INSTRUCTION MANUAL

Programmable Current Source
Model 725

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or part thereof which, within a year after shipment, proves defective upon examination. We will pay local domestic surface freight costs.

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 shipping instructions.

REPAIRS AND CALIBRATION

Keithley Instruments maintains a complete repair and calibration service as well as a standards laboratory in Cleveland, Ohio.

A Keithley service facility at our Munich, Germany office is available for our customers throughout Europe. Service in the United Kingdom can be handled at our office in Reading. Additionally, Keithley representatives in most countries maintain service and calibration facilities.

To insure prompt repair or recalibration service, please contact your local field representative or Keithley headquarters directly before returning the instrument. Estimates for repairs, normal recalibrations and calibrations traceable to the National Bureau of Standards are available upon request.

KEITHLEY
The measurement engineers.

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INSTRUCTION MANUAL

Model 725

Current Source

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WARNING

If current is programmed to 0 and unit is in operate, a COMPLIANCE VOLTAGE up to 125 volts may be present at the output terminals. For maximum operator safety the Model 725 Current Source should always be set to STANDBY mode when no current output is needed. The unit should also be set to STANDBY prior to changing range or polarity. This will ensure that no transient currents will be generated.

WARNING

This instrument is not approved for use in "hazardous locations" as defined in the National Electrical Code, Classes I, II, and III.

Class I: Those locations in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

Class II: Those locations that are hazardous because of the presence of combustible dust.

Class III: Those locations that are hazardous because of the presence of easily ignitable fibers or flyings.

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SECTION 1. GENERAL DESCRIPTION.

1-1. GENERAL. The Model 725 is a completely programmable current source. Ranges are programmed by a BCD code. The magnitude of the current (as a % of full scale) is programmed by use of a Kepco SN-3 Digital-to-Analog Converter or equivalent. Specifications for the Model 725 are given in Table 1-1.

1-2. WARRANTY INFORMATION. The warranty is stated on the inside front cover of the manual.

1-3. CHANGE NOTICE. Improvements or changes to the instrument not incorporated into the manual will be explained on a Change Notice Sheet attached to the inside back cover.

IMPORTANT

The ⚠ symbol can be found in various places in this Instruction Manual. Carefully read the associated CAUTION statements with regard to proper use and handling of the instrument. Damage to the instrument may occur if these precautions are ignored.

The ↯ symbol can be found in various places in the Instruction Manual. This symbol indicates those areas on the instrument which are potential shock hazards. Carefully read the associated WARNING statements with regard to proper use and handling of the instrument. Serious personal injury may result if these precautions are ignored.

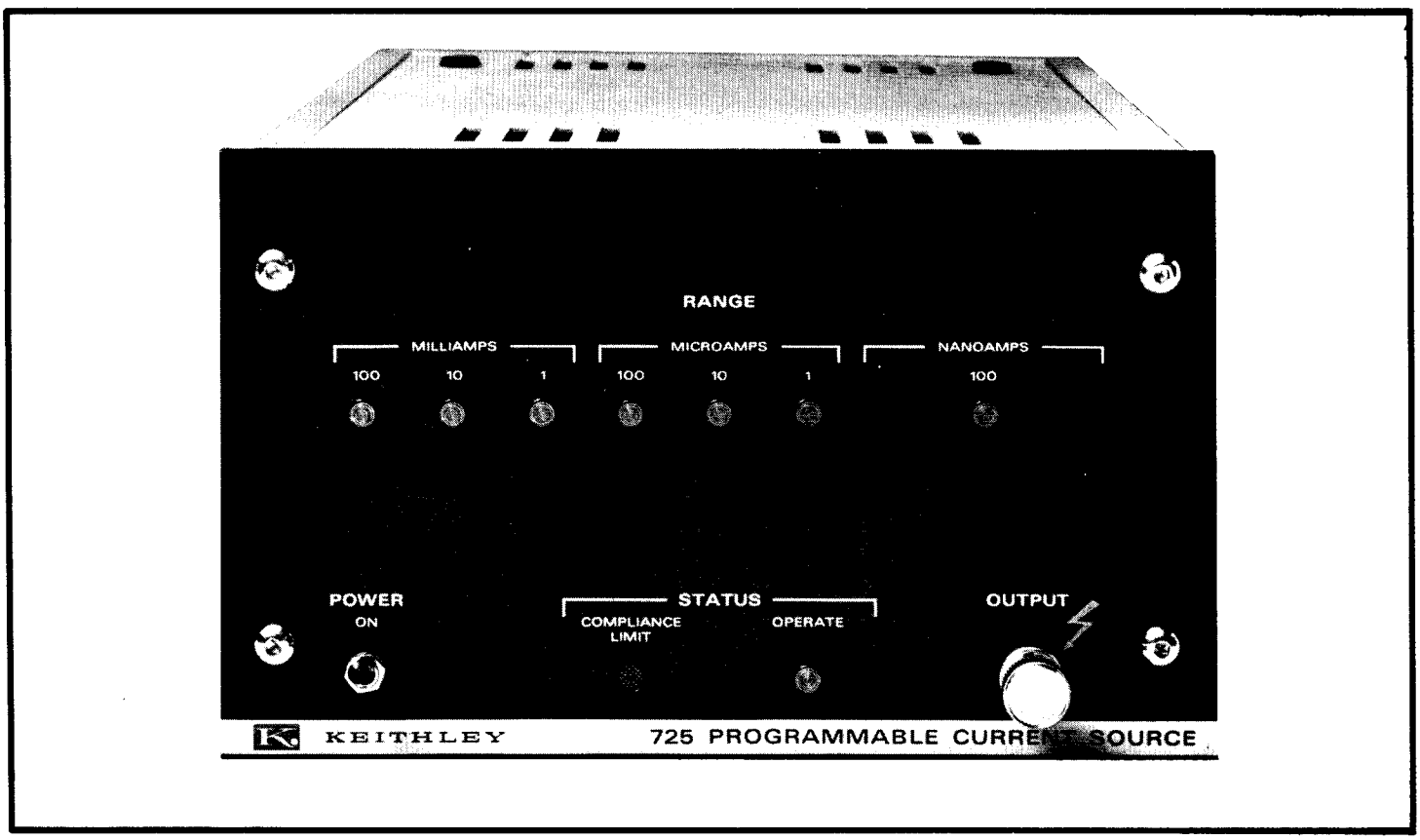


FIGURE 1-1. Model 725 Programmable Current Source.

TABLE 1-1.
SPECIFICATIONS
Model 725 Programmable Current Source

GENERAL:	The Model 725 provides constant current under program control. Range, polarity, operate/standby and selection of compliance limit are all directly programmable. Magnitude is programmed by use of a Kepco SN-3 Digital to Analog Converter or equivalent.
OUTPUT: (when used with Kepco Model SN-3)	
DC Current:	100nA to 100mA full scale in seven decade ranges.
Voltage:	Four digitally selectable compliance limits are variable between 12 volts and 90 volts. With no compliance limit programmed, constant current is maintained to at least 100 volts.
Resolution:	0.1% of range.
Polarity:	Programmable, positive or negative.
Floating:	±100 volts off chassis maximum. Less than 10ppm of full range change in output current per volt on the 1µa to 100mA ranges. Less than 20ppm per volt on the 100nA range.
Accuracy:	±(0.6% of programmed value + 0.1% of range).
Stability:	During the first hour, or in subsequent 8-hour periods: ±(0.02% of programmed value + 0.01% or range) on the 1µA to 100mA ranges. ±(0.1% of programmed value + 0.03% of range) on the 100nA range.
Load Regulation:	±0.005% of full range from no load to full load on the 10µA through 100mA ranges. ±0.02% on the 1µA range. ±0.2% on the 100nA range.
Line Regulation:	±0.005% of full range for 10% change in line voltage.
Overload Protection:	Voltage limited to compliance voltage setting of polarity selected. Automatic recovery.
Nom. Settling Time:	30 milliseconds to within 0.1% of final value.
PROGRAMMING:	
Functions:	Range, polarity, selection of 1 of 4 compliance limits, and operate/standby are all directly programmable. Magnitude is programmed by a 0-10V signal for 0-100% of full range.
Compatible Logic:	TTL or DTL. Maximum input load, 10 TTL loads, except operate/standby where driving circuit must sink 60mA.
Logic Power:	An external 5V (±0.25V) @ 250mA TTL-compatible logic supply is required.
ISOLATION:	10^9ohms; digital low to output low.
ENVIRONMENT:	20° to 30°C up to 50% relative humidity.
CONTROLS, INDICATORS:	Front panel ON/OFF switch. Indicator lights for range, operate, and compliance limit.
CONNECTORS:	Rear panel 15-pin D style connector for digital input (mating connector supplied). Rear panel triaxial connector for magnitude programming. Front and rear panel output triax connectors. Rear panel banana jacks for compliance monitoring.
POWER:	105-125 or 210-250 volts (switch selectable). 50-60Hz. 35 VA maximum.
DIMENSIONS, WEIGHT:	133mm (5-1/4 in.) half-rack. Overall bench size 155mm high x 225mm wide x 310mm deep. (6-1/4 in. x 9 in. x 12-1/4 in.). Net weight 3,4 kg. (7-1/2 lbs.).

SECTION 2. OPERATION.

2-1. GENERAL. This section provides interface information and operating instructions for the Model 725.

2-2. CONTROLS. The Model 725 is remotely programmable and as such, is equipped with only two switches. The line POWER switch (S302) is on the front panel and the LINE VOLTAGE selector switch (S201) is on the rear panel. These switches are shown in Figures 2-1 and 2-2 and functionally described in Table 2-1.

2-3. INDICATORS. Ten front panel indicators provide the operating status of the Model 725. A neon lamp (DS201) is lighted when the line POWER switch is on and line power is applied to the instrument. Nine of the indicators are of the high efficiency light-emitting diode type. Seven of the lamps (DS301-DS307) are dedicated to the current ranges, with the lighted LED indicating the programmed range. The two remaining LED's (DS101 and DS308) give indication of the operating modes of the instrument. When the OPERATE lamp is on, the instrument is in operating mode and current is supplied to the OUTPUT connectors; when off, standby mode is implied. The COMPLIANCE LIMIT lamp lights when the voltage required to drive the programmed current through the load reaches the preset compliance voltage limit. At this point, the 725 changes from constant current to constant voltage mode.

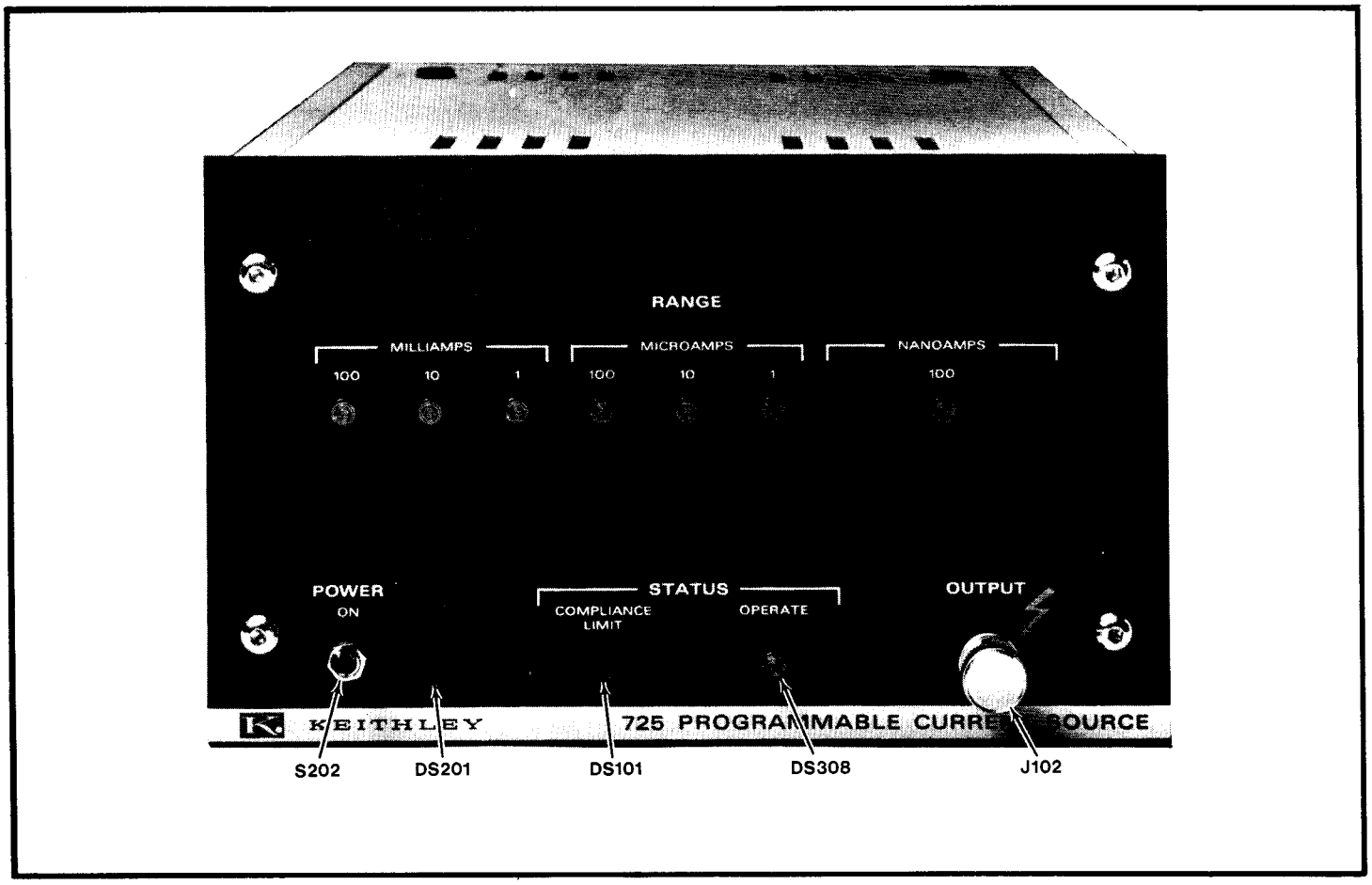


FIGURE 2-1. Model 725 Front Panel.

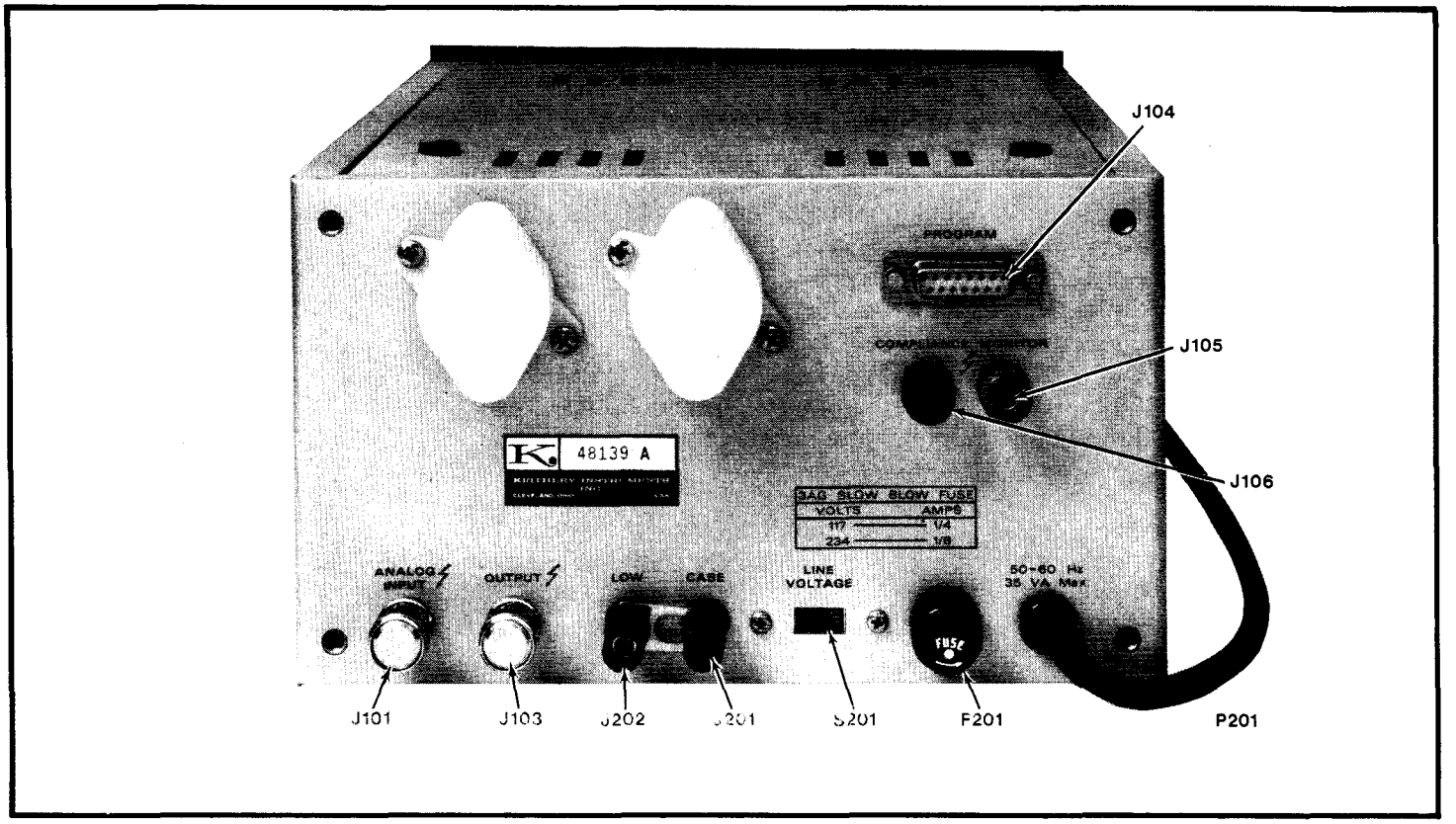


FIGURE 2-2. Model 725 Rear Panel.

2-4. CONNECTIONS. The input and output connections are described below and shown in Figures 2-1 and 2-2. These connections are also listed in Table 2-1. The output connections are also shown schematically in Figure 2-3.

a. Output Connectors. The front and rear panel triaxial OUTPUT connectors (J102, J103) are wired in parallel. By definition, the inner conductor of the triax connector is high, the inner shield is low and the outer shield is chassis ground. The triax connectors are shown schematically in Figure 2-4. The OUTPUT connection can be made to either the front panel connector or the rear panel connector. The unused OUTPUT connector should have a cover (two CAP-18 are supplied) installed to provide protection against electrical shock and dust accumulation. The cover also provides electrical shielding. Output connections should be made using low-noise triaxial cable. For custom length cables, Keithley Part No. SC-22 low-noise triaxial cable should be used. A mating connector is available by ordering Keithley Part No. CS-141.

WARNING

When the Model 725 is floating, high voltage may be present at the OUTPUT connectors even though the instrument is in standby (non-operate mode). The actual voltage present is dependent on the customer supplied voltage source, up to 100 volts.

b. Low and Ground Terminals. Two binding posts are located on the rear panel and identified as LOW (J202) and GROUND (J201).

1. The LOW terminal (Black) is internally connected to the low of the two OUTPUT connectors.

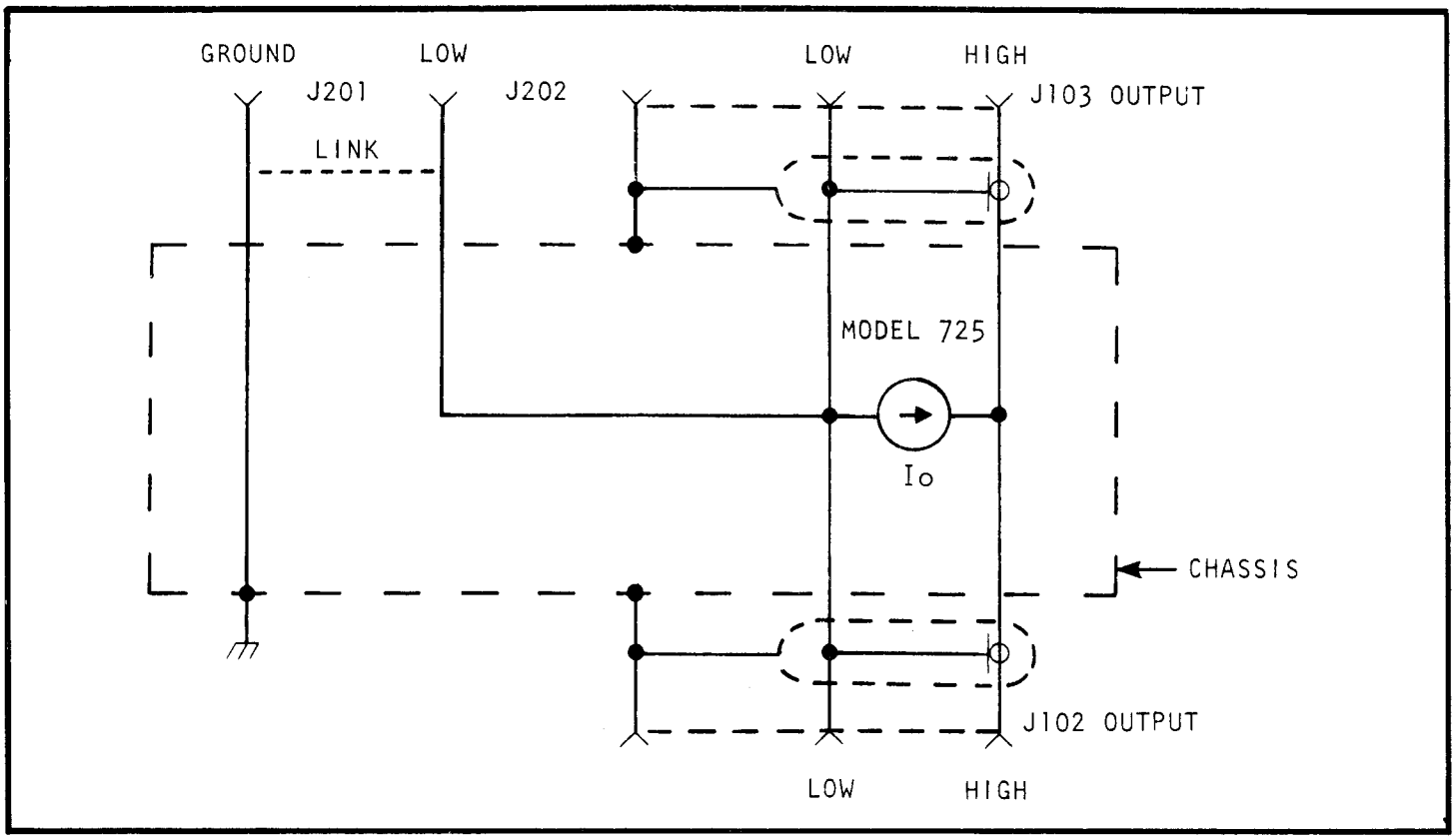


FIGURE 2-3. Schematic of Output Connections.

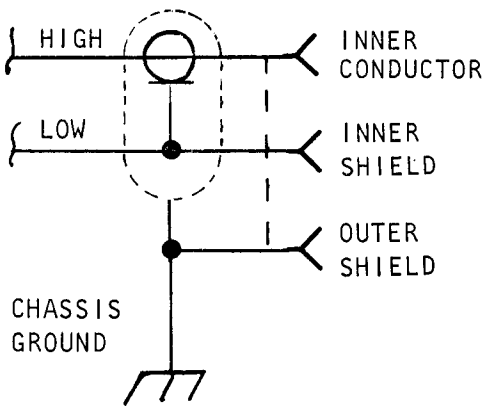


FIGURE 2-4. Triaxial Connector Schematic.

2. The GROUND terminal (Green) is connected to chassis ground. A shorting link is provided for connecting LOW to chassis ground. For floating applications, the link must be removed. For other applications, leave the shorting link in, where possible, to minimize noise pickup.

c. COMPLICANCE MONITOR Terminals. Two banana jacks (Black, Red) are located on the rear panel and permit monitoring of the compliance voltage.

1. The black terminal (J106) is connected to LOW of the OUTPUT connectors.

2. The red terminal (J105) is connected to an internally buffered voltage, which is approximately at the same voltage as OUTPUT HIGH, through a 47KΩ isolation resistor.

d. Analog Input. The ANALOG INPUT triaxial connector (J101) is located on the rear panel. The analog input must be a positive voltage from 0 to 10 volts. (10V = full scale current). The analog voltage must be floating (not referenced to any other signal or chassis ground). A low noise triaxial cable should be used to connect to the voltage source. This cable should be kept ≤ 3 feet to minimize capacitive loading of the source and to improve transient response. A mating connector is available by ordering Keithley Part No. CS-141. When the Kepco SN-3 is purchased, a custom cable is supplied (Keithley Part No. 29449B). Also, see Magnitude Programming, paragraph 2-5f.

CAUTION

⚠ Do not short HIGH or LOW of Analog Input connector to chassis ground, as this may damage the Model 725.

e. Program Connector. Programming and control connections to the Model 725 are made through a 15-pin "D" type connector (J104) located on the rear panel. A mating connector and its accessories are supplied with the Model 725. See Table 2-2 for pin identification, also see the discussion on Remote Programming and Control (paragraph 2-5).

f. Line Power Cord and Fuse.

1. The Model 725 is provided with a three-wire line cord and plug (P201) which mates with third-wire earth grounded receptacles. Prior to connecting P201 to line power, verify that the line voltage selector switch (S201) is set to correspond to the input voltage level, i.e., 117V position for 105-125 volts and 234V position for 210-250 volts.

2. The line fuse (F201) is a type 3AG, slow blow. Use 1/4A for 117V and 1/8A for 234V.

TABLE 2-1.
CONTROLS, INDICATORS AND CONNECTIONS.

Item	Functional Description
FRONT PANEL	
POWER switch (S202)	Controls line power to 725.
Line power lamp (DS201)	Lights when line power is applied by S202.
RANGE Indicators (DS301-DS307)	When a range is programmed, one of seven is lighted - indicating programmed current range.
STATUS Indicators (DS101, DS308)	DS101 indicates that the preset compliance voltage limit has been reached - 725 operates in constant voltage mode, rather than constant current mode when lighted. DS308 is lighted in operate mode. When off standby mode is implied, with no current supplied to OUTPUT connector and HIGH to LOW shorted by 200Ω resistor.
OUTPUT Connector (J102)	Triaxial connector wired in parallel with rear panel OUTPUT connector J103. Use J102 or J103. See NOTE for Triaxial Connector signal definition.
REAR PANEL	
Line VOLTAGE Switch (S201)	Must be set to correspond with the level of the input line voltage (117 or 234 volts).
ANALOG INPUT (J101)	Triaxial connector - See Magnitude Programming, paragraph 2-5f. Inner conductor is HIGH, inner shield is LOW and outer shield is Chassis ground. CAUTION ⚠ Do not short HIGH or LOW of J101 to chassis ground, as this may damage the 725.
OUTPUT Connector (J103)	Triaxial connector wired in parallel with front panel OUTPUT connector J102. Use J102 or J103. See NOTE for triaxial connector signal definition.
LOW and GROUND Connectors (J202, J201)	LOW (J202) is connected to LOW of OUTPUT connectors J102 and J103. Ground (J201) is connected to chassis ground. The link (supplied) permits connecting LOW to chassis ground.
COMPLIANCE MONITOR (J105, J106)	Permits monitoring of the compliance voltage. J106 is connected to OUTPUT LOW and J105 is connected to an internally buffered voltage (≈OUTPUT HIGH) through 47 KΩ isolation.
FUSE (F201)	Type 3AG, Slow Blow. 117V (1/4A); 234V (1/8A)
Power Cord (P201)	Connects line power to instrument.

TABLE 2-1. (CON'T)

Item	Functional Description
PROGRAM Connector (J104)	15-pin "D" type connector - permits connecting the 725 to the digital control. See Table 2-1 for pin identification. NOTE Triaxial Connector signal definition - J101, J102, J103 Inner conductor = HIGH Inner shield = LOW Outer shield = Chassis ground.

2-5. REMOTE PROGRAMMING AND CONTROL.

a. Range Programming. The range is programmed by supplying a BCD code (1,2,4). The numericial code is equal to the range exponent of the range selected. Example: 1 = 100mA range = 10^{-1}A. (10^{-X} where x is the range code). See Table 2-2 for pin identification. Driving circuit must be able to sink ≈3mA per line. The programmed range is indicated by one of seven front panel range indicating LED's.

b. Polarity Control. The current source is set up such that a positive current is supplied unless the POLARITY line is pulled low. See Schematic 28680E.

c. Operate Commaned. The operate line must be pulled low to enable the 725 to produce an output current. In the standby (non-Operate mode) the internal current generator is shorted and a 200 ohm resistor connected across the output connector.

d. Compliance Limit. Four internally adjustable potentiometers are provided for use as preset compliance limits. Selection of a particular preset compliance limit is accomplished by pulling the particular compliance relay line to low. The adjustments are located just behind the top of the front panel. Access can be gained by removal of the top cover. Compliance potentiometers are arranged such that compliance numbers 1 through 4 from left to right facing the front panel may be used at any particular time to provide a larger number of compliance limits. If more than one line is pulled low, the compliance voltage will be less than the lowest preset compliance limit selected. If none of the lines are pulled low, the compliance limit will be approximately 125V. This mode of operation should not be used because of the uncertainty of operation outside of the specified limits (12V-90V). Loading of the compliance lines is 10mA per line.

e. Programming Techniques. Programming can be done in any sequence. However, it is suggested that standby be selected before a range or polarity is changed and standby should be held until a new range has been selected. Standby should also be used when making connections to the Model 725.

f. Magnitude Programming. The magnitude of the current on a particular range is selected by programming a Kepco SN-3 Digital to Analog converter or equivalent. The 725 is a basic voltage to current converter. An analog voltage, 0 to +10V, must be supplied to the "analog input".

CAUTION

⚠ The programming Analog Signal must be floating (not referenced to any other signal or to chassis.) The Kepco SN-3 is such a voltage supply.

g. Kepco SN-3 Interface. The digital interface of the Kepco SN-3 or equivalent, is left to the customer. A SN-3 Manual is supplied whenever the SN-3 is purchased.

h. External +5 Volt Supply. An external floating +5 volt supply is required, +5V @ 250mA minimum. See Table 2-2 for pin connections.

TABLE 2-2.
PIN FUNCTIONS FOR RANGE PROGRAMMING CONNECTOR J104

PIN	FUNCTION	OPERATION
1,2	+5 Supply in (Logic High)	Apply an external +5V to Power Relays & Logic.
3	No Connection	
4	Range Selection BCD 1	High True - Hold low to Common unless selected
5	Range Selection BCD 4	High True - Hold low to Common unless selected
6	No Connection	
7	Compliance 2	Pull down to Common to select
8	Compliance 4	Pull down to Common to select
9	Polarity	HI Positive (Relay deenergized) LO Negative (Relay energized) 60mA
10	Operate	Pull down to Common for output current, otherwise unit is in Standby.
11, 13	Common (Digital ground) -Low of +5 Volt Supply	Low side of 5V Supply is not connected to any other circuit. See Note.
12	Range Selection BCD 2	High True - Hold low to Common unless selected
14	Compliance 1	Pull down to Common to select
15	Compliance 3	Pull down to Common to select

NOTE:

Common (Digital ground) maximum of 30 volts off the chassis ground.

2-6. MEASUREMENT CONSIDERATIONS.

a. Accuracy. Since the total accuracy of the Model 725 is the sum of the programmed current value accuracy and the range accuracy, the user should select the lowest useable range for best possible accuracy.

b. Stability. Since stability is specified in terms of programmed current value and the range selected, the user should select the lowest useable range for best possible stability.

c. Line Regulation. The line regulation is stated as ±0.005% of full range for a corresponding 10% change in line voltage.

d. Load Regulation. The load regulation is specified as ±0.005% of full range from no load to full load on the 10μA through 100mA ranges, ±0.02% on the 1μA range and ±0.2% on the 100nA range. The no load to full load variation corresponds to an output compliance voltage change from 0 volts to 100 volts.

e. Output Impedance. The effective output impedance of the 725 is a function of the load regulation specification and the high to low insulation resistance. The output impedance for each range is given in Table 2-3. The insulation resistance is typically 2×10^{12} ohms; therefore, the maximum output impedance is 2×10^{12} on the 100nA and 1μA ranges. The effective output impedance (R_0) can be determined by the following equations.

For 100mA Range: $R_L = 10^3\Omega$ and % regulation = 0.005%.

$$\text{Since \% regulation} = 100 \times \frac{R_L}{R_0 + R_L}$$

$$\text{Then } R_0 \geq \frac{100R_L}{\%\ \text{REG}} \qquad \text{OR}$$

$$R_0 \geq \frac{100 \times 1000}{0.005} = 2 \times 10^7\Omega$$

TABLE 2-3.
Output Impedance

Programmed Range	Output Impedance
100 mA	$2 \times 10^7\ \Omega$
10 mA	$2 \times 10^8\ \Omega$
1 mA	$2 \times 10^9\ \Omega$
100 μA	$2 \times 10^{10}\ \Omega$
10 μA	$2 \times 10^{11}\ \Omega$
1 μA	$2 \times 10^{12}\ \Omega$
100 nA	$2 \times 10^{12}\ \Omega$

f. Maximum Load. The Model 725 will deliver the programmed current for a load resistance from 0 to R_{MAX}. The value of R_{MAX} is determined by the magnitude of the programmed current (I) and the compliance voltage selected (V_C) where $R_{MAX} = V_C/I$. If the load resistance exceeds R_{MAX}, then the Model 725 will automatically switch into voltage limit mode, indicated by the COMPLIANCE LIMIT lamp (DS101) being lighted.

g. Floating Operation. The instrument can be floated up to ± 100 volts off of chassis ground with less than 20ppm of full range change in output current per volt on the 100nA range and less than 10ppm per volt on the other ranges. For floating operation, the shorting link must be removed. The outer shell of both OUTPUT connectors is always at chassis ground for safety when floating the instrument. A 5µF filter capacitor (C217) is connected between the LOW and chassis GROUND binding posts to minimize line frequency pickup. The LOW to GROUND isolation is approximately 10^7 ohms. A typical example of floating operation is shown in Figure 2-6. In this example, the Model 725 can be used with a voltage supply such as the Keithley Model 240A to extend the maximum useable compliance voltage to +200 volts (+100 + floating voltage). In this case the Model 725 can be adjusted for a compliance voltage of +100 ±100 volts dc. The maximum current is 10 milliamperes (for the Model 240A).

WARNING

When the instrument is floated and no compliance voltage is selected, up to 100 volts will be present at the OUTPUT connectors.

2-7. PRELIMINARY PROCEDURES.

a. Inspection. The Model 725 was carefully inspected both mechanically and electrically before shipment. Upon receiving the instrument, check for any obvious damage which may have occurred during transit. Report any damages to the shipping agent. To verify the electrical specifications, follow the procedures given in Section 6.

b. Power. The Model 725 is provided with a three-wire line cord which mates with third-wire earth grounded receptacles. Connect the instrument to ac line power as follows:

CAUTION

Connect only to the line voltage selected. Application of incorrect voltage can damage the instrument.

1. Set the LINE VOLTAGE switch on the back of the instrument to correspond to the line voltage available. Ranges are 105 to 125 volts ac (117V position) and 210 to 250 volts ac (234V position).

2. Verify that the proper line fuse (F301) is installed for the line voltage, as indicated on the back panel label.

WARNING

Ground the instrument through a properly grounded receptacle before operation. Failure to ground the instrument can result in severe injury or death in the event of a short circuit or malfunction.

3. Set the Power switch on the Front panel to the Off position and plug the power cord into a properly earth-grounded outlet.

c. Input Connections. Make the analog input and program connections as described in Paragraph 2-4. Paragraph 2-5 describes the required signal levels and driving circuits.

d. Adjustment of Compliance Limits. The Model 725 is shipped from the factory with the four compliance limit potentiometers set fully CCW to provide minimum compliance voltage (≈ 12 volts). To preset the compliance voltage limits, proceed as follows:

1. The adjustments are located just behind the top front panel. Remove the top cover to gain access. The compliance potentiometers are arranged such that compliance numbers 1 through 4 are left to right when facing the front panel (R301 through R304, respectively).

2. Disconnect all output loads from Model 725.

3. Connect DMM to COMPLIANCE MONITOR jacks on rear panel of 725. Set DMM for dc volts and appropriate range.

4. Apply line power to the Model 725. Program standby and compliance 1 (COMP. 1 low, other COMP. lines high).

5. Program the desired polarity and current range and magnitude.

NOTE

It is normal to have a slight difference in the compliance limit on the opposite polarity.

6. Program operate (OPERATE line low).

7. Adjust COMP. 1 potentiometer (R301) for the desired limit.

8. Program standby.

9. Repeat steps 4 through 8 above to preset compliance limits 2 through 4. Release the compliance line pulled low before programming the next compliance limit to be set.

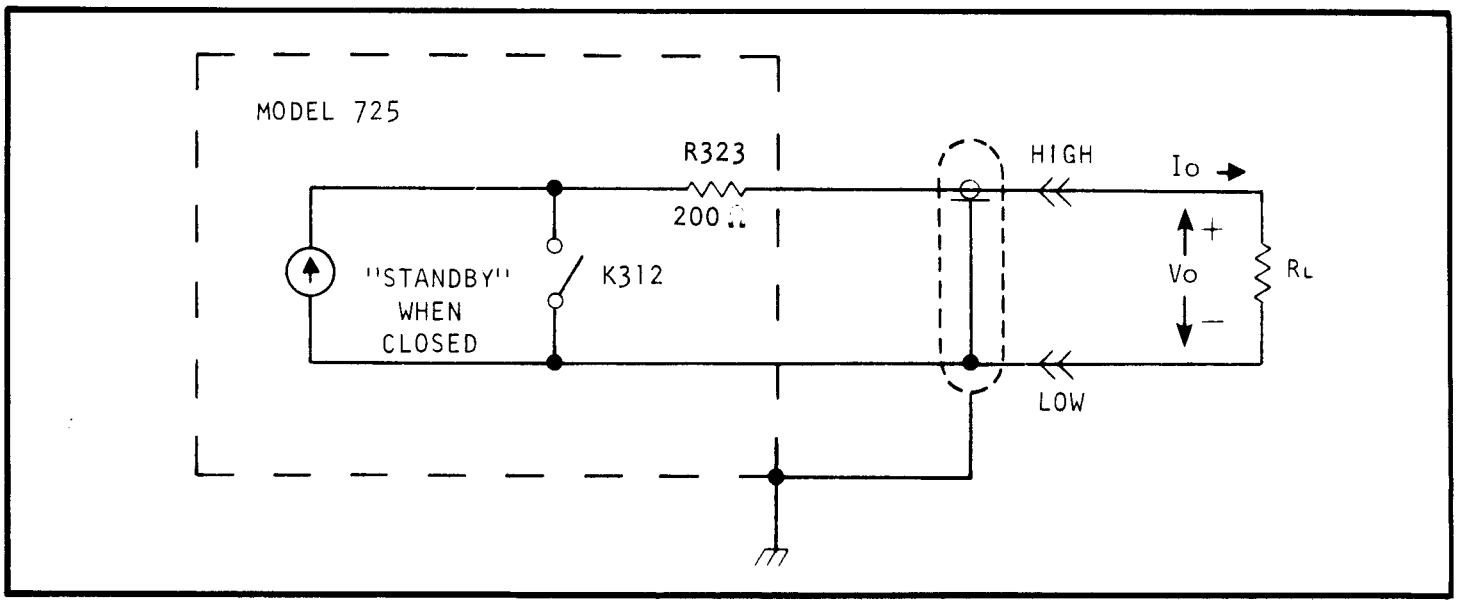


FIGURE 2-5. Resistive Load.

2-8. OPERATING CHARACTERISTICS. In addition to being completely programmable, the Model 725 Current Source has a bipolar output, a constant current up to the maximum compliance setting, and automatic crossover to constant voltage mode.

a. Bipolar Output. The Model 725 can deliver or accept current and as such it has a bipolar output.

1. Current Source. The instrument can be used as a current source with a resistive load as shown in Figure 2-5. In this case, the Model 725 delivers the programmed current. The voltage developed across the load resistance R_L is $V_L = I_0 R_L$.

2. Current Sink. The instrument can be used as a current sink as shown in Figure 2-6. In this case, the polarity of the current is such that current is flowing into the Model 725. The output voltage $V_0 = E - I_0 R_L$, where I_0 is the programmed current, R_L is the load resistance.

b. Constant Current Mode. The Model 725 will deliver the programmed current for resistive, capacitive loads unless the voltage required at the output terminals exceeds the compliance voltage limit.

1. Resistive Load. The instrument can be used to deliver current to a resistive load from 0 ohms to $R_{MAX} = V_C/I_0$ and V_C is the compliance voltage.

2. Capacitive Load. The instrument can also be used to charge a capacitive load as shown in Figure 2-7. The capacitor will charge to the compliance voltage.

CAUTION

⚠ When charging large capacitive loads (> 1000pF charged to > 10 volts) insert a series resistor in the Model 725 OUTPUT to limit peak discharge current to < 500mA. Otherwise, damage to the Model 725 could occur when going to standby mode.

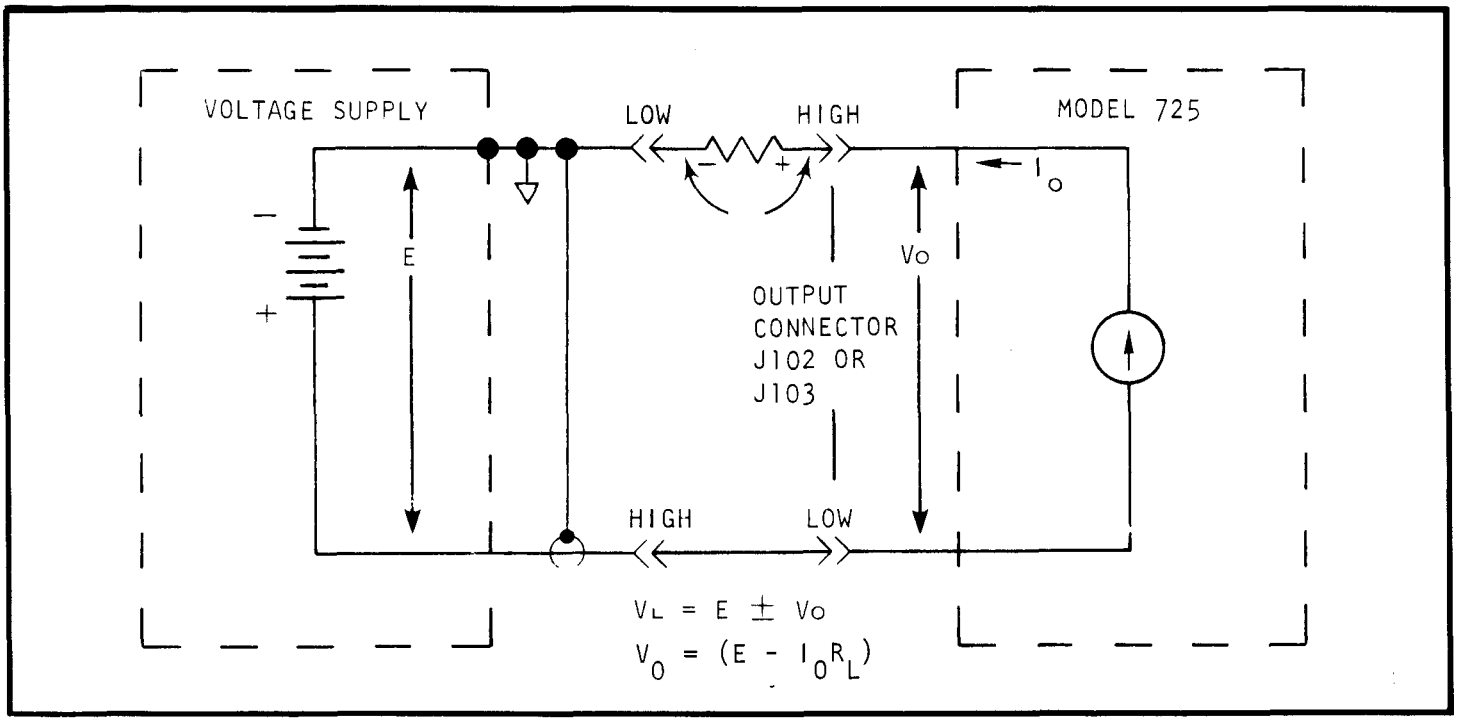


FIGURE 2-6. Floating Supply.

c. Constant Voltage Mode. The Model 725 can be adjusted for a compliance voltage from 10 to 90 volts. The voltage limiting will occur if the load resistance is such that $I_O R_L = V_C$. The instrument will automatically switch into a constant voltage mode (the LIMIT lamp will be lighted) such that the output voltage will not exceed the compliance setting. If the Model 725 is used as a current sink, an output voltage greater than 100 could be developed regardless of the compliance setting. The voltage limiting characteristic can be seen in Figure 2-8.

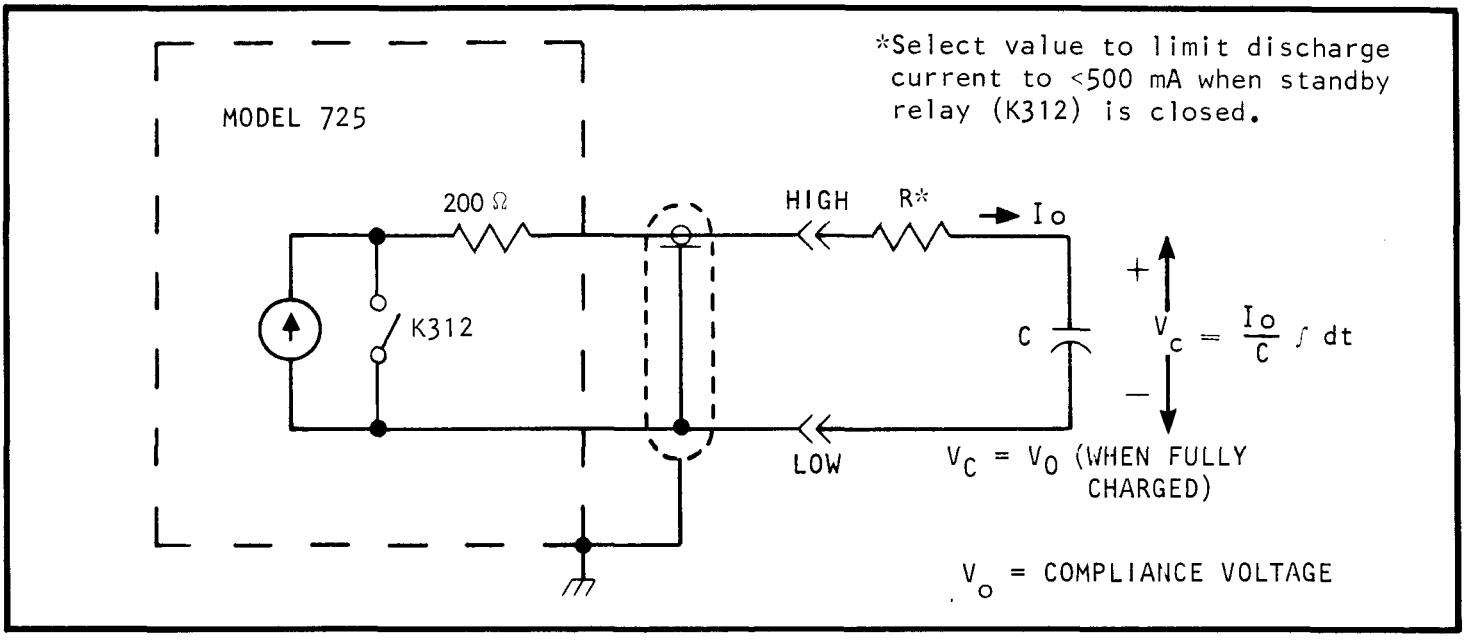


FIGURE 2-7. Capacitive Load.

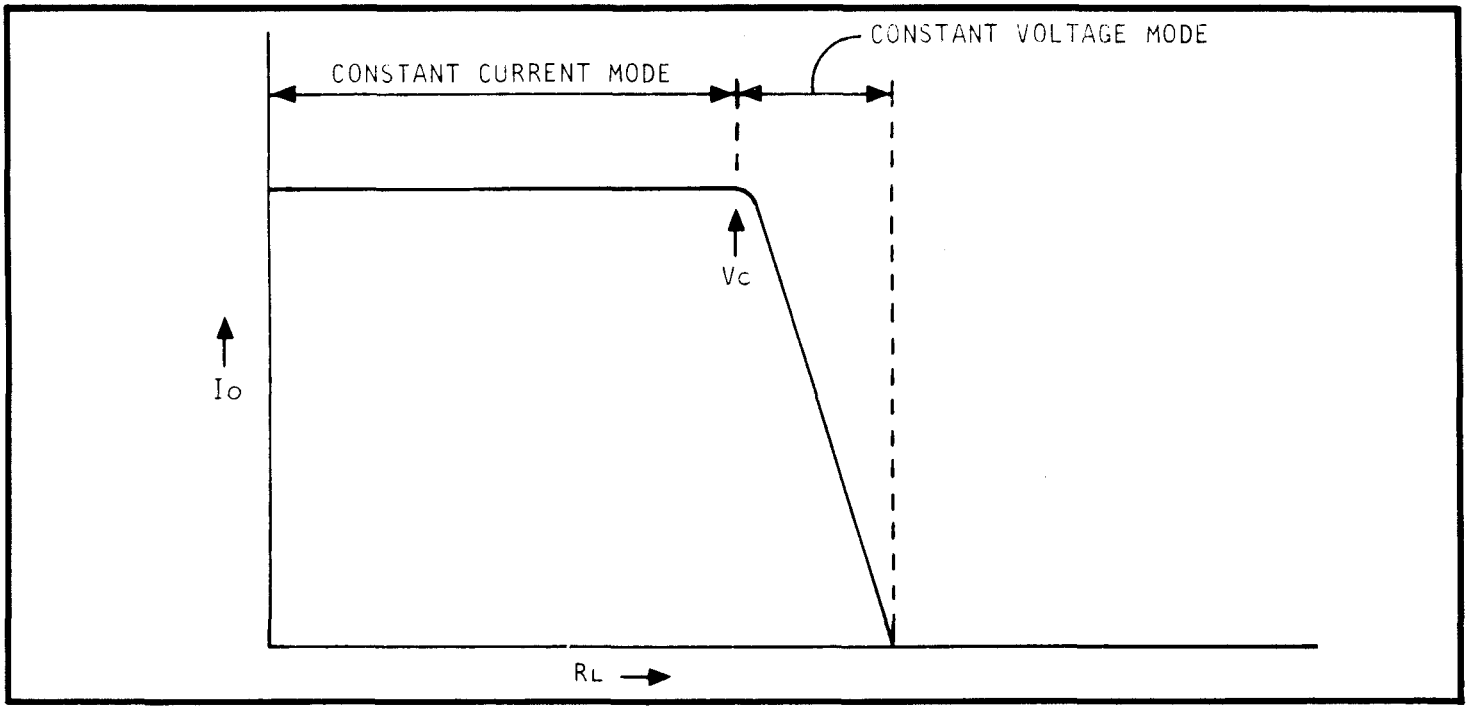


FIGURE 2-8. Voltage Limit Characteristics.

SECTION 3. CIRCUIT DESCRIPTION.

3-1. GENERAL. The Model 725 is an all solid-state current source which is composed of various circuits as shown in Figure 3-1. These circuits include the following types.

a. High Gain Operational Amplifier "A3".
b. Differential Voltage Sensing Amplifier "A1".
c. Voltage Compliance Amplifier "A2".
d. Compliance Voltage Control.
e. Compliance Voltage Supplies ±130 V.
f. Series Regulators.
g. Range Resistor Controls.
h. Power Supplies.

3-2. THEORY OF OPERATION. The Model 725 can deliver currents from 10^{-7} to 10^{-1} amperes with a compliance voltage up to 90 volts. The current source utilizes a high gain differential amplifier "A3" which controls the current through the range resistor "R". The differential voltage sensing amplifier "A1" senses the OUTPUT voltage with respect to a voltage reference. The voltage compliance amplifier "A2" senses the voltage at a point ahead of the range resistor with respect to the compliance voltage control potential. The compliance voltage supplies allow a ±90 volt compliance at the output. These supplies deliver power to the load up to a maximum of 10 watts (100 V x 0.1A). The series regulators are driven by the high gain differential amplifier "A3". The range resistor is selected by the RANGE Switch for currents of 10^{-7} to 10^{-1} ampere full range. The remaining power supplies are used to bias the operational amplifiers and reference source.

3-3. CIRCUITRY. Refer to the Amplifier Schematic (28680E) and Power Supply Schematic (28679E) for the following discussion.

a. High Gain Operation Amplifier "A3". This amplifier is composed of matched emitter followers (Q111 and Q114), a differential npn gain stage (transistors Q112 and Q113), a differential pnp gain stage (transistors Q109 and Q110), an emitter follower transistor Q115 and a second npn control stage (Q116 and Q117).

b. Differential Voltage Sensing Amplifier "A1". This amplifier is composed of a matched pair of FET's (transistors Q118A and Q118B). This stage provides the very high input

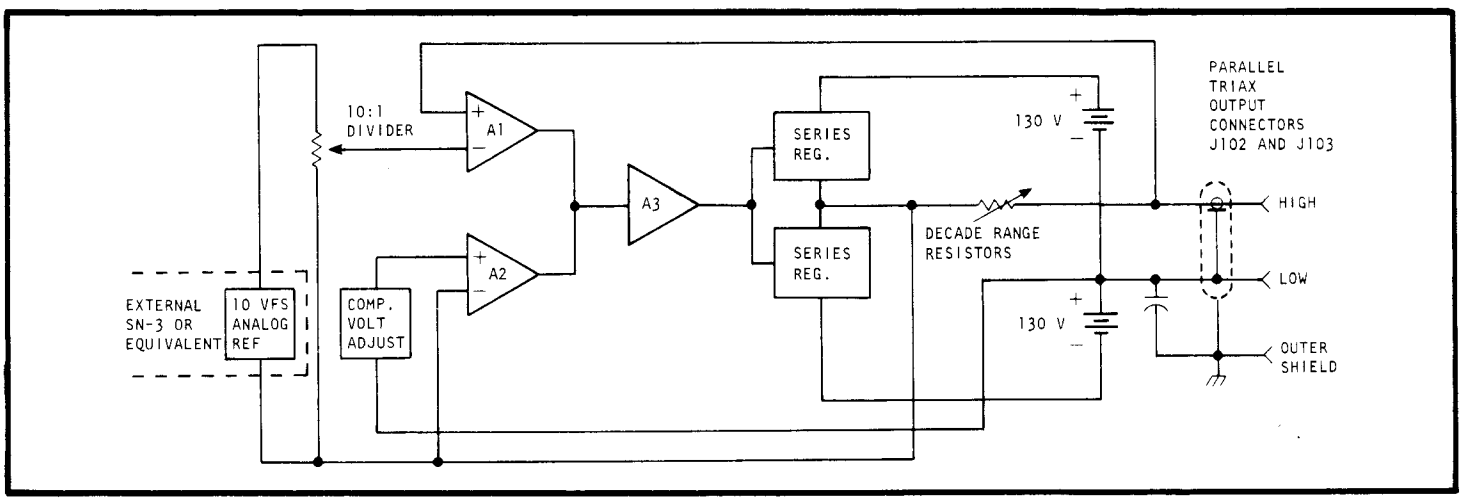


FIGURE 3-1. Model 725 Block Diagram.

impedance necessary for sensing output current on the lower ranges; it does not overload output even with 10MΩ feedback resistor. Teflon insulation is used to isolate critical nodes.

c. Input Divider. An accurate divider, composed of R181 and R183, divides the 10 volts down to 1-volt full scale. Potentiometer R182 is used to adjust the reference voltage to precisely 1-volt.

d. Voltage Compliance Amplifier "A2". This amplifier is composed of a differential gain stage; transistors Q107 and Q108. The bias reference for transistor Q108 is provided by a divider string composed of resistors R115, R116 selected compliance resistor and R118. Potentiometer R116 provides an internal maximum compliance voltage adjustment. The amplifier is biased "off" in the constant-current mode of operation. When the voltage at the "series regulator output" reaches the preselected compliance limit, the amplifier "A2" is turned "ON" and the Model 725 automatically changes to a voltage limit mode. The LIMIT indicator DS101 is turned on automatically when in the "voltage limit mode". For positive polarity, transistor Q103 turns on in the voltage limit mode while Q107 is turned off. The differential output voltage is buffered by emitter-follower stage, Q201 and Q204. Transistor Q202 is turned on and therefore drives transistor Q207. (The LIMIT indicator is connected in series with Q207). Transistor Q202 provides voltage level translation. For negative polarity, the difference voltage between Q107 and Q108 is such that transistors Q205 and Q206 are driven. (Transistors Q201 and Q204 act as buffer stages.) Transistor Q206 provides voltage level translation and drives Q208. The LIMIT indicator is connected in series with Q208 and is turned on. Potentiometers R203 and R207 provide control of the LIMIT indicator turn-on for + limit and - limit, respectively.

e. Compliance Voltage Control. The output voltage appears across R313//R314 and R118. Selecting a compliance line places its pot in parallel with R313 and R314. Divider ratio with R115 and R116 sets limit. Total resistance is (R313//R314//POT) + R118. Compliance limit is the same in both polarities.

f. Compliance Voltage Supplies. These voltage supplies provide unregulated ±130 volts for the series regulators. AC power is obtained from a secondary of transformer T201 and rectified by diode bridge D207. Capacitors C203 thru C206 provide filtering of ac ripple.

g. Series Regulators. Transistors Q101 and Q105 form a quasi-complimentary symmetry output stage. (These transistors are rated at 300 volts, 35 watts.) Transistors Q103 and Q106 are current limiting transistors which shunt current around the output transistors during a transient or fault condition.

h. Range Resistor Controls. The Range relays select full range current from 10^{-7} to 10^{-1} amperes. Range resistors R306 thru R312 are selected such that, for each selected current, the voltage drop across the Range resistor R is 1 volt for full range.

i. Power Supplies. The remaining power supplies provide power to the amplifier stages and voltage references.

1. ±10 volts. Diode bridge D208 provides unregulated voltages for the ±10 volt regulator stages. Capacitors C207 and C208 provide filtering. Transistors Q209 and Q210 and reference zeners D205 and D206 form the ±10 volt regulators. This supply provides bias voltages for the voltage LIMIT indicator circuit.

2. ±12 volts. This supply provides power to the amplifier stages and reference diode D116. The supplies consist of a diode bridge D209, an integrated circuit QA201, and a linear operational amplifier QA202. The voltage developed by QA201 is 24 volts. This output is split to form separate ±12 volt supplies. (These supplies are referenced to the output high.) Potentiometer R226 provides adjustment of the 24 volt output.

3-4. SWITCHING. The polarity relay switches the internal circuitry such that the polarity of the current at the "HIGH" terminal can be changed with respect to "LOW". This is accomplished by reversing the polarity of the voltage references since amplifier "A3" is a bipolar amplifier. The "STANDBY" position permits a change of polarity to be made without developing large transients. The "STANDBY" position connects the "HIGH" output to "LOW" through a 200 ohm shunt as shown in Figure 2-5. Since the selected current will be shunted through the relay contact resistance, up to 40 millivolts can be developed between the "HIGH" and "LOW' terminals with no load.

SECTION 4. ACCESSORIES.

4-1. GENERAL. The following Keithley accessories can be used with the Model 725 to provide additional convenience and versatility.

Model 1004 Rack Mounting Kit

Description:

The Model 1004 is a rack mounting kit with overall dimensions 5-1/2 inches high x 19 inches wide x 10 inches deep.

Application:

The Model 1004 converts the instrument from bench to rack mounting. It is suitable for mounting one instrument in one-half of a standard 19-inch rack.

Parts List:

Item No.	Description	Qty. Per Assembly	Keithley Part No.
1	Top Cover	1	20016B
2	Panel	1	17452B
3	Angle	1	17476A
4	Screw	4	------
5	Plate	1	19126A
6	Screw	4	------
7	Angle	1	14624B
8	Bottom Cover	1	20016B

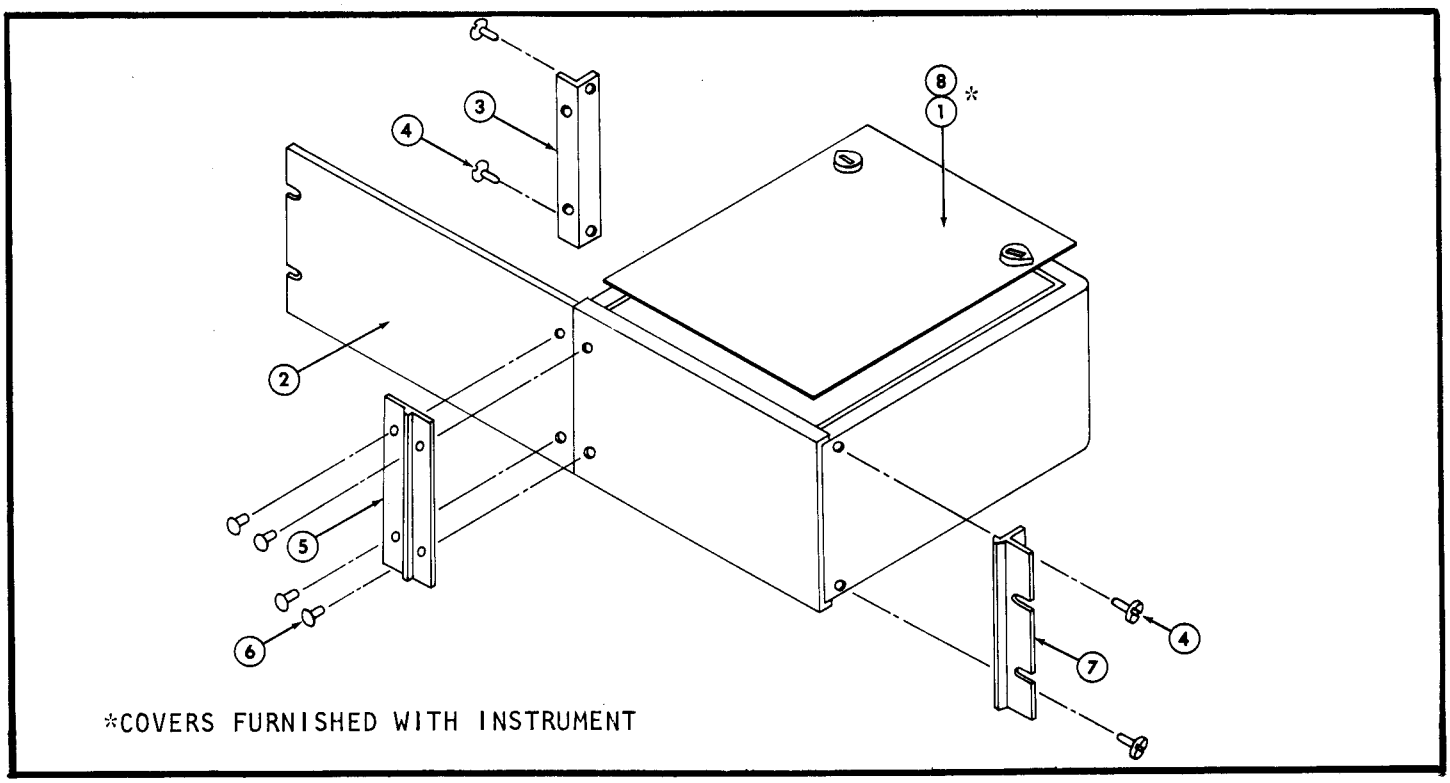


FIGURE 4-1. Model 1004 Rack Mounting Kit.

SECTION 5. MAINTENANCE.

5-1. GENERAL. This section describes procedures for checkout and servicing the instrument. Follow the step-by-step procedures for complete servicing.

5-2. SERVICING SCHEDULE. This instrument requires no periodic maintenance beyond the normal care required for high-quality electronic equipment.

5-3. PARTS REPLACEMENT. Refer to the Replaceable Parts List, Section 7, for information regarding component specifications and part numbers. Replace components as indicated using replacement parts which meet the listed specifications.

5-4. CALIBRATION. Refer to Section 6 for step-by-step procedures for calibrating the Model 725. Perform the steps in the exact order given.

5-5. TROUBLESHOOTING.

a. Troubleshooting Guide. Refer to Figure 6-1 for voltages and test points.

NOTE

If the instrument problem cannot be readily located or repaired, contact a Keithley representative or the Sales Service Department, Cleveland, Ohio.

TABLE 5-1.
Test Equipment.

Code Letter	Instrument Type	Specification	Manufacturer and Model No.	Use
A	Multimeter, Digital	Voltage: ±0.1% of reading. Current: ±0.2% of reading except ±0.3% of reading on 100mA 1A ranges.	Keithley, Model 173.	Accuracy check, General.
B	Oscilloscope	DC-450 kHz, 1mV/div.	Tektronix, Model 503	General.
C	Variac	0-130 V rms.	General Radio	Line Regulation.
D	Power Line Monitor	105-130 V rms.	-	General.
E	Load Fixture	800Ω/10Ω - Resistors	See Text.	Load Regulation.
F	Digital Voltmeter	Voltage: 1V ± 50μV	Keithley, Model 190	Load and Line Regulation.

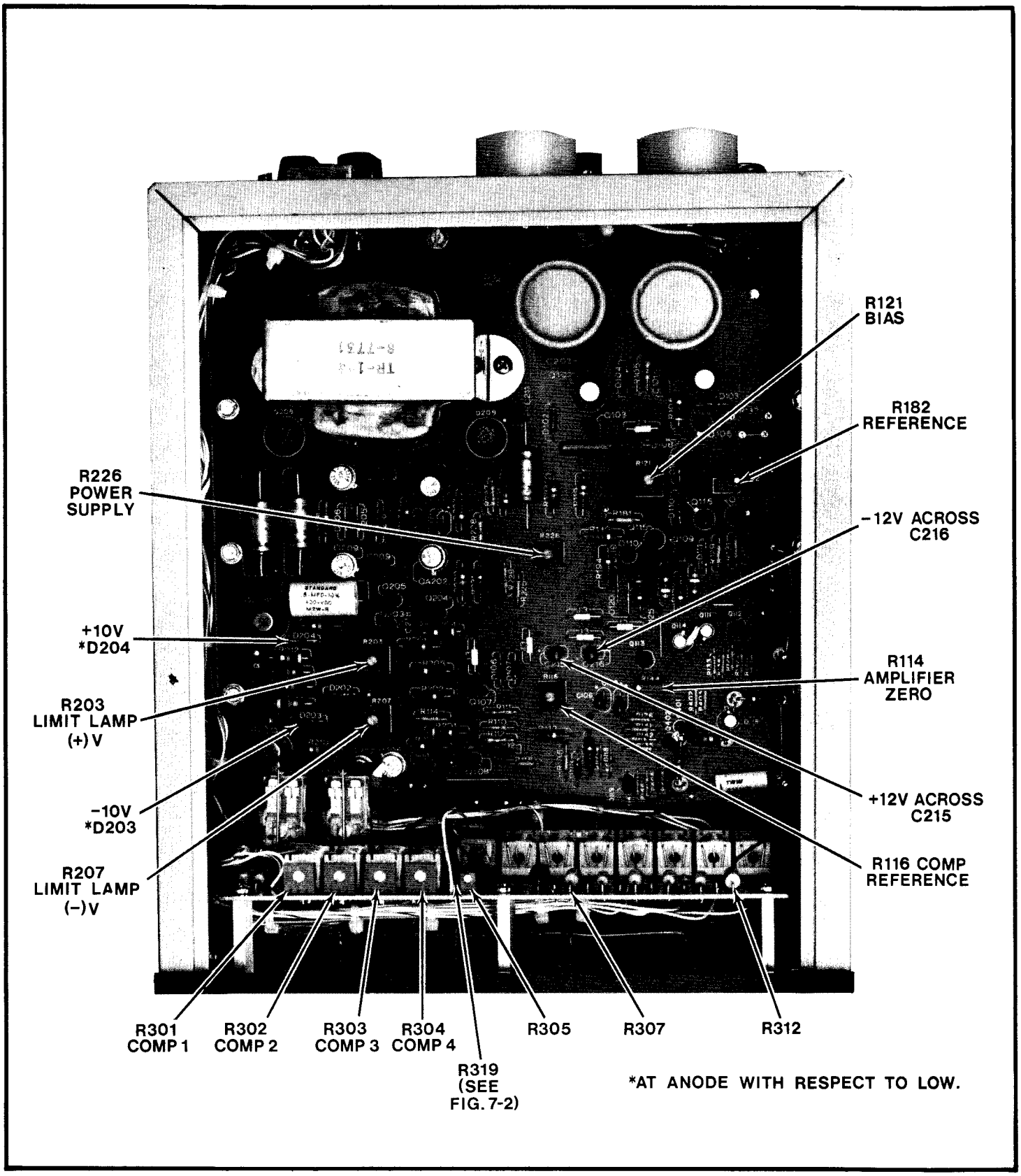


FIGURE 6-1. Chassis - Top View.

SECTION 6. CALIBRATION.

6-1. GENERAL. This section contains procedures for calibrating and checking the instrument in order to verify operation within specifications.

6-2. TEST EQUIPMENT. Refer to Table 5-1 for recommended test equipment for servicing and calibrating this instrument.

NOTE

If proper facilities and equipment are not available, contact a Keithley representative or the Sales Service Department, Cleveland, Ohio. Keithley Instruments, Inc. maintains a complete repair and calibration facility with equipment traceable to the National Bureau of Standards.

6-3. CALIBRATION PROCEDURE. Refer to Table 6-1 for step-by-step procedures for calibrating this instrument. Refer to Figure 6-1 for testpoint and adjustment locations.

a. Warm Up For Calibration. One hour is sufficient assuming instrument has not been brought direct from a not in specification temperature or humidty environment.

b. Perform Calibration procedure in the exact order given.

c. Setup. Unless stated otherwise in the procedure, the following Conditions should exist:

1. Line Voltage Switch: 117V,
2. Ambient Temperature: 25°C,
3. Relative Humidity: $\leq$ 50%,
4. Link connected between LOW and GROUND,
5. Unit in STANDBY with "0" Current Programmed.

TABLE 6-1.
Calibration Procedures.

Specification or Adjustment	Description	Measurement
a. Power Supplies. NOTE: DC voltmeter and oscilloscope must be floated for measurement of 12V supplies. Line Voltage: 117V. Connect link between LOW and GROUND. LINE SWITCH: 117V. NOTE: If 234V power is used, set LINE SWITCH to 234V.	Calibrate power supply. -12 VOLTS DC: Measure -12V supply across C216. Adjust potentiometer R226 for -12V ±0.01V. +12 VOLTS DC: Measure +12V supply across C215. -10 VOLTS DC: Measure -10V at D203 anode with respect to LOW. Ripple should be less than 20mV p-p. +10 VOLTS DC: Measure +10V at D204 anode with respect to LOW. Ripple should be less than 20mV p-p.	Adjust for voltage of -12V ±0.01V. Ripple should be less than 3mV p-p. Voltage should be +12V ±0.24V. Ripple should be less than 3mV p-p. Voltage should be +10V ±1V.

TABLE 6-1. (CON'T)
Calibration Procedures

Specification or Adjustment	Description	Measurement
b. Amplifier Zero. Short reference input high to low. Do not short to chassis!	Set range to 100nA. Set OUTPUT to STANDBY. Connect Digital Voltmeter (A) across R312. Adjust potentiometer R144 for zero.	Adjust for 0 ±0.1 mV.
c. Reference.	Set range to 10mA. Set reference to 9.99V. Set OUTPUT to: +, STANDBY. Connect DMM (A) across R307. Adjust potentiometer R182 for .999V ±0.5mV.	
d. Bias	Set OUTPUT to STANDBY and -polarity. Set range to 100nA. Set reference to 9.99V. Connect Digital Voltmeter across R319. Adjust potentiometer R121 for voltage 27mV. (This sets current thru transistors Q101, Q102).	Adjust for voltage 27mV.
e. Compliance Compliance Reference	Disconnect all loads from OUTPUT. Connect DMM to COMPLIANCE MONITOR jacks. Turn R301 fully CW. Program 10mA range, +, COMP 1, Operate. Set reference to 9.99V. Adjust R116 for 95 ± 1V.	DMM reading should be 95 ± 1V.
	Set OUTPUT to - Polarity.	DMM reading should be 95 ± 5V.
Compliance Limits	Set OUTPUT to + polarity. Adjust R301 for desired COMP 1 limit	12V-90V
	Release COMP 1 and program COMP 2. Adjust R302 for desired COMP 2 limit.	12V-90V
	Release COMP 2 and program COMP 3. Adjust R303 for desired COMP 3 limit.	12V-90V
	Release COMP 3 and program COMP 4. Adjust R304 for desired COMP 4 limit.	12V-90V

TABLE 6-1. (CON'T)
Calibration Procedures

Specification or Adjustment	Description	Measurement
f. Voltage Limit Lamp	Set range to 100mA. Set reference to 2.00V. Select +, Comp 1. Connect Oscilloscope (B) to OUTPUT. Oscilloscope Settings: 2 mV/div. 5 mS/div. Trigger = INTERNAL Input = AC COUPLED Connect load resistor. Set OUTPUT to operate. Adjust potentiometer R203 such that the LIMIT lamp turns on when the 725 changes from current mode to voltage mode. NOTE: To determine the crossover point between current and voltage modes, adjust the COMPLIANCE control R301, until the oscilloscope ripple waveform changes as shown in Figure 6-4. Set OUTPUT to - polarity. Adjust potentiometer R207 such that the LIMIT lamp turns on when the 725 changes from current mode to voltage mode.	SEE FIG. 6-4.
g. Accuracy.	Verify the accuracy on each full-scale range. Set OUTPUT to STANDBY. Connect the Digital Multimeter (A) to OUTPUT receptacle as shown in Figure 6-2. Set COMPLIANCE to 90V.	

TABLE 6-1. (CON'T)
Calibration Procedures

Specification or Adjustment	Description	Measurement
NOTE: Adjustment of R305 (100mA) is intended to compensate for relay contact resistance only. Depending on actual range resistor value (10Ω ±.1% and actual relay contact resistances) it may not be possible to swing thru nominal value. Adjust to as close to nominal as possible, instrument will still meet accuracy specification.	100mA Range: Set reference to 9.99V. Set range to 100mA. Set OUTPUT to +. Measure current. Repeat for - OUTPUT.	Nominal current reading should be 99.9mA ±0.85mA.
	10mA Range: Set reference to 9.99V. Set range to 10mA. Set OUTPUT to +. Measure current. Repeat for - OUTPUT.	Nominal current reading should be 9.99mA ±.085mA.
	1mA Range: Set reference to 9.99V. Set range to 1mA. Set OUTPUT to +. Measure current. Repeat for - OUTPUT.	Current reading should be 999. µA ±8.5µA.
	100µA Range: Set reference to 9.99V. Set range to 100µA. Set OUTPUT to +. Measure current. Repeat for - OUTPUT.	Current reading should be 99.9µA ±0.085 A.
	10µA Range: Set reference to 9.99V. Set range to 10µA. Set OUTPUT to +. Measure current. Repeat for - OUTPUT.	Current reading should be 9.99µA ±0.085µA.
	1µA Range: Set reference to 9.99V. Set range to 1µA. Set OUTPUT to +. Measure current. Repeat for - OUTPUT.	Current reading should be 999. nA ±8.5nA.
	100nA Range: Set reference to 9.99V. Set range to 100nA. Set OUTPUT to +. Measure current. Repeat for - OUTPUT.	Current reading should be 99.9nA ±0.85nA.
h. Line Regulation.	Verify line regulation.	
	Set OUTPUT to STANDBY. Set reference to 9.99V. Connect load resistor between front panel LOW and OUT.as shown in Figure 6-3. (Switch closed). Set COMPLIANCE to 90V. Set range to 100mA.	1V Output.

TABLE 6-1. (CON'T)
Calibration Procedures

Specification or Adjustment	Description	Measurement
	Set line voltage to 105V. Set OUTPUT to +. Measure voltage at load. Repeat for - OUTPUT.	Output voltage change should not exceed 50µV from 115V line.
	Set Line voltage to 125V	Output voltage change should not exceed 50µV from 115V line.
i. Load Regulation.	Verify load regulation.	
	Set OUTPUT to STANDBY. Set reference to 9.99V. Set range to 100mA. Set COMPLIANCE to 90V. Set line voltage to 115V.	
	Connect load resistor between front panel LOW and OUT as shown in Figure 6-3. Set OUTPUT to +. Measure voltage change when switch is moved from closed to open position at load. Repeat for - OUTPUT.	Voltage change should not exceed 50µV.

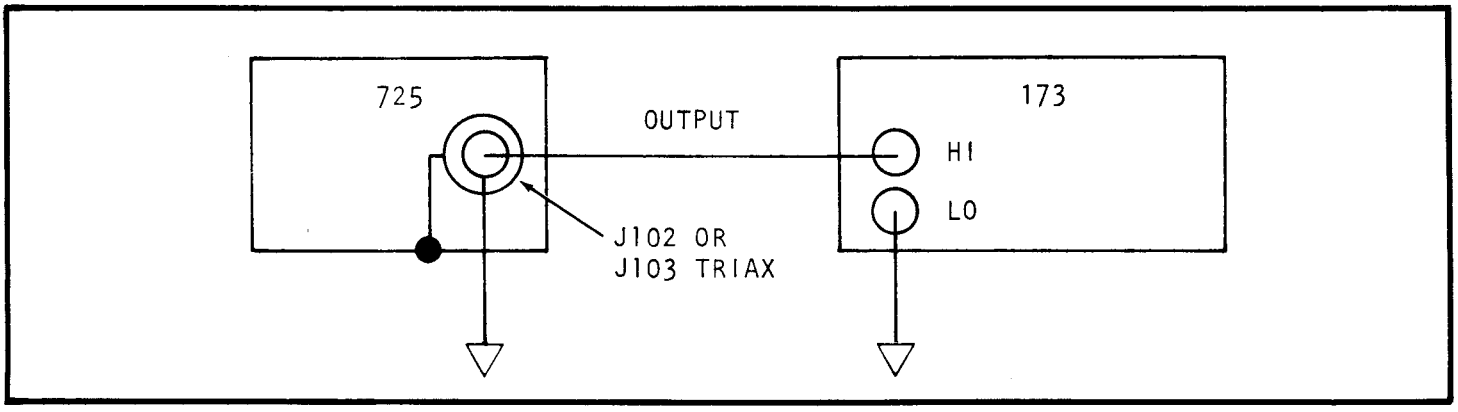


FIGURE 6-2. Accuracy Check.

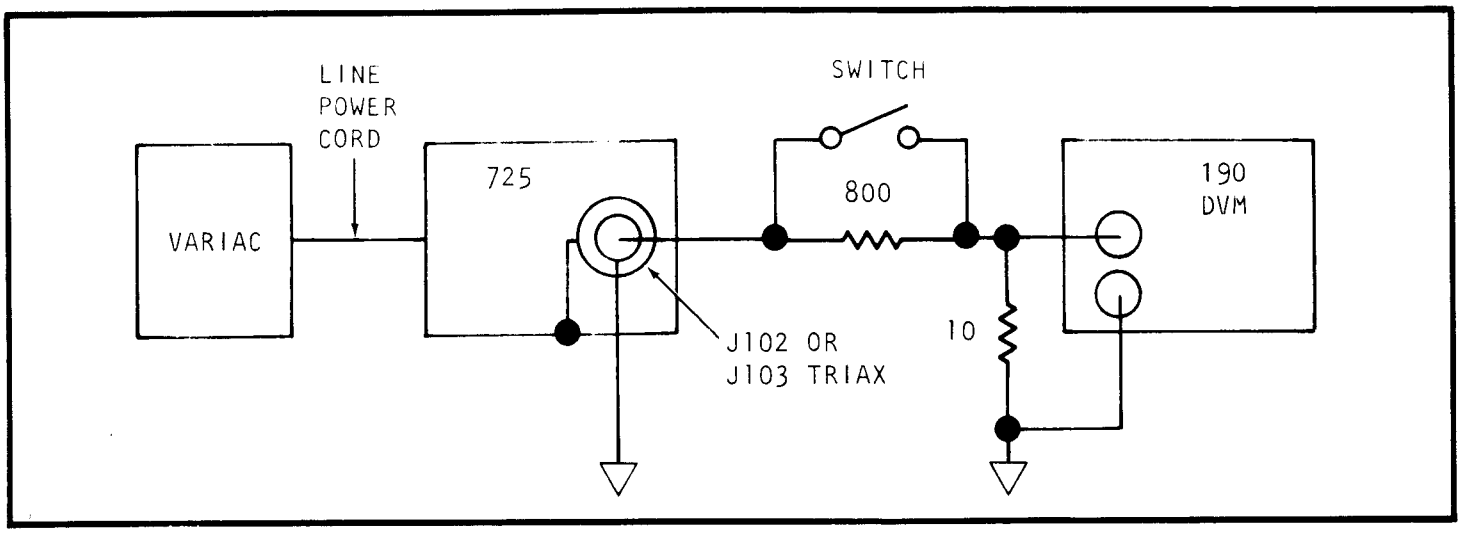


FIGURE 6-3. Regulation Check.

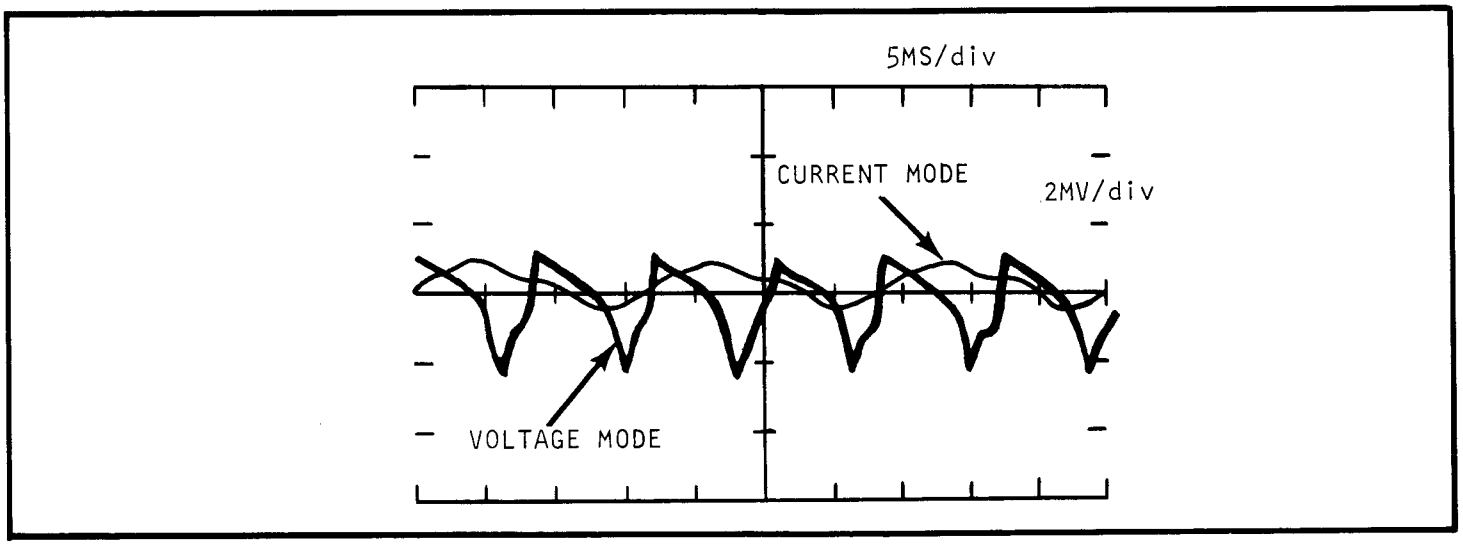


FIGURE 6-4. Current Mode Vs. Voltage Mode Waveforms.

SECTION 7. REPLACEABLE PARTS.

7-1. GENERAL. This section contains information for ordering replacement parts. The parts list is arranged in alphabetical order of their circuit Designations.

7-2. ORDERING INFORMATION. To place an order or to obtain information converning replacement parts, contact your Keithley representative or the factory. See the inside front cover for addresses. When ordering, include the following information:

a. Instrument Model Number.

b. Instrument Serial Number.

c. Part Description.

d. Circuit Designation (if applicable).

e. Keithley Part Number.

7-3. FACTORY SERVICE. If the instrument is to be returned to the factory for service, please complete the Service Form which follows this section, and return it with the instrument.

7-4. CROSS-REFERENCE OF MANUFACTURERS. Table 7-1 provides a cross-reference of manufacturer's designation to Federal Supply code and includes a listing of manufacturer's addresses.

7-5. COMPONENT LAYOUTS.

a. PC-228 (Mother Board) for series 100 and 200 circuit designations.

b. PC-438 (Relay Board) for series 300 circuit designations.

7-6. SCHEMATICS.

a. Amplifier (28680E). This schematic describes the amplifier and the interface circuits for remote ranging and control. Circuit designation series is 100 and 300.

b. Power Supply (28679E). This schematic describes the ±130, ±12 and ±10 volt power supplies. Circuit designation series is 200.

TABLE 7-1.
Cross-Reference of Manufacturers

Mfr. Code	Name and Address	Fed. Supply Code
A-B	Allen-Bradley Corp. Milwaukee, WI 53204	01121
ACI	American Components, Inc Conshohocken, PA 19428	14298
AMP	Amphenol Broadview, IL 60153	02660
BEC	Beckman Inst. Inc. Fullerton, CA 92634	73138
BRN	Bourns, Inc. Riverside, CA 92507	80294
C-I	Components, Inc. Biddeford, ME 04005	06751
CTS	CTS Corporation Elkhart, IN 46514	71450
DIC	Dickson Electronics Corp. Scottsdale, AZ 85252	12954
DLE	Dale Electronics, Inc. Columbus, NE 68601	91637
D-R	Douglas Randall Pawcatuck, Conn. 02891	
ECI	Electro Cube Inc. San Gabriel, CA 91776	14752
EDI	Electronic Devices, Inc. Yonkers, NY 10710	83701
ERI	Erie Technological Prod. Erie, PA 16512	72982
F-I	Fairchild Inst. Corp. Mountain View, CA 94043	07263
H-P	Hewlett-Packard Palo Alto, CA 94304	50434
I-D	Industrial Devices, Inc. Edgewater, NJ 07020	91802
IRC	IRC Division Burlington, IA 52601	07716
K-I	Keithley Instruments, Inc, Cleveland, Ohio 44139	80164
KGS	Kings Elect. Co., Inc. Tuckahoe, NY 10707	91836
L-F	Littlefuse, Inc. Des Plaines, IL 60016	75915
MEP	Mepco, Inc. Morristown, NJ 08050	80031
MOT	Motorola Semi-Prod. Inc. Phoenix, AZ 85008	04713
NCI	National Components, Inc. West Palm Beach, FL	
OHM	Ohmite Mfg. Co. Stokie, IL 60076	44655
P&B	Potter & Brumfield Princeton, IN 47670	12300
RCA	RCA Corporation Morrestown, NJ 08050	02734
SPG	Sprague Electric Co. Visalia, CA 93278	14659
T-I	Texas Instruments, Inc. Dallas, TX 75231	01295
TRW	TRW Capacitor Div. Ogallala, NB 69153	84411

REPLACEABLE PARTS LIST

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code.	Mfr. Desig.	Keithley Part No.
		CAPACITORS (C)			
		"100" Series (Sch. 28680E-Pg. 7-12) (PC-Board 29134D-Pg. 7-10)			
C101	.0068µF, 600V, CerD.	6/D3	ERI	ED-.0068	C22-.0068M
C102	.0022µF, 600V, CerD.	5/C5	ERI	ED-.0022	C22-.0022M
C103	.22µF, 50V, My	9/C3	TRW	601PE	C41-.22M
C104	.02µF, 600V, CerD.	7/D4	ERI	ED-.02	C22-.02M
C105	4.7µF, 20V, ETT.	20/D5	C-I	TSD1-20-475	C179-4.7M
C106	4.7µF, 20V, ETT.	21/C5	C-I	TSD1-20-475	C-179-4.7M
C107	1µF, 200V, My.	15/D6	POT	107-21	C-66-1M
C108	1µF, 200V, My.	-----	POT	107-21	C-66-1M
		"200" Series (Sch. 28679E-Pg. 7-13) (PC-Board 29134D-Pg. 7-10)			
C201	470pF, 1000V, CerD	10/A6	ERI	DD-471	C-64-470pF
C202	.5µF, 400V, My	16/B4	POT	SM1A	C-117-.5M
C203	.001µF, 600V, CerD	11/C2	ERI	ED-.001	C-22-.001M
C204	.001µF, 600V, CerD	12/D2	ERI	ED-.001	C-22-.001M
C205	140µF, 150V, EMC	25/D2	SPG	Type 630	C-183-140M
C206	140µF, 150V, EMC	26/C2	SPG	Type 630	C-183-140M
C207	100µF, 40V, EAL.	17/B4	AMP	C437AR/G100	C-150-100M
C208	100µF, 40V, EAL.	18/A4	AMP	C437AR/G100	C-150-100M
C209	.001µF, 600V, CerD	13/B4	ERI	ED-.001	C-22-.001M
C210	.001µF, 600V, CerD	14/B3	ERI	ED-.001	C-22-.001M
C211	100µF, 40V, EAL.	19/C3	AMP	C437AR/G100	C-150-100M
C212	4.7µF, 20V, ETT.	22/B4	C-I	TSD1-20-475	C-179-4.7M
C213	100pF, 600V, CerD.	3/B4	ERI	ED-100	C-22-100P
C214	.02µF, 600V, CerD.	8/C4	ERI	ED-.02	C-22-.02M
C215	10µF, 20V, ETT	23/C5	C-I	TSD2-20-106	C-179-10M
C216	10µF, 20V, ETT	24/C5	C-I	TSD2-20-106	C-179-10M
C217	.05µF, 600V, My.	-----	SPG	6PS-550	C-62-.05M
C218	150pF, 600V, CerD.	4/B4	ERI	ED-150	C-22-150P
		"300" Series (Sch. 28680E-Pg. 7-12) (PC-Board 28681C-Pg. 7-11)			
C301	10µF, 20V, ETT	4/E4	NCI	KNS106B020K	C-179-10
C302	1µF, 50V, CerD	5/B4	ERI	8131050651-105M	C-237-1
		DIODES (CR)			
		"300" Series (Sch. 28680E-Pg. 7-12) (PC-Board 28681C-Pg. 7-11)			
Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
CR301	Rectifier, 1A, 800V.	41/E2	MOT	1N4006	RF-38
CR302	Rectifier, 1A, 800V.	42/E2	MOT	1N4006	RF-38
CR303	Rectifier, 1A, 800V.	43/E2	MOT	1N4006	RF-38
CR304	Rectifier, 1A, 800V.	44/D2	MOT	1N4006	RF-38
CR305	Rectifier, 1A, 800V.	34/C2	MOT	1N4006	RF-38
CR306	Rectifier, 1A, 800V.	35/C2	MOT	1N4006	RF-38
CR307	Rectifier, 1A, 800V.	36/C2	MOT	1N4006	RF-38
CR308	Rectifier, 1A, 800V.	37/C2	MOT	1N4006	RF-38
CR309	Rectifier, 1A, 800V.	38/B2	MOT	1N4006	RF-38
CR310	Rectifier, 1A, 800V.	39/B2	MOT	1N4006	RF-38
CR311	Rectifier, 1A, 800V.	40/B2	MOT	1N4006	RF-38

DIODES (CR) (CON'T)
"300" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 28681C-Pg. 7-11)

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
CR312	Rectifier, 1A, 800V.	45/E4	MOT	1N4006	RF-38
CR313	Rectifier, 1A, 800V.	46/C4	MOT	1N4006	RF-38

DISPLAYS (D)
"100" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 29134D-Pg. 7-10)

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
D101	NOT USED				
D102	Silicon.	127/C3	T-1	1N645	RF-14
D103	Silicon.	128/D3	T-1	1N645	RF-14
D104	Silicon.	129/D2	T-1	1N645	RF-14
D105	NOT USED		T-1	1N645	RF-14
D106	Silicon.	130/C5	T-1	1N645	RF-14
D107	Silicon.	131/C5	T-1	1N645	RF-14
D108	Silicon.	132/D3	T-1	1N645	RF-14
D109	Silicon.	133/D3	T-1	1N645	RF-14
D110	Silicon.	134/D4	T-1	1N645	RF-14
D111	Silicon.	135/D4	T-1	1N645	RF-14
D112	Silicon.	136/D4	T-1	1N645	RF-14
D113	Silicon.	137/C6	T-1	1N645	RF-14
D114	NOT USED				
D115	NOT USED				
D116	NOT USED				
D117	Silicon.	140/C6	T-1	1N914	RF-28
D118	Silicon.	141/D6	T-1	1N914	RF-28
D119	Silicon.	142/D4	T-1	1N914	RF-28
D120	Silicon.	143/D4	T-1	1N914	RF-28
D121	NOT USED				
D122	Silicon.	------	T-1	1N914	RF-28
D123	Silicon.	------	T-1	1N914	RF-28

"200" Series (Sch. 28679E-Pg. 7-13)
(PC-Board 29134D-Pg. 7-10)

D201	Rectifier, 400mA, 225V	138/B6	T-1	1N645	RF-14
D202	Rectifier, 400mA, 225V	139/B5	T-1	1N645	RF-14
D203	Zener Diode, 6.2V, 25mA.	27/B5	DIC	1N709	DZ-21
C204	Zener Diode, 6.2V, 25mA.	28/B5	DIC	1N709	DZ-21
D205	Zener, 11V, 1/4W	29/B4	DIC	1N715	DZ-22
D206	Zener, 11V, 1/4W	30/B4	DIC	1N715	DZ-22
D207	Rectifier, Full-Wave Bridge. . . .	144/C2	E-D-1	PF-40	RF-46
D208	Rectifier, Full-Wave Bridge. . . .	145/A3	E-D-1	PF-40	RF-46
D209	Rectifier, Full-Wave Bridge. . . .	146/C3	E-D-1	PF-40	RF-46

DISPLAYS (DS)
"100" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 29134D-Pg. 7-10)

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
DS101	Pilot Light, LIMIT	-----	I-D	2100	PL-38

DISPLAYS (DS) (CON'T)
"200" Series (Sch. 28679E-Pg. 7-13)
(PC-Board 29134D-Pg. 7-10)

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
DS201	Pilot Light, Decimal	-----	I-D	2140	PL-47

"300" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 28681C-Pg. 7-11)

DS301	Light Emitting Diode	-----	H-P	5082-4657	PL-65
DS302	Light Emitting Diode	-----	H-P	5082-4657	PL-65
DS303	Light Emitting Diode	-----	H-P	5082-4657	PL-65
DS304	Light Emitting Diode	-----	H-P	5082-4657	PL-65
DS305	Light Emitting Diode	-----	H-P	5082-4657	PL-65
DS306	Light Emitting Diode	-----	H-P	5082-4657	PL-65
DS307	Light Emitting Diode	-----	H-P	5082-4657	PL-65
DS308	Light Emitting Diode	-----	H-P	5082-4657	PL-65

FUSES (F)
"200" Series (Sch. 28679E-Pg. 7-13)
(PC-Board 29134D-Pg. 7-10)

F201	Fuse, 3AG, Slow Blow, 1/4A	-----	L-F	2100	PL-38

CONNECTORS (J)
"100" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 29134D-Pg. 7-10)

J101	Receptacle, BNC, Modulate	-----	AMP	31-221	CS-15
J102	BNC Triax.	-----	KGS	19-64-1-9	CS-253
J103	Receptacle, BNC Front Panel Out. .	-----	AMP	31-221	CS-15
J104	Receptacle, BNC, Rear Panel Out. .	-----	AMP	31-221	CS-15
J105	Receptacle, BNC, Front Panel Low .	-----	AMP	31-221	CS-15
J106	NOT USED				

"200" Series (Sch. 28679E-Pg. 7-13)
(PC-Board 29134D-Pg. 7-10)

J201	Binding Post, Ground	-----	H.H.S.	1517	BP-11B
J202	Binding Post, Rear Panel Low . . .	-----	H.H.S.	1517	BP-11C

RELAYS (K)
"300" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 28681C-Pg. 7-11)

K301	Relay, Single-pole, N.O.	47/E2	D-R	375-670	RL-40
K302	Relay, Single-pole, N.O.	48/E2	D-R	375-670	RL-40
K303	Relay, Single-pole, N.O.	49/E2	D-R	375-679	RL-40
K304	Relay, Single-pole, N.O.	50/D2	D-R	375-370	RL-40
K305	Relay, Single-pole, N.O.	51/D3	D-R	375-670	RL-40
K306	Relay, Single-pole, N.O.	52/C3	D-R	375-670	RL-40
K307	Relay, Single-pole, N.O.	53/C3	D-R	375-670	RL-40
K308	Relay, Single-pole, N.O.	54/C2	D-R	375-670	RL-40
K309	Relay, Single-pole, N.O.	55/B3	D-R	375-670	RL-40
K310	Relay, Single-pole, N.O.	56/B3	D-R	375-670	RL-40
K311	Relay, Single-pole, N.O.	57/B3	D-R	375-670	RL-40
K312	Relay, Single-pole, N.O.	58/C4	D-R	375-670	RL-40
K313	Relay, Single-pole, N.O.	59/C4	D-R	375-670	RL-40
K314	Relay, 4-pole.	61/E3	D-R	-----	RL-58
K315	Relay, 4-pole.	62/F3	D-R	-----	RL-58

CONNECTORS (P)
"200" Series (Sch. 28679E-Pg. 7-13)
(PC-Board 29134D-Pg. 7-10)

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
P201	Power Cord, 6 feet	-----	E-C-1	4638-13	CO-5

TRANSISTORS (Q)
"100" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 29134D-Pg. 7-10)

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
Q101	Selected	-----	K-1	-----	24560A
Q102	NPN	175/C3	MOT	MM3003	TG-58
Q103	NPN, Case TO-106	159/C3	F-1	2N3565	TG-39
Q104	NPN, Silicon, TO-5 Case	176/D3	MOT	MM4003	TG-59
Q105	Selected	-----	K-1	-----	24560A
Q106	PNP, Case TO-110	156/D3	F-1	2N3638	TG-33
Q107	PNP, Case TO-92	169/C5	MOT	2N3905	TG-53
Q108	PNP, Case TO-92	170/C6	MOT	2N3905	TG-53
Q109	PNP, Case TO-92	171/D4	MOT	2N3905	TG-53
Q110	PNP, Case TO-92	172/D4	MOT	2N3905	TG-53
Q111	Silicon	180/D5	AMP	A642L	TG-64
Q112	NPN, Case TO-106	160/D4	F-1	2N3565	TG-39
Q113	NPN, Case TO-106	161/D5	F-1	2N3565	TG-39
Q114	Silicon	180/D5	AMP	A642L	TG-64
Q115	NPN, Case TO-106	162/D4	F-1	2N3565	TG-39
Q116	Silicon	157/D4	F-1	2N3638	TG-38
Q117	Silicon	158/D4	F-1	2N3638	TG-38
Q118	Selected	181/D5	K-1	-----	24670A
Q119	NPN, Silicon	166/D6	MOT	2N3903	TG-49
	"200" Series (Sch. 28679E-Pg. 7-13) (PC-Board 29134D-Pg. 7-10)				
Q201	PNP, Case TO-92	173/B6	MOT	2N3905	TG-53
Q202	PNP Silicon, Case TO-92	177/B6	MOT	MM4003	TG-59
Q203	PNP, Case TO-92	174/B4	MOT	2N3905	TG-53
Q204	PNP, Case TO-92	179/B4	MOT	2N5087	TG-61
Q205	NPN, Silicon, Case TO-92	167/B4	MOT	2N3905	TG-49
Q206	Silicon, NPN, TO-5	164/B6	RCA	40346	TG-44
Q207	Silicon, NPN, TO-5	165/A5	RCA	40346	TG-44
Q208	PNP, Silicon, Case TO-39	178/A4	MOT	MM4003	TG-59
Q209	NPN, Case TO-5	163/B4	RCA	40317	TG-43
Q210	PNP, Case TO-5		RCA	40319	TG-50
Q211	PNP, Case TO-5	168/B3	RCA	40319	TG-50
	"300" Series (Sch. 28680E-Pg. 7-12) (PC-Board 28681C-Pg. 7-11)				
Q301	NPN, Case TO-92	60/C4	MOT	2N3904	TG-47
	"400" Series (Sch. 28680E-Pg. 7-12) (PC-Board 29134D-Pg. 7-10)				
Q401	Selected	183/D5	K-1	-----	28569A
Q402	Selected	182/D5	K-1	-----	28569A
QA201	Integrated Circuit	36/B4	F-1	65R7723393A723C	IC-14
QA202	Linear Integrated Circuit	37/B3	MOT	MC1439C	IC-13

RESISTORS (R)
"100" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 29134D-Pg. 7-10)

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
R101	12KΩ, 10%, 1/2W, Comp	88/C3	A-B	EB	R-1-12K
R102	NOT USED				
R103	NOT USED				
R104	100Ω, 10%, 1/2W, Comp	61/D2	A-B	EB	R-1-100
R105	180Ω, 10%, 1/4W, Comp	95/D2	A-B	CB	R-76-180
R106	470Ω, 10%, 1/2W, Comp	68/D3	A-B	EB	R-1-470
R107	NOT USED				
R108	NOT USED				
R109	NOT USED				
R110	37.4KΩ, 1%, 1/8W, MtF	119/C5	IRC	CEA	R-88-37.4K
R111	402Ω, 1%, 1/8W, MtF	98/C5	IRC	CEA	R-88-402
R112	402Ω, 1%, 1/8W, MtF	99/C5	IRC	CEA	R-88-402
R113	100Ω, 10%, 1/2W	62/C5	A-B	EB	R-1-100
R114	15KΩ, 1%, 1/8W	108/B5	IRC	CEA	R-88-15K
R115	5.49KΩ, 1%, 1/8W	106/C6	IRC	CEA	R-88-5.49K
R116	2KΩ, 20%, 2W, WW	149/C5	CTS	1NS115	RP-50-2K
R117	NOT USED				
R118	5.1KΩ, 1%, 3W, WW	126/B6	OHM	200	R-173-5.1K
R119	22KΩ, 10%, 1/2W, Comp	89/C3	A-B	EB	R-1-22K
R120	10KΩ, 10%, 1/2W, Comp	81/C3	A-B	EB	R-1-10K
R121	1KΩ, 20%, 2W, WW	147/D3	CTS	1NS115	RP-50-1K
R122	8.2KΩ, 10%, 1/2W, Comp	80/D4	A-B	EB	R-1-8.2K
R123	390Ω, 10%, 1/2W, Comp	66/D4	A-B	EB	R-1-390
R124	390Ω, 10%, 1/2W, Comp	67/D4	A-B	EB	R-1-390
R125	4.7KΩ, 10%, 1/2W, Comp	76/D4	A-B	EB	R-1-4.7K
R126	20KΩ, 1%, 1/8W, MtF	109/D5	IRC	CEA	R-88-20K
R127	20KΩ, 1%, 1/8W, MtF	110/D5	IRC	CEA	R-88-20K
R128	20KΩ, 1%, 1/8W, MtF	111/D5	IRC	CEA	R-88-20K
R129	20KΩ, 1%, 1/8W, MtF	112/D4	IRC	CEA	R-88-20K
R130	2.2KΩ, 10%, 1/2W, Comp.	73/D4	A-B	EB	R-1-2.2K
R131	20KΩ, 1%, 1/8W, MtF	113/D4	IRC	CEA	R-88-20K
R132	20KΩ, 1%, 1/8W, MtF	114/D5	IRC	CEA	R-88-20K
R133	49.9KΩ, 1%, 1/8W, MtF	120/D5	IRC	CEA	R-88-49.9K
R134	20KΩ, 1%, 1/8W, MtF	115/D5	IRC	CEA	R-88-20K
R135	20KΩ, 1%, 1/8W, MtF	116/D5	IRC	CEA	R-88-20K
R136	100KΩ, 1%, 1/8W, MtF.	123/C6	IRC	CEA	R-88-100K
R137	NOT USED				
R138	NOT USED				
R139	NOT USED				
R140	100Ω, 10%, 1/2W, Comp	94/E5	A-B	EB	R-1-100K
R141	182KΩ, 1%, 1/8W, MtF.	124/D5	IRC	CEA	R-88-182K
R142	182KΩ, 1%, 1/8W, MtF.	125/D5	IRC	CEA	R-88-182K
R143	10KΩ, 10%, 1/2W, Comp	82/E5	A-B	EB	R-1-10K
R144	500Ω, 20%, 3/4W, Cermet	153/D5	BEC	77PR500	RP-64-500
R145	49.9KΩ, 1%, 1/8W, MtF	122/D6	IRC	CEA	R-88-49.9K
R146	49.9KΩ, 1%, 1/8W, MtF	121/D6	IRC	CEA	R-88-49.9K
R147	10KΩ, 10%, 1/2W, Comp	83/D5	A-B	EB	R-1-10K
R148	NOT USED				
R149	NOT USED				
R150	NOT USED				
R151	NOT USED				
R152	NOT USED				
R153	NOT USED				
R154	NOT USED				
R155	NOT USED				
R156	NOT USED				
R157	NOT USED				
R158	NOT USED				
R159	NOT USED				
R160	NOT USED				
R161	NOT USED				
R162	NOT USED				
R163	NOT USED				

RESISTORS (R) (CON'T)
"100" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 29134D-Pg. 7-10)

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
R164	NOT USED				
R165	NOT USED				
R166	NOT USED				
R167	NOT USED				
R168	NOT USED				
R169	NOT USED				
R170	NOT USED				
R171	NOT USED				
R172	NOT USED				
R173	NOT USED				
R174	NOT USED				
R175	NOT USED				
R176	NOT USED				
R177	NOT USED				
R178	NOT USED				
R179	NOT USED				
R180	NOT USED				
R181	1KΩ, 1%, 1/8W, MtF	101/D4	IRC	CEA	R-88-1K
R182	200Ω, 20%, 2W, WW.	152/D3	CTS	1NS115	RP-50-200
R183	4.99KΩ, 1%, 1/8W, MtF.	105/E3	IRC	CEA	R-88-4.99K
R184	NOT USED				
R185	NOT USED				
R186	NOT USED				
R187	NOT USED				
R188	NOT USED				
R189	NOT USED				
R190	NOT USED				
R191	NOT USED				
R192	NOT USED				
R193	NOT USED				
R194	220Ω, 10%, 1/2W, Comp.	64/D4	A-B	EB	R-1-220
R195	220Ω, 10%, 1/2W, Comp.	65/C5	A-B	EB	R-1-220
R196	3.3Ω, 10%, 1/2W, Comp.	-----	A-B	EB	R-1-3.3

"200" Series (Sch. 28679E-Pg. 7-13)
(PC-Board 29134D-Pg. 7-10)

R201	4.7KΩ, 10%, 1/2W, Comp	77/B5	A-B	EB	R-1-4.7K
R202	6.8KΩ, 10%, 1/2W, Comp	79/B5	A-B	EB	R-1-6.8K
R203	2KΩ, 0.1%, 1/2W, Comp	150/B5	---	SPECIAL	R-67-2K
R204	4.7KΩ, 10%, 1/2W, Comp	78/B4	A-B	EB	R-1-4.7K
R205	2.2KΩ, 10%, 1/2W, Comp	74/B5	A-B	EB	R-1-2.2K
R206	1KΩ, 10%, 1/2W, Comp	69/B5	A-B	EB	R-1-1K
R207	2KΩ, 0.1%, 1/2W, Comp.	151/B5	----	SPECIAL	R-67-2K
R208	2.2KΩ, 10%, 1/2W, Comp	75/B5	A-B	EB	R-1-2.2K
R209	56KΩ, 10%, 1/2W, Comp.	92/A5	A-B	EB	R-1-56K
R210	10KΩ, 10%, 1/2W, Comp.	85/B5	A-B	EB	R-1-10K
R211	10KΩ, 10%, 1/2W, Comp.	86/B4	A-B	EB	R-1-10K
R212	47KΩ, 10%, 1/2W, Comp.	90/A5	A-B	EB	R-1-47K
R213	56KΩ, 10%, 1/2W, Comp.	93/A5	A-B	EB	R-1-56K
R214	47KΩ, 10%, 1/2W, Comp.	91/A5	A-B	EB	R-1-47K
R215	1KΩ, 10%, 1/2W, Comp	70/B4	A-B	EB	R-1-1K
R216	1KΩ, 10%, 1/2W, Comp	71/B4	A-B	EB	R-1-1K
R217	NOT USED				
R218	NOT USED				
R219	NOT USED				
R220	NOT USED				
R221	NOT USED				
R222	NOT USED				
R223	1.8KΩ, 10%, 1/2W, Comp	72/C4	A-B	EB	R-1-1.8K
R224	12Ω, 10%, 1/2W, Comp	60/B4	A-B	EB	R-1-12
R225	6.04KΩ, 1%, 1/8W, MtF.	107/C4	IRC	CEA	R-88-6.04K

RESISTORS (R) (CON'T)
"300" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 28681C-Pg. 7-11)

Circuit Desig.	Description	PC-Board Item No./ Location	Mfr. Code	Mfr. Desig.	Keithley Part No.
R301	200KΩ, 20%, 1/2W	30/E1	BRN	3386-W	RP-116-200K
R302	200KΩ, 20%, 1/2W	31/E1	BRN	3386-W	RP-116-200K
R303	200KΩ, 20%, 1/2W	32/E1	BRN	3386-W	RP-116-200K
R304	200KΩ, 20%, 1/2W	33/D1	BRN	3386-W	RP-116-200K
R305	5KΩ, 75W, Cermet Var	29/D2	BEC	89P	RP-89-5K
R306	10KΩ, 0.1%, 1/4W, WW	15/C2	RCA	7009	R-95-10
R307	100KΩ, 0.1%, 1/2W, MtF	16/C2	DLE	MFF	R-169-100
R308	1KΩ, 0.1%, 1/2W, MtF	17/C2	DLE	MFF	R-169-1K
R309	10KΩ, 0.1%, 1/2W, MtF.	18/C2	DLE	MFF	R-169-10K
R310	100KΩ, 0.1%, 1/2W, MtF	19/B2	DLE	MFF	R-169-100K
R311	1M, 0.1%, 1/2W, MtF.	20/B2	DLE	MFF	R-169-1M
R312	10M, 0.1%, 1/2W	21/B2	A-C	AME-70	R-174-10M
R313	115KΩ, 1%, 1/2W, MtF	14/F2	IRC	CEA	R-94-115K
R314	115KΩ, 1%, 1/2W, MtF	13/F2	IRC	CEA	R-94-115K
R315	5KΩ, 1%, 1/2W, DC,	11/E3	IRC	DCC-5	R-12-5
R316	5KΩ, 1%, 1/2W, DC.	12/E3	IRC	DCC-5	R-12-5
R317	47KΩ, 10%, 1/2W, Comp.	10/D2	A-B	EB-47K-10%	R-1-47K
R318	18KΩ, 10%, 1/2W, Comp.	8/E3	A-B	EB-18-10%	R-1-18
R319	27KΩ, 10%, 1/2W, Comp.	9/E3	A-B	EB-27-10%	R-1-27
R320	220Ω, 5%, 1/4W, Comp	23/D4	MEP	CR25, 5%	R-76-220
R321	220Ω, 5%, 1/4W, Comp	22/C4	MEP	CR25, 5%	R-76-220
R322	4.7KΩ, 5%, 1/4W, Comp.	24/C4	MEP	CR25, 5%	R-76-4.7K
R323	10KΩ, 10%, 1/2W, Comp.	28/C4	A-B	EB-10-10%	R-1-10
R324	4.7KΩ, 5%, 1/4W, Comp.	27/B4	MEP	CR25, 5%	R-76-4.7K
R325	4.7KΩ, 5%, 1/4W, Comp.	26/B4	MEP	CR25, 5%	R-76-4.7K
R326	4.7KΩ, 5%, 1/4W, Comp.	25/B4	MEP	CR25, 5%	R-76-4.7K

"400" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 29134D-Pg. 7-10)

R401	10KΩ, 10%, 1/2W, Comp.	84/D6	A-B	EB-10K-10%	R-1-10K
R402	2.49KΩ, 1%, 1/8W, MtF.	104/D5	IRC	CEA	R-88-2.49K
R403	2.49KΩ, 1%, 1/8W, MtF.	103/D5	IRC	CEA	R-88-2.49K
R404	237KΩ, 1%, 1/8W, MtF	97/D6	IRC	CEA	R-88-237
R405	237KΩ, 1%, 1/8W, MtF	96/D6	IRC	CEA	R-88-237

SWITCHES (S)
"200" Series (Sch. 28679E-Pg. 7-13)
(PC-Board 29134D-Pg. 7-10)

S201	Slide Switch, Line.	-----	K-I	-----	SW-151
S202	Toggle Switch, Power	-----	K-I	-----	SW-4

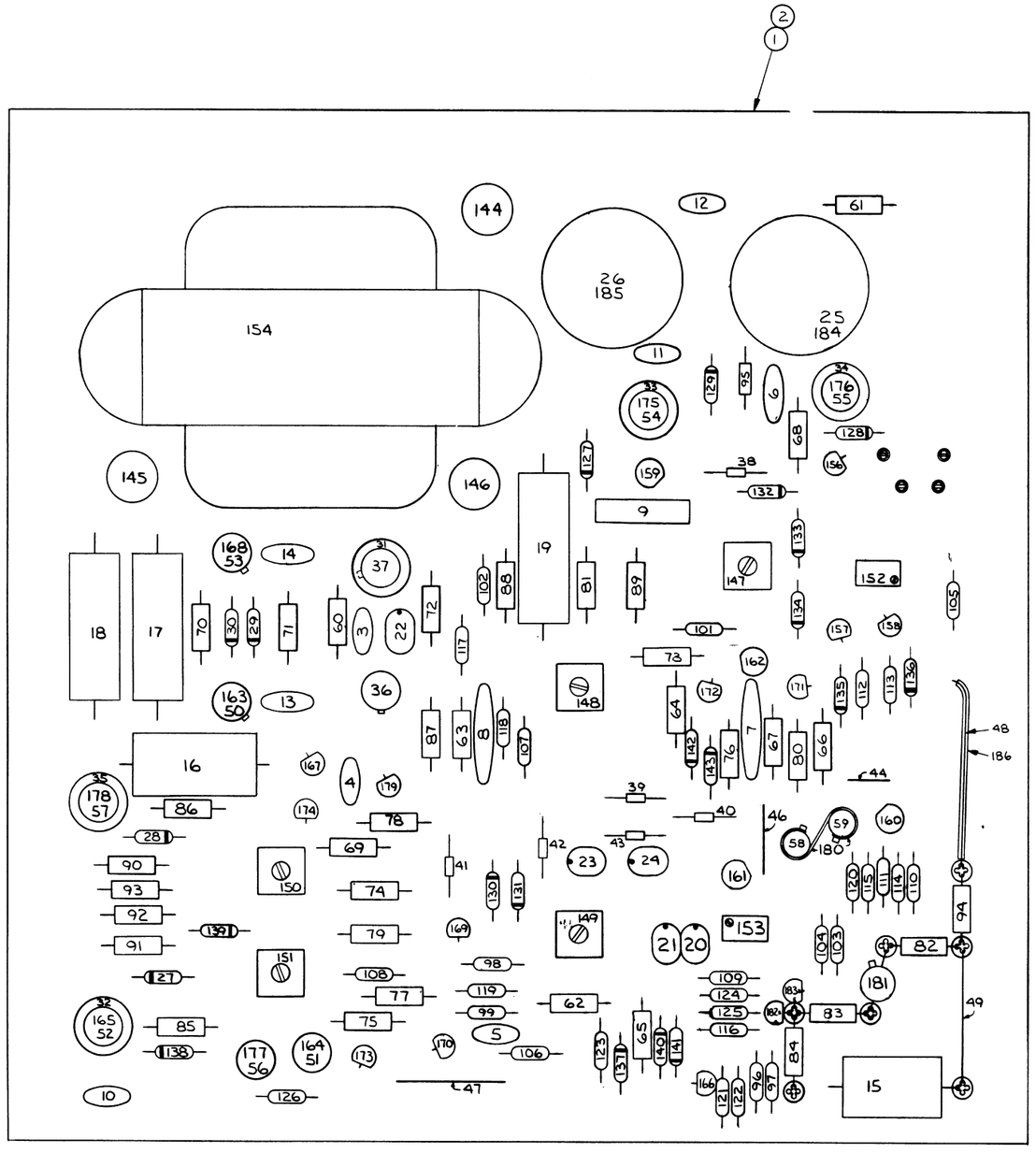
TRANSFORMERS (T)
"200" Series (Sch. 28679E-Pg. 7-13)
(PC-Board 29134D-Pg. 7-10)

T201	Power Transformer.	154/B2	K-I	-----	TR-124

INTEGRATED CIRCUITS (U)
"300" Series (Sch. 28680E-Pg. 7-12)
(PC-Board 28681C-Pg. 7-11)

U301	BCD-TO-Decimal Decoder	6/B4	T-I	SN7445	IC-111

29134D ON



ITEM	PART NO.	SCHEM. DESIG.	ZONE
1	PC-228	~	D1
2	23096B	STAKING	D1
3	C-22-100pF	C213	B4
4	C-22-150pF	C218	B4
5	C-22-.0022	C102	C5
6	C-22-.0068	C101	D3
7	C-22-.02	C104	D4
8	"	C214	C4
9	C-41-.22	C103	C3
10	C-64-470pF	C201	A6
11	C-64-1000pF	C203	C2
12	"	C204	D2
13	"	C209	B4
14	"	C210	B3
15	C-269-.1	C107	D6
16	C-117-.5	C202	B4
17	C-150-100	C207	B4
18	"	C208	A4
19	"	C211	C3
20	C-179-4.7	C105	D5
21	"	C106	C5
22	"	C212	B4
23	C-179-10	C215	C5
24	"	C216	C5
25	C-183-140	C205	D2
26	"	C206	C2
27	DZ-21	D203	B5
28	"	D204	B5
29	DZ-22	D205	B4
30	"	D206	B4
31	HS-2	~	B3
32	"	~	A5
33	"	~	C3
34	"	~	D3
35	"	~	A4
36	IC-13	QA202	B4
37	IC-14	QA201	B3
38	J-3	~	D3
39	"	~	C4
40	"	~	D4
41	"	~	C5
42	"	~	C5
43	"	~	C5
44	#22-5/16 LG. BUSS WIRE		D4
45			
46	#22×3/4 LG. "	"	D5
47	#22×1" LG. "	"	C6
48	#22×1-3/4 LG. "	"	E4
49	#22×1/4 LG. "	"	E5
50	MK-6	~	B4
51	"	~	B6
52	"	~	A5
53	"	~	B3
54	"	~	C3
55	"	~	D3
56	"	~	B6
57	"	~	A4
58	"	~	D5
59	"	~	D5
60	R-1-12	R224	B4
61	R-1-100	R104	D2
62	"	R113	C5
63	R-1-120	R231	C4
64	R-1-220	R194	D4
65	"	R195	C5
66	R-1-390	R123	D4
67	"	R124	D4
68	R-1-470	R106	D3
69	R-1-1K	R206	B5
70	"	R215	B4
71	"	R216	B4
72	R-1-1.8K	R223	C4
73	R-1-2.2K	R130	D4
74	"	R205	B5
75	"	R208	B5

ITEM	PART NO.	SCHEM. DESIG.	ZONE
76	R-1-4.7K	R125	D4
77	"	R201	B5
78	"	R204	B4
79	R-1-6.8K	R202	B5
80	R-1-8.2K	R122	D4
81	R-1-10K	R120	C3
82	"	R143	E5
83	"	R147	D5
84	"	R401	D6
85	"	R210	B5
86	"	R211	B4
87	"	R230	C4
88	R-1-12K	R101	C3
89	R-1-22K	R119	C3
90	R-1-47K	R212	A5
91	"	R214	A5
92	R-1-56K	R209	A5
93	"	R213	A5
94	R-1-33K	R140	E5
95	R-76-180	R105	D2
96	R-88-237	R405	D6
97	"	R404	D6
98	R-88-402	R111	C5
99	"	R112	C5
100			
101	R-88-909	R181	D4
102	R-88-2.21K	R227	C3
103	R-88-2.49K	R403	D5
104	"	R402	D5
105	R-88-9.09K	R183	E3
106	R-88-5.49K	R115	C6
107	R-88-6.04K	R225	C4
108	R-88-15K	R114	B5
109	R-88-20K	R126	D5
110	"	R127	D5
111	"	R128	D5
112	"	R129	D4
113	"	R131	D4
114	"	R132	D5
115	"	R134	D5
116	"	R135	D5
117	"	R228	C4
118	"	R229	C4
119	R-88-37.4K	R110	C5
120	R-88-49.9K	R133	D5
121	"	R144	D6
122	"	R145	D6
123	R-88-100K	R136	C6
124	R-88-182K	R141	D5
125	"	R142	D5
126	R-173-5.1K	R118	B6
127	RF-14	D102	C3
128	"	D103	D3
129	"	D104	D2
130	"	D106	C5
131	"	D107	C5
132	"	D108	D3
133	"	D109	D3
134	"	D110	D4
135	"	D111	D4
136	"	D112	D4
137	"	D113	C6
138	"	D201	B6
139	"	D202	B5
140	RF-28	D117	C6
141	"	D118	D6
142	"	D119	D4
143	"	D120	D4
144	RF-46	D207	C2
145	"	D208	A3
146	"	D209	C3
147	RP-97-1K	R121	D3
148	"	R226	C4
149	RP-97-2K	R116	C5
150	"	R203	B5

ZONE	LTR	ECO NO	REVISION	DATE
	A	5757	RELEASED	10-3-77
	B	5841	ITEM #5 was C66-1, ITEM #24 was 10K	12-15-77
	C	5869	ITEM #106 was 3.09	2-8-78

ITEM	PART NO.	SCHEM. DESIG.	ZONE
151	RP-97-2K	R207	B5
152	RP-109-200	R182	D3
153	RP-104-500	R144	D5
154	TR-124	T201	B2
155			
156	TG-33	Q106	D3
157	"	Q116	D4
158	"	Q117	D4
159	TG-39	Q103	C3
160	"	Q112	D4
161	"	Q113	D5
162	"	Q115	D4
163	TG-43	Q209	B4
164	TG-44	Q206	B6
165	"	Q207	A5
166	TG-49	Q119	D6
167	"	Q205	B4
168	TG-50	Q211	B3
169	TG-53	Q107	C5
170	"	Q108	C6
171	"	Q109	D4
172	"	Q110	D4
173	"	Q201	B6
174	"	Q203	B4
175	TG-58	Q102	C3
176	TG-59	Q104	D3
177	"	Q202	B6
178	"	Q208	A4
179	TG-61	Q204	B4
180	TG-64	Q111/Q114	D5
181	24670A	Q118	D5
182	28569A	Q402	D5
183	"	Q401	D5
184	TX-7	~	D2
185	"	~	C2
186	#20×1-3/8 LG. TEF. TUBING		E4
187			
188			
189			
190			
191			
192			
193			
194			
195			
196			
197			
198			
199			
200			
201			
202			
203			
204			
205			

MODEL	NEXT ASSEMBLY	QTY
725		1
USED ON		

DO NOT SCALE THIS DRAWING

KEITHLEY INSTRUMENTS CLEVELAND, OHIO

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED: XX = ± .015 ANG = ±1° | XXX = ± .005 FRAC = ±1/64 | SURFACE MAX 63

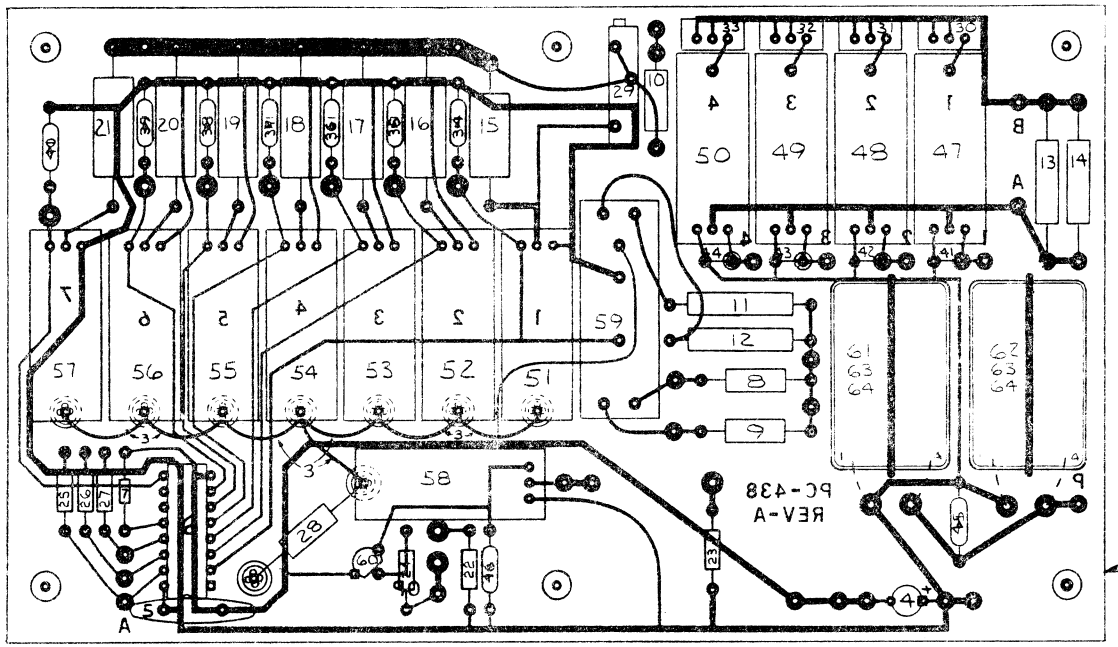
DATE 10-3-77 | SCALE 2-1 | DRN R. SMITH | ENG APPR | MATERIAL ~ | FINISH ~

TITLE: COMPONENT LAYOUT, PC-228

NO 29134D

FORM 285110

Figure 7-1. Component Layout, PC-228.



LTR	ECO NO	REVISION	DATE
A	5757	RELEASED	9-27-77
B	5841	ITEM #5 WAS C-235-1	12-15-77
C	5906	ITEM #29 WAS 2K	3-6-78

ITEM	PART NO.	SCHEM. DESIG.	ZONE
1	PC-438	~	F4
2	29136C	STAKING	F4
3	#22 GA. BARE BUSS WIRE	AS REQ'D	B3 THRU D3
4	C-179-10	C301	E4
5	C-237-1	C302	B4
6	IC-111	U301	B4
7	J-3	~	B4
8	R-1-18	R318	E3
9	R-1-27	R319	E3
10	R-1-47K	R317	D2
11	R-12-5	R315	E3
12	R-12-5	R316	E3
13	R-94-115K	R314	F2
14	"	R313	F2
15	R-95-10	R306	C2
16	R-169-100	R307	C2
17	R-169-1K	R308	C2
18	R-169-10K	R309	C2
19	R-169-100K	R310	B2
20	R-169-1M	R311	B2

ITEM	PART NO.	SCHEM. DESIG.	ZONE
21	R-174-10M	R312	B2
22	R-76-220	R321	C4
23	"	R320	D4
24	R-76-4.7K	R322	C4
25	"	R326	B4
26	"	R325	B4
27	"	R324	B4
28	R-1-10	R323	C4
29	RP-89-5K	R305	D2
30	RP-116-200K	R301	E1
31	"	R302	E1
32	"	R303	E1
33	"	R304	D1
34	RF-38	CR305	C2
35	"	CR306	C2
36	"	CR307	C2
37	"	CR308	C2
38	"	CR309	B2
39	"	CR310	B2
40	"	CR311	B2

ITEM	PART NO.	SCHEM. DESIG.	ZONE
41	RF-38	CR301	E2
42	"	CR302	E2
43	"	CR303	E2
44	"	CR304	D2
45	"	CR312	E4
46	"	CR313	C4
47	RL-40	K301	E2
48	"	K302	E2
49	"	K303	E2
50	"	K304	D2
51	"	K305	D3
52	"	K306	C3
53	"	K307	C3
54	"	K308	C2
55	"	K309	B3

ITEM	PART NO.	SCHEM. DESIG.	ZONE
56	RL-40	K310	B3
57	"	K311	B3
58	"	K312	C4
59	RL-46	K313	D3
60	TG-47	Q301	C4
61	RL-58	K314	E3
62	"	K315	F3
63	SO-79 2/0	SOCKET	E3/F3
64	SO-80 2/0	WIRE RETAINER	E3/F3

MODEL	NEXT ASSEMBLY	QTY
725		

USED ON

DO NOT SCALE THIS DRAWING

KEITHLEY INSTRUMENTS CLEVELAND, OHIO

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
XX = ± .015 ANG = ±1°
XXX = ± .005 FRAC. = ±1/64
SURFACE MAX. 63

DATE 1-19-77 | SCALE 2-1 | DRN R.SMITH | ENG APPR.

TITLE PC-438 COMPONENT LAYOUT

MATERIAL | FINISH

NO 28681C

Figure 7-2. Component Layout, PC-438.

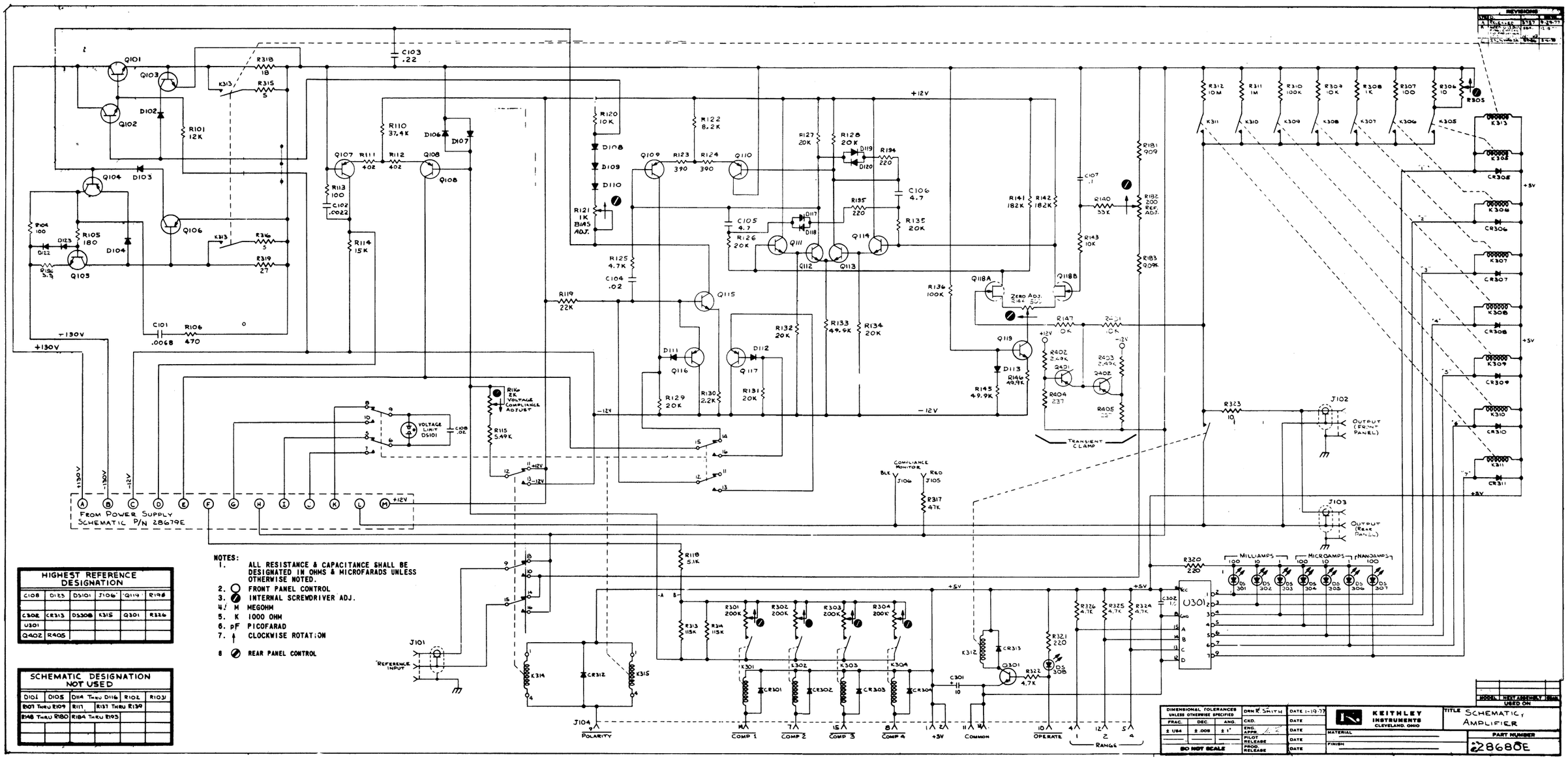


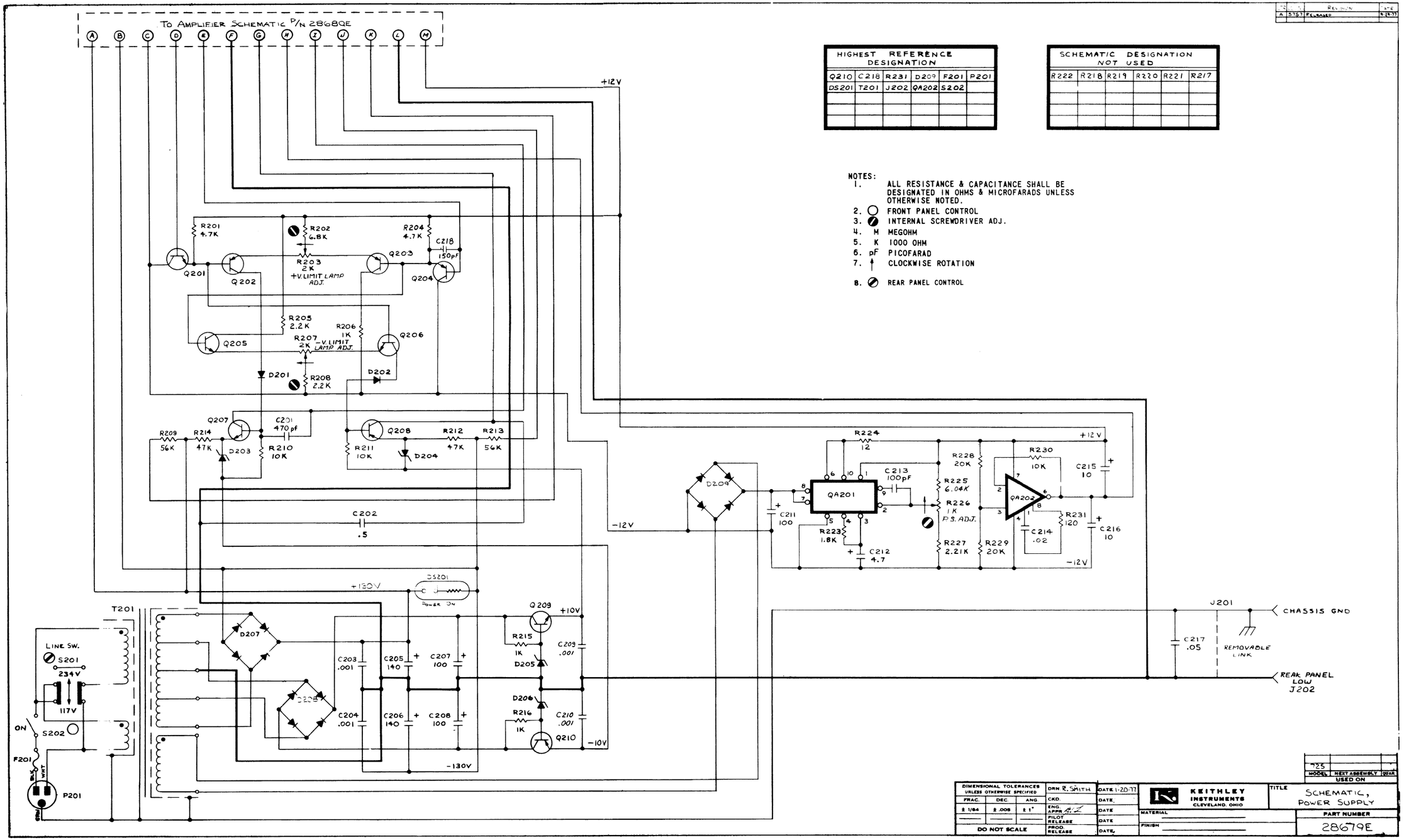
Figure 7-3. Schematic Diagram - Model 725 Amplifier.

REVISION			DATE
A	5757	RELEASED	9/26/77

HIGHEST REFERENCE DESIGNATION					
Q210	C218	R231	D209	F201	P201
DS201	T201	J202	QA202	S202	

SCHEMATIC DESIGNATION NOT USED					
R222	R218	R219	R220	R221	R217

NOTES:
1. ALL RESISTANCE & CAPACITANCE SHALL BE DESIGNATED IN OHMS & MICROFARADS UNLESS OTHERWISE NOTED.
2. ○ FRONT PANEL CONTROL
3. ⊘ INTERNAL SCREWDRIVER ADJ.
4. M MEGOHM
5. K 1000 OHM
6. pF PICOFARAD
7. ↑ CLOCKWISE ROTATION
8. ⊘ REAR PANEL CONTROL



DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			DRN R. SMITH	DATE 1-20-77
FRAC.	DEC.	ANG.	CKD.	DATE
± 1/64	± .005	± 1°	ENG. APPR.	DATE
			PILOT RELEASE	DATE
DO NOT SCALE			PROD. RELEASE	DATE

KEITHLEY INSTRUMENTS CLEVELAND, OHIO

TITLE: SCHEMATIC, POWER SUPPLY

MATERIAL

FINISH

PART NUMBER 28679E

MODEL 725 | NEXT ASSEMBLY USED ON | QUAN

Figure 7-4. Schematic Diagram - Model 725 Power Supply.

KEITHLEY INSTRUMENTS, INC.
28775 AURORA ROAD
CLEVELAND, OHIO 44139

SERVICE FORM

MODEL NO._____ SERIAL NO._____ P.O. NO._____ DATE_____ R-

NAME _____ PHONE _____

COMPANY _____

ADDRESS _____ CITY _____ STATE _____ ZIP_____

1. Describe problem and symptoms using quantitative data whenever possible (enclose readings, chart recordings, etc.) _____

_____

_____ (Attach additional sheets as necessary).

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

3. List the positions of all controls and switches on both front and rear panels of the instrument. _____

_____

4. Describe input signal source levels, frequencies, etc. _____

_____

_____

5. List and describe all cables used in the experiment (length, shielding, etc.).

_____

_____

6. List and describe all other equipment used in the experiment. Give control settings for each. _____

_____

_____

7. Environment:
   Where is the measurement being performed? (Factory, controlled laboratory, out-of-doors, etc.) _____
   What power line voltage is used? _____ Variation? _____ Frequency? _____
   Ambient temperature? _____°F. Variation? ____°F. Rel. Humidity? _____
   Other _____

8. Additional Information. (If special modifications have been made by the user, please describe below.) _____

_____

_____ REV 0774