17 1 MILLIAMPERE RANGE

5-18 Select the 1MA range and connect a 10000.00 ohm resistor for R_L and a 9000 ohm resistor for R_S. Set the DC Voltage Standard to zero volts DC. Check for an indication on the Nullmeter of less than ±100 microvolts. Adjust the front panel ZERO control, if required.

5-19 Set the DC Voltage Standard to 1 volt DC. Adjust R38 for an indication on the Nullmeter of less than ±200 microvolts with and without the switch shorting R_S.

5-20 100 MICROAMPERE RANGE

5-21 Select the 100µA range and connect a 10.000K ohm resistor for R_L and close the switch across R_S. Set the DC Voltage Standard to zero volts DC. Check for an indication on the Nullmeter of ±100 microvolts, or less. Adjust the front panel zero control, if required.

5-22 Set the DC Voltage Standard to 1 volt DC. Adjust R40 for an indication on the Nullmeter of ±200 microvolts, or less.

5-23 10 MICROAMPERE RANGE

5-24 Select the 10µA range and connect a 100.00K ohm resistor for R_L and close the switch across R_S. Set the Voltage Standard to zero volts DC. Check for an indication on the Nullmeter of ±200 microvolts, or less. Adjust the front panel zero control, if required.

5-25 Set the DC Voltage Standard to 1 volt DC. Adjust R42 for an indication on the Nullmeter of ±200 microvolts, or less.

5-26 1 MICROAMPERE RANGE

5-27 Select the 1µA range and connect a 1.0000M ohm resistor for R_L and close the switch across R_S. Set the Voltage Standard to zero volts DC. Check for an indication on the Nullmeter of ±100 microvolts, or less. Adjust the front panel zero control, if required.

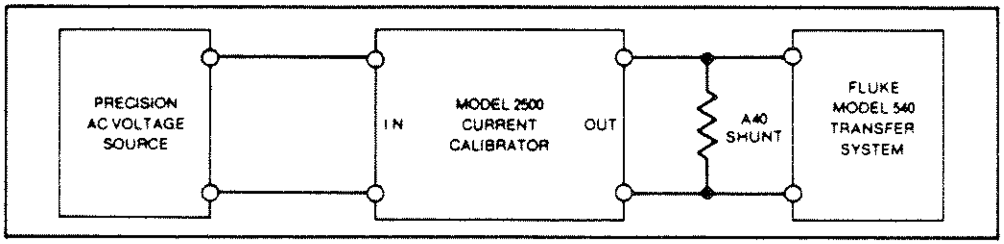


Figure 5-2. Equipment Connections, AC Compliance Test.

5-28 Set the Voltage Standard to 1 volt DC. Adjust R42 for an indication on the Nullmeter of ±100 microvolts, or less.

5-29 FREQUENCY RESPONSE

5-30 The frequency response test need not be performed on a routine basis as the 10 KHz bandwidth is inherent in the design. The frequency response test is an exacting procedure requiring specialized test equipment listed in paragraph 5-3 but not usually found in most service laboratories. Before attempting to perform this test, it is recommended that paragraph 3-13, Application Information, be completely reviewed and that the test operator thoroughly understands the sources of errors and compensates for them during the test. If test equipment other than that listed in paragraph 5-3 is to be used, a comparison of the specifications for the equipment listed and that to be used must be made to insure that the equipment used is an exact equivalent.

5-31 1 AMPERE RANGE

5-32 Connect the Fluke Model A40-1 (1 Ampere) shunt to the ouput of the Model 2500 AC-DC Calibrator and to the input of the Fluke Model 540 Thermal Transfer System. Set the Model 540 Mode switch in the AC Transfer position and the range switch to Shunt.

5-33 Select the 1A range on the Model 2500 and apply 1V RMS at 100 Hz from the AC Voltage Standard to the input of the Model 2500. Null the galvanometer on the Model 540 to zero.

5-34 Increase the frequency output of the AC Voltage Standard to 1000 Hz and verify that the output does not change by more than 0.06%.

5-35 Increase the frequency output of the AC Voltage Standard to 5000 Hz and verify that the output does not change by more than 0.15% from that of paragraph 5-33.

5-36 Increase the frequency output of the AC Voltage Standard to 10 KHz and verify that the output does not change by more than 0.15% from that of paragraph 5-33.

5-37 100 MILLIAMPERE RANGE

5-38 Connect the Fluke Model A40-.1 (100 Milliampere) shunt in place of the A40-1. Repeat the steps of paragraphs 5-33 through 5-36.

5-39 10 MILLIAMPERE RANGE

5-40 Connect the Fluke Model A40-.01 (10 Milliampere) shunt in place of the A40-.1. Repeat the steps of paragraphs 5-33 through 5-36.

5-41 1 MILLIAMPERE RANGE

5-42 Connect the equipment as shown in Figure 5-3 using the 1.000K ohms shunt. Total shunt capacitance, including leads and resistor capacitance, must not exceed 200 picofarads.

5-43 Apply 1V RMS at 100 Hz to the input of the Model 2500 and record the DVM reading.

5-44 Increase the frequency of the AC Voltage Standard to 1000 Hz and verify that the DVM reading does not change by more than 0.06%.

5-45 Increase the frequency of the AC Voltage Standard to 5000 Hz and verify that the DVM reading does not change by more than 0.15% from that obtained in the step of paragraph 5-43.

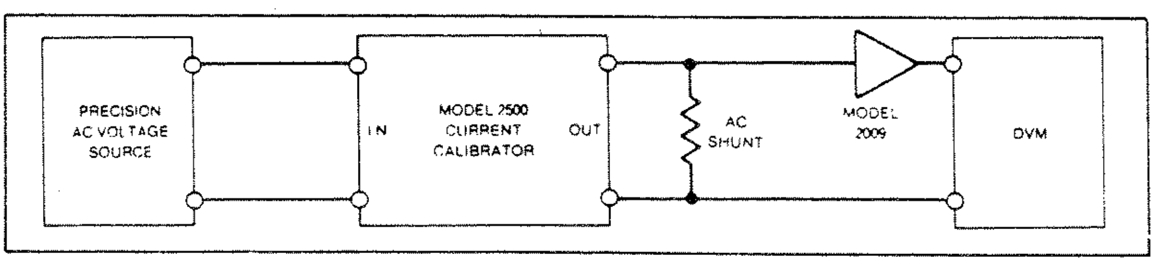


Figure 5-3. Equipment Connections, AC Compliance Test, Lower Ranges.

5-46 Increase the frequency of the AC Voltage Standard to 10 KHz and verify that the DVM reading does not change by more than 0.15% from that obtained in the step of paragraph 5-43.

5-47 100 MICROAMPERE RANGE

5-48 Connect the equipment as shown in Figure 5-3 using the 10.000K Ohms shunt. Total shunt capacitance, including leads and resistor capacitance, must not exceed 20 picofarads.

5-49 Apply 1V RMS at 100 Hz to the input of the Model 2500 and record the DVM reading.

5-50 Increase the frequency of the AC Voltage Standard to 1000 Hz and verify that the DVM reading does not change by more than 0.06%.

5-51 Increase the frequency of the AC Voltage Standard to 5000 Hz and verify that the DVM reading does not change by more than 0.15% from that obtained in the step of paragraph 5-49.

5-52 Increase the frequency of the AC Voltage Standard to 10 KHz and verify that the DVM reading does not change by more than 0.15% from that obtained in the step of paragraph 5-49.

5-53 10 MICROAMPERE RANGE

5-54 Connect the equipment as shown in Figure 5-3 using the 100.00K ohms shunt. Total shunt capacitance, including leads and resistor capacitance, must not exceed 2 picofarads.

5-55 Repeat the steps of paragraphs 5-49 through 5-52.

5-56 1 MICROAMPERE RANGE

5-57 Connect the equipment as shown in Figure 5-3 using the 100.00K ohms shunt. Total shunt capacitance, including leads and resistor capacitance, must not exceed 2 picofarads. Return the AC Voltage Standard to 100 Hz. Record the DVM reading.

5-58 Increase the AC Voltage Standard frequency to 1000 Hz. Verify that the DVM reading does not change by more than 0.06%.

5-59 Increase the AC Voltage Standard frequency to 5000 Hz. Verify that the DVM reading does not change by more than 0.15%

5-60 Increase the AC Voltage Standard frequency to 10 KHz. Verify that the DVM reading does not change by more than 0.15% from that obtained in the step of paragraph 5-57.

NOTE

For factory certifications with National Bureau of Standards traceability, contact your local Valhalla sales representative or Valhalla Scientific, Inc.

5-61 TROUBLESHOOTING

5-62 Difficulties with precision equipment often arise due to misinterpretation of the specifications. Make a careful check with precision test equipment to determine that the equipment is malfunctioning before proceeding with repair procedures.

5-63 POWER SUPPLIES

5-64 The +18V and —18V power supplies are formed by CR16 through CR23 and C9 and C10. These supplies are unregulated and the voltage will vary from 16.5V to 19.8V depending on line voltage and load.

5-65 The +15V DC power supply is formed of Q1, CR4 and R18. This voltage will vary slightly from unit to unit due to component tolerances and will typically be near 14.2V.

5-66 The —15V DC power supply is formed of Q2, CR5 and R20. This voltage will vary slightly from unit to unit due to component tolerances and will typically be near —14.4V.

5-67 AMPLIFIER SERVICING

5-68 Before attempting to service the amplifiers of the Model 2500, it is recommended that the technician review the theory of operation provided in Section IV. The following procedure is only an aid to isolate a catastrophic malfunction to a local area. Short the input terminals and short the output terminals. With the differential DC voltmeter, measure the voltage between the anode of CR15 and pin 6 of IC3. This voltage must be less than 15 millivolts. If it is more than 15 millivolts, IC3 is most likely defective. If it is less than 15 millivolts, the malfunction is in the second amplifier (and/or the current amplifiers), or the feedback network.

NOTE

If IC3, IC4, Q7, Q8 or R34 through R44 are replaced, the AC FREQUENCY RESPONSE TEST *MUST* BE PERFORMED. Contact your Valhalla sales representative or Vallhalla Scientific, Inc. if the AC frequency response test is not satisfactory.

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY
1	C1.4,12	2-10005	Cap Cerm 50pf/500V	56289	5GAQ50	3
2	C2.5	2-30001	Cap Tan 10uf/25V	05397	T360B106M025AS	2
3	C3	2-10001	Cap Cerm 200pf/100V	56289	5GAT20	1
4	C6	2-60002	Cap Paper .1uf/100V	56289	225P10491	1
5	C9,10	2-40002	Cap Elec 11000uf/50V	14655	500-4184-01	2
6	C13	2-70001	Cap Var 2-12pf		21FG010	1
7	C14	2-60001	Cap Paper .22uf,100V Mylar		225P22491	1
8	C15	2-20011	Cap Mica 1000pf,500V Mica		CM06F0102J03	1
9	CR1,2, 6-13,15	3-20000	Diode	07263	IN4148	11
10	CR3,14	3-20005	Diode, Zener	07263	IN5234	2
11	CR16-23	3-20002	Diode, Rect	07263	IN4001	8
12	DS1	5-01005	LED Single Diode,Red		MV5074	1
13	DS2	5-01026	Neon Ind.	IDI	IDI2151A1	1
14	F1	5-04003	Fuse 3A	Little Fuse	312-003	1
15	F2	5-04003	Fuse 1A	Little Fuse	312-001	1
16	IC1,2	3-30013	IC Op-Amp	27014	LM301AH or N	2
17	IC3,4	3-30117	IC Op-Amp	27014	LH0052H	2
18	IC5	3-30036	IC Reg + 15V	27014	LM78MI5CP	1
19	IC6	3-30037	IC Reg - 15V	27014	LM79MI5CP	1
20	J1,3	5-10001	Binding Post	Superior	BP21 RC	2
21	J2,4	5-10002	Binding Post	Superior	BP21 WTC	2
22	J5	5-10063	Power Receptacle	Switch Craft	EAC-301	1
23	Q1,5	3-10007	Transistor NPN	04713	2N2102	2
24	Q6	3-10002	Transistor PNP	04713	2N4036	1
25	Q3,4	3-10000	Transistor FET	15818	U1899E	2
26	Q7	3-10008	Transistor NPN PWR	86684	2N3055 (STEEL)	1
27	Q8	3-10009	Transistor PNP PWR	86684	2N6246-8 (STEEL)	1
28	Q9	3-10003	Transistor NPN	04713	2N5172	1
29	R1-4,45	1-01081	Res Fxd 100K 1/4W 4%	81439	RC07GF104J	5
30	R5-7,16	1-20017	Res Fxd 100K .05% WW	00002	EI27-100K-.05%	4
31	R8	1-50001	Res. Var 50K 10%	91637	89 X R50K	1
32	R9,10	1-10012	Res Fxd 20K 1% MF	81349	RN60C2002F	2
33	R11,14,55	1-01061	Res Fxd 10K 1/4W 5%	81349	RC07GF103J	3
34	R12	1-01053	Res Fxd 4.7K 1/4W 5%	81349	RC07GF472J	1
35	R13,20	1-01043	Res Fxd 1.5K 1/4W 5%	81349	RC07GF152J	2
36	R15,31,32	1-01025	Res Fxd 200ohm 1/4W 5%	81349	RC07GF201J	3
37	R17	1-01041	Res Fxd 1K 1/4W 5%	81349	RC07GF102J	1
38	R19,23-26	1-01015	Res Fxd 47ohm 1/4W 5%	81349	RC07GF470J	5

NOTES:

VALHALLA SCIENTIFIC INC.	PARTS LIST AC-DC Current Calibrator	MODEL : 2500 DWG NO:	REV: D

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY
39	R21,22	1-01038	Res Fxd 750ohm 1/4W 5%	81349	RC07GF751J	2
40	R27-30	1-30001	Res Fxd 1ohm 8W	OHMMITE	1500 BROWN DEVIL	4
41	R33	1-01045	Res Fxd 2K 1/4W 5%	81349	RC07GF202J	1
42	R34	1-20022	Res Fxd 1.01ohm +/-.1% WW			
43	R35	1-20025	Res Fxd 9.09ohm +/-.05% WW	ELLIOT	EI57-9R09-.05% 2PPM	1
44	R36	1-20029	Res Fxd 90.9ohm +/-.05% WW	ELLIOT	EI72-90R9-.05% 2PPM	1
45	R37	1-20012	Res Fxd 897.5ohm WW	ELLIOT	EI48-897R5-.05%	1
46	R38	1-50009	Res Var 5ohm 20%	71450	110-5ohm	1
47	R39	1-20011	Res Fxd 8.9725K WW	ELLIOT	EI48-8.9725K	1
48	R40	1-50010	Res Var 50ohm 20%	71450	110-50ohm	1
49	R41	1-20010	Res Fxd 89.725K WW	ELLIOT	EI48-89.725K-.05%	1
50	R42	1-50004	Res Var 500ohm 20%	71450	X201R501	1
51	R43	1-20009	Res Fxd 897.25K WW	ELLIOT	EI48-897.25K-.05%	1
52	R44	1-50003	Res Var 5K 20%	71450	X201R502	1
53	R46	1-50012	Res Var 10K	BECKMAN	68WR 10K	1
54	R47	1-50013	Res Var 1K	BECKMAN	68WR 1K	1
55	R48,54	1-50014	Res Var 100ohm	BECKMAN	68WR 100ohm	2
56	R50	1-01021	Res Fxd 100ohm 1/4W 5%	81349	RC07GF101J	1
57	R51	1-10033	Res Fxd 6.34K 1%	81349	RC60C6341F	1
58	R52	1-10031	Res Fxd 634ohm 1%	81349	RN60C6340F	1
59	R53	1-10032	Res Fxd 69.8ohm 1%	81349	RN60C698RF	1
60	R56	1-01010	Res Fxd 18ohm 1/4W 5%	81349	RC07GF180F	1
61	S1	5-03004	Range Switch	71590	VS5-03004	1
62	S2	5-03003	Power Switch	71590	004184	1
63	T1	4-20005	Power Transformer	53504	2500-010	1
64	1 ea.	4-30007	P.C. Board	53504	2500-700	1
65	1 ea.	4-30008	P.C. Board	53504	2500-701	1
66	1 ea.	4-10009	Top Cover	53504	3003-202	1
67	1 ea.	4-10016	Bottom Cover	53504	2500-201	1
68	1 ea.	4-10546	2500 "SCREENED" FRONT PANEL	53504	2500-100	1
69	2 ea.	4-10018	Side Rail	53504	2500-202	2
70	2 ea.	4-10019	Heat Sink	53504	2500-203	2
71	1 ea.	4-10022	Rear Panel	53504	2500-204	1
72	4 ea.	5-10015	Rubber Foot	08065	2091-W467	4
73	1 ea.		Power Cord			1
74	2 ea.	5-10057	Socket IC 8-Pin Round		8-IC5	2

NOTES:

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY
75	5 ea.	5-10005	Standoff		1530B-3/16	5
76	4 ea.		Solder Tail Contacts			4
77	2 ea.	5-10004	Fuse Clips		101002	2
78	1 ea.	5-10018	Fuse Holder		342004A	1
79	6"		3/4" X 1/2 Sponge Type	Adhesive	Black Weather Stripping	1
80	8 ea.	5-10073	Button, Switch,BLK	71590	B-304-BLK	8
			HARDWARE:			
81	4 ea.		Screw, S.S., Phil Pan		8-32 X 3/8	4
82	6 ea.		Screw, Blk, Allen HD		6-32 X 3/8	6
83	17 ea.		Screw, S.S., Phil Pan		6-32 X 3/8	17
84	8 ea.		Screw, Nylon, Pan		4-40 X 1/2	8
85	2 ea.		Screw, S.S., Phil Pan		4-40 X 3/8	2
86	4 ea.		Screw, S.S., Phil Pan		6-32 X 1/4	4
87	4 ea.		Screw, S.S., Phil Flat		6-32 X 3/8	4
88	2 ea.		Washers, Internal Star		#4	2
89	21 ea.		Washers, Internal Star		#6	21
90	4 ea.		Washer, Split Lock		#6	4
91	4 ea.		Nut, Radio Hex		6-32	4
92	2 ea.		Nut, Radio Hex		4-40	2
93	1 ea.		WIRE BROWN 30"		22AWG BRN	1
94	1 ea.		WIRE BLACK 4"		22AWG BLK	1
95	1 ea.		WIRE GREEN 6"		12AWG GRN	1
96	1 ea.		WIRE VIOLET 6"		12AWG VIO	1
97	1 ea.		WIRE BUS 9"		22AWG BUS	1
98	1 ea.		WIRE RG 58C/U 5"		RG 58C/U	1
99	1 ea.		INSULATOR CLEAR 9"		22 AWG CLEAR	1
100	1 ea.		SHRINK TUBING 1/4DIA 5"		1/4 DIA BLK	1
101	4 ea.		LUG RING #6 18-22 AWG		#6 18-22 AWG	4
102	3 ea.		LUG RING #6 14-16 AWG		#6 14-16 AWG	3
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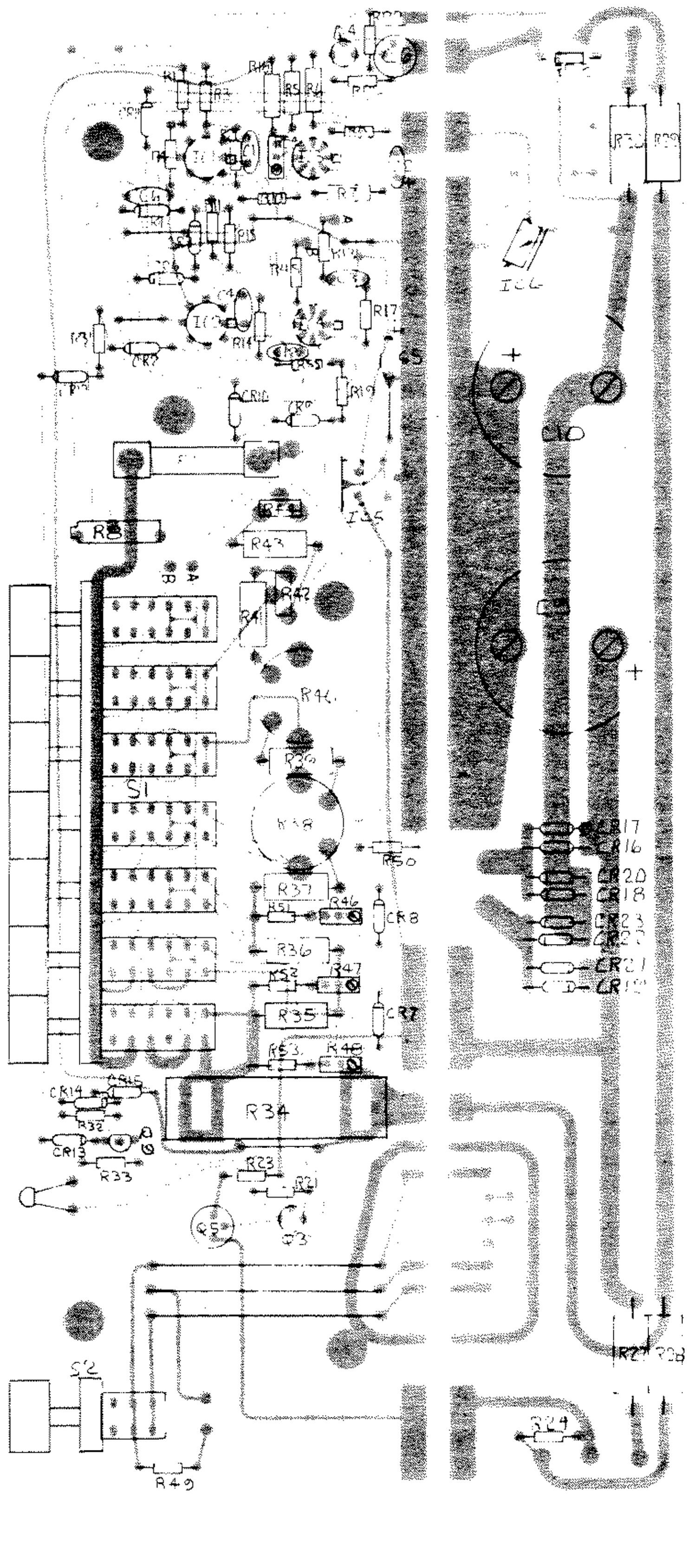

Figure 5-4 Component Locations, Circuit Board.