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BECKMAN INSTRUMENTS, INC.
CEDAR GROVE OPERATIONS

89 COMMERCE ROAD
CEDAR GROVE, NEW JERSEY 07009
U. S. A.

THIS INSTRUMENT HAS BEEN SET FOR 105 TO 125 V. A. C. 50/60 Hz, 1 PHASE INPUT. FOR OTHER VOLTAGE CONNECTIONS SEE INSTRUCTION MANUAL

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INSTRUCTION MANUAL

L-8 MEGOHMMETER

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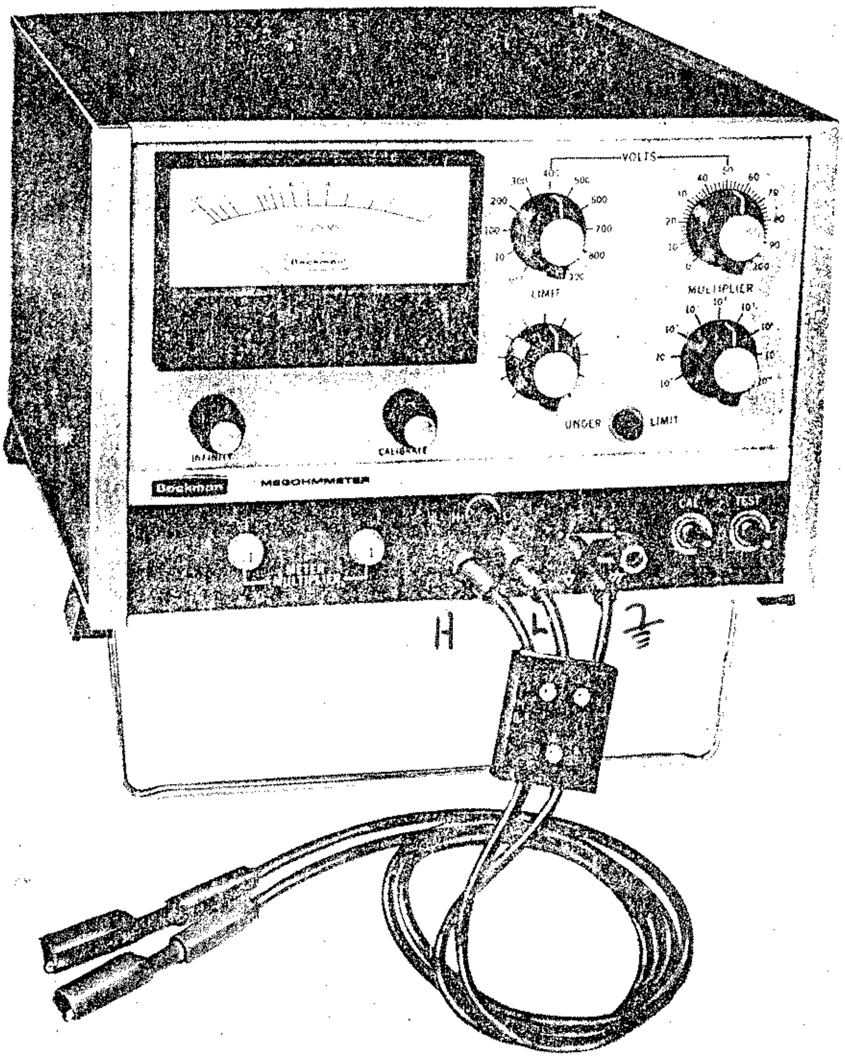

FIG. 1 L8 MEGOHMMETER
WITH
ML-1 TEST LEADS

I DESCRIPTION AND PURPOSE

1.1 INTRODUCTION

1.1.1 The instruction manual for Beckman Instruments Model L-8 Megohmmeter is intended to serve as a guide in the proper operation and maintenance of the instrument. Sufficient information has been included to provide a general understanding of the instrument and its many applications. Operation of the Model L-8 Megohmmeter in accordance with instructions contained herein will insure reliable and satisfactory performance.

1.2 GENERAL INFORMATION

1.2.1 The Beckman Instruments Model L-8 Megohmmeter measures dc resistance between 0.1 megohms and 10^{10} megohms. The test voltage can be selected for any value between 10 and 1000 volts dc. The instrument can be used to measure grounded and ungrounded two or three terminal resistors as well as to measure surface or volume resistivity of insulating materials. The insulation resistance of rotating machinery, transformers, cables, wire, and other electrical equipment can also be easily measured. Excellent power supply regulation and convenient charge and discharge circuitry permit rapid and accurate measurement of the leakage resistance of capacitors. Instrument precision makes it suitable for laboratory service; operation simplicity, convenience and ruggedness makes it ideal for production use.

1.2.2 The operation of the Model L-8 Megohmmeter can be understood with the aid of Fig. 2. The instrument contains a regulated variable test voltage power supply with a range of 10 to 1000 volts dc. The test voltage is connected in series with the unknown resistor R_x and a standard resistor R_s, the value of which is selected by the MULTIPLIER switch. These two resistors form a voltage divider across the regulated power supply. The output of this divider, which is inversely proportional to the value of R_x, is applied to an amplifier having a high input resistance. The amplifier in turn drives a meter calibrated in megohms. The unit is calibrated by depressing the CAL switch, thereby applying a fraction of the test voltage to the amplifier's input. The gain of the amplifier is then adjusted to give full scale deflection. The value of R_c and R_I is selected automatically by the MULTIPLIER switch.

1.3 SPECIFICATIONS

1.3.1

Resistance	Test Voltage
10^6 - 10^{16} ohms	1000 volts dc
10^6 - 10^{15} ohms	100 - 1000 volts dc
10^6 - 10^{14} ohms	10 - 1000 volts dc
10^5 - 10^{14} ohms	10 - 100 volts dc
* 10^5 - 10^{13} ohms	1 - 10 volts dc

* External power source required

1.3.2 Test Voltages

10 to 1000 volts dc continuously variable. Switch selectable at 10, 100, 200, 300, 400, 500, 600, 700, 800 and 900 volts. A vernier control permits continuous adjustment over a 100 volt span. Switch selectable voltages are accurate to ± 2% of setting. The vernier calibration is accurate to ± 3 volts. Available current is limited to approximately 10 milliamperes.

1.3.3 Accuracy

The accuracy of the instrument is a direct function of the scale indication. For a reading of 1, the accuracy of that reading is ± 1%; for a reading of 2, the accuracy is ± 2%, etc. There is a possible additional error of ± 1% of reading on the 10^0 through 10^4 megohm range increasing to ± 2% on the 10^5 through 10^8 megohm range.

1.3.4 Limit Control

A contact closure and a light are provided to indicate that a previously chosen meter deflection has been exceeded. Accuracy is ± 2% of setting for meter deflections between 1 and 10. Contact rating of the limit circuit:

DC resistive load - 15 watts
AC resistive load - 15 VA
Maximum current - 1 amp
AC Breakdown - 300 volts rms

1.3.5 Remote Test Switch

A barrier strip has been provided at the rear of the instrument for connecting a foot activated TEST switch. If Beckman's Model FSW-1 foot switch is not used, a SPDT switch rated for at least 12 volts dc and .2 amps should be connected as shown in the main schematic.

1.3.6 Input Resistance

The input resistance used to scale the external unknown is based on a series of dividers using 1/4% resistors for all ranges except the two highest ranges. 1% resistors are used for these two ranges. Resistance values are as follows:

111.1 ohms - 10^0 range
1,111.0 ohms - 10^1 range
11,111.0 ohms - 10^2 range
111,111.0 ohms - 10^3 range
1,111,111.0 ohms - 10^4 range
11,111,111.0 ohms - 10^5 range
111,111,111.0 ohms - 10^6 range
111,111,111.0 ohms - 10^7 range
111,111,111.0 ohms - 10^8 range

1.3.7 Amplifier Sensitivity

The maximum amplifier sensitivity to drive the meter to full scale is 1 millivolt dc.

1.3.8 Operating Conditions

Ambient temperature range - 0^oC to 40^oC
Maximum relative humidity - 90%

1.3.9 Power Requirements

120/240 volts ac, 50/60 Hz, 39 volt amperes

1.3.10 Physical Size

7 1/2" High x 11" Wide x 13" Deep

1.3.11 Weight

17 lbs. net
21 lbs. shipping

II INSTALLATION

2.1 INSTALLATION PROCEDURE

2.1.1 The Model L-8 Megohmmeter is fully enclosed and can be used on the bench as supplied. If it is desired to raise the front of the instrument, a tilt bail can be swung out from under the instrument. Ventilating holes are provided on the underside and rear of the instrument. Insure that these air passages are not blocked.

2.2 ELECTRICAL CONNECTIONS

2.2.1 An internal 120/240 volts switch allows the megohmmeter to be operated from either 120 or 240 volt power, at 50/60 Hz, without the necessity of rewiring the power transformer primary connection. This switch is located on the rear panel of the instrument. As supplied from the factory, the switch is normally set for 120 volt operation. To convert to 240 volt operation, place a small screw-driver blade into the slot and slide switch until 240 appears on the switch face. Replace existing slow blow fuse with one rated for 240 volts and 1/4 amperes slow blow. If it is required to replace line cord, connect the black wire to the high side of the line, white wire to the neutral side and green wire to the ground terminal.

2.2.2 Plug the power connector into any convenient grounding outlet. When using the adapter, connect the ground clip to a good electrical ground system such as a cold water pipe or equivalent. (as approved by the National Electrical Code.)

2.2.3 The test voltage power supply cannot be damaged by shorting its output terminals. However, the power supply can be damaged by allowing the output voltage to develop into an arc. Although an arcing condition will not immediately harm the power supply, prolonging this condition longer than absolutely necessary may cause serious damage to the instrument.

III OPERATION

3.1 PRELIMINARY ADJUSTMENTS

3.1.1 With the VOLT switch in the off position, turn the meter zero adjusting screw until the meter pointer is at infinity.

3.1.2 Set the INTERNAL TEST VOLTAGE-EXTERNAL TEST VOLTAGE switch, located on the back panel of the instrument, to the INTERNAL TEST VOLTAGE position. If an external test voltage is desired, see paragraph 3.5.

3.1.3 Make sure that the strap connecting circuit ground ⏚ and chassis ground ⏛ is secure. If the item to be measured has one terminal grounded, see paragraph 3.6 for proper connections.

3.2 CALIBRATION

3.2.1 Turn the unit on by setting the VOLTS switch to the desired voltage. If the switch setting is 10, the 0.1 meter multiplier light will glow. If it is 100 or greater, the times 1 meter multiplier light will glow. Allow a few minutes for the instrument to stabilize. The test voltage applied to the item under test will be within ± 2% of that indicated by the front panel controls. If one desires to check this voltage, a voltmeter can be connected to the TEST VOLTAGE terminals located on the back panel of the instrument. The sensitivity of the voltmeter should be greater than 10,000 ohms per volt.

3.2.2 Set the controls to the desired voltage. (Normally this voltage should not exceed the rated voltage of the capacitor or dielectric material under test. When testing resistors, make sure that the voltage rating of the resistor is not exceeded.)

3.2.3 Set the MULTIPLIER switch to the desired range. Adjust INFINITY control such that the scale pointer is set on the infinity mark.

3.2.4 Operate the CAL switch and adjust the CALIBRATE control for a full scale (1 megohm) deflection. Release the CAL switch.

NOTE

When the unit is calibrated with the MULTIPLIER switch in the 10^0 through 10^6 position, that calibration will hold for all ranges up to and including the 10^6 position. Measurements made on the 10^7 and 10^8 position require separate calibrations. RECALIBRATE WHEN SWITCHING TO THE 10^7 OR 10^8 RANGE, OR WHEN SWITCHING BACK TO A LOWER RANGE FROM THE 10^7 OR 10^8 POSITION. Check the calibration of the instrument periodically throughout the day. RECALIBRATE WHENEVER THE TEST VOLTAGE IS CHANGED.

3.3 MEASUREMENT

3.3.1 Connect the capacitor, resistor, or insulation to be tested to the H and L terminals. Use the L terminal for the low side of the apparatus under test (the outside foil, metal case, or negative terminal). Use short leads if possible. If long leads are required, use two shielded cables and connect both shields to the circuit ground ⏚ terminal. (For accurate measurements at the higher ranges of the instrument, the insulation resistance between the center conductor and the shield of the cable used must be greater than 10^{11} ohms.) For measuring high values of resistance it is suggested the ML-1 Test Leads, part number 42091WE, be used to connect the test item to the instrument.

CAUTION

WHEN THE TEST SWITCH IS ACTIVATED, THE H TERMINAL IS AT THE DC TEST VOLTAGE ABOVE GROUND. SINCE THE CURRENT AVAILABLE AT THE TERMINAL IS MORE THAN 5 MILLIAMPHERES, A SHOCK HAZARD MAY EXIST. THIS CONDITION IS INDICATED BY A GLOWING RED LIGHT LOCATED ABOVE THE H TERMINAL. WHEN MAKING CONNECTIONS TO THE H TERMINAL, USE CAUTION AND INSURE THAT THE TEST SWITCH IS NOT ACTIVATED.

3.3.3 To measure the insulation resistance of the test piece, activate the TEST switch and read megohms. If the meter indication is off scale, turn the MULTIPLIER switch to a lower scale. If the indication is above 10 and greater resolution is desired, turn the MULTIPLIER switch to a higher range.

3.4 MEASUREMENT WHEN CAPACITANCE IS PRESENT

3.4.1 When measuring capacitors or when measuring very high values of resistance where the shunt capacitance is appreciable, the charging currents will cause the meter to slam against the stop pin. To reduce this effect, operate the CAL switch first, then the TEST switch. Release the CAL switch and read megohms. While both switches are operated, the capacitance charges rapidly and the meter is protected from slamming to the right. With a little practice the operator soon learns how long it takes to charge different values of capacitance.

3.4.2 When the TEST switch is released, any capacity connected between the H and L terminals is automatically discharged through a 1000 ohm resistor. In the exceptional case where very large capacitors are being measured at high voltages, it is suggested that additional resistance be placed in series with the capacitor being measured. This resistance can be added in series with the L terminal or, if desired, R619 can be increased in value.

WARNING

WHEN THE TEST SWITCH IS ACTIVATED, THE CAPACITOR UNDER TEST BECOMES FULLY CHARGED TO THE DC TEST POTENTIAL. WHEN MEASURING HIGH VALUE CAPACITORS AT HIGH VOLTAGES, THE CHARGE DEVELOPED ACROSS THIS CAPACITOR CAN BECOME LETHAL. USE EXTREME CARE WHEN TESTING THIS TYPE OF CAPACITOR. INSURE THAT THE TEST SWITCH IS DEACTIVATED AND THE TEST CAPACITOR IS FULLY DISCHARGED BEFORE HANDLING.

3.5 MEASUREMENTS USING AN EXTERNAL TEST VOLTAGE

3.5.1 In some applications it may be desirable to use an external power source for the test voltage One application would be in the measurement of high value capacitance with high insulation resistance. Tests performed on this type of capacitor require power supplies with the stability of greater than 10 ppm to insure a continuous smooth charging process. For this type of application, batteries are the preferred source of power. In other applications, specifications may require a test voltage lower than the 10 volt limit of the L-8 power supply. Batteries or a low voltage variable power supply may be used for this type of application.

3.5.2 To operate the instrument with an external test voltage, connect the source of voltage to the binding posts marked EXTERNAL TEST VOLTAGE located on the back panel of the instrument. Connect the positive side of the power supply to the red terminal and the low side of the supply to the black terminal. Place the INTERNAL TEST VOLTAGE-EXTERNAL TEST VOLTAGE switch to the EXTERNAL TEST position. If the external test voltage is 10 volts or less, turn the L-8 VOLT switch to 10. If the external test voltage is greater than 10, turn the L-8 VOLT switch to 100. The operation, calibration and measurement procedures outlined above are applicable for operating the unit with an external power source.

NOTE

When an external power source is used, the output current is no longer automatically limited to a safe value of 10 milliamps. Nor is the input circuit protected against overload conditions. To protect both personnel and the megohmmeter, use an external power supply that is limited to 10 milliampheres or less.

3.5.3 For accurate results, when measuring high value resistors, the low side of the external power supply should be grounded at only one point. That point should be the circuit ground ⏚ terminal located on the front panel of the L-8 Megohmmeter.

3.6 MEASUREMENT OF GROUNDED EQUIPMENT

3.6.1 The L-8 Megohmmeter can be safely used to measure grounded equipment such as cables, appliances, rotating machinery, transformers, etc. With the power off, remove the strap connecting circuit ground ⏚ to chassis ground ⏚. CONNECT THE GROUNDED SIDE OF THE ITEM UNDER TEST TO THE H TERMINAL. CONNECT A JUMPER WIRE BETWEEN THE H TERMINAL AND THE CHASSIS GROUND ⏚ TERMINAL. The other side should be connected to the L terminal. The operation, calibration and measurement procedures outlined above are applicable for operating the unit with one side of the test item grounded.

NOTE

In the normal operation of the unit, the test voltage is positive when measured with respect to ground. When the grounded test item is connected to the H terminal, it effectively grounds the high side of the test voltage. SIGNAL GROUND IS NOW AT A NEGATIVE TEST POTENTIAL WHEN MEASURED WITH RESPECT TO GROUND. If the grounded test item has a guard terminal, the guard should be connected to signal ground, effectively placing the guard circuit at the test potential. Since the current available is more than 5 milliampheres, a shock hazard may exist. Therefore do not touch signal ground when measuring grounded equipment.

3.6.2 Do not remove the top and bottom covers of the instrument while the H terminal is grounded. Sheet metal parts that are normally grounded are now raised to a high potential. Removing the covers exposes these parts and presents a shock hazard.

3.7 LIMIT CONTROL

The limit circuit is activated when the panel meter indicates that a previously chosen set point has been transversed. The limit circuit indicates the relationship between the meter pointer and the set point. It is independent of the range setting of the instrument.

To adjust the set point, connect the low limit standard to the input terminals. If a low limit standard is not available, a ten megohm decade box (Beckman Instruments Model DR-71D or equal) can be adjusted to obtain the desired indication. If the decade box is used, set the RANGE switch to the 10^0 position. Activate the TEST switch and measure the standard. Slowly rotate the LIMIT control until the UNDER LIMIT light glows. Reverse the direction of rotation of the LIMIT control until the light just goes off. The limit control is now set such that the UNDER LIMIT light will glow and the LIMIT contacts will close when the unknown resistance is lower in value than the standard low limit resistor.

IV PRINCIPLES OF OPERATION

4.1 BLOCK DIAGRAM - MEASURING CIRCUIT

4.1.1 The Model L-8 Megohmmeter measuring circuit is illustrated in block form in Fig. 3. A test voltage is connected in series with an unknown resistor R_X and a standard resistor R_S, the value of which is selected by the MULTIPLIER switch SW-504. When the TEST switch is activated, these two resistors form a voltage divider across the highly regulated power supply. The output of the divider, which is proportional to the value of R_X, is applied to an amplifier having a high input resistance. The amplifier in turn drives a meter calibrated in megohms. The meter movement is nonlinear resulting in a scale distribution that minimizes crowding at the higher scale readings. This special movement also allows two orders of magnitude of resistance to be presented on one scale. The unit is calibrated by depressing the CAL switch, thereby applying a fraction of the test voltage to the amplifier input. The gain of the amplifier is then adjusted to give full scale deflection. The value of R_C and R_I are selected automatically by the MULTIPLIER switch SW-504. The output of the high resistance amplifier is monitored by a voltage comparator circuit. When the voltage at the amplifier output exceeds the voltage reference setting, the voltage comparator changes state and activates relay K-401. The relay applies power to the limit light and closes a set of contacts. The limit terminals located on the back panel are connected to these contacts.

4.2 DETAIL CIRCUIT ANALYSIS - MEASURING CIRCUIT (Refer to overall schematic diagram at rear of manual)

4.2.1 The test voltage is divided down by R_X and R_S. The value of R_S is selected by the setting of the MULTIPLIER switch, SW-504, such that the input voltage with full scale deflection will be between 1 and 100 millivolts. The input is protected against large overloads by the shunt regulator DS-401. This input signal is amplified by a seven transistor feedback stabilized amplifier.

4.2.2 The input stage of this amplifier consists of a matched pair of junction field effect transistors mounted in one TO-18 case. The two transistors are connected as a differential pair with their sources connected to a constant current source consisting of Q-408, R-419, and R-420. The output of this stage is further amplified by two additional stages of differential amplification with the output stage consisting of a single ended emitter follower. The CALIBRATE control, R-501 and R-418, complete the feedback loop around the multi-stage amplifier. The amplifier is balanced by adjusting the INFINITY control potentiometer R-502 and R-503 located on the front panel. Further adjustment is available internally by adjusting R-401 which is located on the plug-in amplifier. Diodes CR-401, CR-403, CR-404, limit the output voltage from Q-405 to less than 1.5 volts. The output of Q-405 supplies current to the nonlinear meter, M-501. The voltage developed at the emitter of Q-405 is coupled into the integrated circuit voltage comparator by R-412. The potential at this point for full scale deflection is approximately 250 millivolts.

4.2.3 The reference voltage for the comparator is set by adjusting the limit control potentiometer. For normal operation the output of the comparator is approximately -0.5 volts and Q-407 is biased off. When the voltage at Q-405 is greater than the reference voltage, the comparator changes state and biases Q-407 into conduction. This in turn activates reed relay K-401, the contacts of which activate the limit light and provide the contact closure to the LIMIT terminals.

4.2.4 When the unit is turned on and the TEST and CAL switches are not activated, relay K-601 is energized and relay K-602 is not energized. The schematic diagram shows the relays in the states indicated. When neither switch is activated, both the H and L terminals are connected to ground through two 470 ohm resistors, R-618 and R-619. Activating the test switch removes power from relay K-601. The test voltage is applied to the H terminal and the L terminal is connected to the MULTIPLIER switch SW-504. If the CAL switch is now energized, the L terminal is grounded through a 1K resistor, allowing any capacity being measured to charge through a low resistance path.

4.3 BLOCK DIAGRAM - TEST VOLTAGE SUPPLY

4.3.1 The Model L-8 Megohmmeter test voltage supply is illustrated in block form in Fig. 4. The input line voltage is stepped up and down by the power transformer T101. Rectifiers and filter circuits convert the ac to raw dc. In the high voltage section of the supply, the raw dc is pre-regulated by a series string of zener diodes. The pre-regulated voltage is applied to the series connected pass transistors. The pass transistors are made to alter their conduction such that the output voltage remains constant. The value of the output voltage is selected by adjusting the VOLTS range and VOLTS vernier control. Any change in the output voltage is sensed by the output sampling resistor. The change is amplified by the voltage amplifier and driver circuits and applied to the pass transistors in such a way as to counteract the change.

4.3.2 The current limit circuit senses the voltage drop across the current sampling resistor. When this voltage exceeds a set value, the current limit circuit couples this signal through the driver and limits the conduction of the series pass transistors.

4.3.3 Since the voltage amplifier, driver, current limit circuit and reference supply cannot withstand a large voltage existing with respect to circuit ground, these circuits are "floated" on the main power supply. They are coupled into the main circuit at point A as shown in Fig. 3-4. The potential between the output voltage and point A is approximately 10 volts. This potential will remain constant independent of the output voltage setting. The floating power supply is zener regulated and supplies 36 volts to the voltage amplifier circuits. The reference power supply provides a stable source of voltage against which a portion of the output voltage can be compared.

4.4 DETAILED CIRCUIT ANALYSIS - TEST VOLTAGE SUPPLY

4.4.1 The 10 to 1000 volt dc output is generated by the main dc supply which consists of a bridge rectifier, a zener pre-regulator, and four series connected pass transistors. The conduction of the series pass transistors is controlled by a regulating feedback loop. The bridge rectifier circuit develops 2000 volts dc at filter capacitor C-601. The voltage is reduced to 1200 volts by the series connected zeners CR-601 through CR-606. This pre-regulated voltage is applied to four series connected pass transistors, Q-301, Q-302, Q-303 and Q-310. Resistors R-301, R-302, R-303, and R-327 insure that the applied voltage divides equally across the three transistors. A portion of the output voltage is sensed by resistors R-316, R-317 and R-318. This portion of the output voltage is compared to the reference voltage generated by zener diode CR-304. The error voltage is detected and amplified by a two stage differentially connected amplifier consisting of Q-306, Q-307 and Q-309. The output of Q-306 is coupled into the emitter follower driver Q-304, which in turn controls the conduction of series pass transistor Q-303. Since the emitter of Q-303 is the terminating point for the resistive divider string R-301, R-302, R-303, any change of potential at the emitter of Q-303 will be reflected equally across Q-301 and Q-302.

4.4.2 For purposes of this discussion, assume that the unit is in constant voltage operation and the output voltage is set for 10 volts. Further assume that circuit ground and chassis ground are common and that the output voltage instantaneously rises due to a variation in the line or load. For normal operation, the value of R-316 (part of the output sampling resistor) is adjusted such that 3.12 milliamperes flows through the sampling resistor. For an output voltage of 10 volts, approximately 2 milliamperes flows through the resistor divider string. The remaining 1.12 milliamperes flows through transistors Q-301, Q-302, Q-303. If the output voltage tends to rise, the change is detected by the differential pair Q-309, and further amplified by Q-306 and Q-307. The voltage at the collector of Q-306 decreases in value. This decrease is coupled to the pass transistors and the output voltage is reduced to its original level.

4.4.3 If the external load resistance is decreased to a point where the load current exceeds 5 milliamperes, the voltage developed across R-308 will cause Q-305 to conduct, reducing the current available to Q-304 which in turn limits the current flowing through pass transistors Q-301, Q-302, Q-303 and Q-310. If the load resistance is decreased further, Q-305 will conduct more, limiting the output current to approximately 10 milliamperes.

4.4.4 Under normal operating conditions, 3.12 milliamperes flows through the sampling resistor. To increase the output voltage, resistance is added between point A and circuit ground. This is accomplished by rotating either the VOLTS range switch or the VOLTS vernier potentiometer. For a 100 volt increase in output voltage, a 33.2K resistor is switched in between point A and circuit ground. Instantaneously point A and the output voltage increase by 100 volts. Since the output voltage increased, the current flowing through the voltage divider resistors R-301, R-302, and R-303 decrease. This decrease in current is sensed by the sampling resistor as a decrease in output voltage. The regulating action of the feedback loop causes more current to flow through the pass transistors, such that the current through the sampling resistor returns to its original value. The output voltage is still regulated against line and load variations as previously explained except that point A is now floating at a higher potential.

4.5 DETAILED CIRCUIT ANALYSIS - AMPLIFIER POWER SUPPLY

4.5.1 The raw dc for the amplifier power supply is developed by rectifier and filter capacitors CR-620 through CR-623 and C-609, C-610. The collector voltage for the driver circuits are further filtered by resistors R-608, R-609 and C-609 through C-612. A portion of the output voltage is sensed by resistors R-615 and R-616. Any change is amplified by drivers Q-602 and Q-603 which in turn control the conduction of pass transistors Q-601 and Q-604. Resistors R-607 and R-609 limit the short circuit current to a value which will not harm the pass transistors Q-601 and Q-604.

V MAINTENANCE AND SERVICING

WARNING

High voltage exists on exposed components. Use care when servicing or repairing instruments.

5.1 GENERAL INFORMATION

5.1.1 The components used in the manufacture of the L-8 Megohmmeter are of high quality and are conservatively operated within their design specifications. Even though every precaution has been taken to insure long trouble-free operation, parts within the megohmmeter may fail. The succeeding paragraphs will help in locating the defective component.

5.1.2 Before attempting to troubleshoot the instrument, insure that the fault exists in the instrument and not in the item being measured. Check for the obvious trouble such as an open fuse, input power failure, defective input cable, internal-external voltage switch or input voltage switch incorrectly positioned. Once it is determined that the instrument is at fault, remove the top and bottom covers and inspect for open circuits, broken wires, charred components, mechanical damage, etc. To remove the top and bottom covers, loosen the two thumb screws located on the back panel of the instrument. Slide the two trim strips in the appropriate direction such that they no longer interfere with the removal of the desired cover. To remove the cover, slide it straight back toward the rear of the instrument. Once the defect is corrected, check the unit to the specifications given in Section I.

NOTE

All voltage measurements shown in the schematic are taken with respect to ground. The voltages shown are typical and may vary by ± 20%. Circuit ground and chassis ground are common. Set the following controls to the position indicated:

1. Meter - infinity
2. Multiplier - 10^0 range
3. Volt - 10 Volt range
4. Volts - vernier - 0

All measurements are to be made with a voltmeter having at least 10 megohms input resistance.

5.2 TEST VOLTAGE POWER SUPPLY

5.2.1 The test voltage power supply cannot be damaged by shorting its output terminals. The current limiting circuit keeps the power dissipation of all the components in the supply to a safe value. The test voltage power supply can be damaged by a short between components. Due to the high voltages employed and the series connection of the transistors, a momentary short across one transistor will usually cause all to fail. Use care in the handling of the test probe when taking voltage measurements.

5.2.2 If the test voltage power supply fails, it will generally activate the current limiting circuit, causing transistors Q-306, Q-307 and Q-309 to saturate or cut off. Voltage measurements taken in this condition will not indicate the malfunction. To isolate the area, the following steps should be taken.

5.2.3 Break the connection between the collector of Q-310 and the zener string, (red wire leading to power supply P.C. Board). Connect a 400K ± 10% 5 Watt Resistor across the zener string. The voltage measured across the zener string should be 1200 volts ± 10%. If this voltage is correct, remove the 400K resistor and reconnect the collector of Q-310 to the zener string.

5.2.4 Measure the voltage at the collector of Q-301, Q-302, Q-303, and Q-310. Compute the voltage drop across each transistor. The voltage drop across each transistor should be equal and must not vary by more than 50 volts. If the 50 volt limit is exceeded, replace pass transistors Q-301, Q-302, Q-303, Q-304 and Q-310. When replacing these transistors, use a heat sink compound such as Dow Corning #340 or equal. Cover the leads of the transistor with Teflon tubing to insure that the leads are insulated from the heat sink.

5.2.5 If the fault is not indicated in the preceding steps, measure the voltage across CR-304. It should be 6.2 volts ± 10%. The identical voltage should be measured at the other base of Q-309. If there is a difference between the measurements, replace transistors Q-305, Q-306, and Q-307 and Q-309.

5.3 CALIBRATING OF OUTPUT VOLTAGE

If in the repair of a malfunctioning power supply, transistors Q-308, Q-309, or zener diodes CR-303, CR-304 or resistors R-311, R-316, R-317, R-318, R-319, R-320 are replaced, the output voltage control circuit should be recalibrated. The output voltage should be monitored with a voltmeter having at least 0.1% accuracy and with a sensitivity of greater than 10,000 ohms per volt. The output voltage can be monitored at the test terminals located at the rear of the instrument. Rotate the VOLT switch between the 100 and 200 volt range. The voltmeter should indicate a difference of 100 volts between the two settings. If the readings are not exactly 100 volts apart, adjust R-316 for the correct readings. Set the VOLTS vernier control to zero and adjust the volts range switch to 10. The output voltage should be 10 volts. If an error is recorded, adjust R-320 for the correct reading. The instrument is now calibrated and should meet the specifications listed in paragraph 1.3.2.

5.4 AMPLIFIER ACCURACY

5.4.1 The Model L-8 Megohmmeter derives its accuracy from the precision resistors in the multiplier and calibrate circuits. When no facilities are available to check these resistors to the required accuracy, the instrument should be returned to the factory for service. Before returning the instrument for repair, insure that the resistor being used as a standard is being measured at its correct test voltage and temperature. Insure that the standard's accuracy is not being degraded by shunting paths caused by dirt, fingerprints or the effects of humidity. Once it has been determined that the instrument is in error and the error is not due to the precision resistors in the multiplier and calibrated circuits, check all possible leakage paths emanating from the gate of Q-401. Clean all suspected components and leakage paths with alcohol.

5.5 AMPLIFIER MALFUNCTION

5.5.1 Since the amplifier is enclosed within a feedback loop, voltage measurements taken within the loop will not isolate the faulty component. To open the loop, break the connection between CR-404 and the junction of R-411 and R-418. It is also necessary to break the connection to the calibrate potentiometer R-501. The sensitivity of the balance control will be increased due to the open loop gain of the amplifier. A further modification is necessary to reduce the "pickup" susceptibility of the high resistance input stage. A jumper should be connected across C-401 and C-403, effectively shorting both gates of the input stage. The faulty component can now be located by comparing the measured voltages to the typical voltages given in the schematic.

5.6 TROUBLE-SHOOTING GUIDE

5.6.1 Possible sources of trouble may be located by referring to Table 1. This table lists various symptoms and the possible sources of trouble corresponding to the symptoms.

TABLE I

Symptom	Possible Sources of Trouble
Meter multiplier light does not glow	(1) Power not connected (2) Defective lamp (3) Power fuse defective (4) Line switch defective (5) Defective transformer
Meter cannot be set at infinity with INFINITY control	(1) Defective control R-502, R-503, R-401 (2) Defective amplifier (3) Open resistance in either gate circuit of input transistor (4) Defective meter
Instrument cannot be calibrated	(1) Test voltage adjusted for too low a value for the resistance reading selected (2) Defective test voltage supply (3) Internal test voltage-external test voltage switch in the wrong position (4) Defective relay K-602 (5) Defective calibrating resistor R-621, R-622, R-623, R-624, R-625, R-515, R-516
Erratic meter indication	(1) Item under test not properly shielded (2) Defective relay K-601 (3) Dirty relay contacts (4) Jumper missing on rear terminal strip (5) Defective MULTIPLIER switch (6) Loose strap between circuit ground and chassis ground.
Inaccurate reading	(1) Defective meter (2) Defective calibrating resistor (3) Defective range resistor R-515, through R-521
No Overlimit indication	(1) Limit control incorrectly set (2) Defective limit lamp (3) Defective relay K-401 (4) Defective comparator Q-406

VI REPLACEABLE PARTS

6.1 L-8 MEGOHMMETER SPARE SUB-ASSEMBLIES LIST

Item	Description	Part No.	Serial No.'s Prefixes
1	Multiplier Switch Assembly	40981EA	42070EA
2	Power Supply PC Board Assembly	40628EA	
3	Amplifier PC Board Assembly	40625EA	

6.2 L-8 MEGOHMMETER SPARE PARTS LIST

Item	Symbol	Description	Part No.	
1	T101	Power Transformer	37708T	
2	Q301,Q302, Q303,Q304 Q310	High Voltage Transistors, Selected —	37189TU	755-867890
3	Q305	Transistor, NPN, 2N3904	36534TU	
4	Q306,7,8	Transistor, PNP, 2N3906	36670TU	
5	Q309	Transistor, NPN, Dual, Sprague TD-101	755859976	
6	CR301	Diode, 3000 PIV, Atlantic 50D30	755859974	
7	CR302	Diode, 100 PIV,	755817927	
8	CR303	Diode, zener, 1N706A 5.8V ± 5%	755811425	
9	CR304	Diode, zener, T.C., 1N821, 6.2V	32475ME	
10	CR306,7	Diode, 25 PIV, 1N456	30357ME	
11	R316,20	Potentiometer, Cermet, 500 ohms, Beckman 77PR500	613854383	
12	Q401	Transistor, FET, dual 2N3956	755859973	
13	Q402	Transistor, PNP, dual Sprague TD-401	755859977	
14	Q403,4,5,7	Transistor, NPN, 2N3391	30245TU	
15	Q406	Comparator, Fairchild uA710	885859978	
16	CR401,2,3, 4,5	Diode, 25 PIV, 1N456	30357ME	
17	DS-401	Neon, Selected	825849699	

Item	Symbol	Description	Part No.	Serial No.'s with "A" Prefixes
18	R401	Potentiometer, Cermet 2000 ohms, Beckman 77PR2K	613854385	
19	R402	Potentiometer, Cermet 5000 ohms, Beckman 77PR5K	613854386	
20	K401	Coil, Reed, Coto-Coil SE-24-P	716855837	
21	K401-1, K401-2	Reed, Gordos MR706	716859983	
22	DS501,504	Light, red lens, bulb	824849698	
23	DS502	Light, white, .1 lens, bulb	824849696	
24	DS503	Light, white, 1 lens, bulb	824849697	
25	--	Bulb for above lamps - Drake 765	825867075	
26	M501	Meter	39588ME – 126⁰⁰ 2/24/75	
27	R501	Potentiometer, Wire Wound, Dual 25K ohms, 500 ohms	40787R	
28	R502	Potentiometer, Wire Wound, Dual 250 ohms, 50 ohms	40786R	
29	R504	Potentiometer, Wire Wound, 33.2K ohms	611849695	
30	R514	Potentiometer, Carbon, 1000 ohms	28861R	
31	R515	Resistor, 100 ohms ± 0.25%	8045R	607867152
32	R516	Resistor, 1000 ohms ± 0.25%	5351R	607867151
33	R517	Resistor, 10,000 ohms ± 0.25%	178R	607867153
34	R518	Resistor, 100K ohms ± 0.25%	556R	607867154
35	R519	Resistor, 1 megohm ± 0.25%	1055R	607867150
36	R520	Resistor, Carbon, 10 megohms ± 1%	23089R	
37	R521	Resistor, Metal Film, 100 megohms ± 1%	607849694	
38	R526	Resistor, Wire Wound, 11.1 ohms ± 0.1%	40427R	
39	SW501	Switch, Lever DPST, Switchcraft 6S1272	8651SW	
40	SW502	Switch, lever, SPST, Switchcraft 3033T	701855703	
41	SW503	Switch, VOLTS	34836SW	
42	CR601,602,603, 604,605,606	Diode, Zener, 200V ± 10%, 3W Solitron 3R200A	37626ME	

Item	Symbol	Description	Part No.	Serial No.'s with "A" Prefixes
43	CR607	Diode, Zener, 100V ± 10%, 3W Solitron 3R100A	37627ME	
44	CR608	Diode, Zener, 50V ± 10%, 1W Solitron IR50A	32354ME	
45	CR609	Diode, Zener, 36V ± 5%, 1N4753A	755859975	
46	CR610,11	Diode, Zener, 5.8V ± 5% 1N706A	755811425	
47	CR612,13, 20,21,22,23	Diode, 100 PIV, 1N4002	30108ME	
48	CR614,15,16, 17	Diode, 3000 PIV, Atlantic 50D30	755859974	
49	CR618,619	Diode, 400 PIV, 1N4004	30110ME	
50	CR624,25	Diode, 25 PIV, 1N456	30357ME	
51	DS601	Neon, selected		825849699
52	K601,2	Relay, DPDT	40802ME	
53	Q601	Transistor, NPN, RCA 40407	755859683	
54	Q602	Transistor, NPN, 2N3391	30245TU	
55	Q603	Transistor, PNP, 2N3906	36670TU	
56	Q604	Transistor, PNP, RCA 40406	755859684	
57	R621,22	Resistor, Wire Wound, 500K ± 0.1%	40425R	
58	R623	Resistor, Wire Wound, 125K ± 0.1%	40426R	
59	R624	Resistor, Wire Wound, 1 megohm, ± 0.1%	1055R	
60	R625	Resistor, Wire Wound, 11.1 ohms ± 0.1%	40427R	
61	R628,629	Resistor, Metal Film 250K ± 0.25%		607867149
62	F201	Fuse, .5 amp - Slow Blow For 240 volt operation change Fuse to .25 amp - Slow Blow	28453R	

6.3 ACCESSORIES

Item	Description	Part No.
1	Foot Switch Assembly	41509SW
2	ML-1 Test Leads	42091WE
3	L-8 Rack Mounting Kit	060-10748352

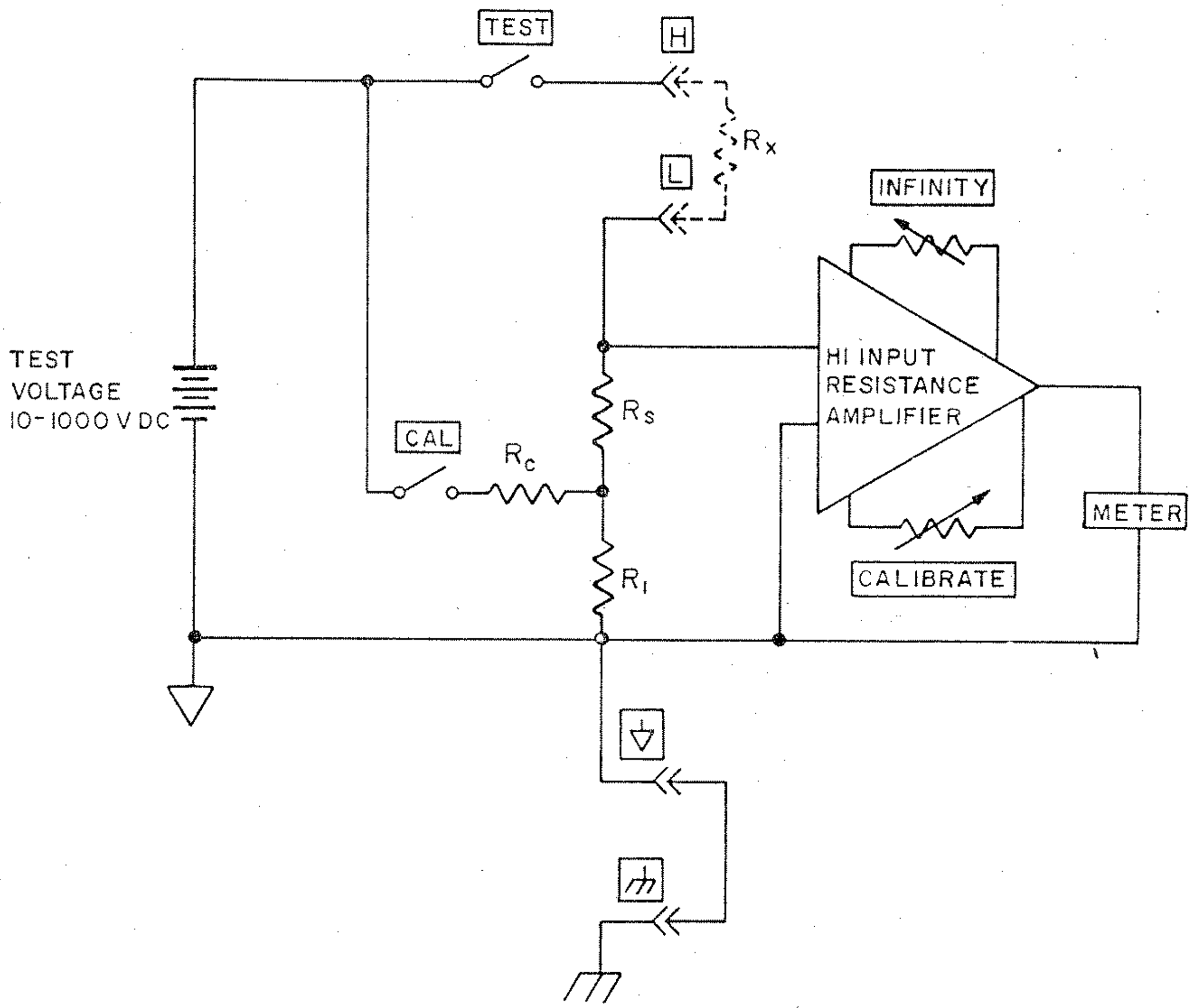

FIG. 2 SIMPLIFIED SCHEMATIC (C-41090)

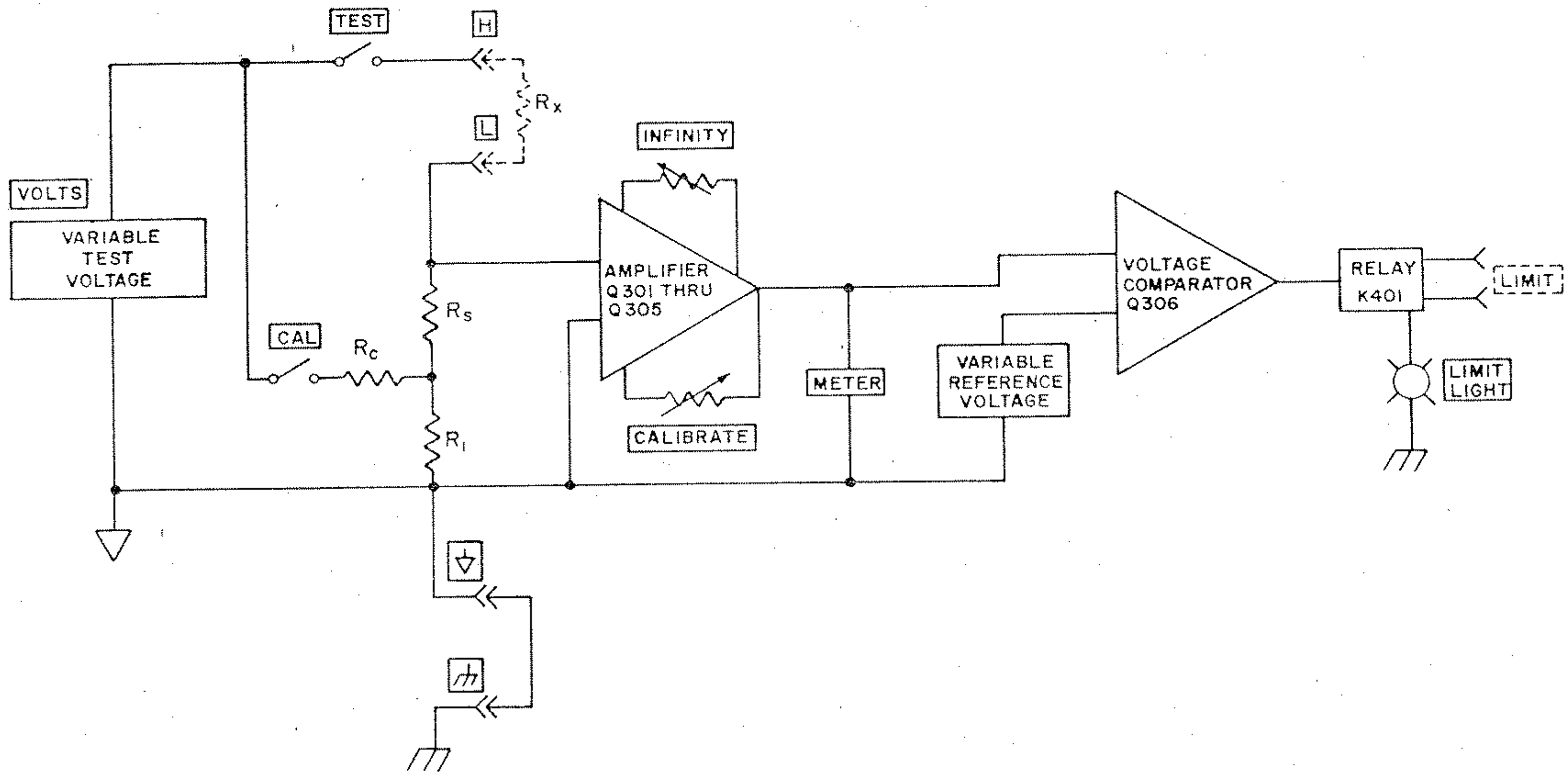

FIG. 3 BLOCK DIAGRAM - MEASURING CIRCUIT (C-41091)

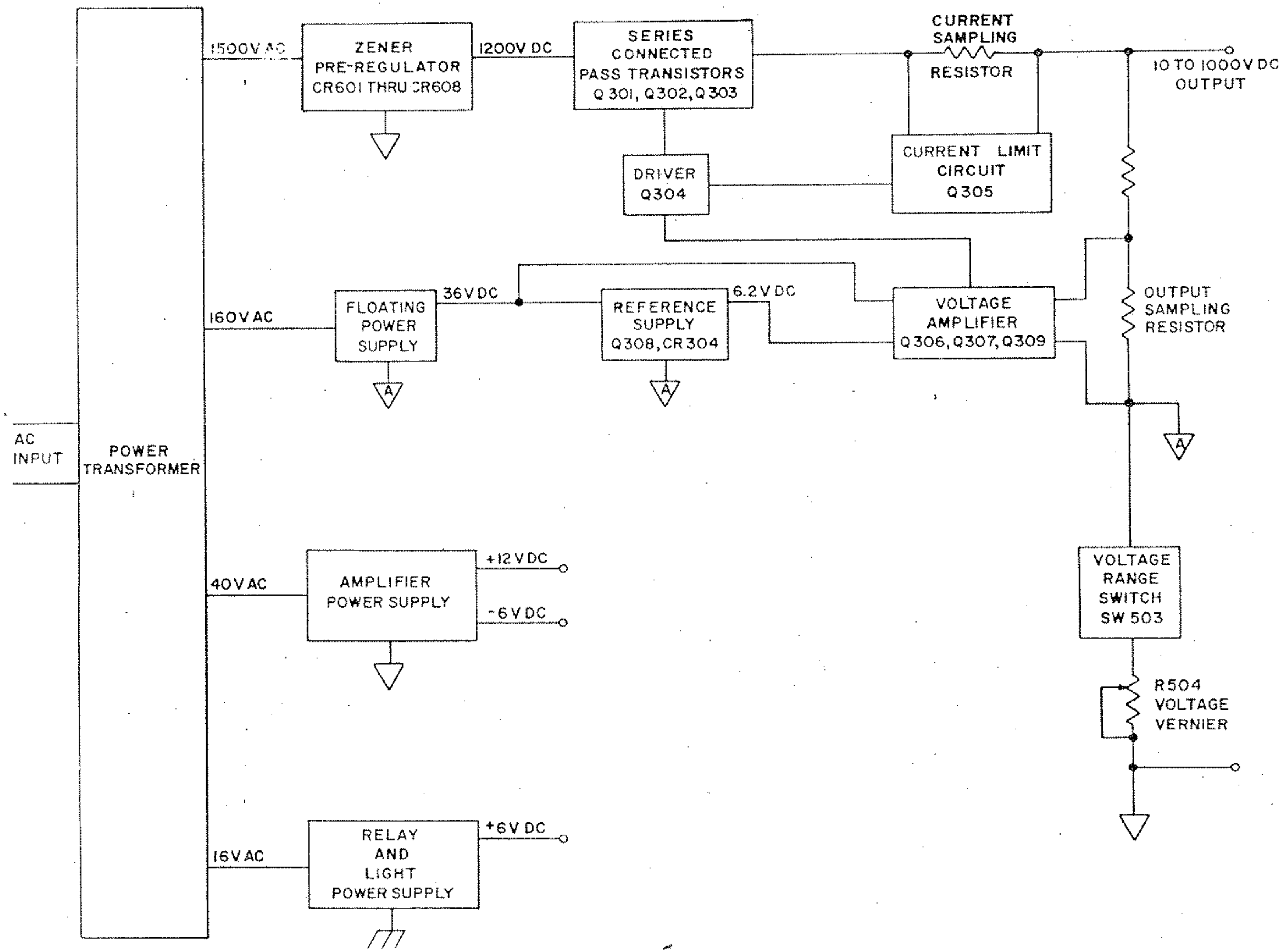

FIG. 4 BLOCK DIAGRAM - TEST VOLTAGE SUPPLY (C-41092)

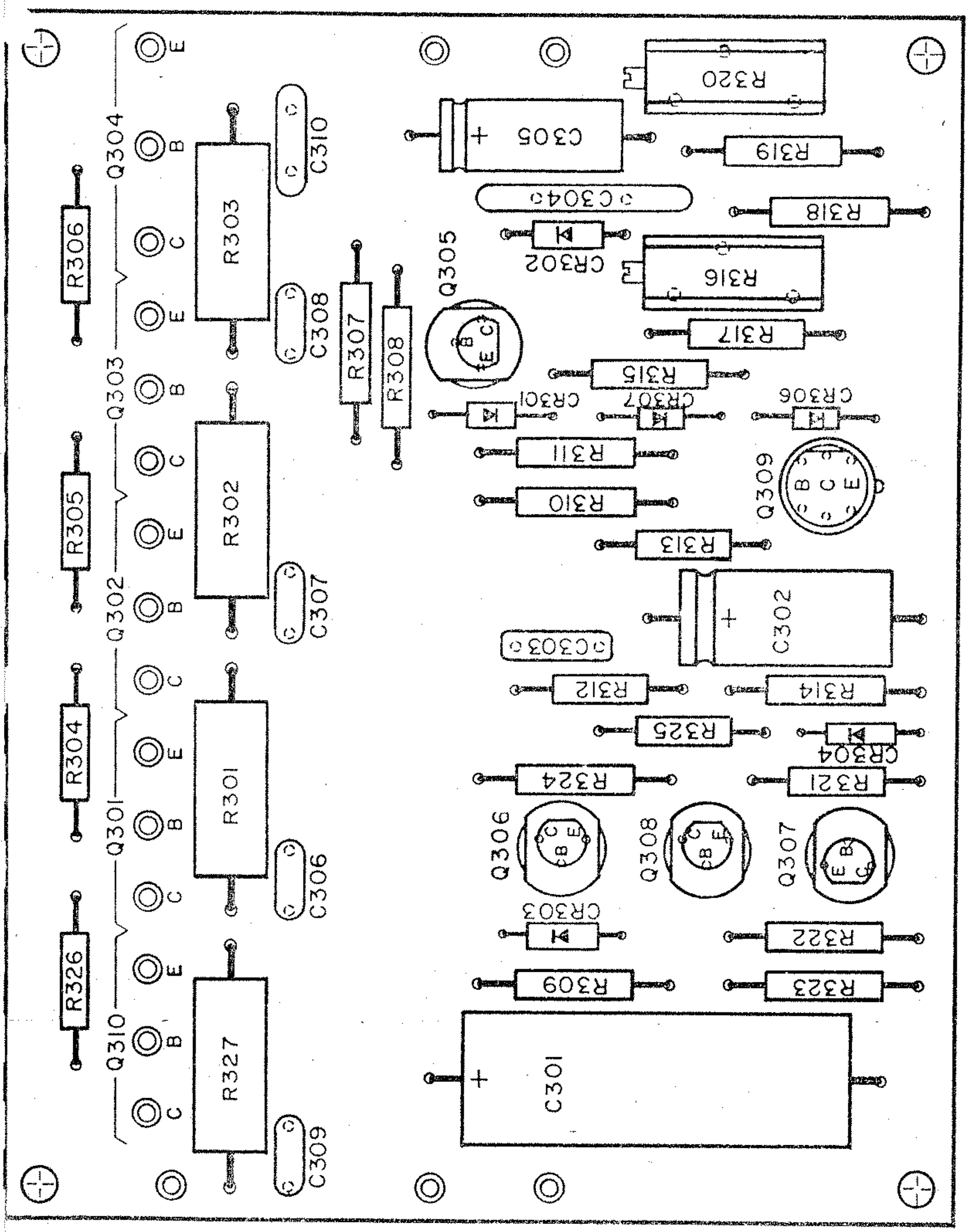

FIG. 5 COMPONENT LAYOUT - POWER SUPPLY P.C. BOARD ASSEMBLY (C-40566)

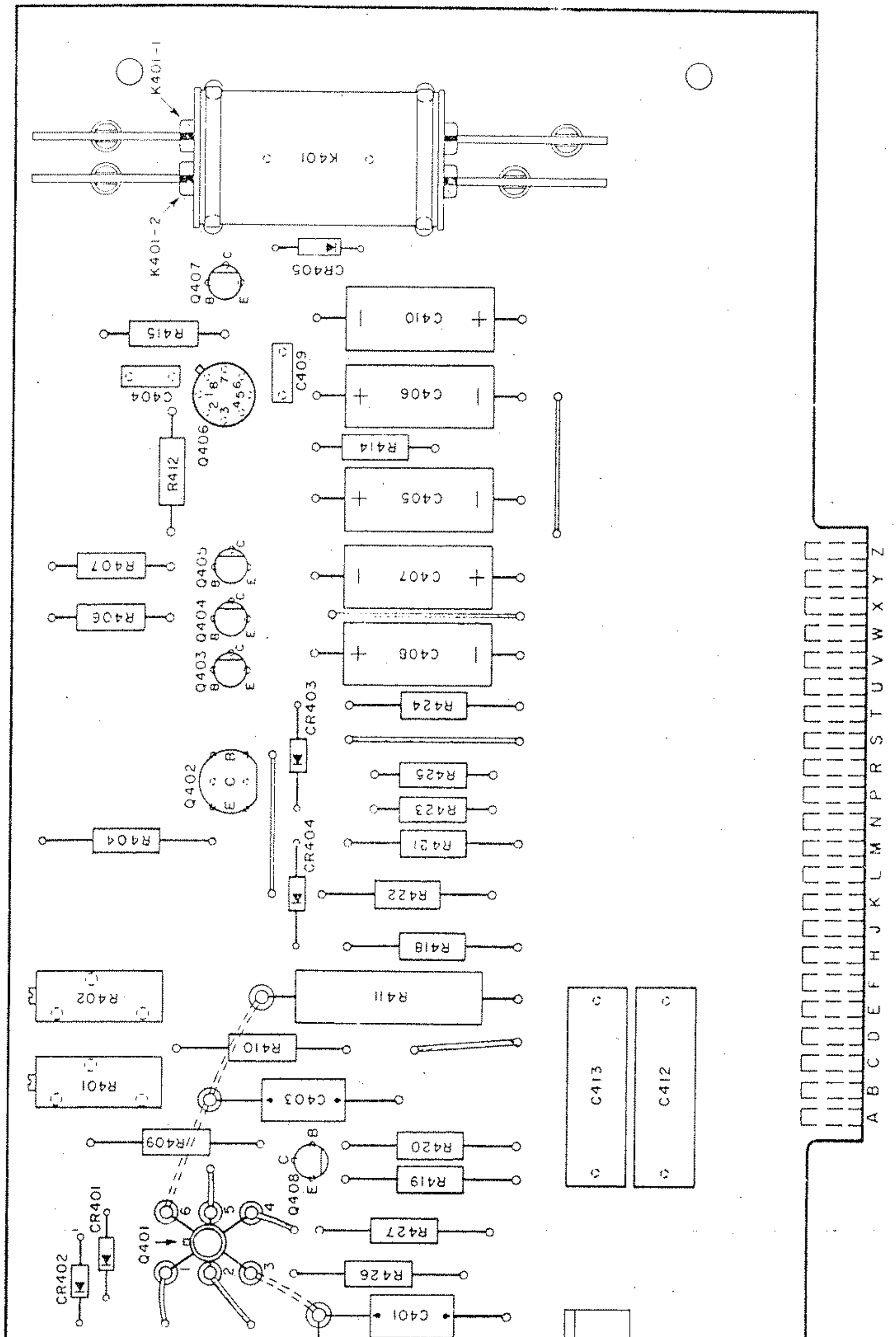

FIG. 6 COMPONENT LAYOUT - AMPLIFIER P.C. BOARD ASSEMBLY (D-40450)

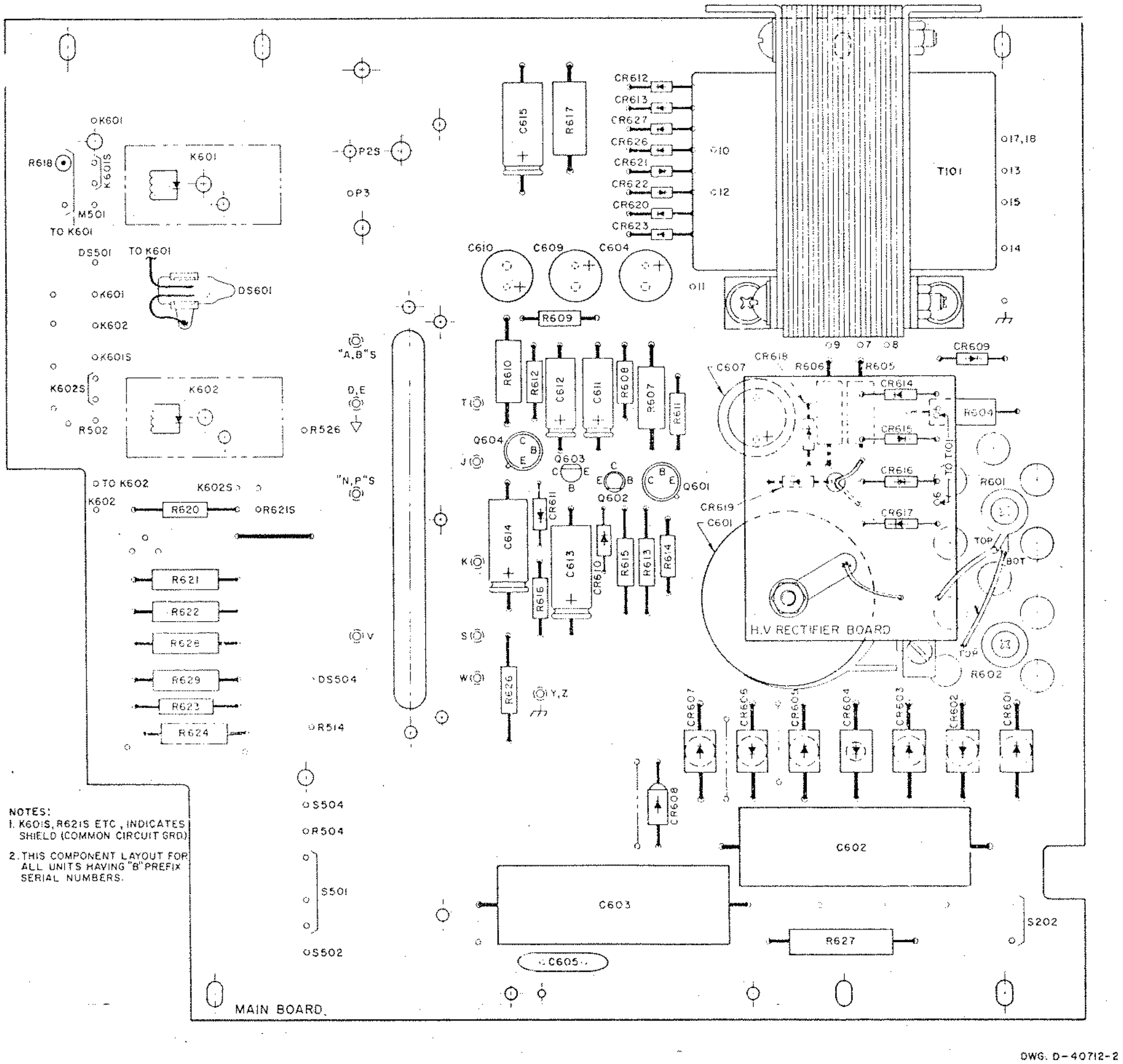

FIG. 7 COMPONENT LAYOUT

MAIN P.C. BOARD ASSEMBLY (D-40712)

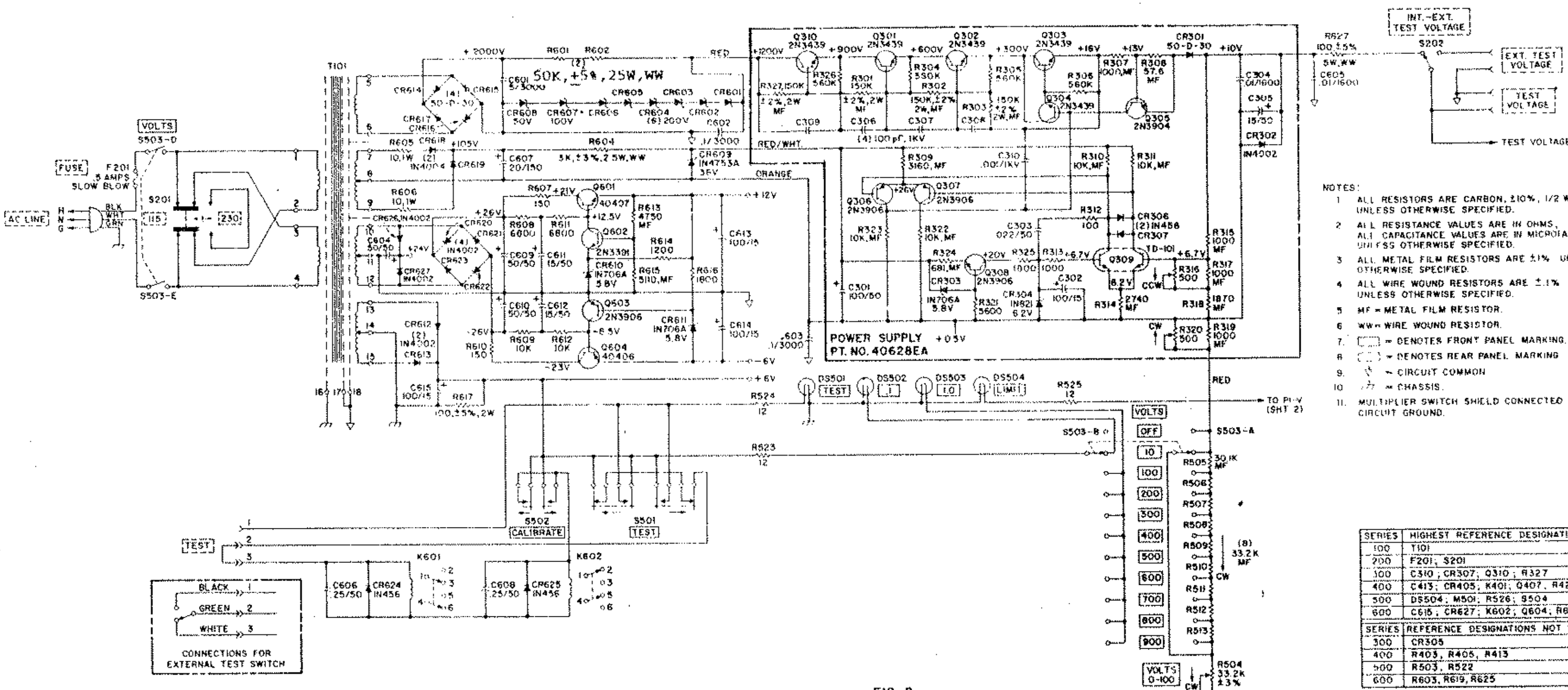

FIG. 8
SCHEMATIC DIAGRAM

NOTES:
1. ALL RESISTORS ARE CARBON, ±10%, 1/2 WATT UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROFARADS UNLESS OTHERWISE SPECIFIED.
3. ALL METAL FILM RESISTORS ARE ±1% UNLESS OTHERWISE SPECIFIED.
4. ALL WIRE WOUND RESISTORS ARE ±1% UNLESS OTHERWISE SPECIFIED.
5. MF = METAL FILM RESISTOR.
6. WW = WIRE WOUND RESISTOR.
7. [ ] = DENOTES FRONT PANEL MARKING.
8. [ ] = DENOTES REAR PANEL MARKING.
9. = CIRCUIT COMMON
10. = CHASSIS.
11. MULTIPLIER SWITCH SHIELD CONNECTED TO CIRCUIT GROUND.

SERIES	HIGHEST REFERENCE DESIGNATIONS
100	T101
200	F201; S201
300	C310; CR307; Q310; R327
400	C413; CR405; K401; Q407; R427; DS401
500	DS504; M501; R526; S504
600	C615; CR627; K602; Q604; R629; DS601
SERIES	**REFERENCE DESIGNATIONS NOT USED**
300	CR305
400	R403, R405, R413
500	R503, R522
600	R603, R619, R625

DWG. E-41102-1

FIG. 8 SCHEMATIC, POWER SUPPLY (E-411(

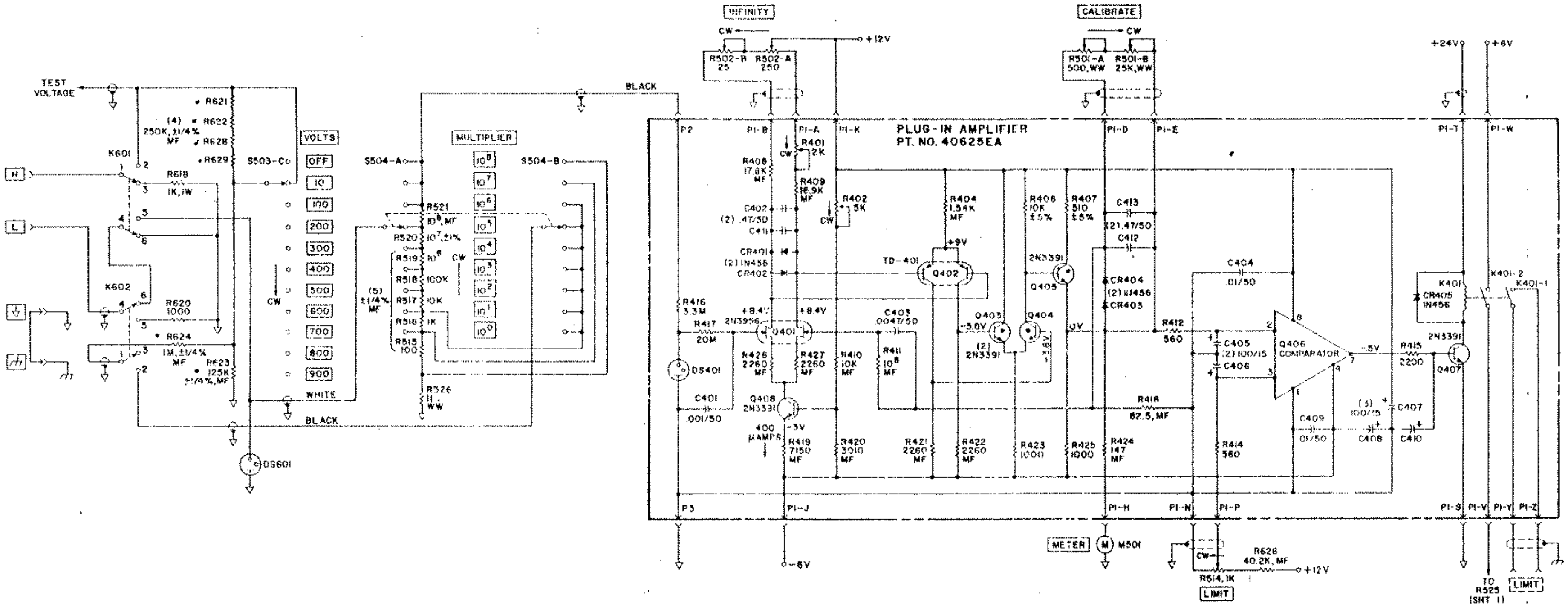

FIG. 8A
SCHEMATIC DIAGRAM

DWG. E-41102-2

SCHEMATIC, AMPLIFIER (E-41102-2)