KEITHLEY

Model 262 Low Thermal Voltage Divider
Instruction Manual

A GREATER MEASURE OF CONFIDENCE

WARRANTY

Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local Keithley representative, or contact Keithley headquarters in Cleveland, Ohio. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without Keithley's express written consent, or misuse of any product or part. This warranty also does not apply to fuses, software, non-rechargeable batteries, damage from battery leakage, or problems arising from normal wear or failure to follow instructions.

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Model 262 Low Thermal Voltage Divider
Instruction Manual

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Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and *contact with hazardous live circuits.*

Maintenance personnel perform routine procedures on the product to keep it operating, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) *states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or* 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product users in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

As described in the International Electrotechnical Commission (IEC) Standard IEC 664, digital multimeter measuring circuits (e.g., Keithley Models 175A, 199, 2000, 2001, 2002, and 2010) are Installation Category II. All other instruments' signal terminals are Installation Category I and must not be connected to mains.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or

removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a  screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

SPECIFICATIONS

DIVIDER RATIO	ACCURACY (1 Year)* 22°-24°C	TEMPARATURE COEFFICIENT 18°-28°C	OUTPUT NOISE (0.1Hz Bw)	THERMAL DRIFT**
10^2 : 1	± 35ppm	2ppm/°C	10nV p-p	10nV
10^3 : 1	± 35ppm	2ppm/°C	10nV p-p	10nV
10^4 : 1	±100ppm	10ppm/°C	1nV p-p	3nV
10^5 : 1	±100ppm	10ppm/°C	1nV p-p	3nV

*Referenced to output terminals.

**For ambient temperature changes ≤1°C/hour. Includes effects of supplied cable.

INPUT RESISTANCE: 20kΩ for divider ratios of 10^2:1 and 10^4:1; 200kΩ for divider ratios of 10^3:1 and 10^5:1.

OUTPUT RESISTANCE: 2Ω for divider ratios of 10^4:1 and 10^5:1; 200Ω for divider ratios of 10^2:1 and 10^3:1.

OVERLOAD PROTECTION: Maximum operating input voltage is 20V. Input is protected against 1000V overloads from calibrators with current limits up to 150mA.

CONTROLS: Polarity and divider ratio.

CONNECTORS: Input: 5-way binding posts for input, sense, and case ground. **Output:** Special low thermal female connector; mates with Models 1506, 1507, 1481, and 1482.

ENVIRONMENTAL LIMITS: Operating: 18°-28°C, 0 to 60% relative humidity. **Storage:** −25° to 65°C.

DIMENSIONS, WEIGHT: 114mm high × 165mm wide × 184mm deep (4½ in. × 6½ in. × 7¼ in.). Net weight 2kg (4½ lbs.).

ACCESSORY SUPPLIED: Low thermal male-to-male cable (3 ft.) for connecting to Models 148 and 181.

ACCESSORIES AVAILABLE:

Model 1481 Low Thermal Twin Lead Shielded Input Cable (4 ft. with clips)

Model 1482: Low Thermal Twin Lead Shielded Input Cable (10 ft. bare copper leads)

Model 1483: Low Thermal Connection Kit

Model 1484: Refill Kit for 1483 Kit

Model 1485: Female Low Thermal Input Connector

Model 1486: Male Low Thermal Input Connector

Model 1503: Low Thermal Solder and Flux

Model 1506: Low Thermal Triax Cable (4 ft. with clips)

Model 1507: Low Thermal Triax Cable (4 ft. with lugs)

OUTPUT NOISE: Source noise is measured over a 30 second interval. Use supplied cable when making measurements. When measuring noise of the Model 262 using the Model 148 (which has 1nV p-p noise spec), the total noise will not exceed 1.4nV p-p for 98.76% of the time.

THERMAL DRIFT: Thermal drift is measured with the Model 262's polarity switch set to zero. Specifications apply to the Model 262 and supplied cable only. Thermal drift is a function of the rate of change of ambient temperature. Using a two channel chart recorder, monitor the rate of change of ambient temperature versus drift due to thermal EMFs. See example below:

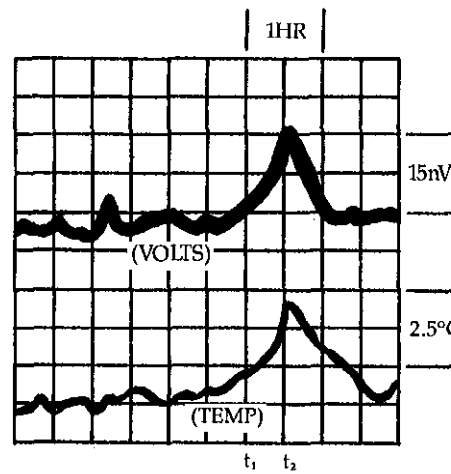
$\Delta t = t_2 - t_1 = 0.5hr$

$\Delta V|_{t_1}^{t_2} = 15nV$

$\Delta T|_{t_1}^{t_2} = 2.5°C$

$\Delta V/\Delta T/\Delta t = 15nV/2.5°C/0.5hr$

$\Delta V/\Delta T/\Delta t = 3nV/°C/hr$



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GENERAL INFORMATION

INTRODUCTION

The Model 262 is a precision low thermal divider with divider ratios of 10^2:1, 10^3:1, 10^4:1 and 10^5:1. The Model 262 is designed to calibrate nanovoltmeters and 1μV sensitive DMMs. A low thermal male-to-male output cable is included with the Model 262.

OPTIONAL ACCESSORIES

Model 1481 Low Thermal Input Cable is useful for making temporary connections in low voltage circuits. The 1.2m (4') cable is terminated with two alligator clips and a male low thermal connector. Recommended for use with the Model 148 Nanovoltmeter.

Model 1482 Low Thermal Input Cable allows a user to make his own special, low thermal input connections for the Model 148. The 3m (10') cable is terminated with a male, low thermal connector and two bare copper leads.

Model 1483 Low Thermal Connection Kit is useful for making low thermal connections in experimental setups. The kit contains a crimp tool, pure copper lugs, alligator clips, low thermal cadmium solder and assorted hardware.

Model 1484 Refill Kit contains replacement parts for the Model 1483 Low Thermal Connection Kit.

Model 1485 Female Low Thermal Input Connector is the connector for Models 148, 181, and 262.

Model 1486 Male Low Thermal Connector mates with the input connector for Models 148, 181 and 262. It allows the user to make a custom length input cable.

Model 1503 Low Thermal Solder is useful when making connections to low voltage circuits.

Model 1506 Low Thermal Input Cable is a triaxial 1.2m (4') cable specially designed to provide excellent shielding for input connections to the Model 181. It has a mating connector and two copper alligator clips. Recommended for use with the Model 262.

Model 1507 Low Thermal Input Cable is a triaxial cable, 1.2m (4'), similar to the Model 1506, but has two copper spade lugs instead of clips. Recommended for use with the Model 262.

WARRANTY INFORMATION

Warranty information is provided on the inside, front cover of this manual. If there is a need to exercise the warranty, contact the Keithley representative in your area to determine the proper action to be taken.

Information concerning the applicaton, operation or service of your instrument may be directed to the applications engineer. Check the inside front cover of this manual for addresses.

MANUAL ADDENDA

Improvements or changes to this manual will be explained on an addendum included with this manual.

SAFETY SYMBOLS AND TERMS

Safety symbols used in this manual are as follows:

The symbol  on the instrument denotes that the user should refer to the operating instructions.

The symbol  on the instrument denotes that 1000V or more may be present on the terminal(s).

The **WARNING** used in this manual explains dangers that could result in personal injury or death.

The **CAUTION** used in this manual explains hazards that could damage the instrument.

UNPACKING AND INSPECTION

The Model 262 is inspected both mechanically and electrically before shipment. Upon receiving the Model 262 unpack all items from the shipping container and check for any obvious damage that may have occurred during transit. Report any damage to the shipping agent. Retain and use the original packaging materials if reshipment is necessary. The following items are shipped with all Model 262 orders:

- Model 262 Low Thermal Voltage Divider
- Model 262 Instruction Manual
- Low Thermal Male-to-Male Cable (part number 262-315)
- Optional accessories as ordered.

REPACKING FOR SHIPMENT

The Model 262 should be packed in its original carton. Before packaging, wrap the instrument in plastic. After it is placed in the box, surround the instrument with styrofoam packaging material.

OPERATION

INTRODUCTION

To operate the Model 262, connect the unit to a DC calibrator and the nanovoltmeter or DMM that is to be calibrated, and select the desired output. See Figures 1 and 2.

NOTE

The Model 262 is designed to be used with a DC voltage calibrator equipped with remote sensing.

NOTE

The user should be familiar with low thermal measuring techniques.

ENVIRONMENTAL CONDITIONS

All measurements should be made at an ambient temperature within the range of 18°C to 28°C, and 0 to 60% relative humidity. Environmental conditions for storage are from −25°C to 65°C.

If the instrument has been subjected to temperature extremes, allow sufficient time for internal temperatures to reach environmental conditions. Typically, it takes one to four hours to stabilize a unit that is 10°C (18°F) out of specified temperature range.

MODEL 262 CONTROLS AND CONNECTORS

The POLARITY switch settings are as follows:

0 Position—In this standby position the DC calibrator input voltage is removed from the Model 262 divider. Use this position when zeroing the nanovoltmeter or DMM.

POS and NEG Positions—These two settings invert the Model 262 output and are useful for checking roll over.

The DIVIDER RATIO switch settings are as follows:

10^2 Position—divides input voltage by 100.
10^3 Position—divides input voltage by 1k.
10^4 Position—divides input voltage by 10k.
10^5 Position—divides input voltage by 100k.

Model 262 connectors are as follows. See Figure 1 through 3 for various equipment set ups.

INPUT Connectors—five way binding posts. Connect to the input of the DC calibrator.

CAUTION
Never apply more than 20VDC to the Model 262. Instrument damage not covered by the warranty may result.

SENSE Connectors—five way binding posts. Connect to the sense terminals of the DC calibrator.

CAUTION
Remove all shorting links from the DC calibrator and the instrument to be calibrated. Switching polarity on the Model 262 with shorting links installed could short out the DC calibrator. Also, shorting links may cause ground loops which will disturb calibration.

Chassis Ground Connector—five way binding post. Connect to the earth ground terminal of the DC calibrator.

OUTPUT Low Thermal Connector—Connect to nanovoltmeter or DMM using the supplied low thermal cable or equivalent.

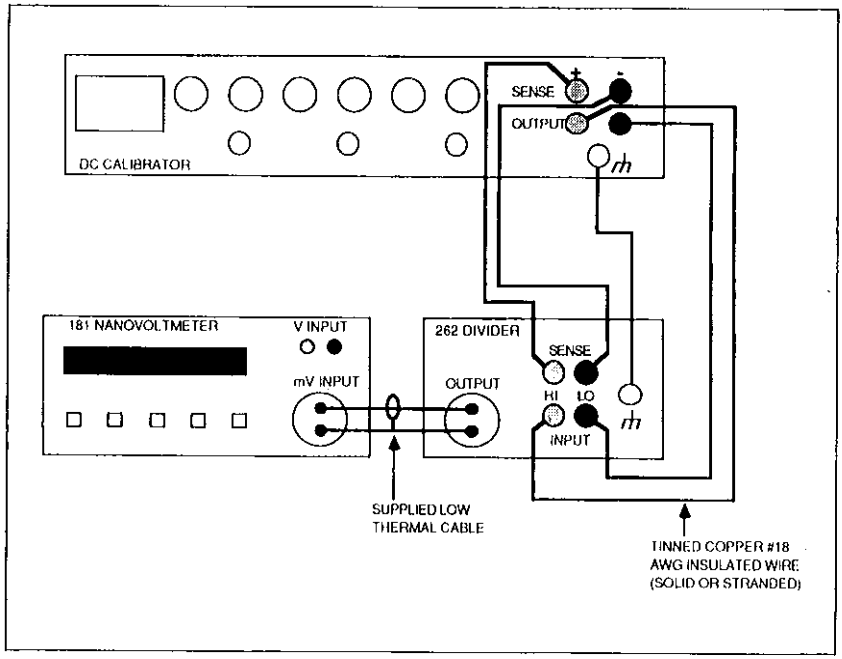


Figure 1. Digital Nanovoltmeter Calibration

MODEL 181 VERIFICATION AND CALIBRATION (2mV, 20mV and 200mV Ranges)

Use the following procedures to verify and calibrate the Model 181 Digital Nanovoltmeter.

NOTE

The Model 262 eliminates the need for a Kelvin-Varley Divider (which generates thermal EMFs) and a custom-made divider box when verifying and calibrating the 2mV, 20mV and 200mV range of the Model 181. Follow the basic verification and calibration procedures found in the Model 181 Service Manual, Document Number 30816, substituting the Model 262 for the Kelvin-Varley Divider and custom-made divider box.

DC Voltage Accuracy Check (2mV, 20mV and 200mV)

Set up the equipment as shown in Figure 1 and use Table 1 to verify the accuracy of the Model 181. Be sure to use a DC Voltage Calibrator with 0.001% or better accuracy. Use both the POS and NEG polarities of the Model 262.

Table 1. Model 181 Verification (2mV, 20mV and 200mV)

181 Range	262 Divider	DC Calibrator Output	Allowable Reading at 18°C to 28°C
2mV	10^3:1	1.9V	1.89967 to 1.90033mV
20mV	10^3:1	19V	18.9970 to 19.0030 mV
200mV	10^2:1	19V	189.970 to 190.030 mV

Nanovolt Preamp Calibration (2mV, 20mV and 200mV)

With the equipment set up as shown in Figure 1, calibrate the Model 181 using Table 2.

Table 2. Model 181 Calibration (2mV, 20mV, and 200mV)

181 Range	262 Divider Ratio+	DC Calibrator Output	Pot Adjustment	Readings
2mV	10^3:1	1.9V	R409	1.900000 ±25 digits
20mV	10^3:1	19V	R410	19.00000 ±10 digits
200mV	10^2:1	19V	R411	190.0000 ±10 digits

MODEL 148 NANOVOLT VERIFICATION

Use the following procedure to verify the accuracy of the Model 148 Nanovoltmeter.

1. Set up the equipment as shown in Figure 2. Use a DMM, such as the Keithley Model 178, to monitor the analog output of the Model 148. Make sure the DC Voltage Calibrator has an accuracy of 0.001% or better.
2. Remove the LO to earth ground link on the rear panel of the Model 148.
3. Using Table 3, check the listed ranges of the Model 148.

Table 3. Model 148 Verification

148 Range	262 Divider Ratio	DC Calibrator Output	DMM Reading
0.01mV	10^3:1	10mV	1VDC ± 10mV
0.03mV	10^3:1	30mV	1VDC ± 10mV
0.1 mV	10^3:1	100mV	1VDC ± 10mV
0.3 mV	10^3:1	300mV	1VDC ± 10mV
1 mV	10^2:1	100mV	1VDC ± 10mV
3 mV	10^2:1	300mV	1VDC ± 10mV
10 mV	10^2:1	1 V	1VDC ± 10mV
30 mV	10^2:1	3 V	1VDC ± 10mV
100 mV	10^2:1	10 V	1VDC ± 10mV
0.01 μV	10^5:1	1mV	1VDC ± 10mV
0.03 μV	10^5:1	3mV	1VDC ± 10mV
0.1 μV	10^5:1	10mV	1VDC ± 10mV
0.3 μV	10^5:1	30mV	1VDC ± 10mV
1 μV	10^4:1	10mV	1VDC ± 10mV
3 μV	10^4:1	30mV	1VDC ± 10mV
10 μV	10^3:1	10mV	1VDC ± 10mV
30 μV	10^3:1	30mV	1VDC ± 10mV
100 μV	10^3:1	100mV	1VDC ± 10mV

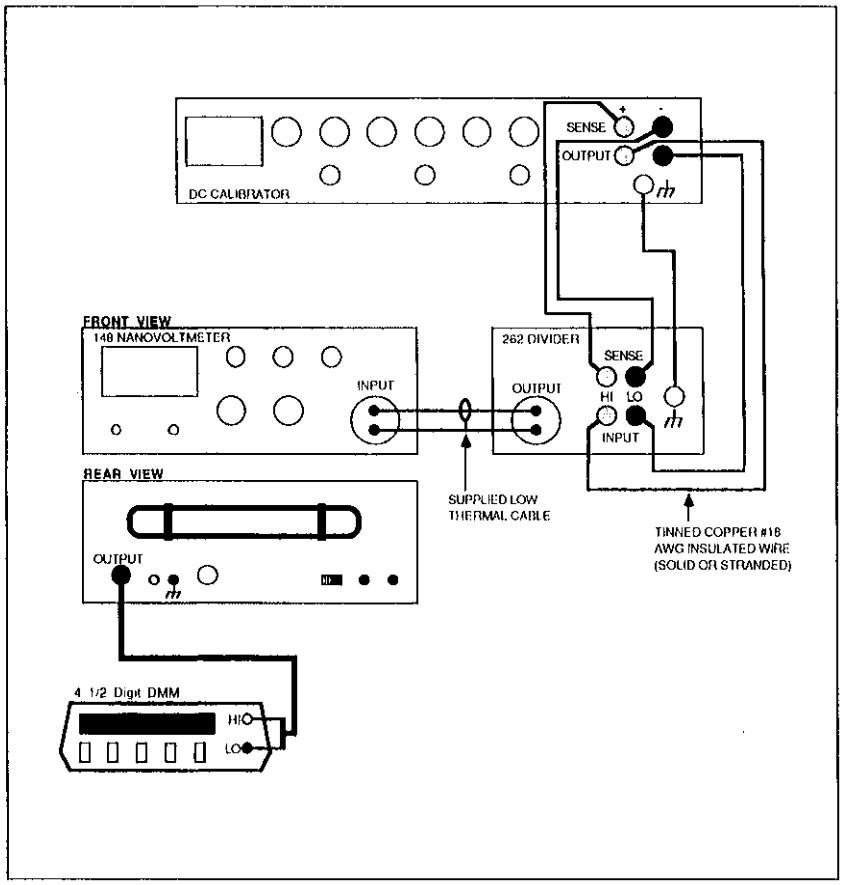


Figure 2. Analog Nanovoltmeter Calibration

DMM CALIBRATION

To calibrate 1μV or more sensitive DMMs do the following procedure.

1. Set up the equipment as shown in Figure 3. The Model 1507, a low thermal input cable terminated with copper lugs, is recommended when connecting to five-way binding posts. For DMMs that have banana jacks that are not five-way, low thermal banana plugs* must be used.

2. Refer to Table 4 for calibrating the 20mV and 200mV ranges of 1μV sensitive DMMs.

*Low thermal banana plugs are available, on special order, from Pomona Electronics.

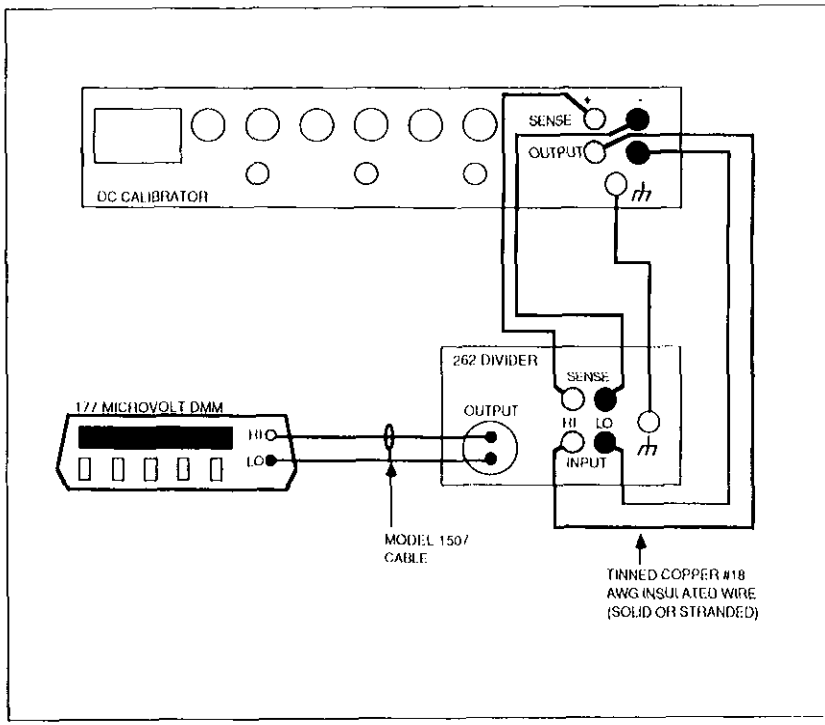


Figure 3. DMM Calibration

Table 4. DMM Calibration

DMM Range	262 Divider Ratio	DC Calibrator Output
20mV	10^3:1	19V
200mV	10^2:1	19V

CALIBRATION

INTRODUCTION

Calibration consists of nulling the three adjustable legs of the Model 262 divider to a standard divider (see Figure 4). A lead compensator is used to compensate for the lead resistances of the standard divider and the Model 262. Failure to compensate for lead resistance variances will result in an invalid calibration.

NOTE

This calibration procedure is intended for qualified electronic maintenance personnel who are familiar with low thermal techniques, standard metrology lab procedures and the use of the lead compensator. Calibration should be done yearly and checked whenever the performance of the unit is in question.

NOTE

If a lead compensator other than the Model 721A is used and it does not have a range of 500 or greater, a shunt resistor across the input of the Kelvin-Varley divider (720A) will be needed for "Adjustment One". Use a 2kΩ to 5kΩ value with a TC of 20ppm/°C or better. Connect it between the 1.0 Input Terminal and the Input Low Terminal (see Figure 4).

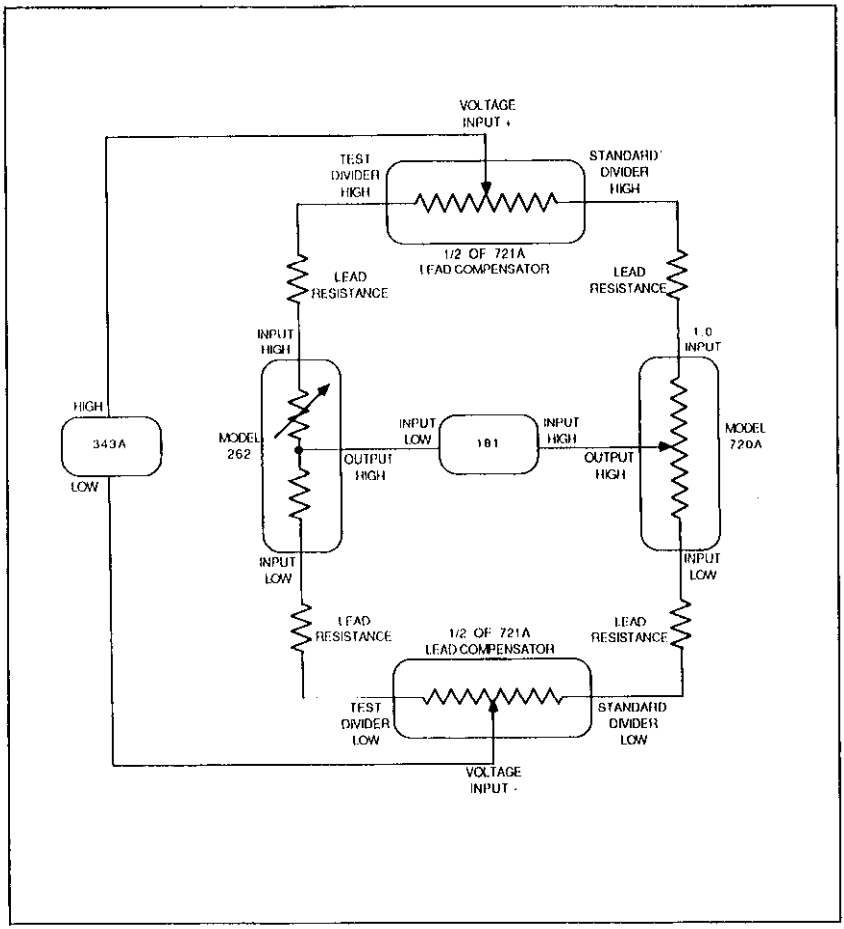


Figure 4. Calibration Configuration Schematic

ENVIRONMENTAL CONDITIONS

Calibration must be performed in a measurement lab at 23 ±1°C and 30-60% relative humidity.

Precautions:

1. Use low thermal techniques. Clean copper lugs with Scotch Brite® . Do not touch connections with hands after cleaning. Make sure that all connections are tight and that copper to copper connections are protected from air currents by foam sleeves or wrap. Always wait at least one minute after making a low thermal connection before making adjustments or taking readings.
2. Be careful not to disturb lead compensator settings during calibration by brushing with leads or hands.
3. The settings and readings called out in this procedure are thermally sensitive. Allowance was made for some drift when the limits and procedure were determined. It is good practice to null as close to zero as possible, then wait 10-20 seconds to assure that the null has not drifted (due to temperature gradients) outside the limits specified.

INITIAL EQUIPMENT CONDITIONS

Refer to Table 5 for recommended equipment

1. Turn the DC calibrator and the Model 181 on, and allow to warm up and stabilize for four hours.
2. Set the DC calibrator to output 0.000000V (10 volt range) and set the current limit between 15-25mA.
3. Set the Model 181 to the 2mV range. High resolution, damping, and filter MUST be off.
4. Set the lead compensator to the "R STD greater than R TEST" mode. Keep the VOLTAGE switch in the ON position.
5. Set the Kelvin-Varely divider to all zeroes.

Table 5. Recommended Equipment

Item	Description	Mfr.	Model
A	DC Calibrator (0.002%)	Fluke	343A
B	Lead Compensator	Fluke	721A
C	Kelvin-Varley Divider	Fluke	720A
D	Nanovoltmeter	Keithley	181
E	Low Thermal Input Cable (2 required)	Keithley	1507
F	Wire-Single Conductor 12 AWG, Copper		
G	Bolt—#8-32 × ¼"; mating nut #8-32		

ADJUSTMENT ONE

Low Lead Compensation (Coarse)

1. Set up the circuit as shown in Figure 5 A and B (refer to Table 5 for recommended equipment). Connect the DC calibrator to the lead compensator using unterminated copper wire test leads. Connect the clean copper wires directly to the binding posts. (Do not use banana plugs). Connect the input low of the Model 181 to the output low of the Model 262 using a bolt (Item G, Table 5) to secure the clean copper lugs (see cleaning instructions). Wrap the low thermal junctions to minimize thermals.

NOTE

Whenever low thermal cables are disturbed wait at least one minute for stabilization to occur.

2. Set the Model 262 to POS polarity and 10^4 ratio. During the entire procedure the POLARITY control on the Model 262 MUST NOT be disturbed. Remove the calibration cover (held in place by two retaining screws on the left side of the Model 262) and push in the CALIBRATION switch.

CAUTION

Do not apply more than 1.9V to the Model 262 when the CALIBRATION switch is pushed in. Application of a higher voltage will cause self heating of precision components and possible resistor damage.

3. Make sure that the Kelvin-Varley divider is set to all zeroes.
4. Zero the Model 181 with the DC calibrator outputting 0.000000V.
5. Set the DC calibrator to output 1.900000V.
6. Adjust the lead compensator's low balance controls to obtain a null ±0.00050mV (including noise) on the Model 181 (2mV range).

NOTE

The low compensation setting in ADJUSTMENT ONE can be altered significantly if the POLARITY or DIVIDER RATIO controls of the Model 262 are disturbed during this adjustment. Avoid bumping or jarring the Model 262 or these controls during ADJUSTMENT ONE.

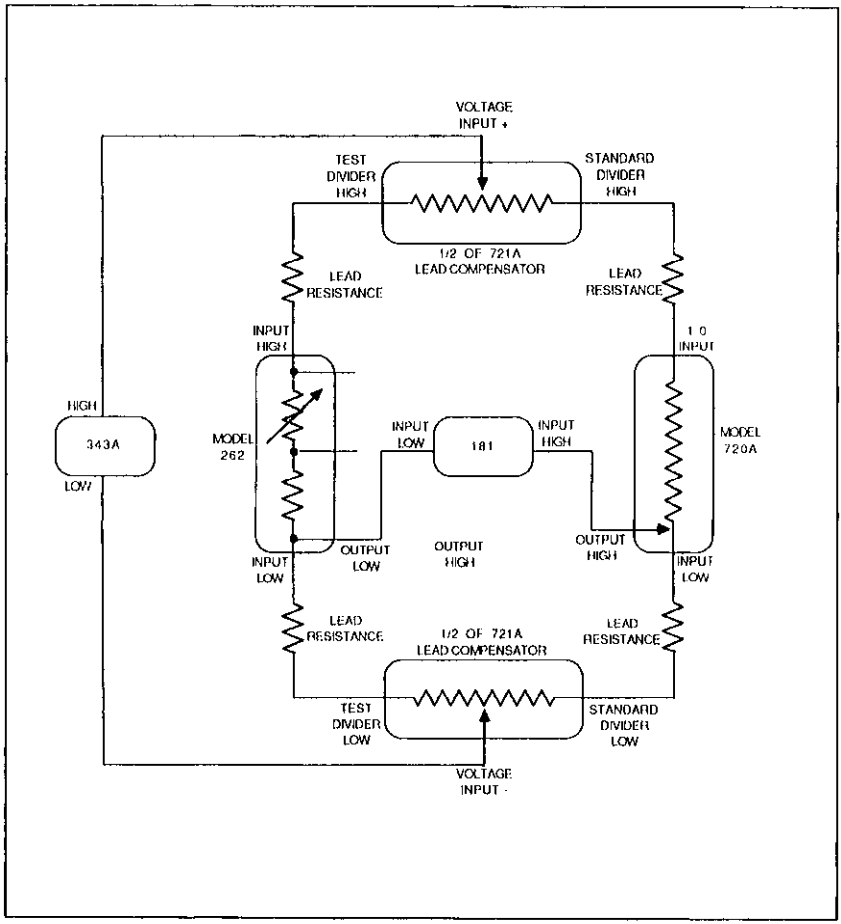


Figure 5A. LO Lead Compensation Schematic

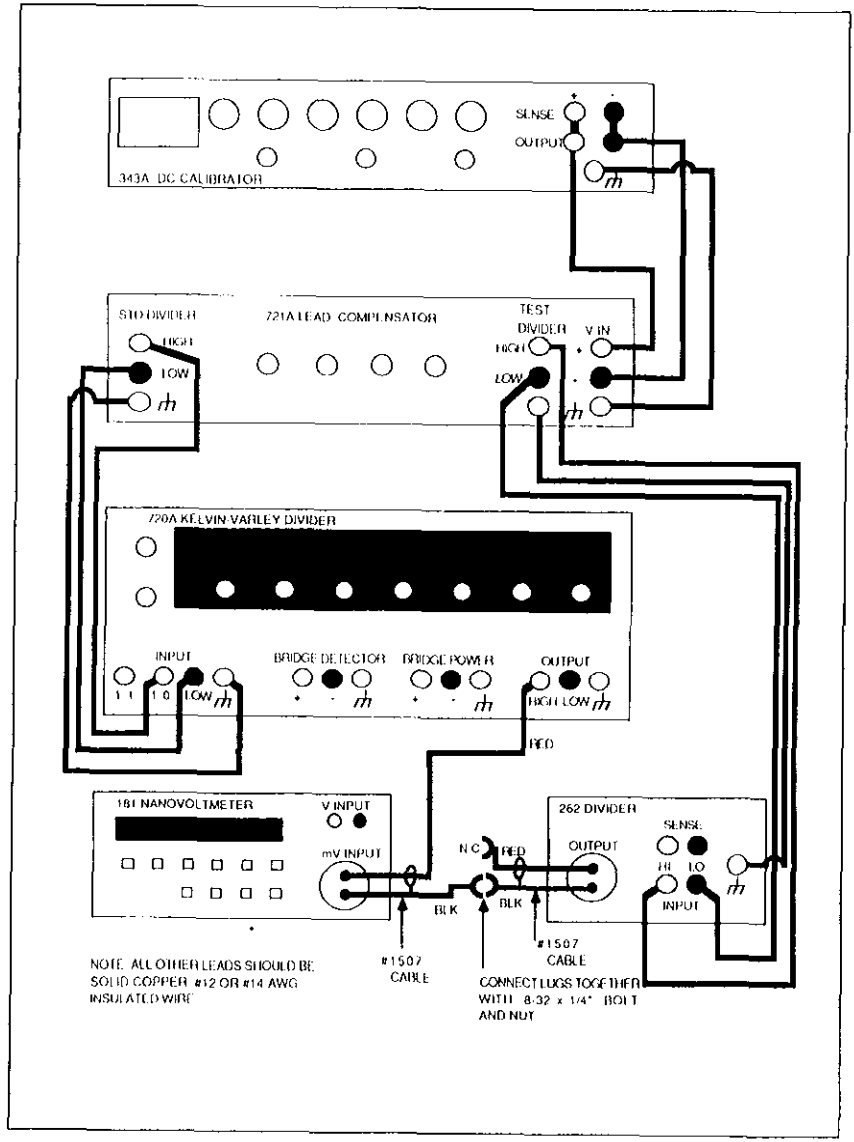


Figure 5B. LO Lead Compensation Connection Diagram

High Lead Compensation

7. Modify the equipment set up as shown in Figure 6A and B.
8. Set the Kelvin-Varley divider to 0.999999X.
9. Zero the Model 181 with the DC calibrator outputting 0.000000V.
10. Set the DC calibrator to output 1.900000V.
11. Adjust the lead compensator's high balance controls to obtain a null on the Model 181 (2mV range) within the high lead compensation limit specified in Table 6.
12. Set the DC calibrator to output 0.000000V.

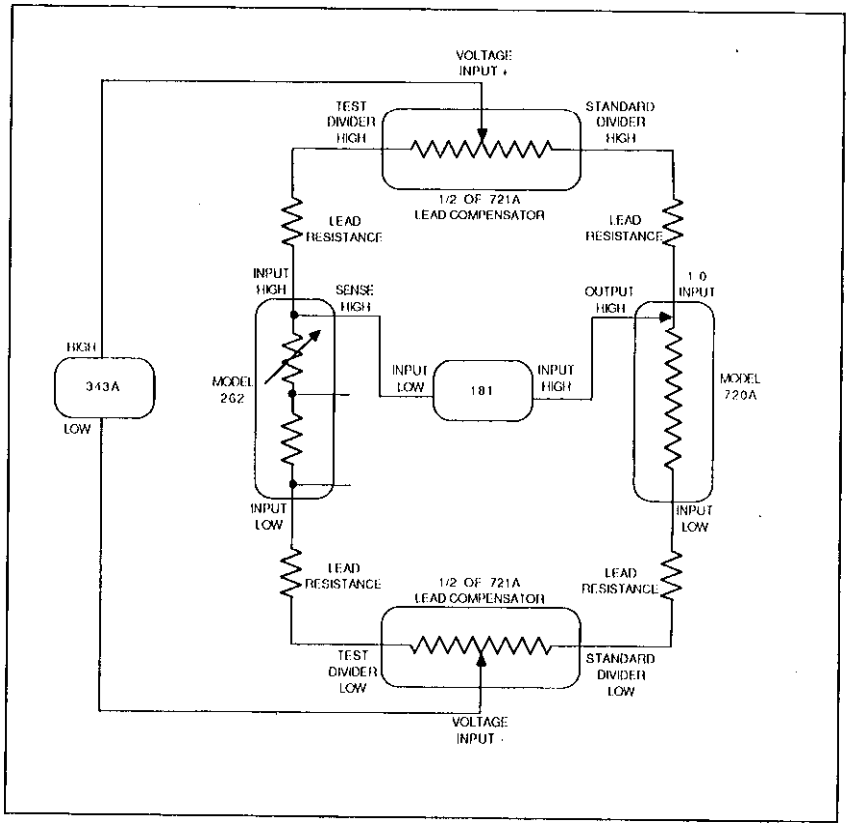


Figure 6A. HI Lead Compensation Schematic

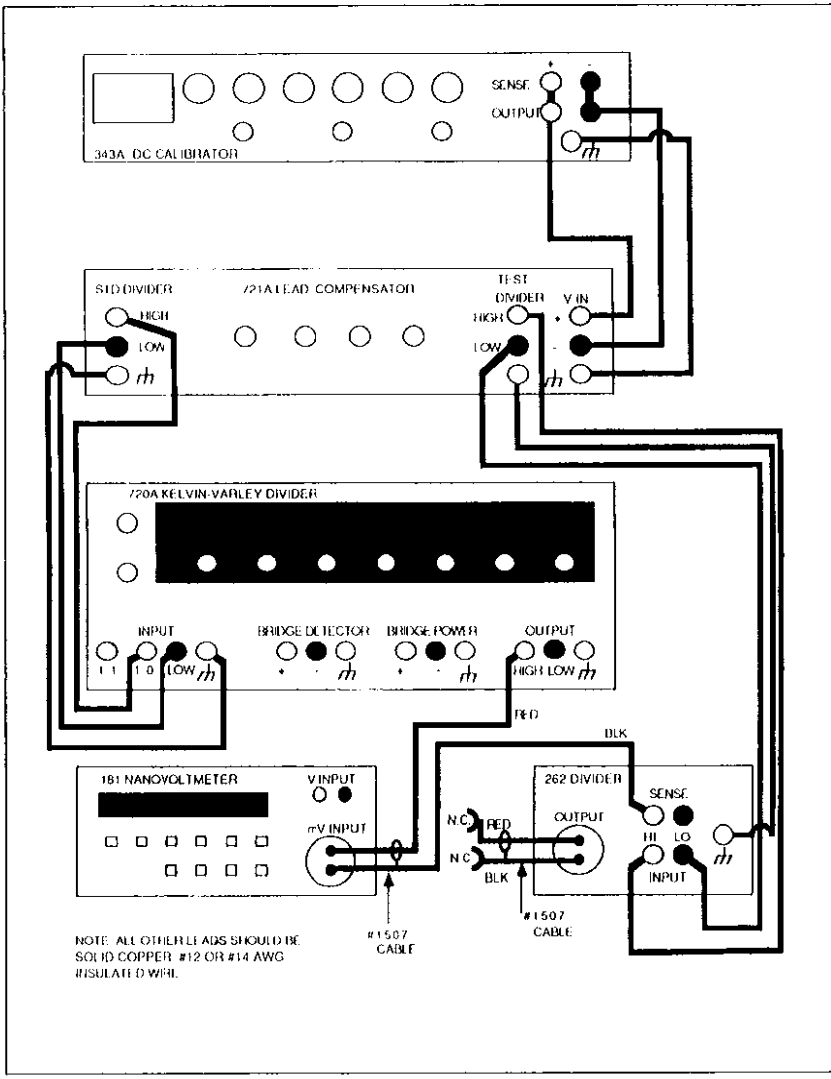


Figure 6B. HI Lead Compensation Connection Diagram

Low Lead Compensation (Final)

13. Change the equipment set up back to that illustrated in Figure 5A and B.
14. Set the Kelvin-Varley divider to all zeroes.
15. Zero the Model 181 with the DC Calibrator outputting 0.000000V.
16. Set the DC calibrator to output 1.900000V.
17. Adjust the lead compensator's low balance controls to obtain a null on the Model 181 (2mV range) within the low lead compensation limit specified in Table 6. Record the actual reading displayed on the Model 181.
18. Set the DC calibrator to output 0.000000V. Reverse the calibrator output leads. After allowing 30 seconds for the reading to settle, zero the Model 181.
19. Set the calibrator to 1.900000V and record the reading displayed on the Model 181.
20. The sign of the voltages recorded for steps 17 and 19 is expected to differ. However, the absolute value must not. Repeat steps 15 through 19 until the absolute value of the readings differs by less than 100nV (0.00010mV).
21. Set the DC calibrator to output 0.000000V and return the output leads to the original configuration for "+" outputs.

Pot Adjustment

22. Modify the equipment set up as shown in Figure 7A and B.
23. Set the Kelvin-Varley divider to 0.0100000.
24. With the DC calibrator set to 0.000000V, zero the Model 181.
25. Set the DC calibrator to output 1.900000V.
26. Adjust Calibration Pot R105 (See Figure 8) to obtain a null on the Model 181 (2mV range) within the adjustment limit for R105 specified in Table 6. Record the actual reading obtained.
27. Set the DC calibrator to output 0.000000V and reverse the calibrator output leads. After allowing 30 seconds for the reading to settle, rezero the Model 181.
28. Set the DC calibrator to 1.900000V and record the reading displayed on the Model 181.

29. The sign of the voltages recorded in steps 26 and 28 is expected to differ. However, the absolute value must not. Repeat steps 24 through 28 until the absolute value of the readings differs by less than 100nV (0.00010mV).
30. Set the DC calibrator output to 0.000000V and return the output leads to the original configuration for "+" output.

Final Low Lead Compensation Check

31. Repeat Low Lead Compensation (Final), except DO NOT readjust settings. Instead, verify that null in step 20 is within the adjustment limit specified in Table 6 and that readings differ by less than 100nV (0.00010mV) in step 29.
32. If these limits are not met, it will be necessary to repeat the above ADJUSTMENT from the beginning. If these limits are met, go on to the next adjustment.

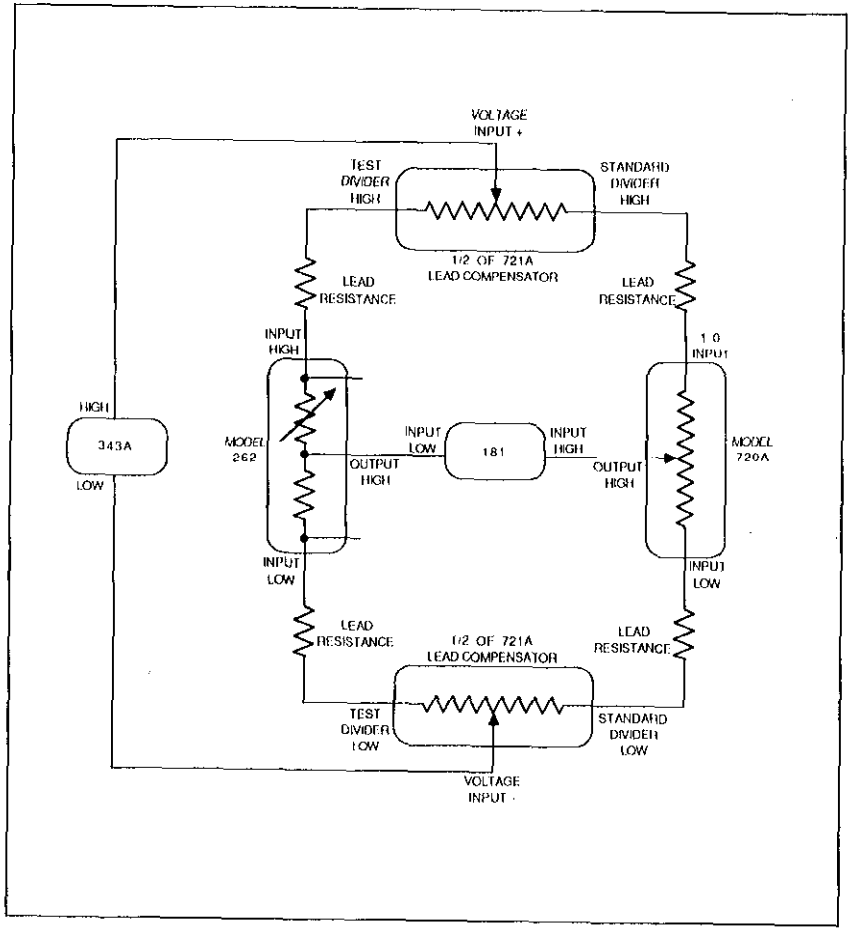


Figure 7A. Pot Adjustment Set Up Schematic

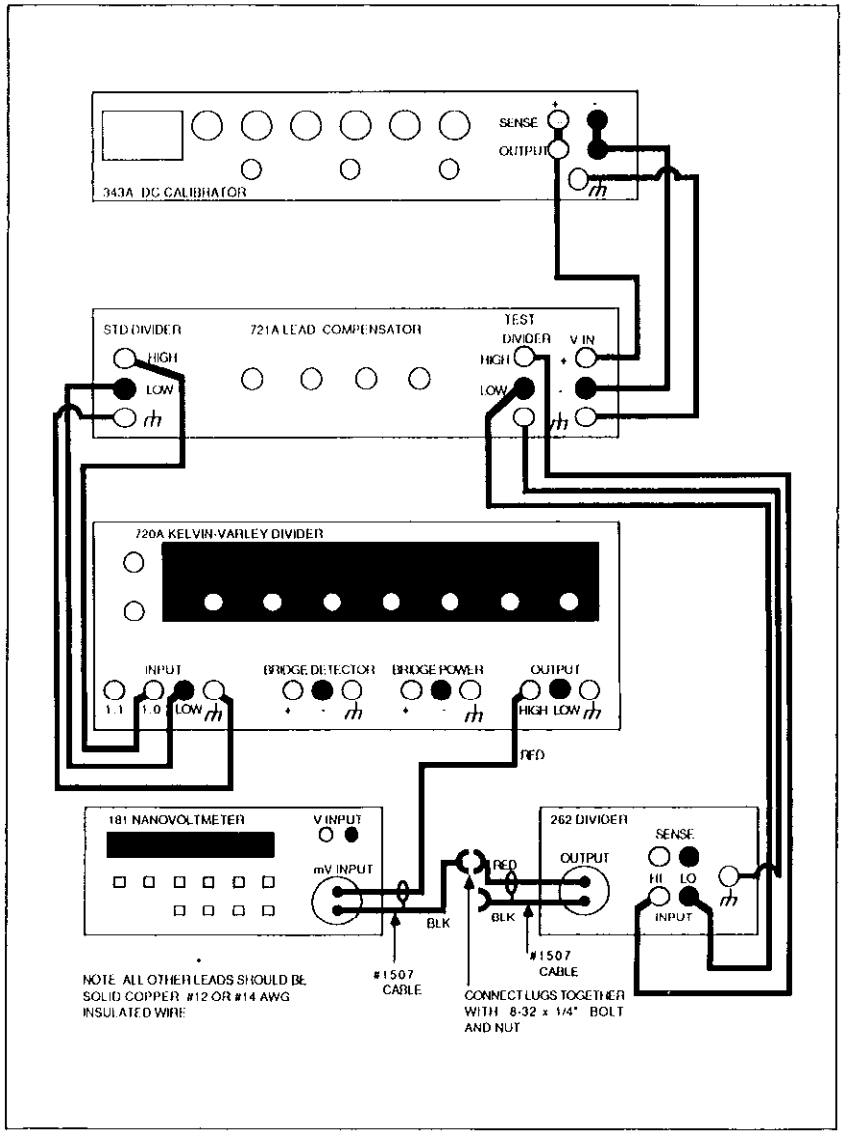


Figure 7B. Pot Adjustment Connection Diagram

ADJUSTMENT TWO

The procedure used in ADJUSTMENT ONE is followed from the beginning with the following changes:

1. Set the Model 262 to the 10^2 ratio and **release** the CALIBRATION switch (step 2).
2. Output 19V, instead of 1.9V, from the DC calibrator (100V range), in steps 5, 10, 16, 19, 25 and 28.
3. Adjust only R106 in Step 26 of Pot Adjustment. See Figure 8 for location. Be sure to use Table 6 to determine appropriate limits.

ADJUSTMENT THREE

The procedure used in ADJUSTMENT ONE is followed from the beginning with the following changes:

1. Set the Model 262 to 10^3 ratio and **release** the CALIBRATION switch (step 2).
2. Output 19V, instead of 1.9V, from the DC calibrator (100V range), in steps 5, 10, 16, 19, 25 and 28.
3. Set the Kelvin-Varley divider to 0.0010000 in step 23.
4. Adjust only R107 in step 26 of Pot Adjustment. See Figure 8 for location. Be sure to use Table 6 to determine appropriate limits.
5. After all adjustments described above have been completed, disconnect the Model 262 from all equipment and replace the calibration cover (held in by two retaining screws on left side of unit).

Full calibration of Model 262 is now complete.

Table 6. Calibration Limits

Adjustment One	10^4 RATIO	Limits
High Lead Compensation		±0.00500mV
Low Lead Compensation (Final)		±0.00020mV
Adjust R105*		±0.00015mV
Adjustment Two	**10^2 RATIO**	**Limits**
High Lead Compensation		±0.0002mV
Low Lead Compensation (Final)		±0.0001mV
Adjust R106*		±0.0005mV
Adjustment Three	**10^3 RATIO**	**Limits**
High Lead Compensation		±0.0001mV
Low Lead Compensation (Final)		±0.0001mV
Adjust R107*		±0.0001mV

*See Figure 8

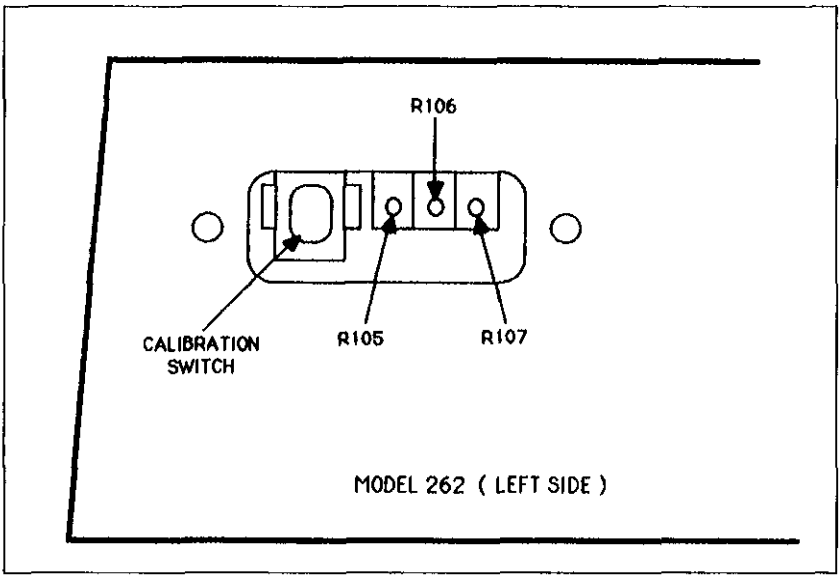


Figure 8. Calibration Adjustments

SERVICING INFORMATION

All servicing information is intended for use by qualified electronic technicians who are familiar with the maintenance of low thermal test equipment.

NOTE

Periodic internal maintenance, such as cleaning, is not necessary. Service the Model 262 only if it becomes non-functional or cannot be calibrated.

CLEANING INSTRUCTIONS

Use the disassembly instructions to gain access to the various parts that need to be cleaned.

CAUTION

Once parts are cleaned, do not touch or contaminate during reassmebly.

Switch Disk

1. With the switch disk removed, clean with Scotch Brite® *, rinse with methyl alcohol and then dry.
2. Using a clean, lint free cloth apply a thin film of Cramolin® Red** (cleaner) on the disk and then wipe off.
3. Using a cotton tipped swab apply a thin film of Cramolin® Blue** (lubricant) on the contact pin track of the disk. Using another clean swab, wipe off excess lubricant from the disk.

CAUTION

Excess lubricant will cause a build-up of debris over a period of time and will adversely affect performance. The lubricant should not be visible on the disk.

4. After the Model 262 is reassembled rotate the DIVIDER RATIO switch back and forth several times.

Contact Pins

With the switch disk removed clean the pins with Scotch Brite® .

Lugs

Clean crimped copper lugs with Scotch Brite® . To clean uncrimped copper lugs for the resistor set, refer to "Low Thermal Connections" for instructions.

PC Board

After replacing resistors or protection diodes, remove solder flux with a solvent, rinse with methyl alcohol and let dry.

CAUTION

Do not contaminate rotary switches, switch disk or contact pins when cleaning the PC board.

*Scotch Brite® is a nonmetallic abrasive pad. It is a product of Minnesota Mining and Manufacturing (3M).

**Cramolin® Red and Blue is a cleaner and lubricant for switches. It is a product of Caig Laboratories, Inc.

LOW THERMAL CONNECTIONS

CAUTION

Once parts are cleaned do not touch or contaminate.

Resistor Set/Contact Pins

When replacing the resistor set and/or the contact pins of the low thermal switch, follow the instructions provided for making low thermal connections.

1. Clean bare copper wire leads with Scotch Brite® .
2. Clean copper lugs with Scotch Brite® .
3. Crimp lugs/contact pins to wires within 24 hours of cleaning.
4. Make gas tight lug connections to PC Board by tightening screws securely.

Output Connector Assembly

Utilize the following instructions and use the original connector assembly as a guide for putting together a new low thermal ouptut connector assembly. See Figure 9 for parts comprising the connector assembly.

1. Remove an appropriate length of insulation from the ends of the #30 AWG wires; clean the bare wire ends with Scotch Brite® .
2. Clean the four lengths of #20 AWG wires with Scotch Brite® .
3. Run a drill (#50) into the pins of the connector (crimp side of connector). This will clean the inside walls of the pins.
4. Wrap a cleaned end of one of the #30 AWG wires around a clean length of #20 AWG wire and insert into a pin of the connector; then crimp. Repeat this process for the other pin.
5. Connect the other ends of the #30 AWG wires to the copper lugs using the same method described in step 4.

NOTE

Plastic sleeving and shrink tubing as used on the original connector assembly will add support to the leads.

6. Twist the two leads together to minimize thermals and magnetic loops.

THEORY OF OPERATION

The Model 262 is a passive divider enclosed in a cast aluminum housing. Special low thermal construction minimizes thermal effects due to temperature changes. A low thermal switch is used for ratio selection. The Model 262 is designed to be used with DC voltage calibrators equipped with remote sensing. Sense lines are connected internally to the Model 262 divider to eliminate any error due to cable and lead resistance.

The Model 262 uses a matched set of four wire wound resistors (R101, R102, R108 and R109). If any of the resistors in the matched set become defective the entire set must be replaced. R108 and R109 are of low thermal construction and require the use of low thermal installation techniques when replacing them (see "Low Thermal Connections").

The POLARITY switch inverts the input signal and sense lines simultaneously. Note that the case is tied to divider circuit low. When the POLARITY switch is in the zero position the DC calibrator is disconnected from the Model 262 divider.

DISASSEMBLY INSTRUCTIONS

Bottom Cover Removal

1. Place the Model 262 on its side on a table or bench.
2. Remove the four retaining screws and remove the bottom cover from the chassis.

PC Board Removal

1. Remove the switch knobs and bushings from the top of the unit. Each knob is secured by two set screws.
2. Remove bottom cover (see Bottom Cover Removal).
3. Unplug connector P1007 from the PC board.

4. Disconnect the two wires on the low thermal output connector from the PC board. Each wire is terminated with a copper lug and secured to the PC board with a screw and flat washer.

NOTE

Clean the four exposed copper lugs before reinstalling them (see Cleaning Instructions). Do not handle or touch the cleaned, pure copper lugs.

5. Place the Model 262 on its side so that the calibration port is facing upward.
6. Remove the four screws securing the PC board to the chassis. The PC board will now easily slip out of the chassis.

Switch Disk Removal

1. Remove the PC board (see PC board Removal).
2. Make note of the switch disk position on the shaft to ensure proper reassembly.
3. Loosen the two set screws located on the hub of the switch disk and carefully slide the assembly off the shaft.

NOTE

When reinstalling the switch disk assembly, there must be a 0.375-inch to 0.400-inch space between the disk and the PC board. This location will place proper contact pin pressure on the disk.

Top Cover Removal

1. Remove the PC board (see PC board Removal).
2. Place the Model 262 right side up and remove the six screws securing the top cover to the chassis. The top cover, along with its connectors, will now easily separate from the chassis.

NOTE

When reinstalling the top cover, tighten the top two screws first. This will ensure that the switch knob bushings can be installed properly.

REPLACEABLE PARTS

This section contains replacement parts information, schematic diagram, and the component layout for the Model 262. A view of the Model 262's mechanical parts are shown in Figures 9 and 10.

PARTS LIST

Parts are listed alphabetically in order of their circuit designations. Table 7 contains a parts list for the Model 262.

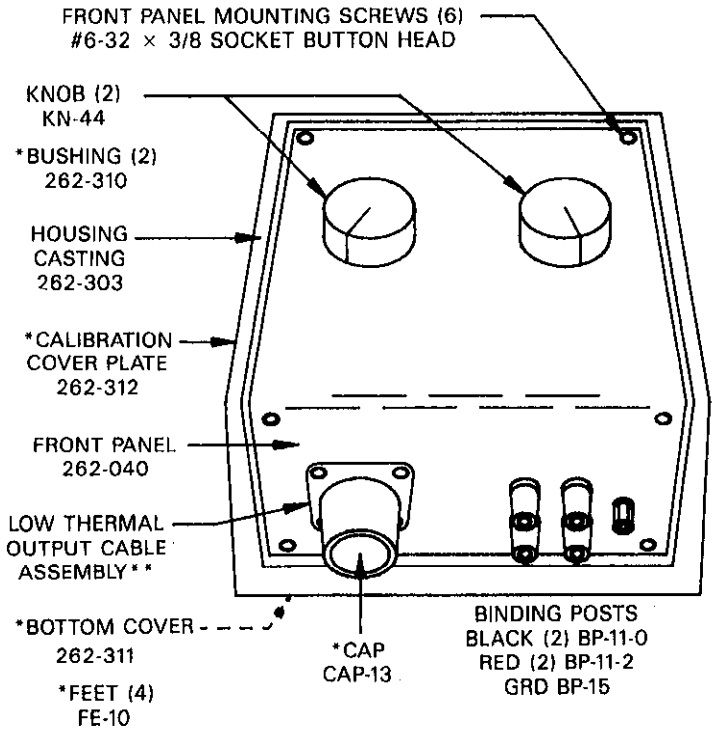
ORDERING INFORMATION

To place an order, or to obtain information concerning replacement parts, contact your Keithley representative or the factory. See the inside front cover for addresses. When ordering include the following information.

1. Instrument Model Number
2. Instrument Serial Number
3. Part Description
4. Circuit Description (if applicable)
5. Keithley Part Number

FACTORY SERVICE

If the instrument is to be returned to the factory for service, complete the service form which follows this section and return it with the instrument.



*NOT SHOWN

**CONNECTOR, KEITHLEY PART NUMBER 30591 PURE COPPER WIRE, #20 AWG, 3/8" LONG, 4 REQUIRED

PURE COPPER WIRE, #30 AWG, SHELLAC INSULATION 4" LONG, 2 REQUIRED

PURE COPPER LUGS, 2 REQUIRED KEITHLEY PART NUMBER LU-39

Figure 9. Model 262 Mechanical Parts

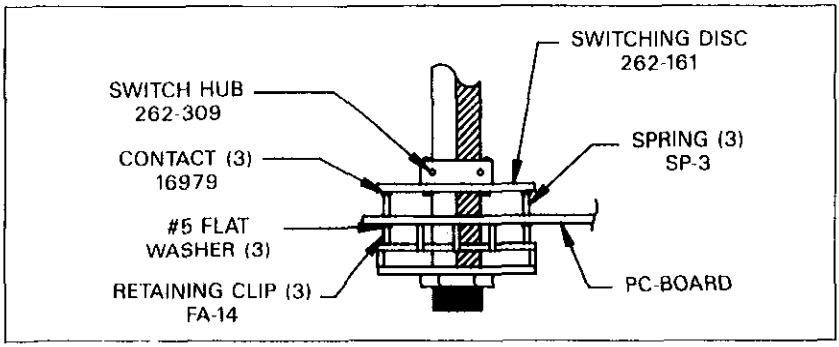


Figure 10. Divider Ratio Switch

Table 7. Model 262, Parts List

Circuit Desig.	Description	Schem. Location	Keithley Part No.
CR101	Zener Diode, (1N5363)	B2	DZ-69
CR102	Zener Diode, (1N5363)	B3	DZ-69
J1007	Connector, Male, 5-pin, (Molex A2391-5A)	A2	CS-288-5
	Connector, Female, Mates to J1007		
	Housing		CS-287-5
	Contacts (5)		CS-276
R101	R101, R102, R108 and R109 are a selected set	G2	R-314
R102	R101, R102, R108 and R109 are a selected set	F3	R-314
R103	588.6kΩ, 0.1%, $^1/_{10}$W, Metal Film	G3	R-263-588.6k
R104	22.500kΩ, 0.1%, $^1/_{10}$W, Metal Film	G4	R-263-22.500k
R105	10kΩ, Cermet Pot	G4	RP-89-10k
R106	50kΩ, Cermet Pot	G3	RP-89-50k
R107	500Ω, Cermet Pot	G2	RP-89-500
R108	R101, R102, R108 and R109 are a selected set	F4	R-314
R109	R101, R102, R108 and R109 are a selected set	F5	R-314
	Copper lugs for resistor set and contacts (8)		LU-39
S101	Switch, Pushbutton	D4	SW-410
S102	Switch, Polarity	B2, B4	SW-442
S103	Switch, Divider Ratio	D2, E5	SW-441
	Supplied Cable: male-to-male low thermal output cable		262-315

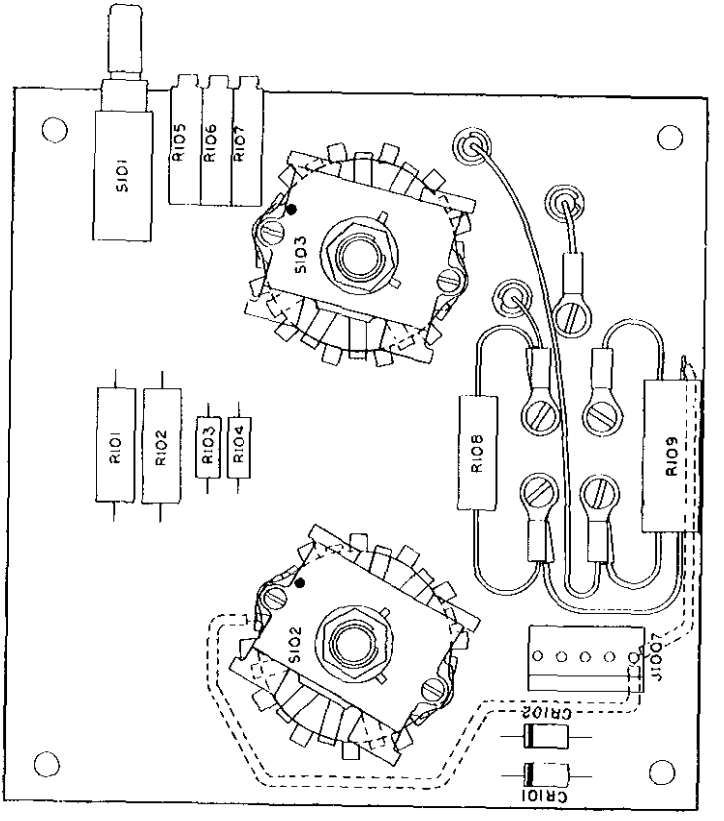


Figure 11. Model 262, *Component Location Drawing, Dwg. No.* 262-100

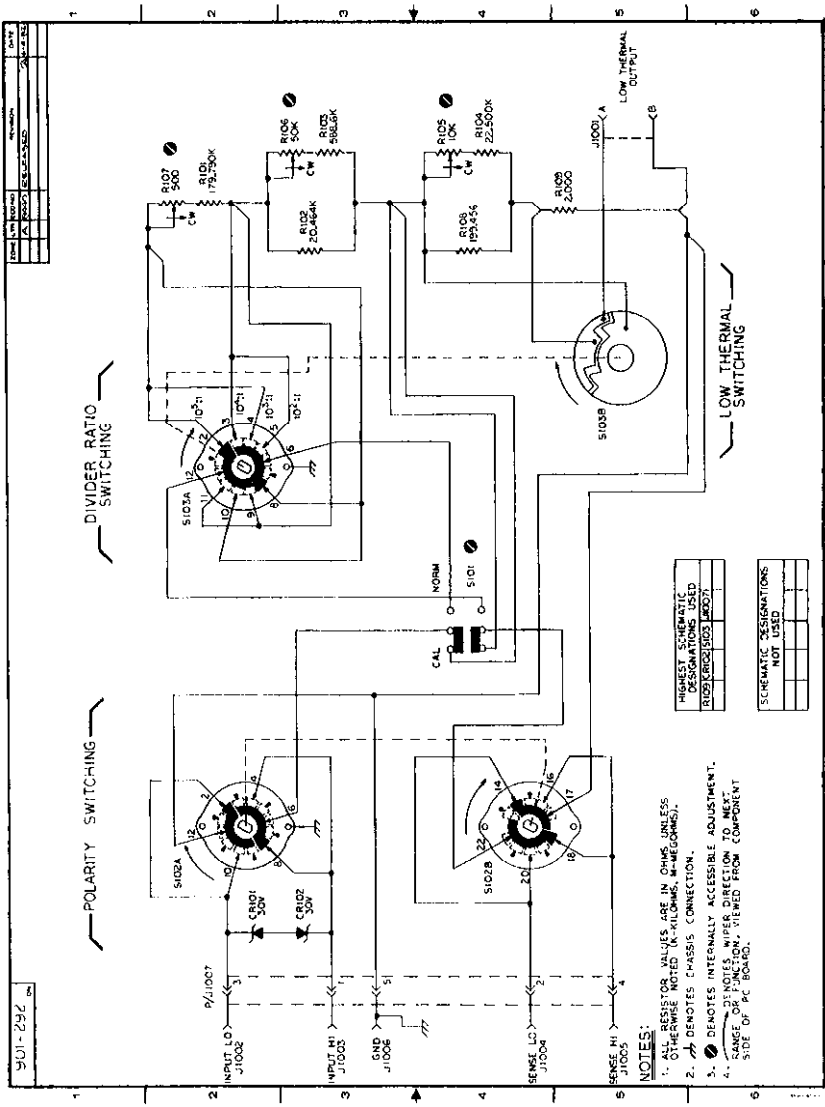


Figure 12. Model 262, Schematic Diagram, Dwg. No. 262-106

KEITHLEY

Service Form

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem.

_____

_____

❑ Intermittent ❑ Analog output follows display

❑ Particular range or function bad; specify _____

❑ IEEE failure

❑ Batteries and fuses are OK

❑ All ranges or functions are bad

❑ Obvious problem on power-up

❑ Front panel operational

❑ Checked all cables

Display or output (check one)

❑ Drifts ❑ Unable to zero ❑ Unstable

❑ Overload ❑ Will not read applied input

❑ Calibration only ❑ Certificate of calibration required ❑ Data required

(attach any additional sheets as necessary)

Show a block diagram of your measurement including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)_____

_____

What power line voltage is used?_____ Ambient temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

_____

Be sure to include your name and phone number on this service form.

Specifications are subject to change without notice.

KEITHLEY

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1-888-KEITHLEY (534-8453) www.keithley.com

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