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FLUKE 382A

JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

November 1, 1964

FOR REFERENCE PURPOSES ONLY

MODEL 382A

VOLTAGE/CURRENT CALIBRATOR

382A serial no. 240 and above.

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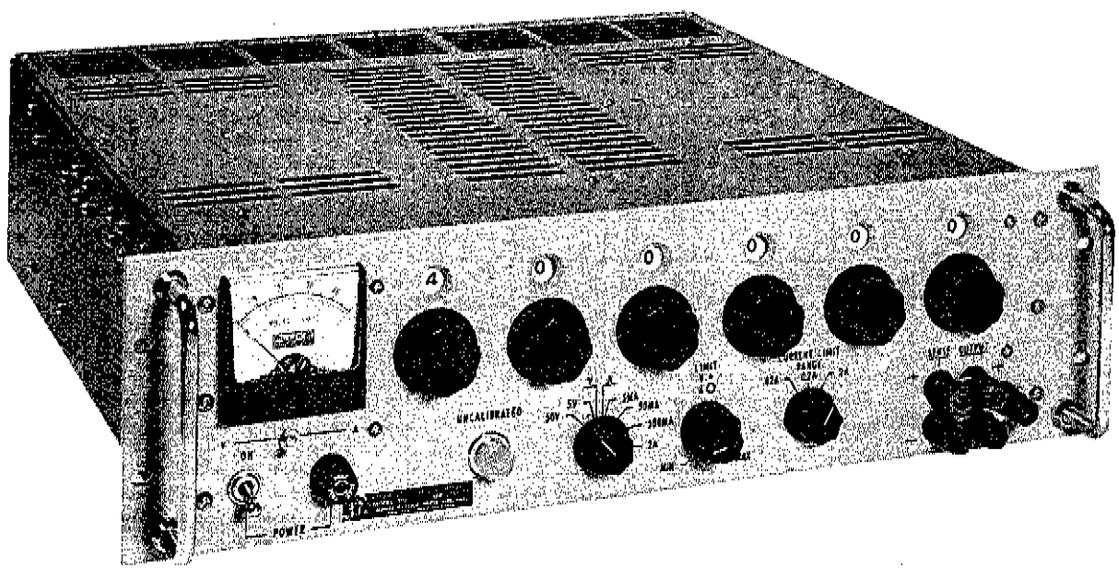


382A VOLTAGE/CURRENT CALIBRATOR

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. GENERAL DESCRIPTION

1-3. The Fluke Model 382A Voltage/Current Calibrator is capable of providing a calibrated voltage of 0 to 50 VDC, and a calibrated current of 0 to 2 amperes. The 382A is not damaged by a continuous short circuit, and normal operation is restored when the overload is removed.

1-4. The instrument is capable of either constant voltage or constant current operation. There are constant-voltage ranges of 0 to 5 VDC and 0 to 50 VDC. Constant voltage operation can be current limited to any current between 2 ma and 2.2 amperes. There are four constant current ranges of 0 to 5 ma, 0 to 50 ma, 0 to 500 ma, and 0 to 2 amperes. Constant current operation can be voltage limited to any value between 5 VDC and 55 VDC. Voltage and current limiting can operate simultaneously.

1-5. The 382A is capable of remote sensing of the load voltage, which eliminates error due to voltage drop in the connecting wires. Provision is also made for remote control of the output voltage or current. Applications of the 382A include: calibration of voltmeters, ammeters, and current shunts; measuring latch and release currents of precision relays; testing and sorting voltage regulator and voltage reference tubes; powering magnetic fields; testing the PIV of diodes; and forming capacitors.

1-6. The 382A requires 5-1/4 inches of rack space, and has side panels tapped for standard chassis slides, which should be used when the instrument is rack mounted.

1-7. RECEIVING INSPECTION

1-8. This instrument has been thoroughly checked and tested before being shipped from the factory. Immediately upon receipt of the instrument, carefully inspect for any damage which may have occurred in transit. If any damage is noted, refer to the instructions outlined on the warranty page in the back of this manual.

1-9. SPECIFICATIONS

1-10. CONSTANT VOLTAGE OPERATION

OUTPUT VOLTAGE: 0 to 50 VDC; 0 to 5 VDC.

CALIBRATION ACCURACY: ±0.01% of setting or 100 uv (whichever is greater).

OUTPUT CURRENT: 0 to 2 amperes.

CURRENT LIMITING: Continuously variable from 2 ma to 2 amps in three full scale ranges of 20 ma, 200 ma, and 2 amps.

LINE REGULATION: 0.0005% or 50 uv (whichever is greater) for a 10% line change from nominal.

LOAD REGULATION: 0.0005% or 50 uv (whichever is greater) for a 2 ampere load change.

OUTPUT IMPEDANCE: Less than 0.0001 ohm from DC to 100 cps; less than 0.001 ohm to 1 KC; less than 0.2 ohm to 100 KC.

OUTPUT POLARITY: Either terminal may be grounded or both may be left floating up to 500 V above ground.

REMOTE PROGRAMMING: By external rheostat connected to rear terminal strip (1000 ohms per volt on 50V range; 10,000 ohms per volt on 5V range.)

REMOTE SENSING: Output voltage may be sensed directly at load through front panel terminals or rear terminal strip.

RESOLUTION: 100 uv on 50V range; 10 uv on 5V range.

RIPPLE: Less than 50 uv RMS.

STABILITY: ±0.002% or 100 uv (whichever is greater) per hour. ±0.0025% or 100 uv (whichever is greater) per day. ±0.005% or 100 uv (whichever is greater) per month.

1-11. CONSTANT CURRENT OPERATION

CALIBRATION ACCURACY: ±0.02% of setting or ±0.002% of range (whichever is greater).

LINE REGULATION: 0.0005% of range for a 10% line change from nominal.

LOAD REGULATION: 0.001% of range for a 50V load change.

OUTPUT CURRENT: 0 to 5 milliamperes
0 to 50 milliamperes
0 to 500 milliamperes
0 to 2 amperes

OUTPUT POLARITY: Negative terminal may be grounded, or both terminals may be left floating up to 500V above ground. Positive terminal must be isolated from chassis ground by load.

OUTPUT VOLTAGE: 0 to 50 VDC.

REMOTE PROGRAMMING: By external rheostat connected to rear terminal strip (10,000 ohms per ma for 5 ma range; 1000 ohms per ma for 50 ma range; 100 ohms per ma for 500 ma range; 10 ohms per ma for 2 amp range).

RESOLUTION: 0.01 ua on 5 ma range
0.1 ua on 50 ma range
1.0 ua on 500 ma range
10.0 ua on 2 amp range

RIPPLE: Less than 0.002% of range RMS.

STABILITY: 5 ma and 50 ma ranges; ±0.0025% of setting or ±0.0005% of range (whichever is greater) per hour; ±0.005% of setting or ±0.001% of range (whichever is greater) per month.

500 ma and 2 amp ranges; ±0.0025% of setting or ±0.0005% of range (whichever is greater) per hour after 2 minutes at constant current output; ±0.005% of setting or ±0.001% of range (whichever is greater) per month after 2 minutes at constant current output.

VOLTAGE LIMITING: Continuously variable from 5 to 55 VDC in one range.

1-12. GENERAL

CONNECTORS: Front panel insulated binding posts for positive and negative output, positive and negative sense, and chassis ground. Rear terminal strip has same connections plus remote programming and reference monitoring terminals.

INPUT POWER: 115/230 VAC, ±10%, 50 to 60 cps, approximately 300 VA maximum.

METER: One meter to monitor either output voltage or current.

MOUNTING: Standard relay rack; side panels tapped for standard chassis slides; rubber supports for bench use.

SIZE: 5-1/4" high by 18" deep by 19" wide.

TEMPERATURE RANGE: 0°C to 55°C operating; -40°C to 60°C storage.

WEIGHT: 50 pounds

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

2-2. The location, reference designation, and functional description of external controls, terminals, and indicators on the 382A are given in Figure 2-1. Controls, terminals, and indicators are identified in Figure 2-2.

2-3. PRELIMINARY OPERATION

2-4. This instrument is normally supplied for 115 volt operation. When requested, instruments are supplied for 230 volt operation. If it becomes necessary to change from one voltage to the other, refer to the instructions on the schematic diagram.

CONTROL, TERMINAL, OR INDICATOR	LOCATION	REFERENCE DESIGNATION	FUNCTIONAL DESCRIPTION
POWER Switch	Front Panel	S1	Applies AC line voltage to the primary of the power transformer.
Meter Switch	Front Panel	S4	Selects either voltage monitoring (V) or current monitoring (A) for the panel meter.
Six Decade Controls	Front Panel	S201, S202, S203, S204, S205, S206	Controls either output voltage or output current, according to the position of the V-A range switch.
Range Switch V-A	Front Panel	S2	Selects full-scale voltage range of 5 or 50 volts or full-scale current range of 5ma, 50ma, 500ma, or 2 amperes. This switch also changes the full-scale voltage range of the panel meter and selects the proper position of the decimal lamp for the six decade controls.
LIMIT Controls	Front Panel	R6 & R18	R6 varies the current limiting value from 10% to 120% of the range indicated by the CURRENT LIMIT RANGE switch. R18 varies the voltage limiting value from 5 volts to 55 volts.
CURRENT LIMIT RANGE Switch	Front Panel	S3	Selects output current limit ranges of 0.02, 0.2, and 2 amperes; also changes the full scale current range of the panel meter.
Panel Meter	Front Panel	M1	Indicates approximate output voltage or current according to the position of the panel meter switch. When the meter switch is set to V, full scale meter deflection is 5V when the V-A switch is set to 5V. Full scale meter deflection is 50V when the V-A switch is set to 50V, .005A, .050A, or 2A. When the panel meter switch is set to A, full scale meter deflection corresponds to the position of the CURRENT LIMIT RANGE switch.
UNCALIBRATED Lamp	Front Panel	DS3	Illuminates just before current limiting or voltage limiting begins. When this lamp is illuminated, the calibrated output dials may no longer indicate the correct output.

Figure 2-1. FUNCTION OF CONTROLS, TERMINALS, AND INDICATORS (sheet 1 of 2)

CONTROL, TERMINAL, OR INDICATOR	LOCATION	REFERENCE DESIGNATION	FUNCTIONAL DESCRIPTION
SENSE Terminals	Front Panel		Provided for controlling the output voltage at the point of sensing.
OUTPUT Terminals	Front Panel		Provided for connecting the load to the 382A.
GROUND Terminal	Front Panel		Provided for grounding either output terminal.
REFERENCE CALIBRATE Control	Back Panel	R8	Permits calibration of the internal reference voltage.
Terminal Strip	Back Panel		OUTPUT terminals (2 and 3) are for connecting to the load; SENSE terminals (1 and 4) are for sensing the load voltage; ground terminal (5) is for grounding the 382A chassis; REMOTE PROGRAMMING terminals (6, 7, and 8) are for connection to a remote control element; and REFERENCE MONITOR terminals (9 and 10) provide a 1.02V reference voltage for monitoring and calibration adjustment.

Figure 2-1. FUNCTION OF CONTROLS, TERMINALS, AND INDICATORS (sheet 2 of 2)

2-5. Heat producing transistors in the 382A are mounted on heat sinks in the rear of the instrument. Cooling air for these heat sinks enters through the lower perforated chassis cover and leaves through the top. Care must be taken to ensure that the air flow is not restricted by covering the chassis perforations. The instrument is supplied with rubber supports for bench use. If the supports are removed, the chassis must be raised by other means to provide the necessary airflow.

2-6. Before the instrument is turned on, verify that the SENSE terminals are connected to the OUTPUT terminals at either the front panel or rear terminal strip. Also, verify that the jumper between terminals 6 and 7 on the rear terminal strip is in place.

2-7. SEQUENCE OF OPERATION

a. Connect line plug to a 115 volt AC power source. If instrument has been wired for 230 volt operation, connect to 230 volts AC.

NOTE

This instrument is equipped with a 3-wire line cord, one lead of which is connected to the metal chassis. Connection to a properly wired outlet automatically connects the chassis of the instrument to earth ground. An adapter is furnished with the cord to permit connection to a two-contact outlet. If this is used, the green lead extending from the adapter should be connected to a good earth ground.

b. Connect + SENSE terminal to + OUTPUT terminal, and connect - SENSE terminal to - OUTPUT terminal. This is usually done with the shorting links provided on the front panel terminals. When using the rear terminal strip for output connections, also use the rear terminal strip for sense connections.

c. Connect the ground terminal to the + OUTPUT terminal, the - OUTPUT terminal, or leave the instrument floating for constant voltage operation, as desired. The shorting link on the front panel may be used for this purpose. When using the rear terminal strip for output connections, also use the rear terminal strip for grounding.

CAUTION

Be sure output is sensed at only one location: otherwise, the 382A may not be within specifications. To avoid excessive ripple, be sure the + OUTPUT terminal is not grounded during constant current operation.

d. Set the CURRENT LIMIT RANGE switch to the range which will provide the required output current.

e. Set voltage limit and current limit controls as desired. (Refer to paragraphs 2-13 thru 2-18.)

f. Set V-A range switch to desired constant voltage or constant current range.

g. Set decade dials to the desired output.
h. Connect the load to the OUTPUT terminal and set the POWER switch to ON.
i. Monitor the output voltage or current by setting the panel meter switch to V (voltage) or A (current).

NOTE

To prevent transient current surges in excess of the decade dial setting during constant current operation, short the output terminals prior to connecting or disconnecting the load. When the instrument is open-circuited during constant current operation, the output voltage will rise to over 50 volts, if not limited.

2-8. REMOTE VOLTAGE SENSING

2-9. When a load is connected to the output of the 382A, there may be an appreciable voltage drop between the 382A and the load. The nomograph of Figure 2-3 can be used to determine the approximate voltage drop in the wires from the instrument to the load. Figure 2-3 is used as follows: using a straight-edge, connect the output current to the size of wire used. The voltage drop per foot per conductor can be read in the third column. For example, assume #12 wire is used to connect a load which requires 2 amperes. The voltage drop in the wires is 3.2 mv per foot per wire. If two wires, each 3 feet long, are used to connect the load, this represents a voltage drop of 9.6 mv per wire, which is several times the published load regulation of the 382A at 50V output. Consequently, the advantage of remote sensing is that specified regulation is maintained at the load, the voltage drop in the connecting wires then having no effect.

2-10. It should be noted that even though remote sensing eliminates the effects of voltage drop in the load wires, there is a small voltage drop in the remote sensing leads, the effect of which is not eliminated. However, the magnitude of this voltage drop is extremely small, and if desired, can be calculated. The output voltage can then be set high by a corresponding amount. The current through the remote sensing leads is 0.1 ma when the V-A range switch is in the 5V position, and 1.0 ma when the V-A range switch is in any other position. Remote sensing is connected as follows:
a. Set the POWER switch to off, and remove the connections between the SENSE and OUTPUT terminals on front or back of the instrument.
b. Using shielded, twisted pair wire, connect SENSE terminals directly to the load at which the voltage is to be controlled. Be sure the + SENSE terminal is connected to the positive side of the load, and the - SENSE terminal is connected to the negative side of the load. Connect the shield to chassis ground to prevent pick-up of ripple and noise.
c. In most cases, it is desirable to connect a high-quality electrolytic capacitor of 1000 uf, 75 volts rating across the load.
d. Proceed with steps c through i of paragraph 2-3.

2-11. REMOTE CONTROL OF OUTPUT

2-12. The 382A can be resistance controlled from a remote location, as follows:
a. Set POWER switch to off, and remove the jumper between terminals 6 and 7 on the rear terminal strip.
b. Using insulated, shielded, twisted pair cable, connect the remote programming resistor between terminals 4 and 7 for constant voltage operation, or between terminals 6 and 7 for constant current operation. Connect the shield to terminal 8. For constant current operation, the decade dials must be set to zero. The remote programming resistor may be either fixed or variable. For remote voltage programming, the resistance must be equal to the desired output voltage multiplied by 1000 ohms/volt for the 50 volt range, and 10,000 ohms/volt for the 5 volt range. For remote current programming, the resistance must be equal to the desired output current multiplied by 10,000 ohms/ma for the 5 ma range, 1000 ohms/ma for the 50 ma range, 100 ohms/ma for the 500 ma range, and 10 ohms/ma for the 2 ampere range. An external capacitor of the approximate size and voltage rating of C201 must be connected across the programming resistor.

NOTE

The shield will be of the same potential as the + SENSE terminal and must be insulated to avoid accidental grounding.

c. Proceed with steps b through f and h through i of paragraph 2-7.
d. The output voltage or current may be controlled by varying the resistance of the remote resistor.

2-13. CURRENT LIMIT CONTROL

2-14. The current limit control is designed to protect the equipment connected to the 382A from damage which may be caused by excessive load current. When it is necessary to protect the load from excessive current during turn-on of the power supply, proceed as follows:
a. Perform steps b and c of paragraph 2-7.
b. Set the controls on the 382A as follows:

CONTROL	POSITION
V-A range	50V
CURRENT LIMIT RANGE	As desired
Current LIMIT	Mid-range
Voltage LIMIT	As desired
Decade dials	04.0000
Meter switch	A
POWER	ON

c. Short the OUTPUT terminals and adjust the current LIMIT control until the meter indicates the desired current. The maximum output current limit as set here will limit the output current in the event of a short circuit. Actual limiting will begin at approximately 2.5 ma less than the selected value in the 0.02A range, 25 ma less in the 0.2A range, and 250 ma less in the 2A range. The UNCALIBRATED warning lamp will illuminate just prior to the start of current limiting.
d. Remove the short from the OUTPUT terminals.
e. Proceed with steps f through i of paragraph 2-7.

2-15. The current limiting value may be set more accurately after connecting the load to the instrument.

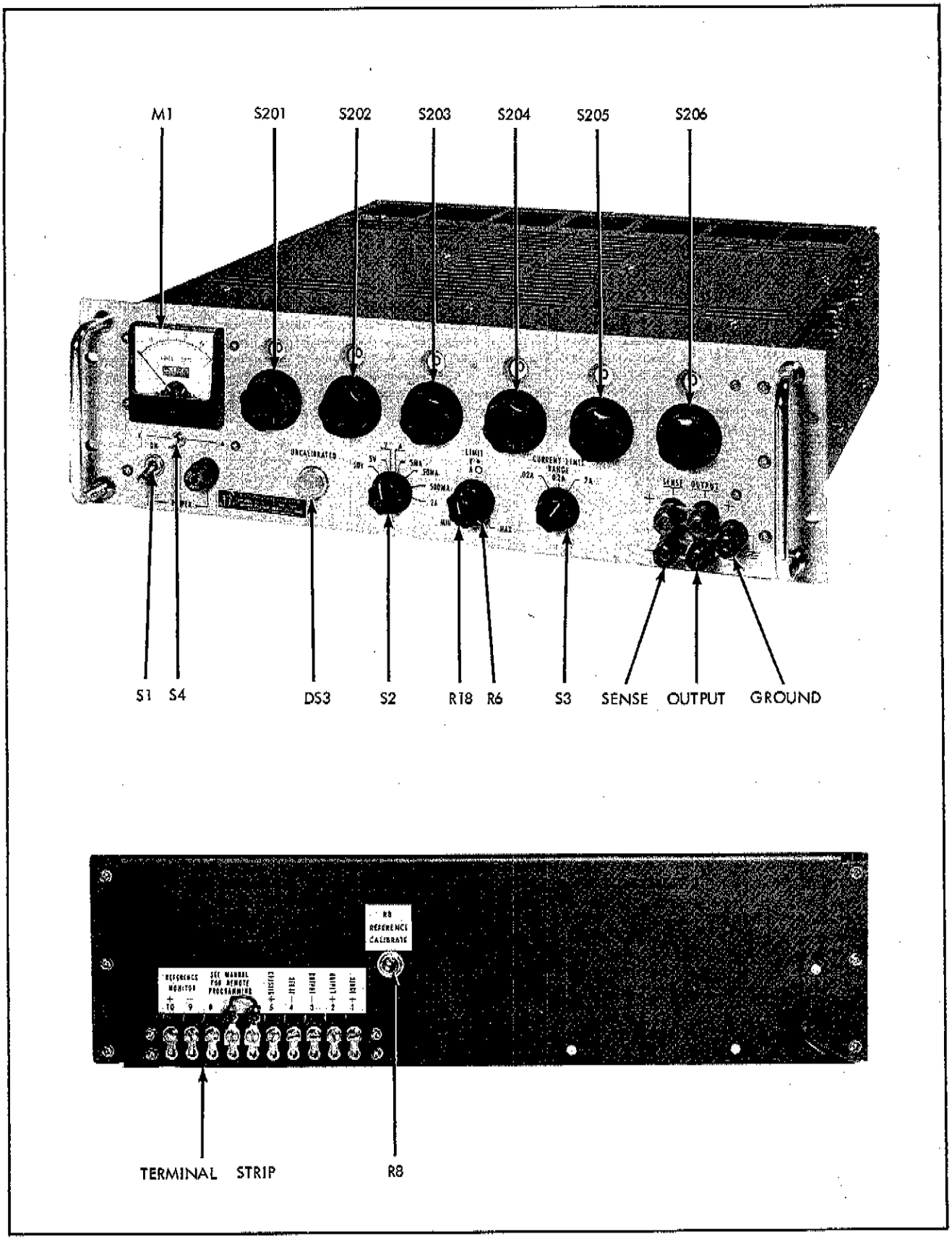


Figure 2-2. LOCATION OF CONTROLS, TERMINALS, & INDICATORS

When it is not necessary to provide initial protection for the equipment connected to the 382A, the current limit should be set as follows:

a. Perform steps b and c of paragraph 2-7.
b. Connect the load to the OUTPUT terminals.
c. Set the controls on the 382A as follows:

CONTROL	POSITION
V-A range	As desired
CURRENT LIMIT RANGE	As desired
Current LIMIT	MAX
Voltage LIMIT	As desired
Decade dials	As desired
Meter switch	As desired
POWER switch	ON

d. Set the maximum current limit by turning the current LIMIT control counterclockwise until the UNCALIBRATED lamp illuminates, and then turning slightly clockwise until the UNCALIBRATED lamp goes out. Limiting will then begin at a current slightly greater than that indicated by the panel meter.

CAUTION

The current limiting circuit cannot protect against large transient currents which may be generated due to a short circuit. The 500 uf output capacitor must discharge before current limiting can be established.

2-16. VOLTAGE LIMIT CONTROL

2-17. The voltage limit control is designed to protect the equipment connected to the 382A from damage which may be caused by excessive load voltage. When it is necessary to protect the load from excessive voltage during turn-on of the power supply, proceed as follows:

a. Perform steps b and c of paragraph 2-7.
b. Set the controls on the 382A as follows:

CONTROL	POSITION
V-A range switch	Any current range
CURRENT LIMIT RANGE	As desired
Current LIMIT	As desired
Voltage LIMIT	Mid-range
Decade dials	As desired
Meter switch	V
POWER switch	ON

c. Open the OUTPUT terminals and set the maximum output voltage limit by adjusting the voltage LIMIT control until the meter indicates the desired voltage. The voltage limit as set here will limit the output voltage in the event of an open circuit. The UNCALIBRATED lamp will illuminate just prior to the start of voltage limiting. The actual limiting value of the load voltage will vary from the selected limit by an amount equal to the voltage drop across the current sampling resistor, which can be a maximum of 5 volts.
d. Proceed with steps f through i of paragraph 2-7.

2-18. The limit voltage may be set more accurately after the load is connected to the instrument. When initial protection of the load is not necessary, it is best to set the voltage limit as follows:

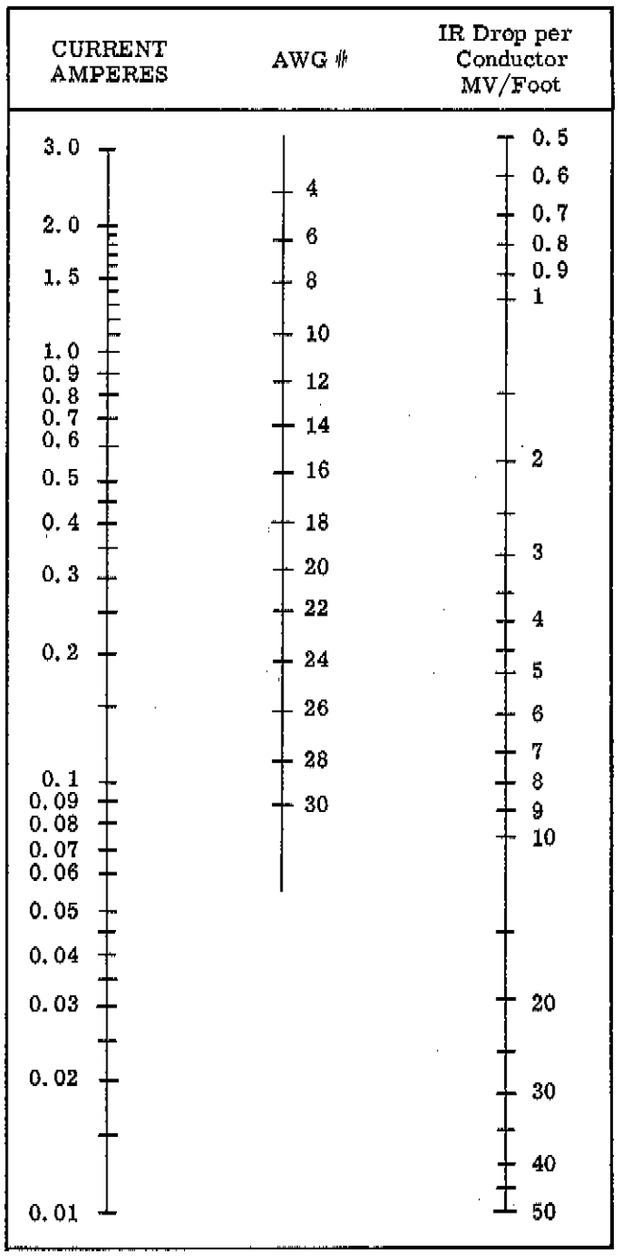


Figure 2-3. NOMOGRAPH OF VOLTAGE DROP IN LOAD LEADS

a. Perform steps b and c of paragraph 2-7.
b. Connect the load to the output terminals.
c. Set the controls on the 382A as follows:

CONTROL	POSITION
V-A range switch	As desired
CURRENT LIMIT RANGE	As desired
Current LIMIT	As desired
Voltage LIMIT	MAX
Decade dials	As desired
Meter switch	As desired
POWER	ON

d. Set the maximum output voltage limit by turning the voltage LIMIT control counterclockwise until the UNCALIBRATED lamp illuminates, and then turn the voltage LIMIT control slightly clockwise until the UNCALIBRATED lamp goes out.

2-19. USE AS AN AUXILIARY VOLTAGE REGULATOR

The 382A may be used to regulate the voltage of another power supply having higher output voltage, but poorer regulation, than the 382A. This is performed as follows:

a. Connect the 382A and the other power supply as shown in Figure 2-4. Diode CR1 limits the voltage of a reverse polarity which would be applied to the 382A in the event of a short circuit across the load, or when the other instrument is turned on first. Fuse F1 is a protective device which opens the circuit if the load becomes shorted, to prevent applying a continuing reverse voltage to the 382A. The rating of fuse F1 should be equal to, or slightly higher than, the rated full-load current of the other power supply. Diode CR1 must be capable of conducting the maximum short-circuit current of the other power supply until fuse F1 opens the circuit. Resistor R1 is an external voltage control resistor, the value of which must be 1000 ohms per volt of the output of the other power supply. Capacitor C1 provides a path for AC voltages, and should be between 1 uf and 5 uf. The value of C1 may be selected to provide the minimum amount of ripple in the combined output.

b. If one of the sense leads of the 382A is opened, the instrument attempts to increase the output voltage. Under this condition the output of the 382A would rise to approximately 75 volts. Diodes CR6 and CR7 are attached near the back panel between the OUTPUT and SENSE terminals to limit the output voltage if the sense leads become opened. However, the presence of these two diodes may prevent the 382A from regulating the output voltage of the combined instruments under certain conditions. Consequently, it is usually desireable to remove these two diodes when the 382A is to be operated as an auxiliary voltage regulator.

c. After the circuit of Figure 2-4 is connected, the 382A is operated in the usual manner. It is usually desireable to set the output voltage of the 382A at its mid-range value. This will provide the maximum range over which the 382A can regulate the combined output voltages.

2-20. CONSTANT CURRENT OPERATION

2-21. Operation of the 382A as a constant current source causes several changes in the internal configuration of the instrument compared to constant voltage operation. Thus, the following items should be noted:

2-22. The + OUTPUT terminal must not be grounded during constant current operation. To do so may cause excessive ripple and/or oscillation in the output.

2-23. During constant current operation of the 382A, if the meter switch is set to the current (A) position, it will be noted that the meter will indicate approximately -1 ma on the 5 ma range at zero output current. This is due to a negative current which is driven through R1, R1001, or R1002 to compensate for sampling string current during constant voltage operation. However, during constant current operation, the sampling string

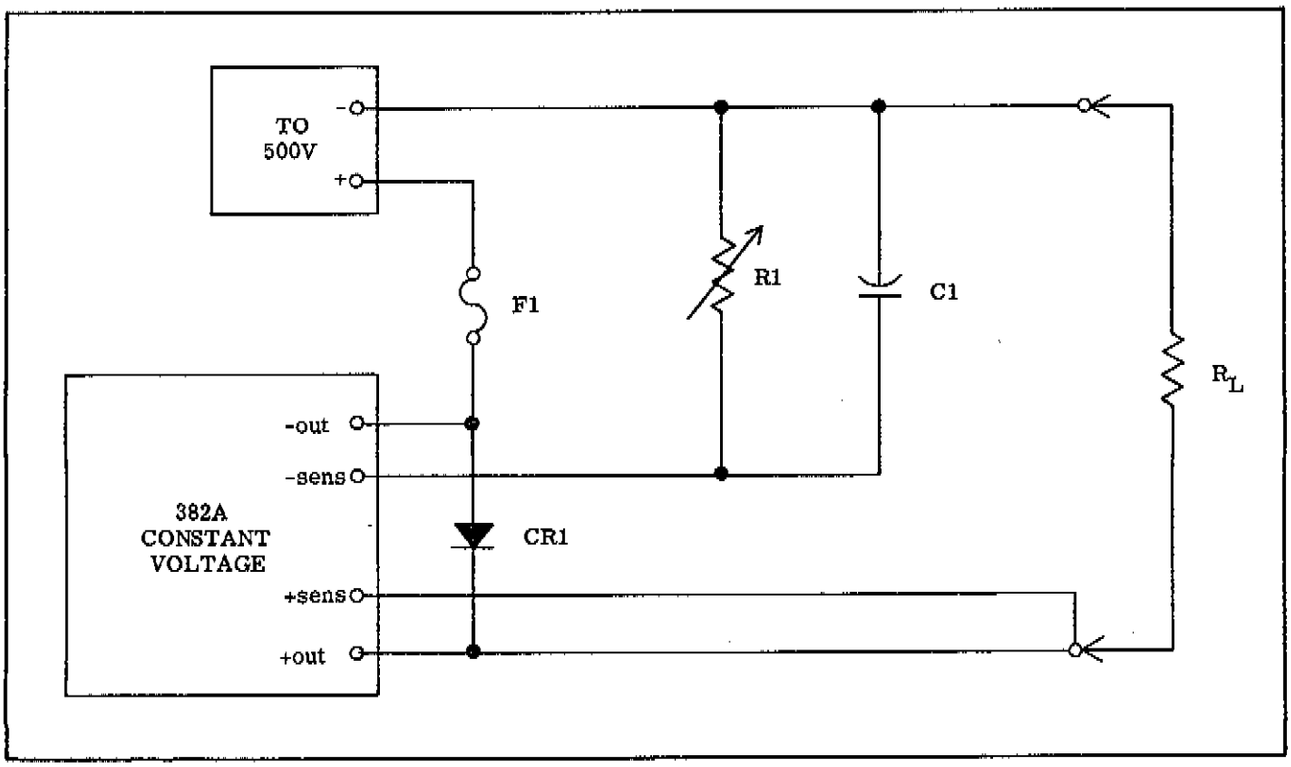


Figure 2-4. AUXILIARY VOLTAGE REGULATOR

current doesn't flow through R1, R1001, or R1002, and consequently, the compensating current causes the meter to read approximately 1 ma low when measuring current. The calibrated front panel controls should be relied upon to indicate the magnitude of the output current.

2-24. When an inductive load is connected to the 382A, there may be a tendancy for the output to oscillate. One way of preventing this is to connect a large electrolytic capacitor across the load; however, this is not recommended, because doing so essentially changes the constant current operation to constant voltage operation. A suitable method of eliminating the oscillation is to connect as large a resistor as possible in series with the load.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. This section of the manual describes the theory of operation of the Model 382A. Reference is made to the functional schematic following Section V. This schematic is intended to aid in troubleshooting, and in understanding the theory of operation. Components enclosed by a dashed line are mounted on the same printed circuit board.

3-3. An abbreviated diagram of the 382A is given in Figure 3-1. Operation of the 382A is described in the following paragraphs.

3-4. The main differential amplifier controls the output voltage or current. As shown in Figure 3-1, one input to the main differential amplifier is connected to the positive bus. The other input is connected at point P, the junction of the voltage/current control resistors R_f

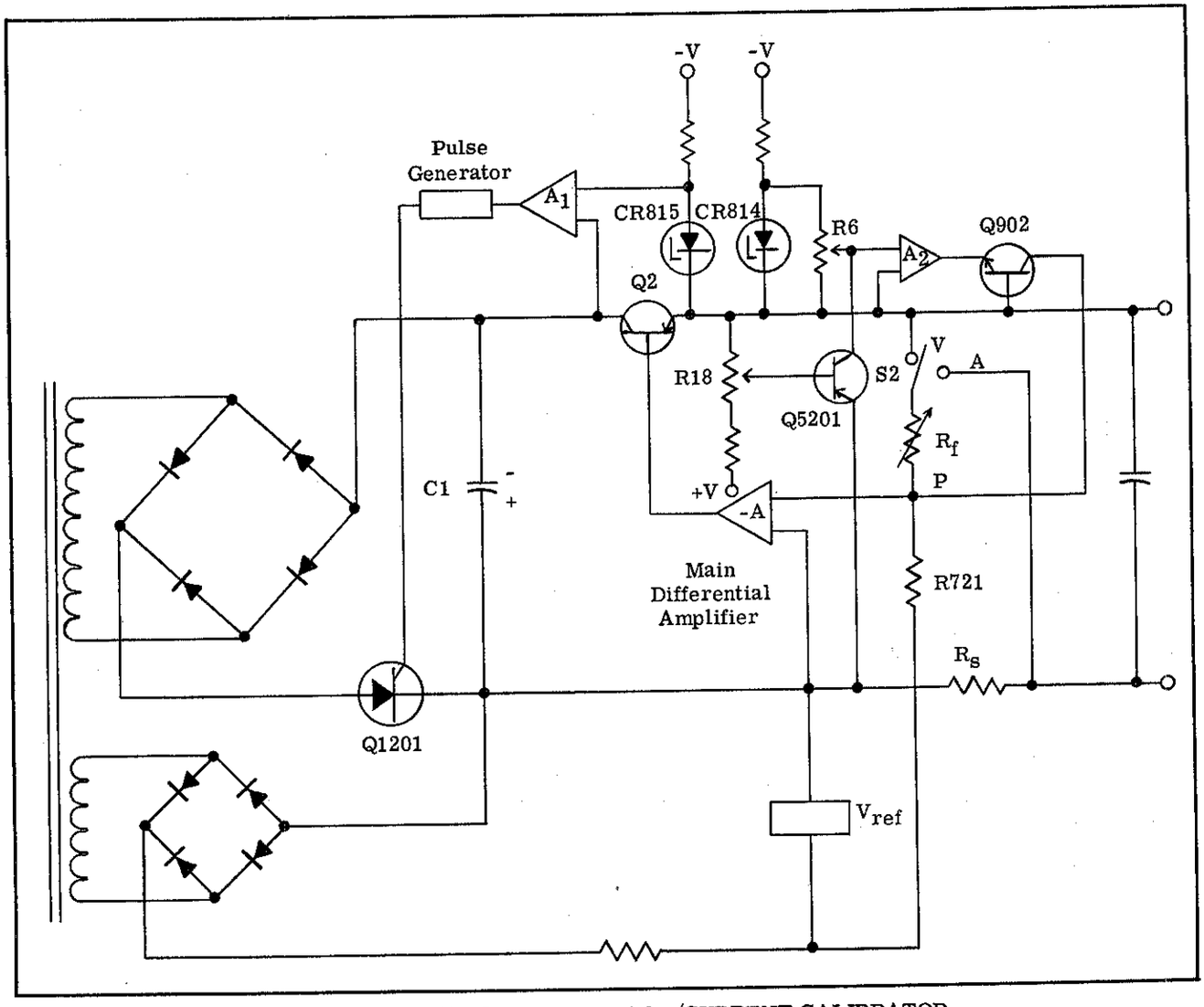


Figure 3-1. MODEL 382A VOLTAGE/CURRENT CALIBRATOR

and the fixed resistor-reference supply combination, R721 and V_{ref}. The tendency of the differential amplifier is to alter the conduction of Q2 so that the potential of the two inputs to the differential amplifier is equal. When switch S2 is in the V position (constant voltage operation), then the differential amplifier tends to hold both inputs at positive bus voltage. Since V_{ref} is constant, the current through R721 is constant, and the current through R_f is also constant. Therefore, the output voltage is equal to the IR drop across R_f, and is directly proportional to R_f. When switch S2 is in the A position (constant current operation), then the differential amplifier tends to equalize the voltage drop across R_s and R_f. Consequently, the output current is a function of the IR drop across R_f, which is directly proportional to R_f. If desired, R_f may be external to the 382A, which provides for remote programming of voltage or current. Also, one terminal of R_f and one terminal of the main differential amplifier may be connected directly to the load for remote sensing.

3-5. The output voltage is controlled by Q2 and the main differential amplifier; however, the voltage into Q2, which is the charge on capacitor C1, is controlled by Q1201, a silicon controlled rectifier. CR801 through CR804 apply rectified, full wave pulses to the anode of Q1201. The conduction angle of Q1201 is controlled by the pulse generator, which is a unijunction transistor oscillator (Q802). The conduction cycle of Q1201 is controlled to maintain the charge on C1 approximately 8 volts above the output voltage, so that approximately 8 volts appear across Q2. If a sudden current drain reduces the charge on C1, then amplifier A_1 causes the pulse generator to produce pulses at a higher frequency, which causes Q1201 to conduct earlier in the cycle, restoring the charge on C1. When a low output voltage is selected, Q1201 conducts later in the cycle, which reduces the power dissipation of Q2 at low output voltages. It should be noted that if the output voltage is suddenly turned to zero with a load connected to the instrument, then the approximate voltage of C1 would appear across Q2. Provision is made for rapidly discharging C1 when the output voltage is suddenly reduced, thus preventing damage to Q2. A description of this function is given in paragraph 3-11.

3-6. Controls are provided on the 382A which will limit the output voltage or current to any value within the range of the instrument. This function is performed as follows: The value of current limit is selected by R6 (refer to Figure 3-1). Transistor Q902 is normally in the non-conducting state. When the output current begins to exceed the selected limit, amplifier A_2 causes Q902 to begin to conduct. This by-passes part of the current from R_f, which reduces the output voltage. The value of voltage limit is selected by R18. When the output voltage begins to exceed the selected limit, Q5201 begins to conduct, which causes Q902 to begin to conduct. This by-passes part of the current from R_f, which reduces the output current. When Q902 is conducting, any increase in the setting of the front-panel readout dials will produce only a minor increase in the actual output voltage or current, because more of the sampling string current will pass through Q902. Consequently, when the voltage/current limiting portion of the circuit is in operation as indicated by the illumination of the UNCALIBRATED lamp, the calibration accuracy of the front-panel dials is no longer valid.

3-7. CIRCUIT DESCRIPTIONS

3-8. Master Voltage Reference (313A-401). The main reference voltage is developed across CR1402. This zener diode is selected and aged to have a stability of better than 25 ppm per 1000 hours. Transistor Q1401 and diode CR1401 form a constant-current source, which provides current for the reference voltage diode and for the voltage monitor circuit. The 1.02 volt reference monitor voltage is developed by R111, which has a constant current of 1 milliampere. R8 is a calibration adjustment with which to compensate for drift due to aging. CR1401, CR1402, Q1401, and R1401 are enclosed in a temperature-controlled oven to prevent any changes in the reference voltage which would otherwise be caused by changes in ambient temperature. Resistors R103, R116, and R117 are used to adjust current through the voltage/current control resistors.

3-9. Main Amplifier (313A-407). The error signal from the junction of R721 and the Voltage/Current Control Resistor Assembly (313A-402) is applied to the input of the main differential amplifier. The base of Q703 is the input path for AC signals: the input path for DC signals is through the chopper amplifier into the base of Q702. (Operation of the chopper amplifier is discussed in the next paragraph.) Providing the separate input path for AC provides more rapid regulation of the output voltage. Q701 and Q708 are current sources for the two stages of the differential amplifier. Use of these current sources provides maximum gain from the differential amplifier. The compound connection of Q702 to Q704, and Q703 to Q705, provides high input impedance and minimizes temperature effects. Feedback capacitor C701 provides frequency compensation of the feedback loop. The output of the amplifier is from the collector of Q706. This signal is applied to the driver amplifier for further amplification.

3-10. Chopper Amplifier (313A-405). The chopper amplifier consists of three cascaded amplifiers. The input is chopped by a 60 cycle chopper, which samples the difference between the actual output voltage and the output voltage set on the front panel decade controls. The amplified control signal is then synchronously rectified by G501 and filtered by R518, C508, and C509. This provides an amplified DC error signal that is proportional to the magnitude and polarity of any error in the output voltage. The amplified error signal is then applied to one input of the differential amplifier. Use of the chopper amplifier decreases the effects of any drift which may occur in the differential amplifier.

3-11. Driver Amplifier (313A-411). The error signal from the differential amplifier is applied to Q1104 and Q1105, which provide additional amplification of the error signal. Q1103 is a common-base amplifier which provides additional voltage gain. The signal is then applied to the parallel transistors Q1102 and Q1108, which control the series passing transistor. The conduction of the series passing transistor varies according

to the load. Q1101 provides a constant current for the collector of Q1103. If the output voltage is suddenly reduced, the voltage drop across Q2 will increase due to the stored charge on C1. If the voltage drop across Q2 exceeds the voltage of the zener diode CR815, then a positive voltage will be applied to the base of Q1106, causing Q1106 to conduct. This causes Q1107 to conduct heavily through R9, thus discharging C1.

3-12. SCR Firing Circuit (313A-408). CR801 through CR804 comprise a full wave bridge rectifier which supplies a pulsating DC voltage to the SCR firing circuit. CR805 clips this pulsating waveform and delivers the resultant to the unijunction oscillator. The unijunction transistor Q802 will conduct whenever the emitter voltage exceeds the base-to-base voltage by a fixed ratio. C802 and R804 in parallel with Q803 form an R-C charging circuit which determines the emitter voltage of Q802. When the voltage of C802 exceeds the emitter-to-base voltage of Q803, Q803 will conduct, and an output pulse will appear across R803. This pulse is amplified by Q804 and applied through T801 to the gate of Q1201. The charging time of C802 may be varied by controlling the collector current of Q803. Any difference in voltage drop across CR815 and Q2 is detected by Q803, which controls the firing time of Q1201 to reduce the voltage difference to zero.

3-13. SCR Bridge Assembly (313A-412). Lamps DS1 and DS2 limit the voltage applied to the bridge for protection of the semiconductors. CR1201 through CR1204 apply full-wave, rectified, unfiltered DC pulses to the anode of Q1201. Q1201 conducts during a portion of each pulse, the angle at which conduction begins being determined by the timing of the pulse from the unijunction oscillator. When output power requirements are minimum, the unijunction pulse appears near the end of the rectifier conduction cycle; when output power requirements increase, the pulse appears earlier in the rectifier conduction cycle, thus maintaining a constant voltage drop across Q2.

3-14. Voltage/Current Control (313A-402). The voltage/current control resistors are connected between one differential amplifier input terminal and the - SENSE terminal. The junction of the output control string with the differential amplifier and master voltage reference is maintained at positive bus potential by the differential amplifier and series passing transistor. The current through the output control string is constant at 1 milliampere on the 50 volt range, and 0.1 milliampere on all other ranges. Since the output voltage/current is dependent upon the IR drop across the control resistors, the stability and accuracy of the resistors used is very important, particularly in the higher resistance values. For this reason, special Fluke wirewound resistors are used which have been matched for resistance accuracy and temperature coefficient, and have been designed for excellent long term stability.

3-15. Overcurrent Limit/Indicator (313A-409). Q903 and Q904 form a differential amplifier, one input of which is fixed. Resistor R6 is used to set the limiting value of current by adjusting the bias of Q904. Q905 is the current source for the differential amplifier. R922, R923, and thermistor R924 provide temperature compensation for the current source. When the pre-set value of output current begins to be exceeded, as sensed by the current shunts R1, R1001, or R1002, the output from the collector of Q904 turns on Q902, which diverts the sampling string current and reduces the output voltage. The collector of Q903 turns on Q901, which illuminates the UNCALIBRATED lamp (DS3).

3-16. Overvoltage Limit/Indicator (382A-452). The base of Q5201 is connected to R18, which is connected between the negative output bus and a positive voltage source. R18 is used to set the limiting value of voltage. As long as the selected value of voltage is not being exceeded, Q5201 is biased off; however, when the selected voltage limit begins to be exceeded, Q5201 begins to conduct. This causes Q902 to begin to conduct, which has the same effects as described in the preceeding paragraph.

3-17. Voltmeter-Ammeter Circuit (313A-410). Switch S2 selects the correct value of series dropping resistor according to the selected voltage range. Switch S3 selects the correct value of meter shunt and current limiting shunt resistance according to the selected current range.

3-18. Auxiliary DC Voltage Supplies (313A-403 and 313A-404). CR301 through CR304, C301, C302, and R301 provide filtered, unregulated DC voltage. Q304 and Q305 form a differential amplifier. The base of Q305 is connected to zener diode CR307, which is the source of reference voltage. The base of Q304 is connected to a voltage divider which samples the output voltage. Any error in the output voltage results in an error signal from the collector of Q304, which is applied to the base of Q303. Since the current gain from the base of Q303 to the collector of Q302 is 1200 minimum, a small error signal causes an appreciable change in the conduction of Q302, which restores the output voltage to its initial value. The operation of the -15VDC supply is identical to the operation of the +25VDC supply, except that voltage polarities are reversed.

3-19. Overshoot Protection. Relay K1 is connected across rectifiers CR201 through CR204. When line power is removed from the instrument, K1 is de-activated. Contacts K1B connect R5 across the output of the instrument, which limits any overshoot that may occur. Contacts K1A connect R10 across capacitor C1, which provides a discharge path for C1.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. Maintenance of the 382A Voltage/Current Calibrator is discussed in this section of the manual. Preventive maintenance is discussed in paragraph 4-4. A discussion of troubleshooting and a troubleshooting chart are presented in paragraphs 4-5 through 4-10. Calibration procedure and the equipment necessary are presented in paragraphs 4-11 through 4-25.

4-3. PREVENTIVE MAINTENANCE

4-4. Preventive maintenance consists primarily of occasional cleaning to remove dust. If desired, the instrument may be cleaned with a rag saturated with anhydrous denatured ethyl alcohol. The voltage control resistors are protected by a dust cover, which should not be removed. Because of the high accuracy of the voltage control resistors (R201 through R229), they should not be touched, nor bent.

4-5. TROUBLESHOOTING

4-6. The 382A is provided with a test adapter which facilitates troubleshooting. The test adapter may be inserted between the printed circuit boards and the chassis connector. The test adapter provides voltage test points and current loops for monitoring current through the use of clip-on current probes. Using a milliammeter in a transistor circuit will change the bias of the transistor, and is not a satisfactory method of measurement.

4-7. When measuring voltages on the printed circuit boards, it is recommended that the major portion of the voltage probe be wrapped with insulating tape. This will reduce the possibility of damaging a transistor due to an accidental short-circuit to a high-voltage component. Transistors in the 382A are mounted to the circuit boards by use of transistor sockets. This is an aid to measuring voltages, as well as providing easy removal of the transistor for testing.

4-8. Figure 4-1 is a table of various failures and their probable causes. Reference to Figure 4-1 will occassionally indicate the cause of a failure. Components may be located by referring to Section V. Figure 4-2 is a table of the pin voltages of the transistors in the 382A. Figure 4-2 may be used in conjunction with Figure 4-1, or in conjunction with the following paragraphs.

4-9. A list of equipment required for troubleshooting is given in Figure 4-4. The following procedure can be used to locate the general area of a malfunction.

a. Visually inspect the interior of the instrument for burned parts, broken wires, loose transistors, or loose circuit boards.

b. Check the SCR regulator loop for proper operation as follows:

(1) Remove the 313A-411 printed circuit board.

(2) Connect positive lead of 881A voltmeter to terminal 1 of the 382A-452 circuit board.

(3) Connect common lead of voltmeter to terminal V of the 313A-408 circuit board.

(4) Set POWER switch to ON. Voltmeter should indicate approximately 8 volts.

c. Check the auxiliary voltage supplies for proper operation by measuring the voltages in Figure 4-3.

d. Check the reference voltages as follows:

(1) Connect the voltmeter to terminals 9 and 10 on the rear terminal strip. The voltmeter should indicate 1.02 volts.

(2) Connect positive lead of voltmeter to terminal V of circuit board 313A-401. Connect voltmeter common lead to + SENSE. Voltmeter should indicate +6.0 volts.

(3) Connect positive lead of voltmeter to terminal T of circuit board 313A-401. Connect voltmeter common lead to + SENSE. Voltmeter should indicate +0.6 volts.

e. Check the operation of the chopper and control circuits as follows:

(1) Remove circuit boards 313A-411 and 313A-408.

(2) Place the test adapter between printed circuit board 313A-407 and the chassis connector.

(3) Connect the positive lead of the 881A to terminal B of the test adapter. Connect the common lead of the voltmeter to the + SENSE terminal. The 881A should indicate 2.5 volts minimum.

(4) Connect the positive lead of the DC power supply to the + OUTPUT terminal, and connect the common lead to the - OUTPUT terminal. Set the external power supply and 382A for 10 volts output.

(5) Vary the external power supply voltage around the 10 volt level, and observe a change in the voltage indicated by the 881A of -2.5V to +2.5V minimum.

(6) Connect the positive lead of the 881A to terminal T of the test adapter, and connect the common lead of the 881A to the + SENSE terminal.

(7) Adjust the voltage of the external power supply from 9 volts to 11 volts, approximately, and observe that the 881A indicates a change in the same direction.

SYMPTOM	PROBABLE CAUSE	REMEDY
No output	Blown power fuse	Check fuse F1 and replace if necessary.
Constant percentage error in output voltage or current	Improper calibration	Re-calibrate according to paragraph 4-4.
	Change in reference voltage	Check 1.02V reference voltage at terminals 9 and 10 on rear terminal strip.
	Leaky C201	Test and replace if necessary.
Percentage error over part of voltage or current range	Defective wirewound resistor in one of the voltage selector switches.	Set output voltage to a maximum and decrease one position at a time until the error disappears. The defective resistor will be found at the last switch position in which the error was noted.
Output erratic over part of range	Same as percentage error over part of range	
	Defective voltage selector switch (S201 through S206)	Carefully replace switch.
Output voltage or current suddenly rises above selected value	Shorted Q2, Q1101, Q1102, or Q1108	Test and replace if necessary
	Open sample resistor or switch	Remove jumper between terminals 6 and 7 on rear terminal strip, and connect an ohmmeter between terminals 4 and 6. Measure the resistance of the sampling string and compare to the schematic diagram.
Loss of control	Open R723	Test and replace if necessary.
Poor line regulation	Incorrect voltage from auxiliary supplies	Measure output voltage of auxiliary -15V, -20V, and +25V supplies. Repair if necessary.
	Change in reference voltage	Check reference voltage at terminals 9 and 10 on rear terminal strip.
Poor load regulation	Defective component on 313A-405 board	Check and repair as necessary.
	Incorrect SENSE connections	Check connections of SENSE leads to the load.
Oscillation in output	Incorrect adjustment of R1116	Refer to paragraph 4-20.
	Defective component of 313A-407 board	Test and repair as necessary.
	Oscillation in auxiliary supplies	Test and repair if necessary.
Excessive drift	Auxiliary +25V supply voltage too high	Test and repair as necessary.
	Defective Q1401, CR1401, or CR1402	Test and replace if necessary.

Figure 4-1. TROUBLESHOOTING CHART (sheet 1 of 2)

SYMPTOM	PROBABLE CAUSE	REMEDY
Excessive ripple	Excessive ripple in auxiliary supplies.	Test and repair auxiliary supplies.
	Defective component on 313A-407 board	Test and repair as necessary.
Fuse blows repeatedly	Shorted C6 or C7	Test and replace if necessary.
	Shorted Q1106, Q1107, or CR1206	Test and replace if necessary.
	Defective relay K1	Test and replace if necessary.

Figure 4-1. TROUBLESHOOTING CHART (sheet 2 of 2)

f. Check the operation of the CURRENT LIMIT RANGE and CURRENT LIMIT controls as follows:

(1) Set CURRENT LIMIT RANGE to . 02A.
(2) Set the meter range switch to A.
(3) Set the decade controls to 000000.
(4) Connect an 8. 2K, 10%, 1W resistor across the OUTPUT terminals.
(5) Set CURRENT LIMIT to mid-range.
(6) Set the decade controls so that the panel meter indicates 5 milliamperes (approximately 41 volts).
(7) Reduce the CURRENT LIMIT control until the UNCALIBRATED lamp illuminates.
(8) Parallel the 8. 2K resistor with a 100 ohm, 5%, 1/2W resistor. The panel meter should indicate 7. 5 milliamperes or less. Remove both resistors.
(9) Set the CURRENT LIMIT RANGE control to 0, 2A.
(10) Set decade controls to 000000.
(11) Connect a 2. 2K, 10%, 2W resistor across the OUTPUT terminals.
(12) Set the CURRENT LIMIT control to mid-range.
(13) Set the decade controls so that the panel meter indicates 20 milliamperes, (approximately 44 volts).
(14) Reduce the CURRENT LIMIT control until the UNCALIBRATED lamp illuminates.
(15) Parallel the 2. 2K resistor with a resistor of 100 ohms, 5%, 1/2W. The panel meter should indicate less than 35 milliamperes. Remove both resistors.
(16) Set the CURRENT LIMIT RANGE to 2A.
(17) Set the decade controls to 000000.
(18) Connect two 470 ohm, 10%, 2W resistors in parallel across the OUTPUT terminals.
(19) Set the CURRENT LIMIT control to mid-range.
(20) Set the decade controls so that the panel meter indicates 200 milliamperes (approximately 47 volts).
(21) Reduce the CURRENT LIMIT control until the UNCALIBRATED lamp illuminates.
(22) Parallel the two 470 ohm resistors with a 10 ohm, 10%, 2W resistor. The panel meter should indicate less than 350 milliamperes.
(23) Remove the three resistors and set the POWER switch to off.

g. Operation of the VOLTAGE LIMIT control can be checked as follows:

(1) Set the VOLTAGE LIMIT control to mid-range.
(2) Set the V-A switch to 5 ma.
(3) Connect a 10K, 5%, 1/2W resistor across the OUTPUT terminals.
(4) Connect the 881A to the OUTPUT terminals.
(5) Set the decade controls to 4. 000000 ma.
(6) Set POWER switch to ON.
(7) Set the VOLTAGE LIMIT to a minimum. The 881A should indicate that the output voltage decreases to below 5 volts.

4-10. The following paragraphs are tests which can be performed on the 382A to determine correct operation of the instrument, and/or aid in troubleshooting.

a. AUXILIARY SUPPLY VOLTAGES

(1) Place the test adapter between printed circuit board (PCB) 313A-407 and the chassis connector.
(2) Set the POWER switch to ON.
(3) Connect the positive lead of the 881A to terminal U of the test adapter, and connect the negative lead of the 881A to the + SENSE terminal. The 881A should indicate -15 (±0. 5) volts.
(4) Connect the positive lead of the 881A to terminal M of the test adapter. The 881A should indicate +25 (±0. 5) volts.

b. DIODE CHECK, SENSE TERMINALS

(1) Set the POWER switch to the off position, and remove the shorting links between the SENSE and OUTPUT terminals.
(2) Connect the positive lead of the Simpson 260 to the + OUTPUT terminal, and connect the negative lead of the Simpson 260 to the + SENSE terminal. The Simpson should indicate between 5 ohms and 25 ohms. Reverse the leads and observe a resistance greater than 1, 000 ohms.

TRANSISTOR	V_E	V_B	V_C	TRANSISTOR	V_E	V_B	V_C
Q2	-10.4	-10.5	-20.5	Q707	15.0	14.6	0.6
Q301	41.8	41.5	27.0	Q708	19.0	18.5	15.0
Q302	25.5	26.0	42.5	Q802	B_1	B_2	E
Q303	26.0	26.8	42.5		-64.0	-70.0	-64.5
Q304	8.8	9.5	27.0	Q803	-53.5	-53.1	-64.5
Q305	9.0	9.8	25.5	Q804	-69.2	-69.0	-51.0
Q401	-25.4	-25.2	-16.0	Q901	-42.0	-43.8	+79.0
Q402	-26.0	-25.8	-16.0	Q902	-41.0	-41.5	0.0
Q403	-16.5	-16.0	-25.5	Q903	-41.4	-41.0	-43.8
Q404	-9.6	-10.0	-16.0	Q904	-40.8	-41.0	-40.8
Q405	-9.2	-9.5	-26.0	Q905	-36.2	-36.3	-40.5
Q501	0.2	1.0	17.0	Q1101	-49.6	-49.1	-41.4
Q502	17.0	16.5	0.2	Q1102	-10.4	-10.7	-20.5
Q503	0.2	0.8	14.5	Q1103	+0.2	0.0	-10.8
Q504	14.8	14.5	0.2	Q1104	10.2	10.1	0.2
Q505	7.0	7.1	17.8	Q1105	0.2	0.7	10.2
Q701	-5.0	-4.5	-1.0	Q1106	-20.6	-20.8	-0.1
Q702	-1.0	-0.1	+15.0	Q1107	-0.2	-0.1	-20.7
Q703	-0.8	-0.2	+15.0	Q1108	-10.5	-10.8	-20.6
Q704	15.0	14.8	-0.8	Q1201	0.0	0.0	A
Q705	15.0	14.5	-0.8				+68.0
Q706	15.0	14.6	0.6				

This chart is to be used under the following conditions:

(a) Output voltage set to 40V.

(b) No load connected to the instrument.

(c) Output polarity: negative (+ grounded).

(d) All measurements made with VTVM from chassis ground to specified terminal.

(e) These voltages may vary as much as 20% between instruments; however, the difference between V_E and V_B should be approximately as shown.

Figure 4-2. TRANSISTOR VOLTAGE CHART.

CONNECT VOLTMETER POSITIVE LEAD TO	CONNECT VOLTMETER COMMON LEAD TO	VOLTMETER INDICATION
Terminal U of 313A-407 circuit board	+ SENSE	- 15 volts
Terminal M of 313A-407 circuit board	+ SENSE	+ 25 volts
Terminal T of 313A-411 circuit board	- OUTPUT	+ 100 volts
Terminal R of 313A-409 circuit board	- OUTPUT	- 20 volts
Terminal A of 313A-409 circuit board	- OUTPUT	+ 70 volts
Terminal C of 313A-411 circuit board	- OUTPUT	- 10 volts
Terminal S of 313A-411 circuit board	+ OUTPUT	+ 18 volts

Figure 4-3. VOLTAGES OF AUXILIARY SUPPLIES

(3) Connect the positive lead of the Simpson 260 to the - SENSE terminal, and connect the negative lead to the - OUTPUT terminal. The Simpson should indicate between 5 ohms and 25 ohms. Reverse the leads and observe a resistance greater than 1,000 ohms.

c. OPERATION OF CROWBAR CIRCUIT

(1) Connect the negative lead of the Simpson 260 to terminal E of the 313A-411 printed circuit board. Connect the positive lead to terminal A of the 313A-411 printed circuit board. Set the Simpson to the 50V range.

(2) Set the POWER switch to ON.

(3) Set the DC VOLTS controls to 40.0000.

(4) Observe that the Simpson deflects briefly at each position, as the decade controls are reduced in steps of 10 volts. The meter should deflect only when changing the output voltage, and not during steady-state conditions.

d. ABSENCE OF TRANSIENTS

(1) Connect the oscilloscope to the OUTPUT terminals. Set oscilloscope sweep speed to 0.5 sec/cm, and set vertical sensitivity to 0.5 volts/cm, with DC coupling.

(2) Set decade controls to zero.

(3) Alternately set the POWER switch to ON and off. Transients indicated by the oscilloscope should not exceed ±1.00 volts.

e. 500 VOLT ISOLATION

(1) Connect a one megohm resistor in series with the negative output of the 407D DC Power Supply. Connect the resistor to the - OUTPUT terminal. Connect the positive power supply terminal to the 382A chassis ground terminal.

(2) Using the line cord adapters furnished with the 382A and the 407D, isolate the chassis of both instruments from line ground.

(3) Remove the shorting links from the 382A.

(4) Connect the 881A voltmeter across the one megohm resistor.

(5) Set the POWER switch to ON.

(6) Turn on the 407D, and set to 500 volts output.

(7) The 881A should indicate less than 0.5 volts.

NOTE

One hour warm-up is required before the following tests are performed.

f. LINEARITY TEST

(1) Connect the 881A to the 382A OUTPUT terminals.

(2) Set the 881A to 0 volts and 0.001 null range.

(3) Set decade controls to 000000.

(4) Set the V-A switch to 50V.

(5) Set POWER switch to ON. Also, apply power to the 881A.

(6) Simultaneously adjust the first decade control and the 881A "A" control in ten-volt increments. The 881A should indicate the following voltages:

VOLTAGE POSITION	VOLTAGE MEASURED
10 volts	10 (±0.001) volts
20 volts	20 (±0.002) volts
40 volts	40 (±0.004) volts

(7) Set decade controls to zero, and turn the 881A controls to zero.

(8) Simultaneously adjust the second decade control and the 881A "B" control in one-volt increments. The 881A should indicate the following voltages:

VOLTAGE POSITION	VOLTAGE MEASURED
1 volt	1 (±0.0001) volt
2 volts	2 (±0.0002) volts
4 volts	4 (±0.0004) volts
6 volts	6 (±0.0006) volts
8 volts	8 (±0.0008) volts

(9) Set the decade controls to zero, and set the 881A controls to zero.

g. LINE REGULATION-CONSTANT VOLTAGE OPERATION.

(1) Set the V-A switch to the 50 volt range.

(2) Set the output voltage to 50 VOLTS.

(3) Connect the 382A to the Variac, and adjust the Variac for 115 VAC output.

(4) Connect a series combination of the galvanometer and the standard cell bank to the standard cell terminals of the voltage reference divider, and set the divider for the correct standard cell voltage.

(5) Connect the 382A SENSE terminals to the 50 volt terminals of the voltage reference divider.

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED
Simpson #260, or equivalent	Ohmmeter
Variac, or autotransformer	100-to-130 VAC, 5 amperes
Oscilloscope, Tektronixs 543 with type L plug in, or equivalent	Minimum of 0.5 sec/cm sweep speed, and 0.5 volts/cm vertical sensitivity
Voltmeter, Fluke 881A	0.01% accuracy, 100uv null detector
Load Resistor Bank	2 ampere capacity
Resistors	1M ±10%, 1/2W 100K ±10%, 1/2W 8.2K ±10%, 1W 100Ω ±5%, 1/2W 2.2K ±10%, 2W 470Ω ±10%, 2W 10Ω ±10%, 2W 10K ±5%, 1/2W 1K ±5%, 3W 100Ω ±10%, 30W
True RMS voltmeter, Fluke 910A	Capacility to measure non-sinusoidal waves
DC power supply, Fluke 407D	0 to 500 VDC
Preamplifier, AC to AC, Tektronix 123	Gain of approximately 20 db, less than 3 uv noise. Battery powered.
Resistors, wirewound, non-inductive, shielded	100Ω ±1%, 1/2W 10Ω ±1%, 1/2W 1Ω ±1%, 1/2W 0.25Ω ±1%, 2W
Resistors, variable	0-10,000Ω, +0/-5%, 1/2W 0-1,000Ω, +0/-5%, 3W 0-100Ω, +0/-5%, 30W 0-25Ω, +0/-5%, 110W
Precision 4-terminal shunts, with minimum short term stability of 0.0003%	200Ω ±.5%, 1/2W 20Ω ±.5%, 1/2W 2Ω ±.5%, 1W 0.5Ω ±.5%, 5W
Enclosed Standard Cell, Julie SCO-106	Accuracy of 0.0002%
Microvolt source, Fluke Model 831A	Variable source of approximately 19 mv
Null detector, Fluke Model 845A	Input impedance of 1M, or greater

Figure 4-4. EQUIPMENT REQUIRED FOR TROUBLESHOOTING

(6) Set the POWER switch to ON, and adjust the resistor bank for 2 amperes load current. Record the voltage indicated by the galvanometer.

(7) Reduce the Variac output to 100 VAC. The galvanometer should indicate less than 0.00025 volts change from step (6).

(8) Return the Variac to 115 VAC output. Record the voltage indicated by the galvanometer.

(9) Increase the Variac output to 130 VAC. The galvanometer should indicate less than 0.00025 volts change from step (8).

(10) Disconnect the resistor bank from the OUTPUT terminals and repeat the measurements of steps (6) through (9).

h. LINE REGULATION-CONSTANT CURRENT OPERATION

(1) Connect the 382A to the Variac, and set the Variac to 100V output.

(2) Connect the test equipment as in Figure 4-5, omitting resistor R1 from the circuit. Use the 200 ohm shunt for R2. The connecting wires should be pure copper.

(3) Set the V-A switch to 5ma.

(4) Set the decade controls to zero.

(5) Set the POWER switch to ON.

(6) Set the 845A to an open position.

(7) Set the decade controls to 4.999910.

(8) Set the reference emf controls on the 831A to 19mv.

(9) Set the 845A to the 0.5V range. Increase the sensitivity of the 845A to 50uv, adjusting the reference emf controls on the 831A as necessary to maintain meter null.

(10) Vary the output voltage of the Variac from 100V to 115V. The null detector indication should change by less than ±5uv.

(11) Vary the output voltage of the Variac from 115V to 130V. The null detector indication should change by less than ±5uv.

(12) Repeat steps (9) through (11) with the shunt resistance values given in the table below.

WARNING

Before changing shunts, set the 845A to an open position, to prevent current drain from the standard cell, and set the CURRENT LIMIT control to zero (CCW) to prevent an overload on the shunt.

382A RANGE	R2-SHUNT	TOLERANCE
50 ma	20 ohms	0 ±5uv
500 ma	2 ohms	0 ±5uv
2 amp	0.5 ohms	0 ±5uv

i. LOAD REGULATION-CONSTANT CURRENT OPERATION

(1) Connect the 382A to the Variac, and set the Variac output to 115V.

(2) Set the decade controls to zero.

(3) Connect the test equipment as in Figure 4-5. Use the 200 ohm shunt for R2, and the 0-10,000 ohm variable resistor for R1. The connecting wires should be pure copper.

(4) Set the POWER switch to ON.
(5) Set the V-A switch to 5ma.
(6) Set the decade controls to 4. 999910.
(7) Set the 845A to the 0. 5V range. Increase the sensitivity of the 845A to 50uv, adjusting the reference emf controls on the 831A as necessary to maintain meter null, with R1 set to zero. Then set the 845A to an open position.
(8) With the 845A in an open position increase R1 from 0 to the maximum value given in the table below.
(9) After 10 seconds, return the 845A to 50uv. The 845A should indicate within ±10uv of null.
(10) Perform steps (7) through (9) for each of the resistance values given in the table below. Observe the Warning in step h. (12).

382 RANGE	R1-LOAD	R2-SHUNT	TOLERANCE
5 ma	0-10,000 ohms	200 ohms	0 ±10uv
50 ma	0-1,000 ohms	20 ohms	0 ±10uv
500 ma	0-100 ohms	2 ohms	0 ±10uv
2 amp	0-25 ohms	0. 5 ohms	0 ±10uv

j. LOAD REGULATION-CONSTANT VOLTAGE OPERTION.
(1) Connect the 382A to the Variac, and set the Variac to 115 VAC output.
(2) Measure the output voltage of the 382A by connecting the combination of a galvanometer, a standard cell bank, and a voltage reference divider to the SENSE terminals, as in paragraph 4-9g.
(3) Set the output voltage to 50 volts.
(4) Set the POWER switch to ON, and adjust the resistor bank for 2 amperes load current.
(5) Alternately connect and disconnect the load by switching a 100K resistor in series with the load. The galvanometer should indicate less than 0. 00025 volts change in the output voltage.

k. RIPPLE
(1) Remove the shorting link between the OUTPUT terminal and the chassis ground terminal.
(2) Connect the 382A as in Figure 4-6a. All connecting leads must be coaxial cable.
(3) Set the POWER switch to ON.
(4) Set the decade controls to 49. 99910V.
(5) Adjust the resistor bank for a load current of 2 amperes.
(6) Measured RMS ripple should be less than 0. 00005 volts.
(7) Disconnect the resistor bank.
(8) Measured RMS ripple should be less than 0. 00005 volts.
(9) Connect a non-inductive precision shunt of 100 ohms resistance across the OUTPUT terminals as in Figure 4-6b. The resistor must be shielded.

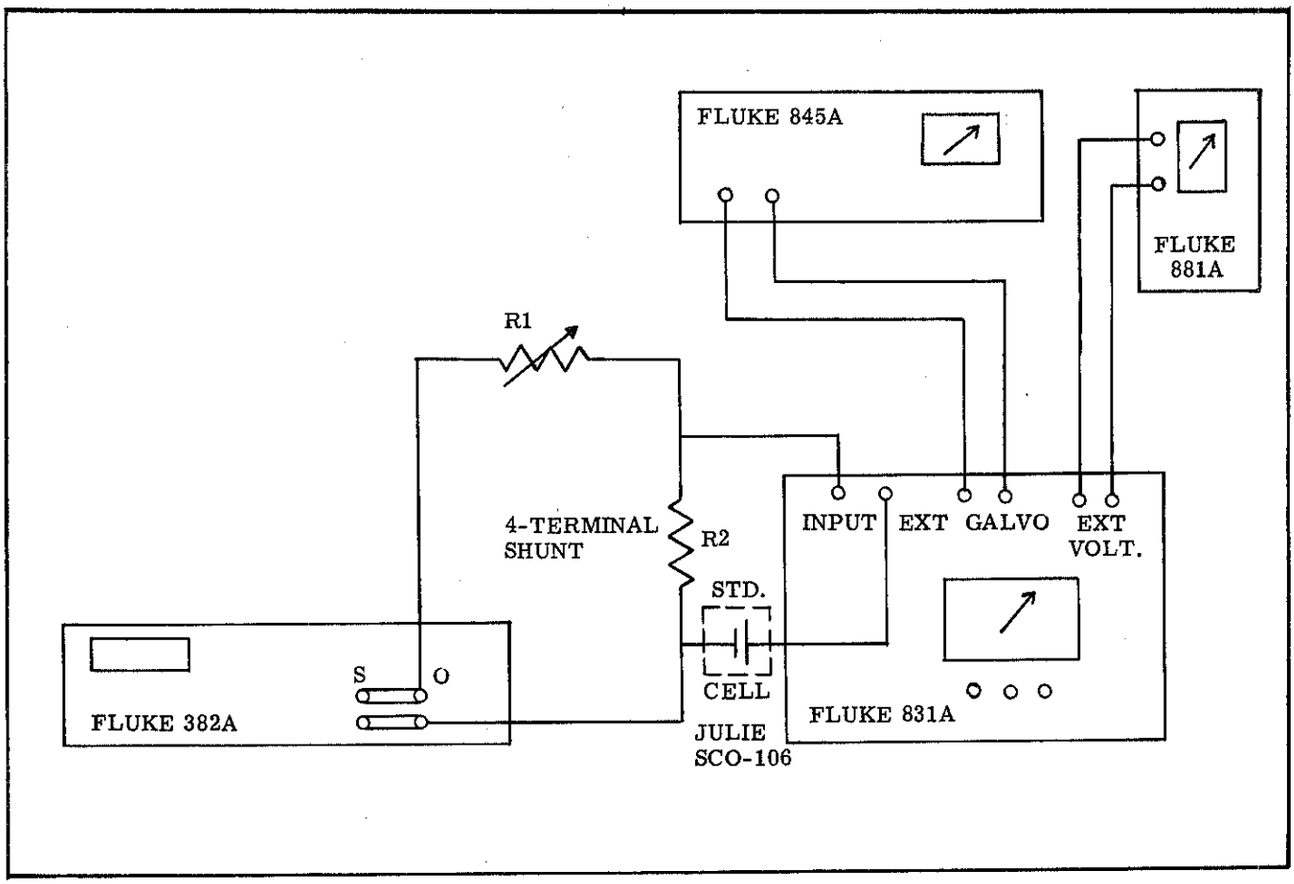


Figure 4-5. CONNECTIONS FOR LOAD REGULATION - CONSTANT CURRENT OPERATION.

(10) Connect the 910A across the SENSE terminals. Use a pre-amplifier with the 910A.

NOTE

First connect 910A and amplifier to each shunt without connecting the 382A and determine system noise. Subtract this value from measurements obtained with 382A connected to the circuit to determine ripple of the 382A.

(11) Set the V-A switch to 5 ma.
(12) Set the decade controls for 5 ma output current.
(13) The 910A should indicate less than 0.00001 volts RMS ripple due to the 382A.
(14) Repeat steps (9) through (13) using the ripple tolerances and approximate resistance values given below:

Output Current	Shunt Resistance	Measured Ripple
50 ma	10 ohms	0.00001 volt RMS
500 ma	1 ohm	0.00001 volt RMS
2 amperes	0.25 ohms	0.00001 volt RMS

4-11. CALIBRATION

4-12. INTRODUCTION

4-13. The 382A should be checked every 30 days. Calibration should be performed in a draft-free area having an ambient temperature of 72 (±3)°F. The equipment required is shown in Figure 4-7. Calibration adjustments may be located with the aid of Figure 4-8. The test adapter is located on the left rear panel of the instrument.

4-14. PRELIMINARY PROCEDURE

a. Remove the top cover of the 382A.
b. Set POWER switch to ON, and allow the 382A to warm to equilibrium temperature for at least one hour.
c. Turn on all test equipment and allow it to warm to equilibrium temperature.

4-15. CURRENT LIMIT ADJUSTMENT

a. Set the 382A POWER switch to off, and place the test adapter between board 313A-409 and the chassis connector.
b. Set the controls on the 382A as follows:

CONTROL	POSITION
CURRENT LIMIT RANGE	0.2A
Current LIMIT	MIN.
Decade dials	0.00000
V-A range	50V
POWER	ON

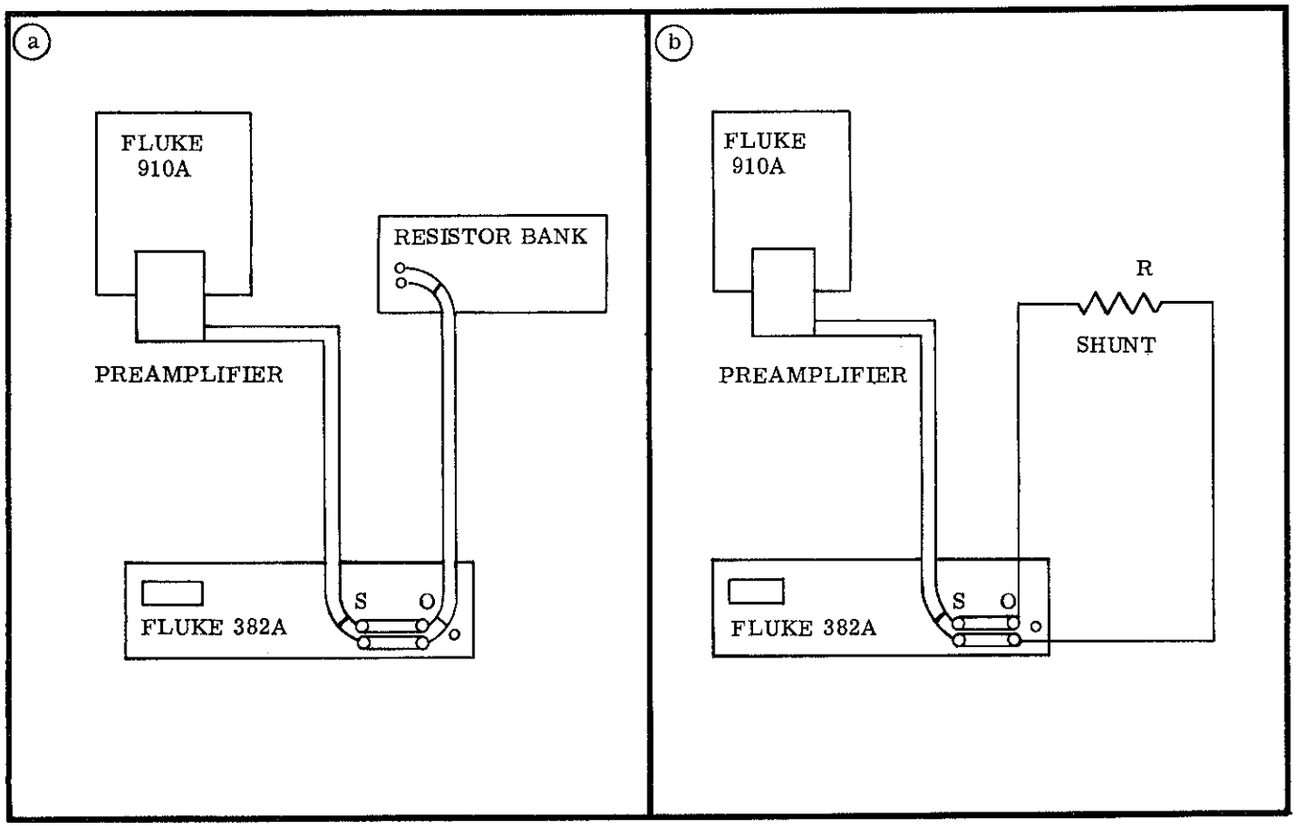


Figure 4-6. CONNECTIONS FOR RIPPLE MEASUREMENT

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED
Saturated standard cell bank with an accuracy of ±0.001% Voltage reference divider having 5 and 50 volt terminals with an accuracy of ±0.001% Galvanometer suitable for use with voltage reference divider	Must be capable of measuring 5 and 50 volts with a minimum accuracy of ±0.003%
Fluke Model 881A or 883A Differential Voltmeter	Must be capable of measuring 0, 1.02, 2.6, 15, and 25 volts with an accuracy of ±(0.01% + 5 uv). Must have 100 uv null range
Tektronix type 543 oscilloscope	Must have a 15 megacycle band width and 5 mv/cm vertical sensitivity
A 10 ohm and a 100 ohm NBS Type (Rosa) Resistor	Must have resistances of about 10 ohms and 100 ohms with an accuracy known to ±0.002% and a current rating of at least 50 ma
A 0.1 ohm Reichsanstalt Type Resistor	Must have a resistance of about 0.1 ohm, an accuracy known to ±0.002%, and a current rating of at least 2 amperes
Precision DC Potentiometer	Must be capable of measuring approximately 50, 200, and 500 mv with an accuracy of ±0.003%. Also must be capable of measuring 2 uv
Resistor Wirewound	1K, 1%, 1W 20Ω, 10%, 20W

Figure 4-7. EQUIPMENT REQUIRED FOR CALIBRATION

c. Connect differential voltmeter between terminals J and P of test adapter.
d. Set POWER switch to ON.
e. Adjust R909 so that the voltmeter indicates 0 (±0.1) volts.
f. Adjust R911 so that the UNCALIBRATED lamp just begins to glow.
g. Repeat steps e and f until both conditions occur simultaneously.
h. Set POWER switch to off.
i. Remove test adapter and replace 313A-409 circuit board.

4-16. ADJUSTMENT OF 15 VOLT SUPPLY

a. Set 382A POWER switch to off, and place test adapter between circuit board 313A-404 and the chassis connector.
b. Connect differential voltmeter between terminals U and K of test adapter.
c. Set 382A POWER switch to ON.
d. Adjust R409 so that voltmeter indicates 15 (±0.1) volts.
e. Note that if Q404, Q405, or any associated circuit component is replaced, it may be necessary to balance the differential amplifier in the 15 volt supply. This is performed as follows:
(1) Connect voltmeter between test points TP401 and TP402 on circuit board 313A-404.
(2) Adjust R406 so that voltmeter indicates 0 (±0.005) volts.

4-17. ADJUSTMENT OF 25 VOLT SUPPLY.

a. Set 382A POWER switch to off, and place test adapter between circuit board 313A-403 and chassis connector.
b. Connect voltmeter between terminals C and H of test adapter.
c. Set 382A POWER switch to ON.
d. Adjust R309 so that voltmeter indicates 25 (±0.25) volts.
e. Note that if Q304, Q305, or any associated circuit component is replaced, it may be necessary to balance the differential amplifier in the 25 volt supply. This is performed as follows:
(1) Connect differential voltmeter between test points TP301 and TP302 on board 313A-403.
(2) Adjust R306 so that voltmeter indicates 0 (±0.005) volts.

4-18. ZENER CURRENT ADJUSTMENT.

a. Place test adapter between circuit board 313A-401 and chassis connector.
b. Connect differential voltmeter between terminals C and E of test adapter.
c. Adjust R103 so that the voltmeter indicates 2.1 (±0.01) volts.

4-19. REFERENCE VOLTAGE ADJUSTMENT.

a. Internally zero the 881A, and connect to terminals 9 and 10 on the rear terminal strip.
b. Set POWER switch to ON.
c. Adjust R8 on rear panel so that voltmeter indicates 1.02 (±0.000005) volts.

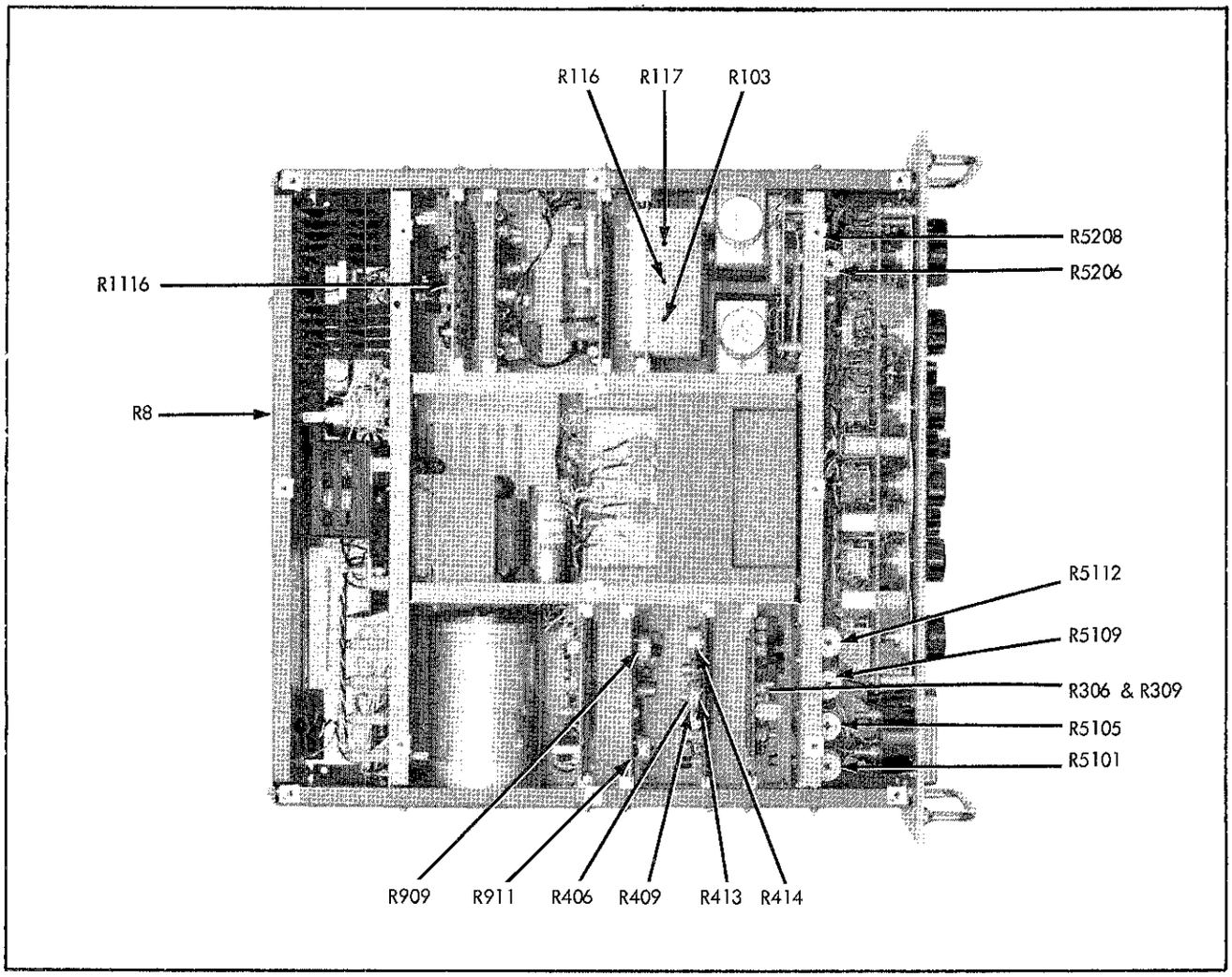


Figure 4-8. LOCATION OF CALIBRATION ADJUSTMENTS

4-20. DRIVER FREQUENCY RESPONSE

a. Set 382A POWER switch to off, and place test adapter between circuit board 313A-411 and chassis connector.

b. Set controls on the 382A as follows:

CONTROL	POSITION
V-A range	50V
Decade dials	20.0000
POWER switch	ON
CURRENT LIMIT RANGE	2A
Current LIMIT	Mid-range

c. Connect 20 ohm load to 382A OUTPUT terminals.

d. Connect oscilloscope to 382A SENSE terminals.

e. Adjust oscilloscope to trigger on silicon controlled rectifier spike, and set sweep speed to 10 microseconds per centimeter.

f. Set vertical sensitivity to 5 millivolts per centimeter with AC coupling.

g. Adjust R1116 on circuit board 313A-411 so that oscilloscope indicates a minimum amplitude of the damped transient following the silicon controlled rectifier spike. Usually it will be necessary to turn R1116 fully counterclockwise.

4-21. ZERO ADJUSTMENT

a. Set V-A switch to 5V, and turn all decade dials to zero.

b. Connect the 881A to the OUTPUT terminals, and connect the + OUTPUT terminal to the chassis ground terminal.

c. Adjust R413 on circuit board 313A-404 so that voltmeter indicates 0 (±0.00001) volts.

d. Set V-A switch to 50V.

e. Adjust R414 on circuit board 313A-404 so that voltmeter indicates 0 (±0.00001) volts.

4-22. ADJUSTMENT OF 50 VOLT RANGE.

a. Set V-A switch to 50V and set the decade dials to 49.99910 (50 volts).
b. Internally zero the differential voltmeter, and connect to the OUTPUT terminals.
c. Set differential voltmeter to 50 volts.
d. Adjust R117 for a null on the differential voltmeter. Disconnect the voltmeter.
e. Connect a series combination of the galvanometer and the standard cell bank to the standard cell terminals of the voltage reference divider.
f. Set the voltage reference divider for the correct standard cell voltage.
g. Connect the 382A OUTPUT terminals to the 50 volt terminals of the voltage reference divider.
h. Adjust R117 for a null on the galvanometer.

4-23. ADJUSTMENT OF 5 VOLT RANGE.

a. Set the V-A switch to 5V, and set the decade dials to 4.999910 (5 volts).
b. Internally zero the differential voltmeter, and connect to the OUTPUT terminals.
c. Set differential voltmeter to 5 volts.
d. Adjust R116 for a null on the differential voltmeter. Disconnect the voltmeter.
e. Connect the OUTPUT terminals to the 5 volt terminals of the voltage reference divider.
f. Adjust R116 for a null on the galvanometer.

4-24. ADJUSTMENT OF REFERENCE CURRENT.

a. Connect the 1K, 10%, 1W resistor to the OUTPUT terminals.
b. Set the V-A switch to 5 ma.
c. Set the decade controls to 0.00000.
d. Connect the 881A to the load terminals.
e. Adjust R5208 so that the voltmeter indicates 0 (+0, -0.00005) volts.

4-25. CURRENT RANGE ADJUSTMENTS

NOTE

This is a complete current calibration procedure and should not be necessary unless components have been changed. Usually, slight adjustment of R5206 and R5208 are adequate for routine calibration. The following procedure should be undertaken only when necessary to completely recalibrate the instrument.

a. Set all 382A decade dials to zero and connect a 100 ohm NBS Type (Rosa) Resistor to output terminals.
b. Set current adjustment resistors R5101, R5105, R5109, and R5112 on circuit board 382A-451 to the center of their ranges.
c. Set V-A range switch to 5 MA.
d. Measure voltage across 100 ohm resistor with a precision DC potentiometer.
e. Adjust R5208 to obtain 0 (±20) nanoamperes (10^{-9}) as measured with potentiometer across standard resistor 0 (±2 uv).
f. Set decade dials to 4.999910 (5 ma).
g. Adjust sample string current with R5206 for an output of 5 ma (±0.005%) as measured with potentiometer across standard resistor.
h. Set all decade dials to zero.
i. Repeat preceeding steps d through h until currents of 0 (±20) na and 5 ma (±0.005%) are obtained simultaneously without further adjustment of R5208 and R5206.
j. Set V-A range switch to 5V.
k. Replace 100 ohm NBS Type Resistor with a 10 ohm NBS Type Resistor.
l. Set V-A range switch to 50MA and decade dials to 49.99910 (50 ma).
m. Adjust R5105 for 50 ma (±0.005%) as measured with potentiometer across standard resistor. If required current can not be obtained within span of variable resistor, repeat entire procedure from step a with R5101 set to some value other than the center of its range.
n. Set all decade dials to zero and then set V-A range switch to 5V.
o. Replace 10 ohm NBS Type Resistor with a 0.1 ohm Reichsanstalt Type Resistor.
p. Set V-A range switch to 500MA and decade dials to 499.9910 (500 ma).
q. Adjust R5109 for 500 ma (±0.005%) as measured with potentiometer across standard resistor. If required current can not be obtained within span of variable resistor, repeat entire procedure from step a with R5101 set to some value other than the center of its range.
r. Set V-A range switch to 2A.
s. Adjust R5112 for 2 amperes (±0.005%) as measured with potentiometer across standard resistor. If required current can not be obtained within span of variable resistor, repeat entire procedure from step a with R5101 set to some value other than the center of its range.

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. The following list describes all normally replaceable parts of the Model 382A Voltage/Current Calibrator. Parts are identified on the list and on corresponding illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are identified on the illustrations by Fluke stock number.

5-3. HOW TO OBTAIN PARTS

5-4. Standard components have been used wherever possible, and can be obtained locally. All parts manufactured or altered by Fluke, and all parts for which Fluke controls the design, are identified by an asterisk preceding the Fluke stock number. All structural parts and special parts should be ordered from your local Fluke representative or from the factory.

5-5. When ordering parts always include:
a. Reference designation, description, and Fluke stock number.
b. Instrument model and serial number.

5-6. Most structural parts are not listed. To order these, give complete description, function, and location of part.

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Final Assembly (Rack Model) (See Figure 5-1)	*153692	
	Front Panel Assembly (See Figure 5-2)	*153684 (382A-500)	
	Shunt Assembly - 2A (See Figure 5-3)	*153676 (382A-457)	
	Shunt Assembly - 500 Ma (See Figure 5-1)	*153668 (382A-456)	
	Master Voltage Reference (See Figure 5-4)	*145003 (313A-401)	
	Auxiliary Power Supply Assembly, +25V (See Figure 5-5)	*125823 (313A-403)	
	Auxiliary Power Supply Assembly, -15V (See Figure 5-6)	*125831 (313A-404)	
	Chopper Amplifier Assembly (See Figure 5-7)	*125849 (313A-405)	
	Main Amplifier Assembly (See Figure 5-8)	*145011 (313A-407)	
	SCR Firing Circuit Assembly (See Figure 5-9)	*125864 (313A-408)	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Overcurrent Limiting Assembly (See Figure 5-10)	*125872 (313A-409)	
	Meter Shunt Assembly (See Figure 5-11)	*125880 (313A-410)	
	Driver Assembly (See Figure 5-12)	*125898 (313A-411)	
	Rectifier Assembly (See Figure 5-13)	*125906 (313A-412)	
	Reference Oven Assembly (See Figure 5-14)	*145029 (313A-418)	
	Current Shunt Assembly (See Figure 5-15)	*153619 (382A-451)	
	Voltage Limit Assembly (See Figure 5-16)	*153627 (382A-452)	
	Bucking Oven Assembly (See Figure 5-17)	*153635 (382A-453)	
C1	Capacitor, electrolytic, 9500 uf -10/+75%, 75V	1502-106971	
C2	Capacitor, ceramic, 0.05 uf -20/+80%, 500V	1501-105676	
C3	Capacitor, electrolytic, 500 uf -10/+100%, 25V	1502-105031	
C4	Capacitor, electrolytic, 500 uf -10/+75%, 100V	1502-143149	
C6, C7	Capacitor, electrolytic, 150 uf -10/+100%, 150V	1502-106914	
C10, C11, C12	Capacitor, ceramic, 0.01 uf -20/+80%, 500V	1501-105668	
C13, C14, C15	Capacitor, ceramic, 0.05 uf -20/+80%, 500V	1501-105676	
C16	Capacitor, ceramic, 0.01 uf -20/+80%, 500V (Not illustrated)	1501-105668	
C17	Capacitor, plastic, 0.47 uf ±20%, 600V	1507-105494	
C18	Capacitor, ceramic, 0.01 uf -20/+80%, 500V	1501-105668	
CR6, CR7	Diode, silicon, 6 PIV, 0.10A	4802-113308	C
CR8	Diode, silicon, 100 PIV, 1A	4802-116111	
CR9	Diode, silicon, 100 PIV, 1A	4802-116111	G
DS1, DS2	Lamp, neon, Type NE48	3902-125971	
DS6	Lamp, incandescent, Type 10C7	3901-104539	
K1	Relay, DPDT, 5A, 115 VAC	4501-106864	
L1	Choke, 75mh	1801-126086	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
L2	Choke, R.F., 100 uh, ±5%, 1/2W	1801-111542	
Q2	Transistor, PNP, Germanium, Type 2N1556	4805-160663	
R1	Resistor, wirewound, 1.5Ω, 1%, 50W	4706-113498	
R4	Resistor, wirewound, 1K ±5%, 5W	4706-113282	
R5	Resistor, wirewound, 2K ±5%, 5W	4706-113506	
R7	Resistor, wirewound, 3.5K ±5%, 5W	4706-113290	
R8	Resistor, variable, wirewound, 10Ω ±10%, 2W	4702-112995	
R9	Resistor, wirewound, 150Ω ±5%, 10W	4706-112334	
R10	Resistor, wirewound, 20Ω ±5%, 5W	4706-113522	
R11	Resistor, composition, 8.2K ±10%, 2W	4704-110072	
R12	Resistor, wirewound, 0.43Ω ±5%, 10W	4706-113548	
R16	Resistor, deposited carbon, 195K ±1%, 1/2W	4703-143529	
R17	Resistor, metal film, 10Ω ±1%, 1/2W	4705-151043	
R19	Resistor, deposited carbon, 500K ±1%, 1/2W	4703-107367	
R20	Resistor, composition (not illustrated) 18Ω ±10%, 1/2W	4704-108811	B
R21	Resistor, composition (not illustrated) 2.4K ±5%, 1/2W	4704-108902	G
T1	Transformer, power	5602-126078	
	Line cord, 3 wire	6005-102822	

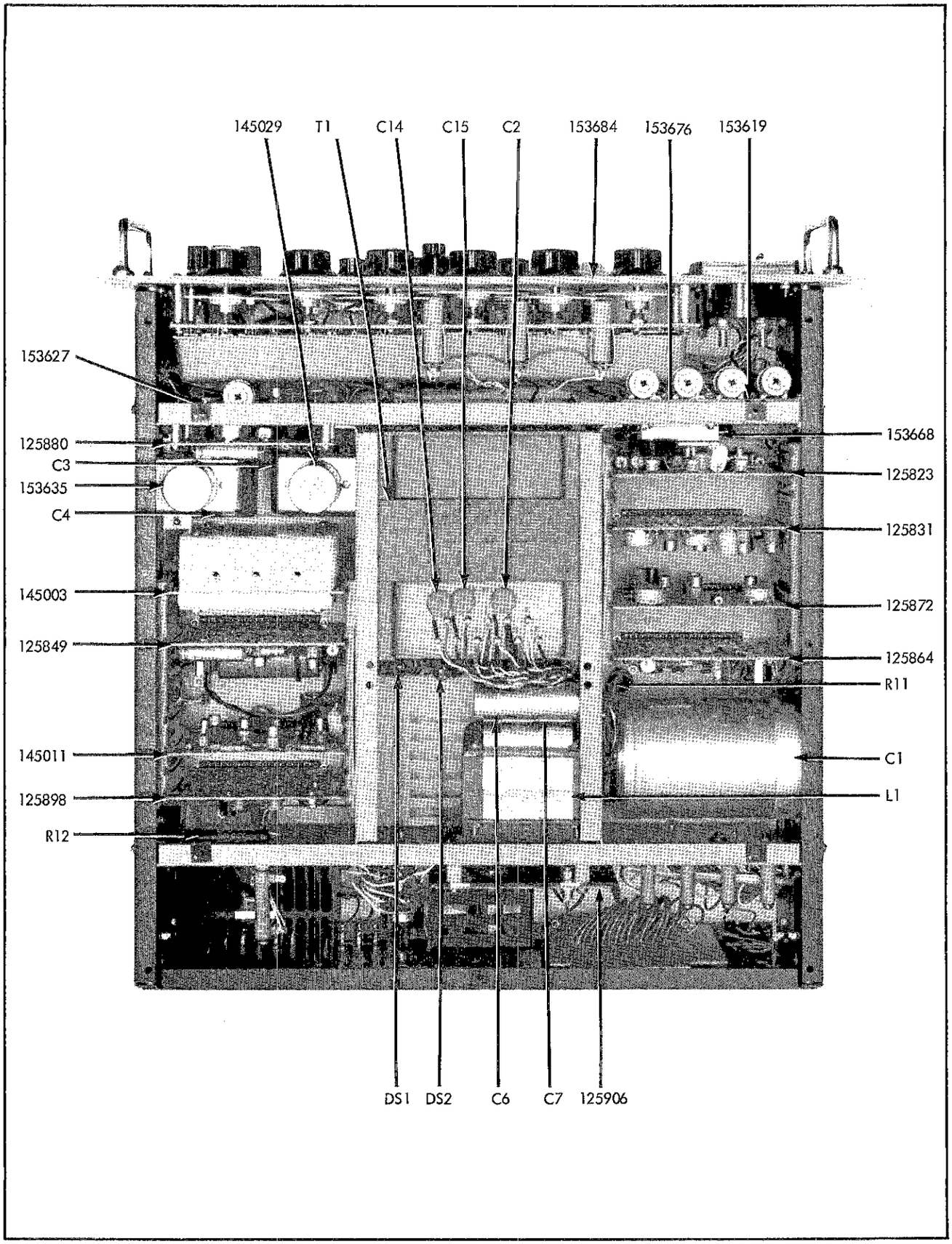


Figure 5-1. FINAL ASSEMBLY (sheet 1 of 2)

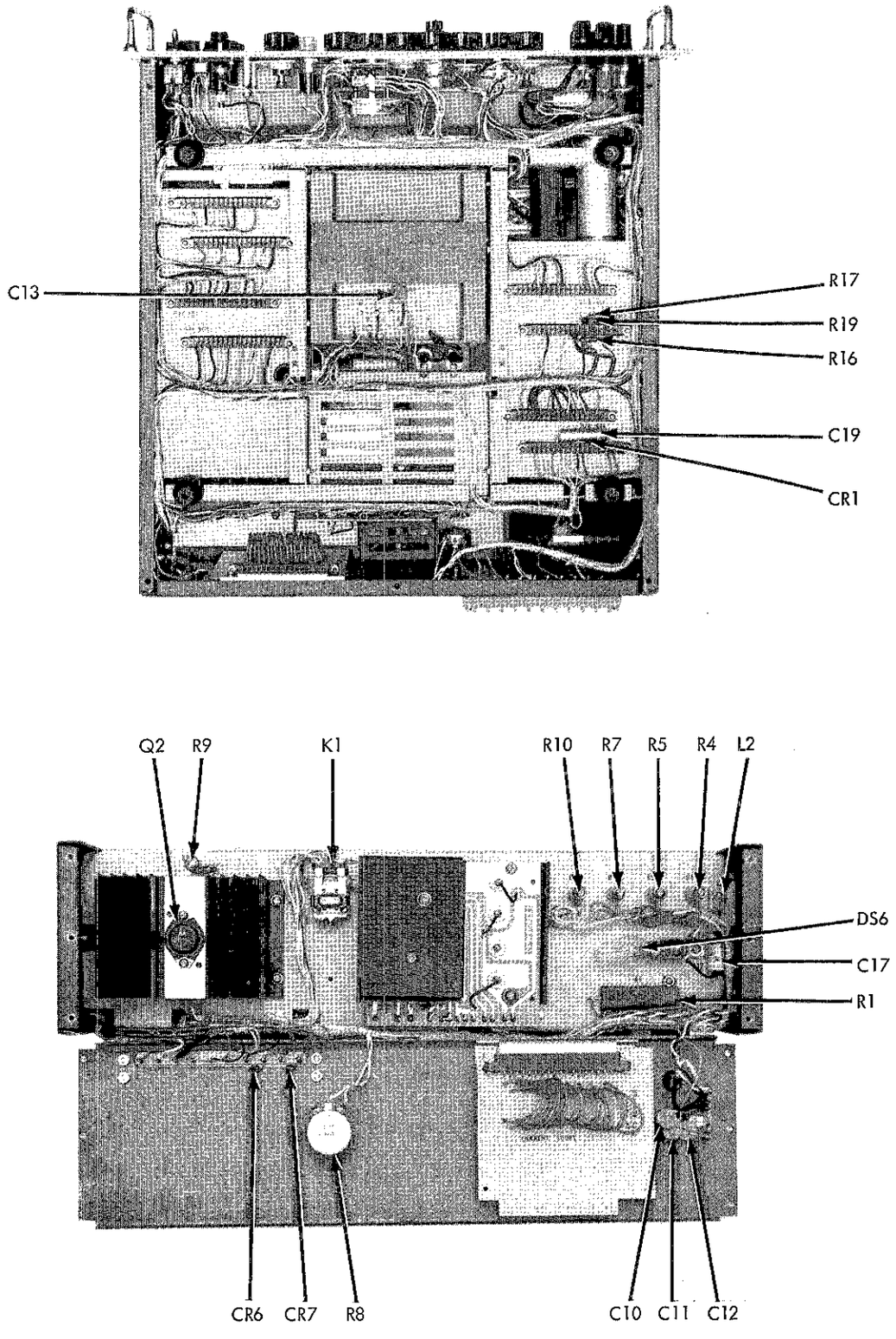


Figure 5-1. FINAL ASSEMBLY (sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Front Panel Assembly	*153684 (313A-500)	
	Sample Resistor Assembly	*125815 (313A-402)	
C201	Capacitor, plastic, 2 uf ±20%, 100V	*1507-106963	
R201	Resistor, wirewound, 10K ±0.01%, 1/2W	*4707-131664	
R202, R203	Resistor, wirewound, 20K ±0.01%, 1/2W	*4707-131680	
R204	Resistor, wirewound, 1K ±0.01%, 1/2W	*4707-131706	
R205 thru R208	Resistor, wirewound, 2K ±0.01%, 1/2W	*4707-131714	
R209	Resistor, wirewound, 100Ω ±0.015%, 1/10W	*4707-155846	
R210 thru R213	Resistor, wirewound, 200Ω ±0.01%, 1/2W	*4707-131656	
R214	Resistor, wirewound, 10Ω ±0.03%, 1/2W	*4707-131775	
R215 thru R218	Resistor, wirewound, 20Ω ±0.03%, 1/2W	*4702-155887	
R219	Resistor, wirewound, 1Ω ±0.2%, 1/10W	*4707-131888	
R220 thru R223	Resistor, wirewound, 2Ω ±0.2%, 1/10W	*4707-131870	
R224	Resistor, wirewound, 0.096Ω ±1%, 1/10W	*4707-131904	
R225 thru R229	Resistor, wirewound, 0.196Ω ±1%, 1/10W	*4707-131896	
S201	Switch, rotary, 2 sections, 5 positions Switch, rotary, 2 sections, 5 positions	*5110-126029 *5105-154971	E F
S202 thru S205	Switch, rotary, 2 sections, 10 positions Switch, rotary, 2 sections, 10 positions	*5110-126011 *5105-154963	E F
S206	Switch, rotary, 2 sections, 11 positions Switch, rotary, 2 sections, 11 positions	*5110-126003 *5105-154955	E F
	Note: When ordering R201 thru R229, include all the markings on the old resistor. These resistors are grouped according to resistance accuracy and temperature coefficients, and the old markings are necessary to completely identify the resistor.		
DS3	Lamp, neon, Type NE51	3902-101709	
DS201 thru DS203	Lamp, incandescent, 6.3V, Type 47	3901-102855	
M1	Meter, 1 ma, ±1%	2901-111500	
R6, R18	Resistor, variable, dual, 10K ±5%, 4W; 50K ±10%, 1/3W	4702-153239	
S1	Switch, toggle, DPST, 6A, 125V	5106-114835	
S2	Switch, rotary, 5 sections, 6 positions	5105-153197	
S3	Switch, rotary, 1 section, 3 positions	5110-125997	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
S4	Switch, toggle, DPDT, 5A, 115V	5106-115113	
	Binding post, black	2811-142984	
	Binding post, red	2811-142976	
	Fuse, 3A, Fast-blowing	5101-109199	
	Fuseholder	2102-100107	
	Knob, 1 inch (not illustrated)	2405-101287	R
	Knob, 1 inch (not illustrated)	2405-188565	S
	Knob, 1-1/2 inch (not illustrated)	2405-101121	R
	Knob, 1-1/4 inch (not illustrated)	2405-188581	S
	Knob, 1 inch (not illustrated)	2405-150557	R
	Knob, 13/16 inch (not illustrated)	2405-188540	S
	Knob, 3/4 inch (not illustrated)	2405-150565	R

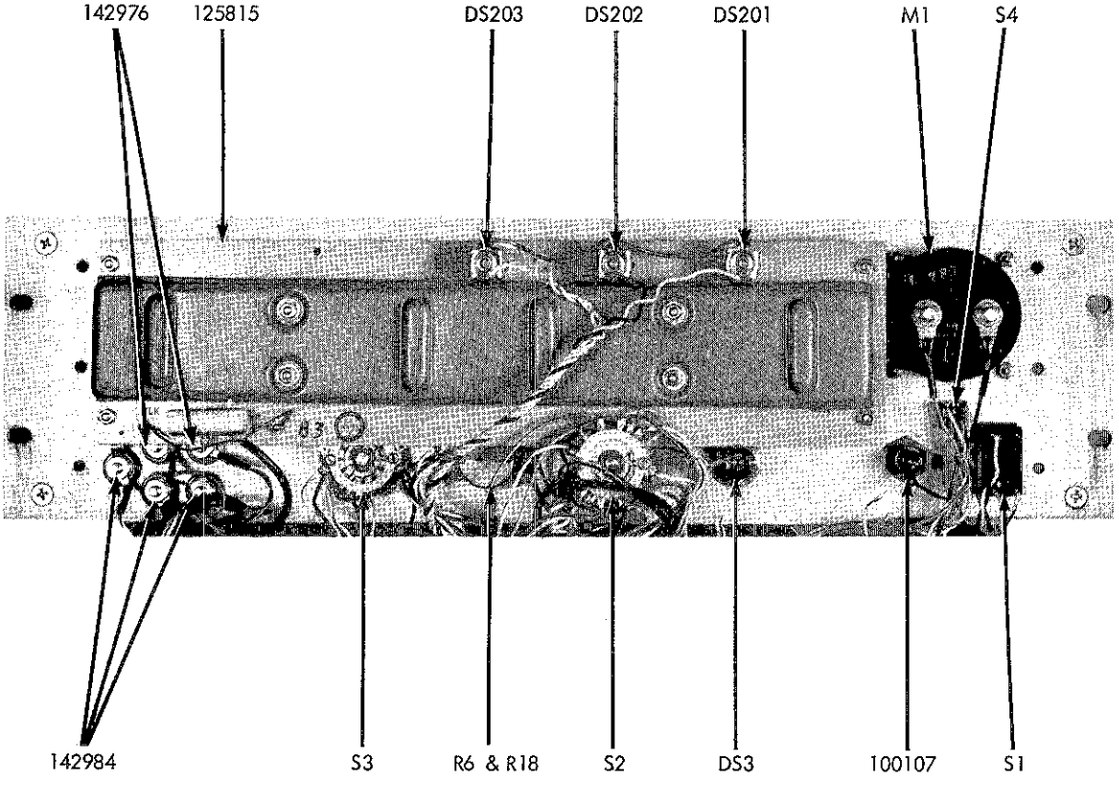


Figure 5-2. FRONT PANEL ASSEMBLY (sheet 1 of 2)

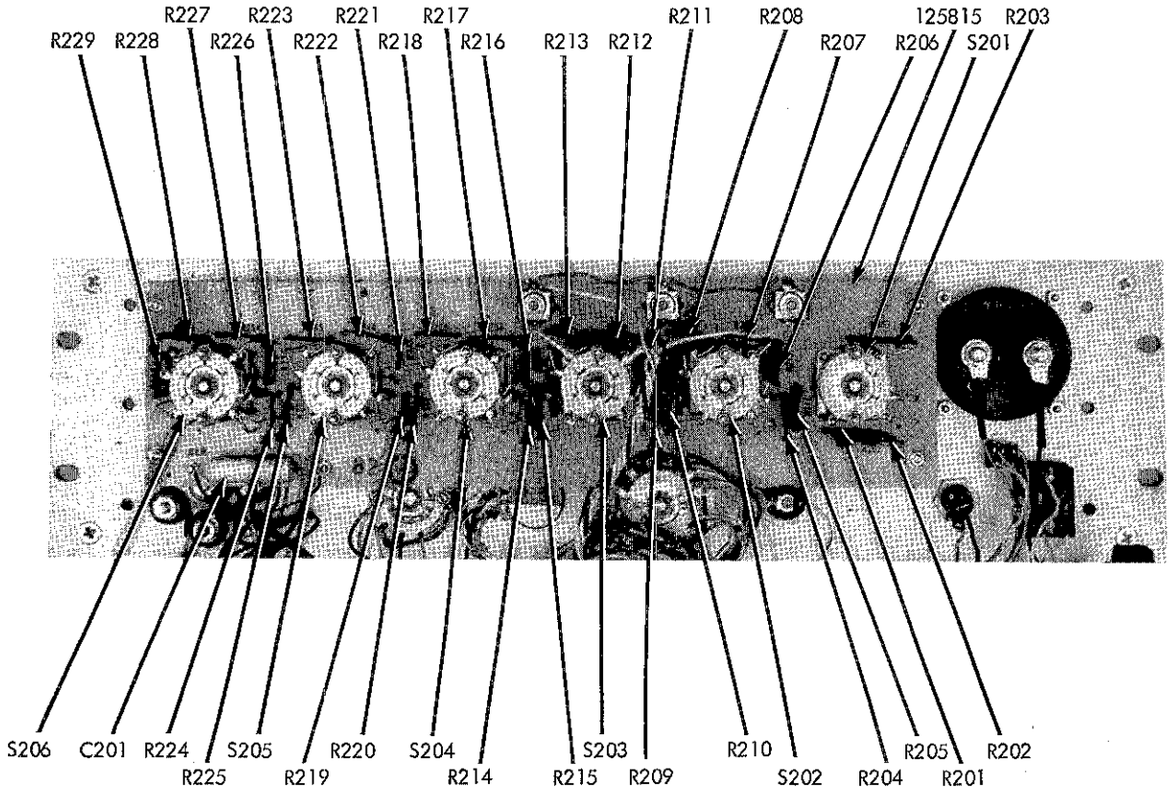


Figure 5-2. FRONT PANEL ASSEMBLY (sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R14	Shunt Assembly - 2A	*153676 (382A-457)	
	Resistor, wirewound (2 used) 2Ω ±1%, 50W	4707-158444	
	Resistor, metal film factory selected		
R15	Shunt Assembly - 500 Ma (See Figure 5-1)	*153668 (382A-456)	
	Resistor, wirewound (2 used) 20Ω ±1%, 50W	4707-158436	
	Resistor, metal film factory selected		

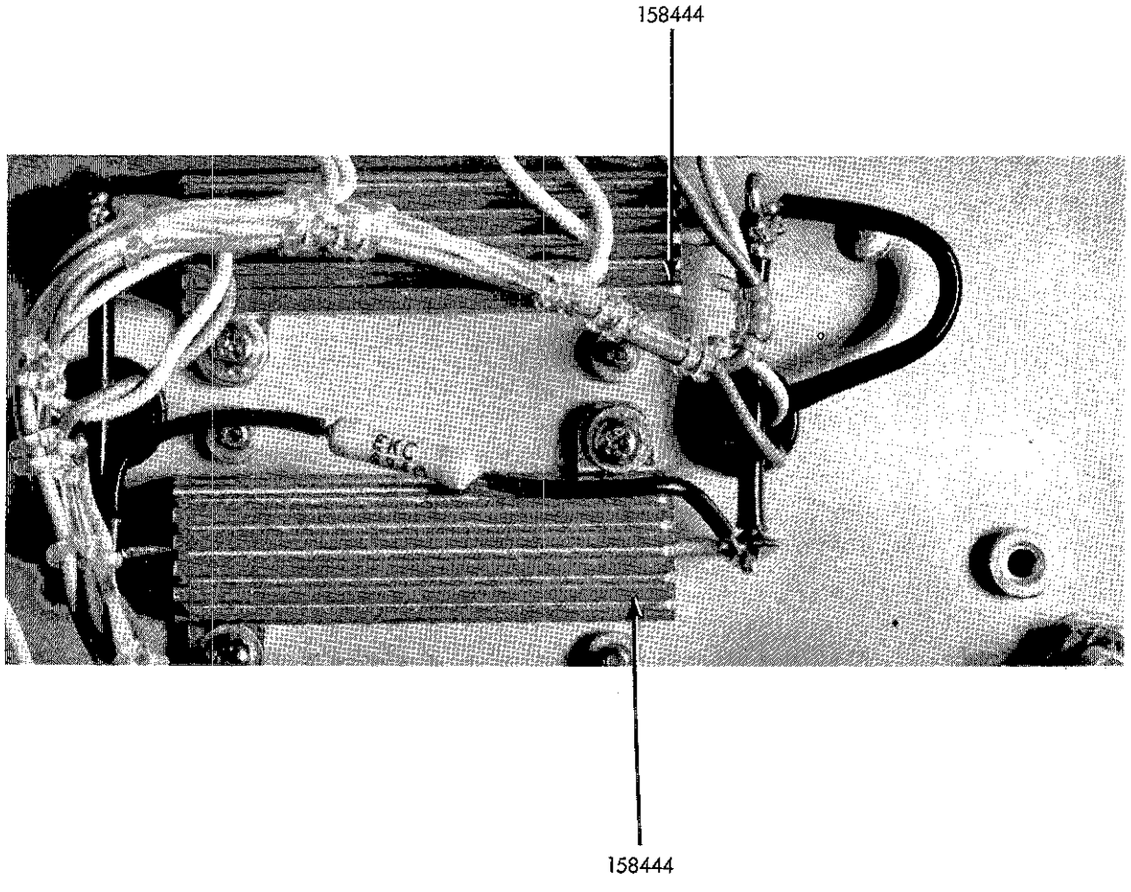


Figure 5-3. SHUNT ASSEMBLY - 2A

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Master Voltage Reference Assembly	*145003 (313A-401)	
	NOTE: When ordering the Master Voltage Reference Assembly, be sure to provide the three digit number stamped on the assembly. The Master Voltage Reference Assembly is matched to the Zener Reference Oven Assembly, and this three-digit number is necessary for complete identification.		
C101	Capacitor, plastic, 0.1 uf ±20%, 200V	1507-106435	
R103	Resistor, variable, wirewound, 150Ω ±10%, 1-1/4W	4702-113092	
R107	Resistor, wirewound, 800Ω ±0.1%, 1/2W Resistor, wirewound, 459.8Ω ± 0.025%, 1/8W	*4707-155176 *4707-132001	O P
R109	Resistor, wirewound, 200Ω ±0.015%, 1/2W	*4707-131656	
R110	Resistor, wirewound, matched, 5.0K ±0.1%, 1/2W	*4707-149708	
R111	Resistor, wirewound, matched, 1.02K ±0.1%, 1/2W	*4707-145128	
	NOTE: R110 and R111 are matched according to resistance accuracy and must be ordered as a set.		
R112	Resistor, wirewound, 5.418K ±0.1%, 1/2W Resistor, wirewound, 6K ±0.05%, 1W	*4707-147470 *4707-147462	R S
R113	Resistor, wirewound, 668Ω ±0.1%, 1/2W	*4707-147488	
R114	Resistor, wirewound, 6.0K ±0.1%, 1/2W	*4707-147462	
R115	Resistor, wirewound, matched, 150Ω ±0.1%, 1/8W Resistor, wirewound, matched, 180Ω ±0.1%, 1/8W	*4707-156000 *4707-156000	R S
	NOTE: When ordering R115, be sure to supply the three-digit number which is stamped on the Zener Reference Oven. This number is necessary for complete identification of the resistor.		
R116	Resistor, variable, wirewound, 25Ω ±10%, 1-1/4W Resistor, variable, wirewound, 300Ω ±10%, 1-1/4W	4702-113431 4702-154583	R S
R117	Resistor, variable, wirewound, 25Ω ±10%, 1-1/4W	4702-113431	
R118	Resistor, wirewound, 4K ±0.03%, 1/2W	*4707-131672	S
R119	Resistor, wirewound, 50K ±0.1%, 1W	*4707-156455	S

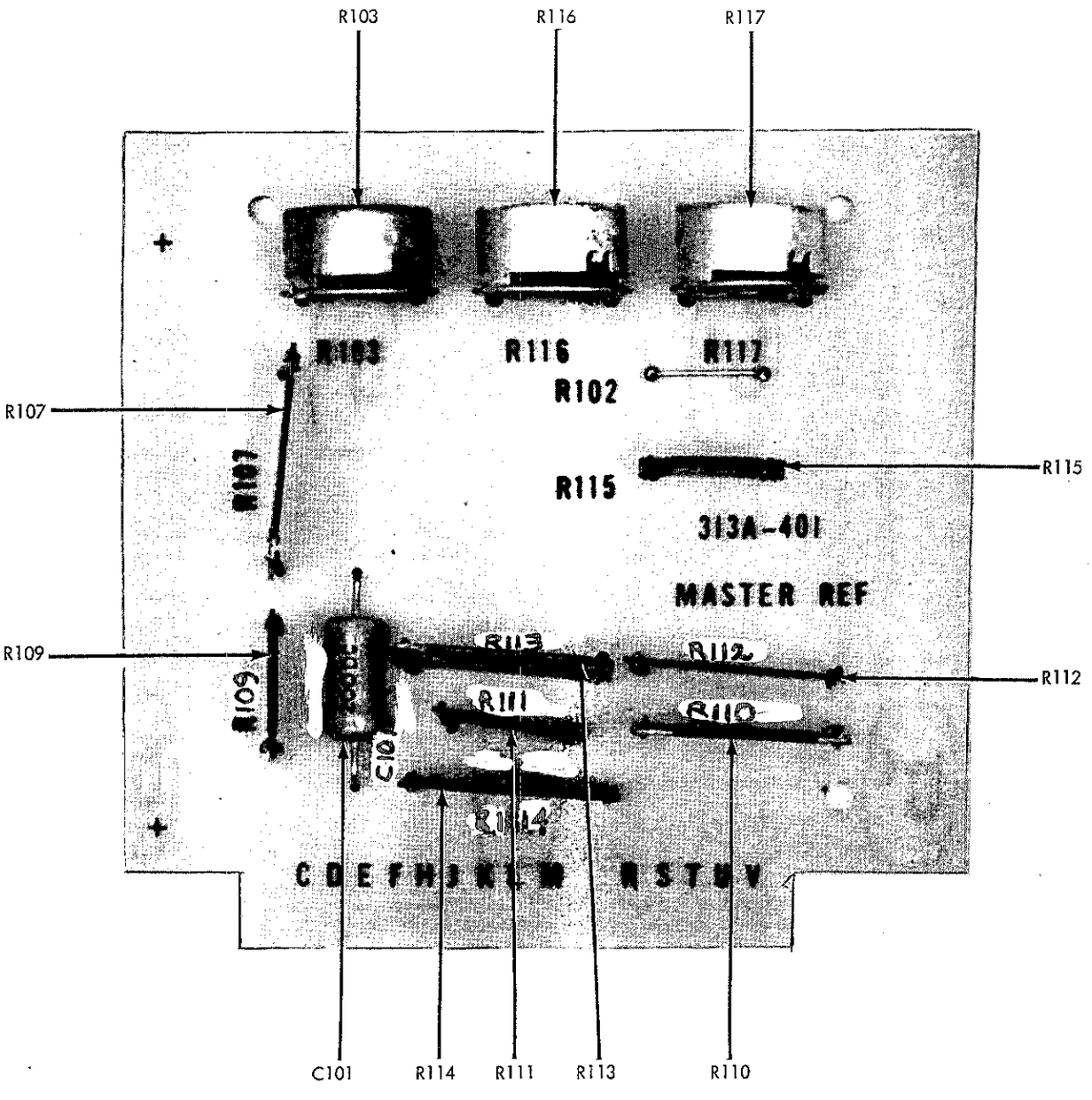


Figure 5-4. MASTER VOLTAGE REFERENCE

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Auxiliary Power Supply Assembly +25V	*125823 (313A-403)	
C301, C302	Capacitor, electrolytic, 50 uf -10/+100%, 50 V	1502-105122	
C303	Capacitor, plastic, 2 uf ±20%, 100V	1507-106963	
C304	Capacitor, plastic, 0.1 uf ±20%, 200V	1507-106435	
C305	Capacitor, electrolytic, 20 uf -10/+100%, 50V	1502-106229	
C306	Capacitor, ceramic, 30 pf ±10%, 500V	1501-105734	
CR301 thru CR304	Diode, silicon, 600 PIV, 0.75A Diode, silicon, 100 PIV, 1A	4802-112383 4802-116111	A B
CR305, CR306	Diode, silicon, 6 PIV, 0.10A	4802-113308	
CR307	Diode, zener, 9V, 7.5 ma Diode, zener, 6.3V, 7.5 ma	4803-113373 4803-172148	O P
Q301	Transistor, PNP, germanium, type 2N1373 Transistor, PNP, germanium, type 2N1372	4805-116723 4805-116129	A B
Q302	Transistor, NPN, silicon, type 2N2040 Transistor, NPN, silicon, type CDQ10449	4805-117200 4805-153551	A B
Q303 thru Q305	Transistor, NPN, silicon, type NS734 Transistor, NPN, silicon, type CDQ10449	4805-117192 4805-153551	A B
R301	Resistor, composition, 120Ω ±10%, 2W	4704-155531	
R302	Resistor, composition, 5.1K ±5%, 1W	4704-109918	
R303	Resistor, composition, 470Ω ±10%, 1/2W	4704-108415	
R305	Resistor, composition, 2.7Ω ±10%, 1/2W	4704-108845	
R306	Resistor, variable, wirewound, 500Ω ±10%, 1-1/4W	4702-112433	
R307	Resistor, composition, 1.3K ±5%, 1/2W Resistor, composition, 750Ω ±5%, 1/2W	4704-109157 4704-108894	O P
R308	Resistor, deposited carbon, 6.81K ±1%, 1/2W Resistor, metal film, 8.06K ±1%, 1/2W	4703-107979 4705-159467	O P
R309	Resistor, variable, wirewound, 1K ±20%, 1-1/4W Resistor, variable, wirewound, 500Ω ±10%, 1-1/4W	4702-111575 4702-112433	O P
R310	Resistor, deposited carbon, 3.89K ±1%, 1/2W Resistor, metal film, 2.55K ±1%, 1/2W	4703-107268 4705-176362	O P
R311	Resistor, composition, 2.7Ω ±10%, 1/2W	4704-108845	
R312	Resistor, composition, 2.2K ±5%, 1/2W Resistor, composition, 2.4K ±5%, 1/2W	4704-108506 4704-108902	O P

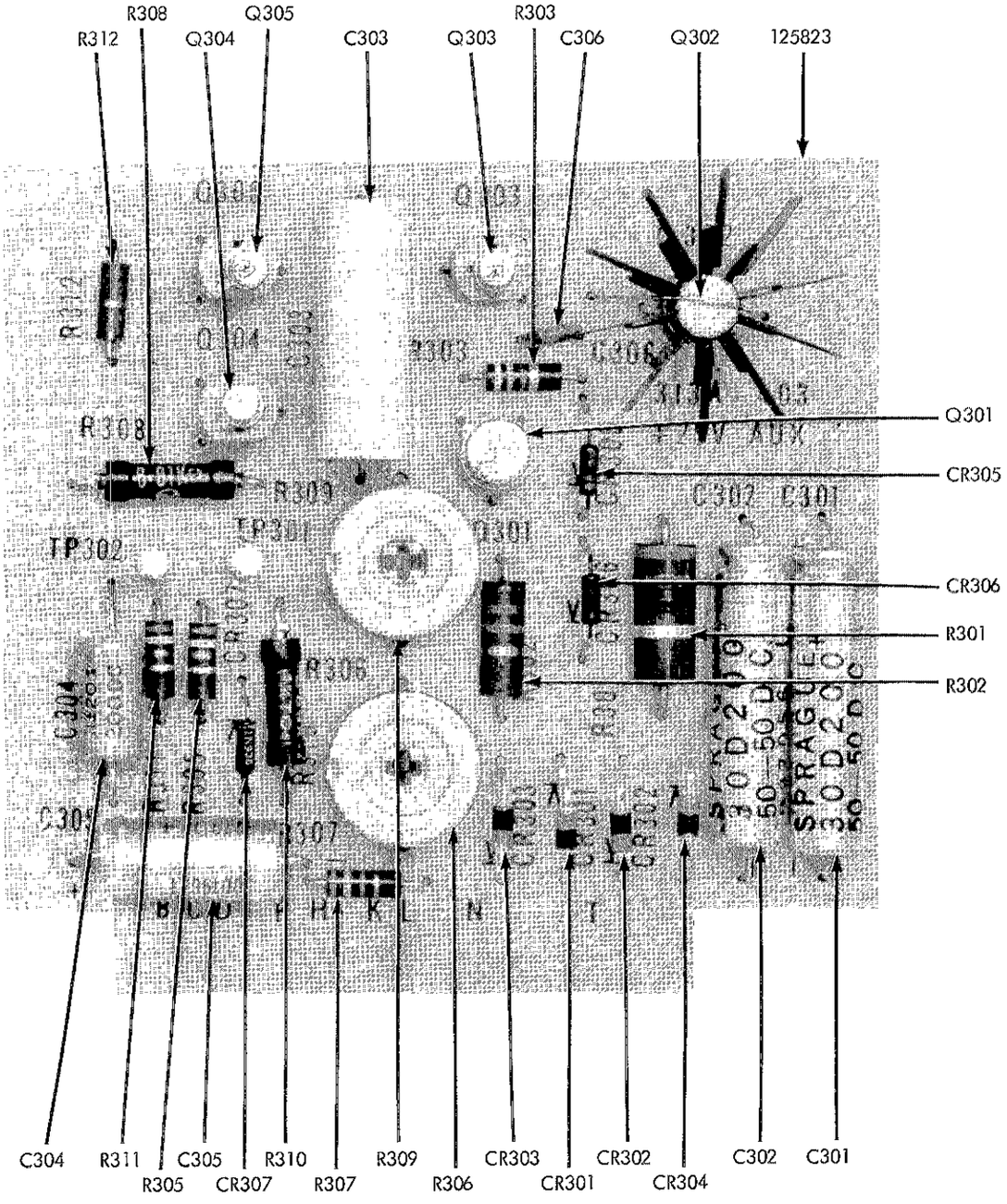


Figure 5-5. AUXILIARY POWER SUPPLY ASSEMBLY, +25V

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Auxiliary Power Supply Assembly, -15V	*125831 (313A-404)	
C401, C402	Capacitor, electrolytic, 50 uf, -10/+100%, 50V	1502-105122	
C403	Capacitor, plastic, 2 uf ±20%, 100V	1507-106963	
C404	Capacitor, plastic, 0.1 uf ±20%, 200V	1507-106435	
C405	Capacitor, electrolytic, 20 uf -10/+100%, 50V	1502-106229	
C406	Capacitor, ceramic, 0.0027 uf, GMV, 600V	1501-106211	
CR401 thru CR404	Diode, silicon, 600 PIV, 0.75A Diode, silicon, 100 PIV, 1A	4802-112383 4802-116111	A B
CR405, CR406	Diode, silicon, 6 PIV, 0.10A	4802-113308	
CR407	Diode, silicon, 600 PIV, 0.75A Diode, silicon, 100 PIV, 1A	4802-112367 4802-116111	H Q
CR408	Diode, zener, 9V at 7.5 ma Diode, zener, 6.3V at 7.5 ma	4803-113373 4803-172148	O P
Q401	Transistor, NPN, germanium, type 2N1304	4805-117127	
Q402	Transistor, NPN, silicon, type CDQ10449 Transistor, NPN, silicon, type 2N3053	4805-153551 4805-150359	O P
Q403 thru Q405	Transistor, PNP, germanium, type 2N1379	4805-117143	
R401	Resistor, composition, 82Ω ±10%, 1W	4704-109884	
R402	Resistor, composition, 2.2K ±10%, 1W	4704-109843	
R403	Resistor, composition, 390Ω ±10%, 1/2W	4704-108365	
R404	Resistor, composition, 560Ω ±10%, 1/2W	4704-108316	
R405	Resistor, composition, 2.7Ω ±10%, 1/2W	4704-108845	
R406	Resistor, variable, wirewound, 500Ω ±10%, 1-1/4W	4702-112433	
R407	Resistor, composition, 1.2K ±10%, 1/2W Resistor, composition, 750Ω ±5%, 1/2W	4704-108803 4704-108894	O P
R408	Resistor, deposited carbon, 2.7K ±1%, 1/2W Resistor, metal film, 2.0K ±1%, 1/2W	4703-107276 4705-151266	O P
R409	Resistor, variable, wirewound, 1K ±20%, 1-1/4W Resistor, variable, wirewound, 500Ω ±10%, 1-1/4W	4702-111575 4702-112433	O P
R410	Resistor, deposited carbon, 3.89K ±1%, 1/2W Resistor, metal film, 2.55K ±1%, 1/2W	4703-107268 4705-176362	O P
R411	Resistor, composition, 2.7Ω ±10%, 1/2W	4704-108845	
R412	Resistor, composition, 820Ω ±5%, 1/2W Resistor, composition, 1.1K ±5%, 1/2W	4704-109066 4704-160432	O P
R413, R414	Resistor, variable, wirewound, 5K ±5%, 1-1/4W	4702-111609	

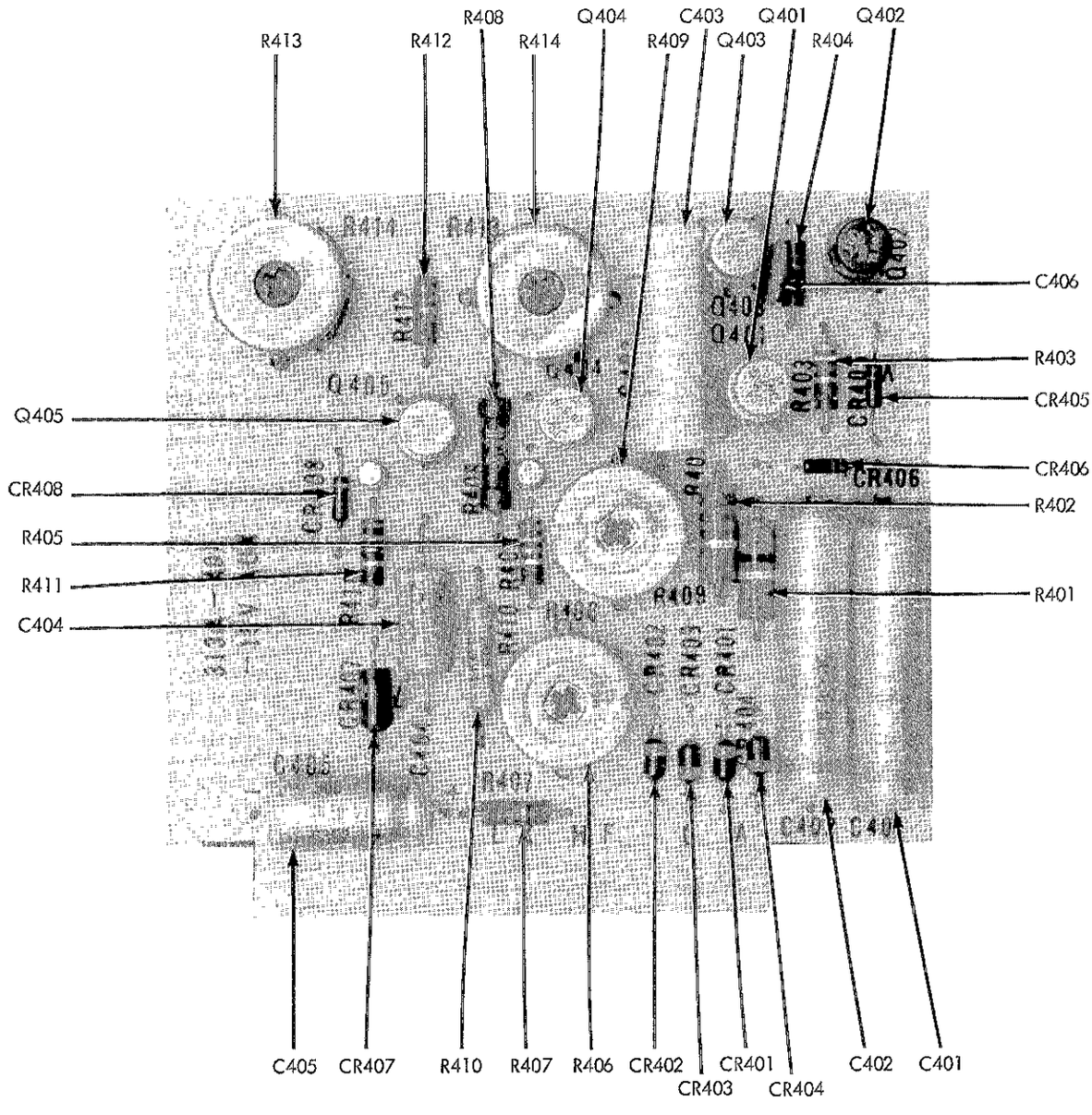


Figure 5-6. AUXILIARY POWER SUPPLY ASSEMBLY, -15V.

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Chopper Amplifier Assembly	125849 (313A-405)	
C501	Capacitor, plastic, 2 uf ±20%, 100V	1507-106963	
C502	Capacitor, electrolytic, 40 uf -10/+100%, 6V	1502-105205	
C503	Capacitor, plastic, 0.047 uf ±20%, 100V	1507-106096	
C504	Capacitor, electrolytic, 20 uf -10/+100%, 50V	1502-106229	
C505	Capacitor, electrolytic, 40 uf -10/+100%, 6V	1502-105205	
C506, C507	Capcitor , electrolytic, 20 uf -10/+100%, 50V	1502-106229	
C508, C509	Capacitor, electrolytic, 500 uf -10/+100%, 3V	1502-106328	
C510	Capacitor, electrolytic, 2 uf -10/+100%, 50V	1502-105197	
G501	Chopper, DPDT	5901-104349	
Q501	Transistor, NPN, silicon, type NS734 Transistor, NPN, silicon, type CDQ10449	4805-117192 4805-153551	A B
Q502	Transistor, PNP, germanium, type 2N1372	4805-116129	
Q503	Transistor, NPN, silicon, type 2N2270 Transistor, NPN, silicon, type CDQ10449	4805-117135 4805-153551	A B
Q504	Transistor, PNP, germanium, type 2N1372	4805-116129	
Q505	Transistor, NPN, germanium, type 2N1304	4805-117127	
R501	Resistor, deposited carbon, 26.6K ±1%, 1/2W	4703-107680	
R502	Resistor, composition, 62K ±5%, 1/2W	4704-108522	
R503	Resistor, deposited carbon, 8.2K ±1%, 1/2W	4703-107243	
R504	Resistor, composition, 1.8K ±5%, 1/2W	4704-109140	
R505	Resistor, composition, 47K ±10%, 1/2W	4704-108480	
R506	Resistor, composition, 8.2K ±10%, 1/2W	4704-109017	
R507	Resistor, composition, 75Ω ±5%, 1/2W	4704-108753	
R508	Resistor, composition, 62K ±5%, 1/2W	4704-108522	
R509	Resistor, composition, 8.2K ±10%, 1/2W	4704-109017	
R510	Resistor, composition, 1.8K ±5%, 1/2W	4704-109140	
R511	Resistor, composition, 47K ±10%, 1/2W	4704-108480	
R512	Resistor, composition, 8.2K ±10%, 1/2W	4704-109017	
R513	Resistor, composition, 75Ω ±5%, 1/2W	4704-108753	
R514	Resistor, composition, 3K ±5%, 1/2W	4704-109090	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R515	Resistor, composition, 2.7K ±5%, 1/2W	4704-109074	
R516, R517	Resistor, composition, 10K ±10%, 1/2W	4704-108118	
R518	Resistor, composition, 39K ±10%, 1/2W	4704-108555	
R519	Resistor, composition, 47K ±10%, 1/2W	4704-108480	
R520	Resistor, composition, 18K ±10%, 1/2W	4704-108183	

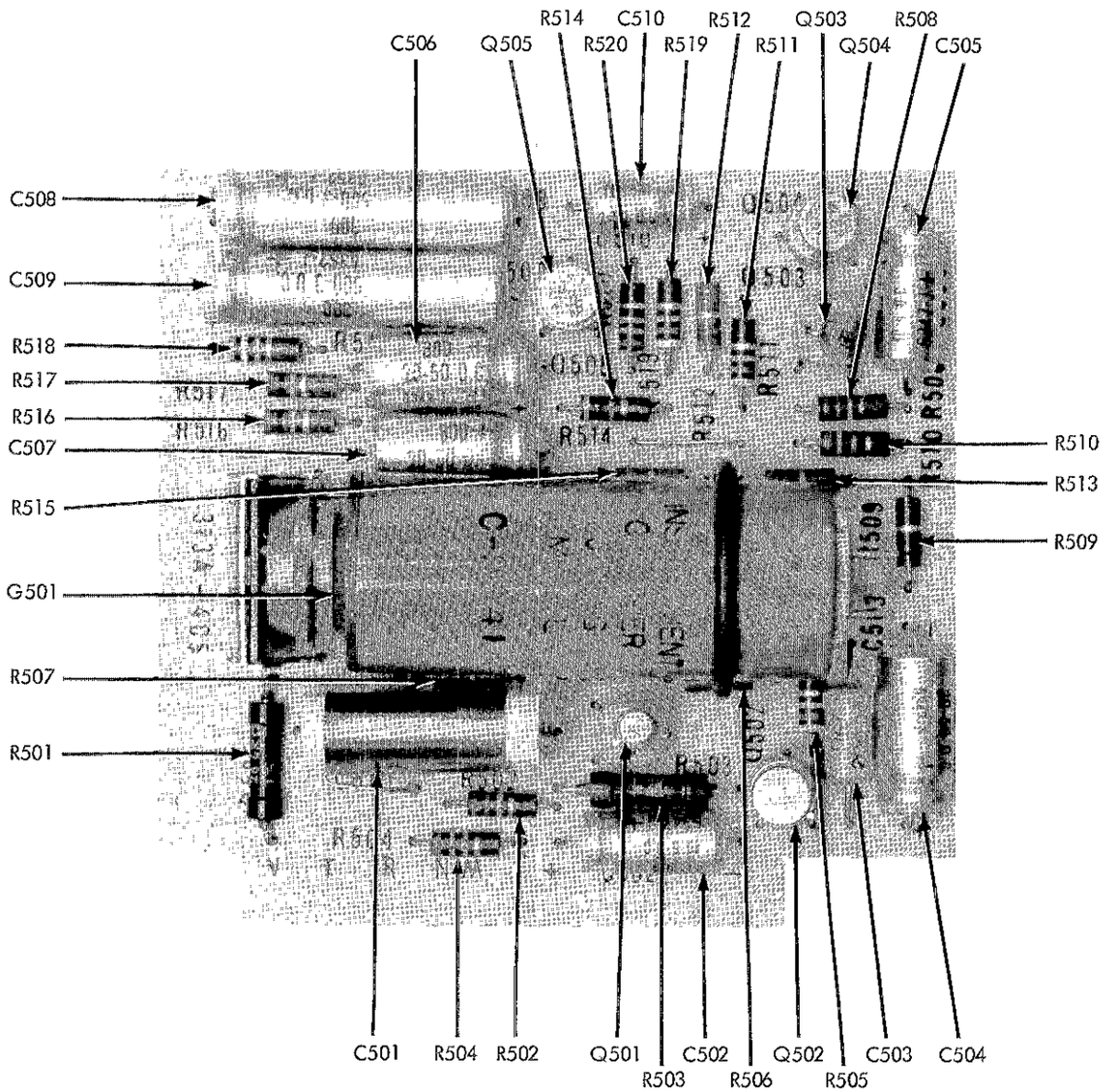


Figure 5-7. CHOPPER AMPLIFIER ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Main Amplifier Assembly	*145011 (313A-407)	
C701	Capacitor, plastic, 0.068 uf ±10%, 200V	1507-105981	
C702	Capacitor, plastic, 2 uf ±20%, 100V	1507-106963	
C703	Capacitor, electrolytic, 10 uf ±20%, 6V	1508-106906	
C704	Capacitor, ceramic, 0.05 uf -20/+80%, 500V	1501-105676	
CR701, CR702	Diode, silicon, 600 PIV, 0.75A Diode, silicon, 100 PIV, 1A	4802-112383 4802-116111	A B
Q701	Transistor, NPN, germanium, type 2N1304	4805-117127	
Q702, Q703	Transistor, NPN, silicon, type CDQ10449	4805-153551	
Q704, Q705	Transistor, PNP, silicon, type SM4144	4805-159491	
Q706, Q707	Transistor, PNP, germanium, type 2N2189	4805-144816	
Q708	Transistor, PNP, germanium, type 2N1379	4805-117143	
R701	Resistor, deposited carbon, 5K ±1%, 1/2W	4703-107110	
R702	Resistor, deposited carbon, 10K ±1%, 1/2W	4703-107128	
R703	Resistor, deposited carbon, 5K ±1%, 1/2W	4703-107110	
R704	Resistor, deposited carbon, 26.6K ±1%, 1/2W	4703-107680	
R706	Resistor, deposited carbon, 5K ±1%, 1/2W	4703-107110	
R707, R708	Resistor, composition, 300Ω ±5%, 1/2W	4704-108829	
R709, R710	Resistor, composition, 470K ±5%, 1/2W	4704-108290	
R712, R713	Resistor, deposited carbon, 12K ±1%, 1/2W	4703-144709	
R714	Resistor, deposited carbon, 5K ±1%, 1/2W	4703-107110	
R715, R716	Resistor, composition, 51Ω ±5%, 1/2W	4704-144717	
R717	Resistor, composition, 150Ω ±1%, 1/2W	4704-144683	
R718	Resistor, deposited carbon, 40K ±1%, 1/2W	4703-107151	
R719	Resistor, deposited carbon, 8.2K ±1%, 1/2W	4703-107243	
R720	Resistor, deposited carbon, 1K ±1%, 1/2W	4703-107086	
R721	Resistor, wirewound, factory selected Resistor, wirewound, 6K ±0.05%, 1W	4703-107086 4707-147462	M N
R722	Resistor, deposited carbon, 100K ±1%, 1/2W	4703-107185	
R723	Resistor, composition, 100Ω ±10%, 1/2W	4704-108381	
R728	Resistor, deposited carbon, 100K ±1%, 1/2W	4703-107185	

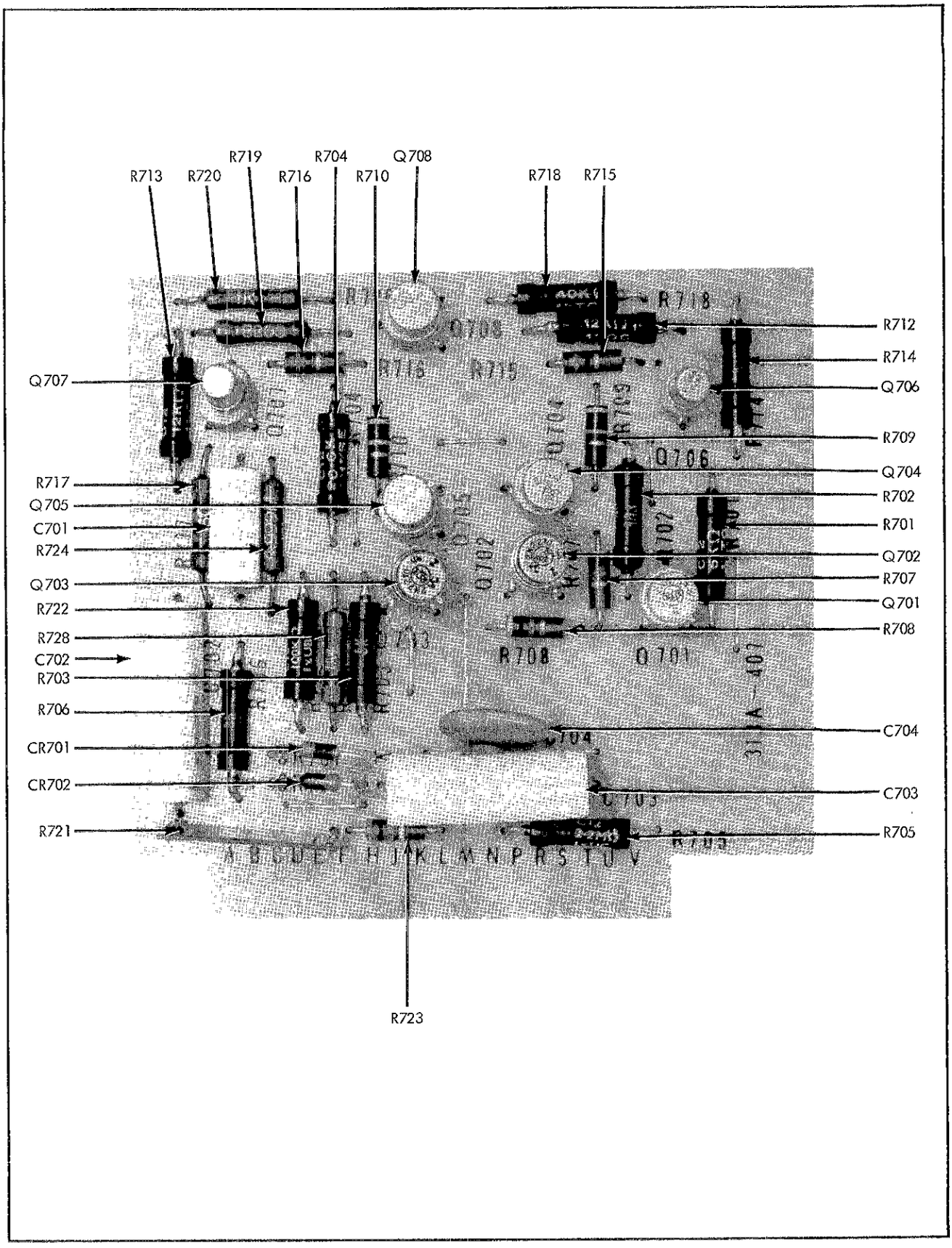


Figure 5-8. MAIN AMPLIFIER ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	SCR Firing Circuit Assembly	*125864 (313A-408)	
C801	Capacitor, ceramic, 0.05 uf -20/+80%, 500V	1501-105676	
C802	Capacitor, plastic, 0.1 uf ±20%, 200V	1507-106435	
C804	Capacitor, electrolytic, 200 uf -10/+100%, 6V	1502-105189	
C805	Capacitor, plastic, 0.22 uf ±10%, 200V	1507-105767	
C806	Capacitor, electrolytic, 50 uf -10/+100%, 50V	1502-105122	
C807	Capacitor, electrolytic, 100 uf -10/+100%, 25V	1502-106518	
C808	Capacitor, ceramic, 0.05 uf -20/+80%, 500V	1501-105676	
C809	Capacitor, ceramic, 560 pf ±10%, 600V	1501-106203	
CR801 thru CR804	Diode, silicon, 600 PIV, 0.75A	4802-112383	
CR805	Diode, zener, 18V, 14 ma	4803-113365	
CR808, CR809	Diode, silicon, 600 PIV, 0.75A Diode, silicon, 100 PIV, 1A	4802-112383 4802-116111	A B
CR810 thru CR813	Diode, silicon, 600 PIV, 0.75A Diode, silicon, 100 PIV, 1A	4802-112383 4802-116111	A B
CR814	Diode, zener, 20V, 6.2 ma	4803-113340	
CR815	Diode, zener, 10V, 12.5 ma	4803-113324	
CR816, CR817	Diode, zener, 3.9V, 20 ma	4803-113316	
CR818	Diode, silicon, 600 PIV, 0.75A	4802-112383	A
CR819	Diode, silicon, stabistor, 6 PIV, 0.150A	4802-113308	A
CR818, CR819	Diode, silicon, 100 PIV, 1A	4802-116111	B
Q802	Transistor, unijunction, type 2N1671	4805-117176	
Q803	Transistor, PNP, germanium, type 2N1372	4805-116129	
Q804	Transistor, NPN, germanium, type 2N1304	4805-117127	
R802	Resistor, composition, 270K ±10%, 1/2W	4704-108258	
R803, R804	Resistor, composition, 100Ω ±10%, 1/2W	4704-108100	
R805	Resistor, composition, 2.7K ±10%, 1/2W	4704-108837	
R806	Resistor, composition, 2.2K ±10%, 1/2W	4704-108605	
R808	Resistor, composition, 1.5K ±10%, 1/2W	4704-108159	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R809	Resistor, composition, 1.8K ±10%, 1/2W	4704-108860	
R810	Resistor, composition, 220Ω ±10%, 1/2W	4704-108191	
R811	Resistor, composition, 2.7Ω ±10%, 1/2W	4704-108845	
R812	Resistor, composition, 390Ω ±5%, 1/2W	4704-109082	
R814	Resistor, variable, wirewound, 5K ±5%, 1-1/4W	4702-111609	
R815	Resistor, composition, 1.5K ±10%, 1/2W	4704-108159	
R816	Resistor, composition, 1K ±10%, 1/2W Resistor, composition, 1.1K ±5%, 1/2W	4704-108563 4704-160432	C D
R817	Resistor, composition, 22K ±10%, 1/2W	4704-108209	
R818	Resistor, composition, 820Ω ±10%, 1/2W	4704-108423	
T801	Transformer	5602-160309	

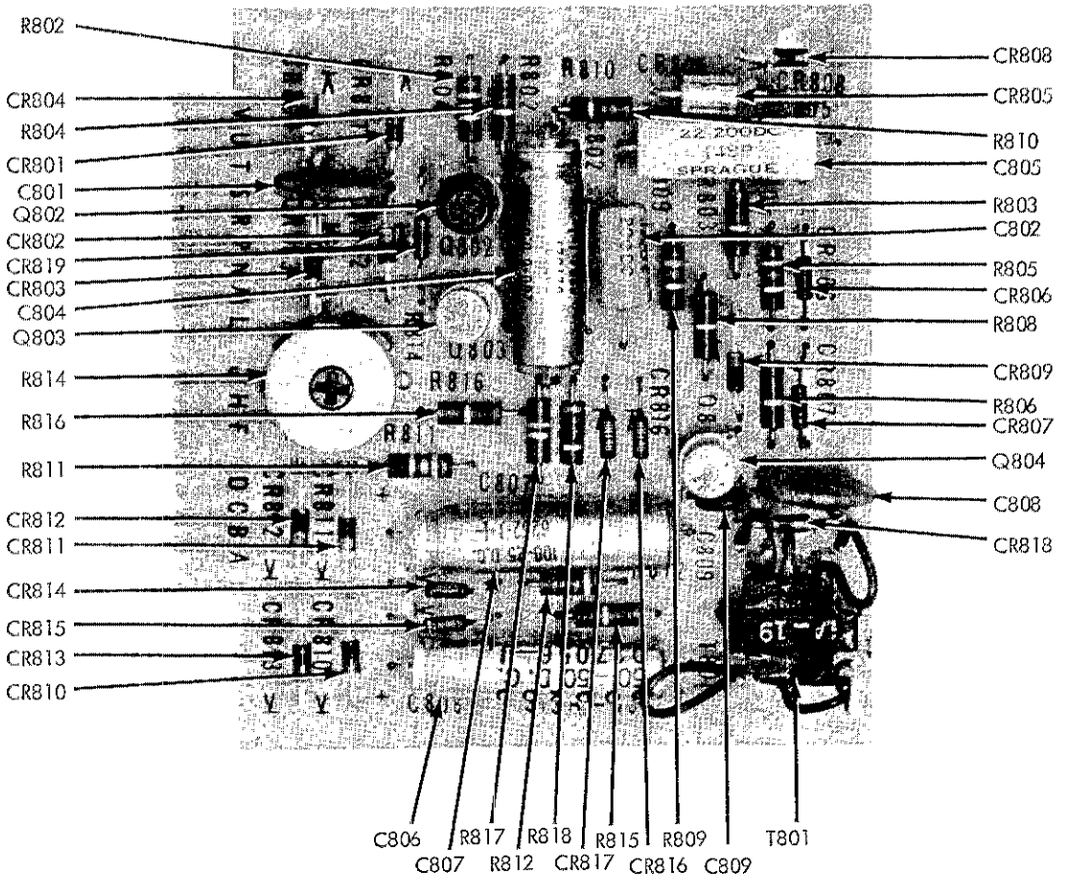


Figure 5-9. SCR FIRING CIRCUIT ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Overcurrent Limiter Assembly	*125872 (313A-409)	
C901	Capacitor, ceramic, 0.05 uf -20/+80%, 500V	1501-105676	A
C902	Capacitor, ceramic, 180 pf ±10%, 500V	1501-105890	A
C904	Capacitor, ceramic, 560 pf ±10%, 600V	1501-106203	
C905	Capacitor, ceramic, 0.01 uf -20/+80%, 500V	1501-105668	
C906	Capacitor, electrolytic, 15 uf, -10/+75%, 6V	1502-105700	B
C907	Capacitor, ceramic, 0.002 uf, GMV, 1000V	1501-105569	B
CR901	Diode, zener, 16V, 7.8 ma	4803-113332	
CR902	Diode, silicon, stabistor, 6 PIV, 0.15A	4802-113308	
CR908	Diode, zener, 12V, 10.5 ma	4803-113456	
CR909	Diode, silicon, stabistor, 6 PIV, 0.15A	4802-113308	
Q901	Transistor, NPN, silicon, type T1496 Transistor, NPN, silicon, type CDQ10449	4805-117218 4805-153551	A B
Q902	Transistor, NPN, silicon, type 2N2270 Transistor, NPN, silicon, type CDQ10449	4805-117135 4805-153551	A B
Q903 thru Q905	Transistor, PNP, germanium, type 2N1372	4805-116129	
R901	Resistor, composition, 22K ±10%, 1/2W	4704-108209	
R902	Resistor, composition, 100K ±10%, 1/2W	4704-108126	
R903	Resistor, composition, 820Ω ±10%, 1/2W	4704-108423	
R904	Resistor, composition, 3.9K ±10%, 2W	4704-110213	
R907	Resistor, composition, 6.8M ±10%, 1/2W Resistor, composition, 220K ±10%, 1/2W	4704-108662 4704-108217	A B
R908	Resistor, composition, 5.1K ±5%, 1/2W	4704-109108	
R909	Resistor, variable, wirewound, 100Ω ±20%, 1-1/4W	4702-112797	
R910	Resistor, composition, 1K ±10%, 1/2W	4704-108563	
R911	Resistor, variable, wirewound, 3K ±10%, 1-1/4W	4702-112458	
R912	Resistor, composition, 5.1K ±5%, 1/2W	4704-109108	
R913	Resistor, composition, 8.2K ±10%, 1/2W	4704-109017	
R914	Resistor, composition, 20K ±5%, 1/2W	4704-109041	
R915	Resistor, composition, 10K ±5%, 1/2W	4704-109165	
R916	Resistor, composition, 33.3K ±1%, 1/2W	4704-107714	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R918	Resistor, composition, 52.14K ±1%, 1/2W	4704-107284	
R919	Resistor, composition, 2.7Ω ±10%, 1/2W	4704-108845	
R921	Resistor, composition, 430Ω ±5%, 1/2W	4704-109058	
R922	Resistor, composition, 6.8K ±10%, 1/2W	4704-108399	
R923	Resistor, composition, 10K ±10%, 1/2W	4704-108118	
R924	Thermistor, 10K ±10%, 3 mw	4708-104596	
R925	Resistor, composition, 560Ω ±10%, 1/2W	4704-108316	B
R926	Resistor, composition, 5.1K ±5%, 1/2W	4704-109918	B

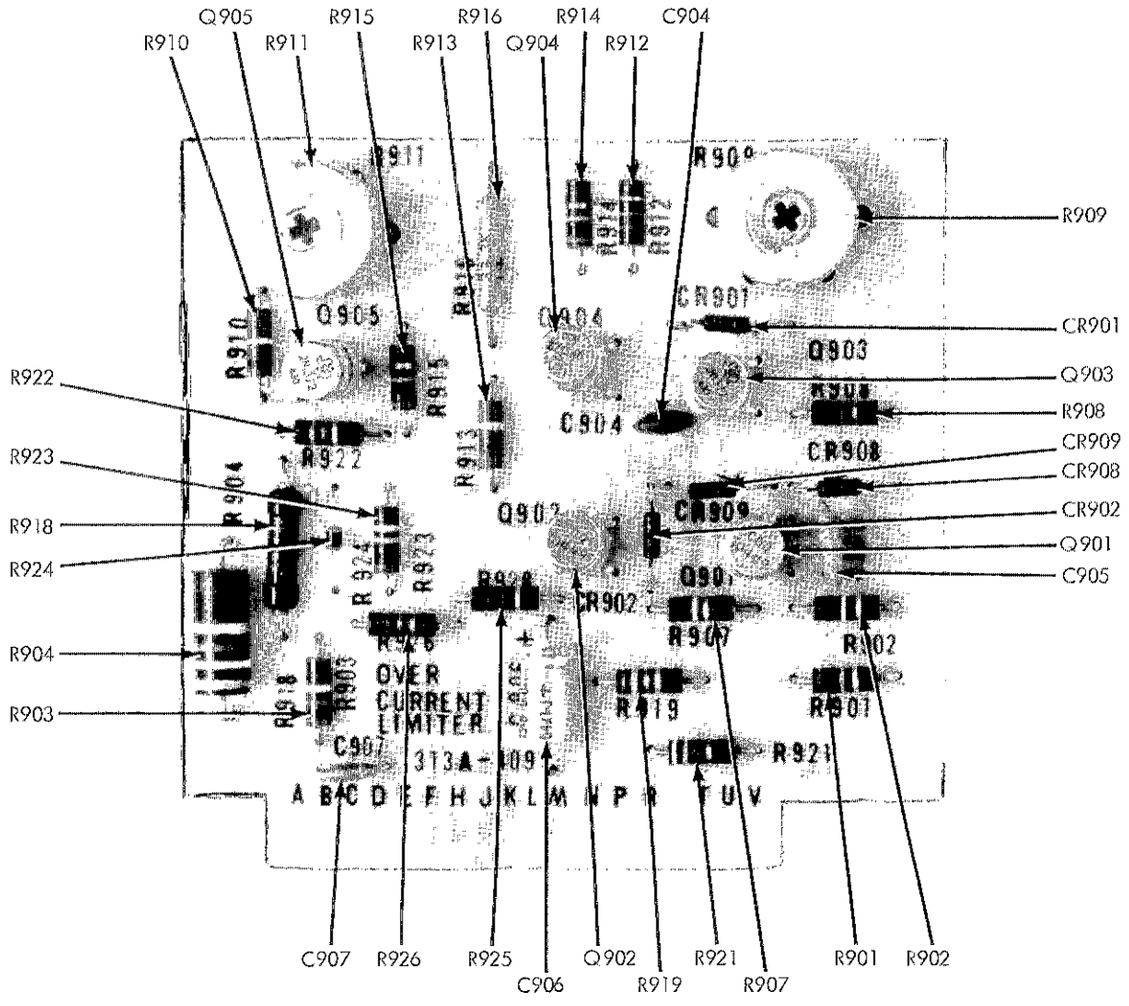


Figure 5-10. OVERCURRENT LIMITER ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Meter Shunt Assembly	*125880 (313A-410)	
C1001	Capacitor, electrolytic, 50 uf -10/+100%, 50V	1502-105122	A
C1002	Capacitor, electrolytic, 100 uf -10/+100%, 25V	1502-106518	A
CR1001	Diode, silicon, 600 PIV, 0.75A Diode, silicon, 100 PIV, 1A	4802-112383 4802-116111	A B
R1001	Resistor, wirewound, 15Ω ±1%, 1/2W	4707-113464	
R1002	Resistor, deposited carbon, 165Ω ±1%, 1W	4703-107946	
R1003	Resistor, deposited carbon, 4.75K ±1%, 1/2W	4703-107961	
R1004	Resistor, deposited carbon, 7.5K ±1%, 1/2W	4703-108027	
R1005	Resistor, deposited carbon, 44.2K ±1%, 1/2W	4703-107912	
R1006	Resistor, composition, 100Ω ±10%, 1/2W	4704-108092	
R1007	Resistor, deposited carbon, 20K ±1%, 1/2W	4703-107136	
R1008	Resistor, deposited carbon, 43.5K ±1%, 1/2W	4703-107706	

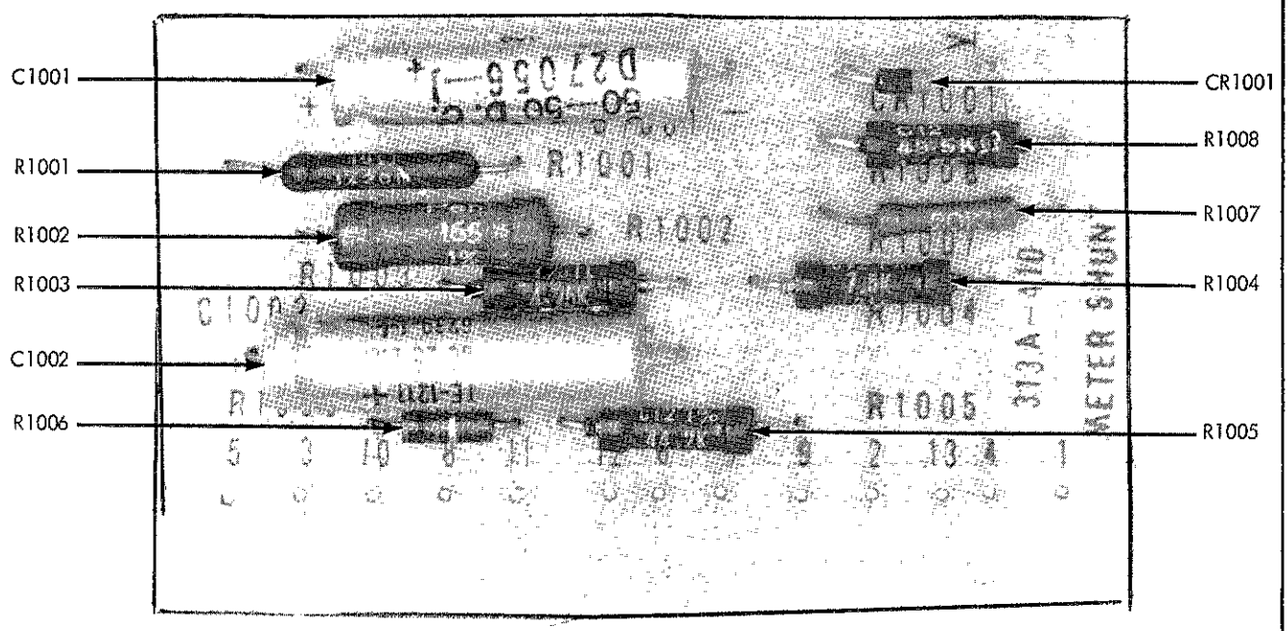


Figure 5-11. METER SHUNT ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Driver Assembly	*125898 (313A-411)	
C1101	Capacitor, plastic, 0.047 uf ±20%, 100V	1407-106096	
C1102	Capacitor, plastic, 0.1 uf ±20%, 200V	1507-106435	
C1103	Capacitor, ceramic, 500 pf ±10%, 500V	1501-105692	M
	Capacitor, ceramic, 1200 pf ±10%, 500V	1501-106732	N
CR1101, CR1102	Diode, silicon, 6V, 0.10A	4802-113308	
CR1103, CR1104	Diode, silicon, 600 PIV, 0.75A	4802-112383	A
	Diode, silicon, 100 PIV, 1A	4802-116111	B
CR1105	Diode, silicon, 6V, 0.10A	4802-113308	A
	Diode, silicon, 100 PIV, 1A	4802-116111	B
Q1101	Transistor, NPN, silicon, type T1496	4805-117218	K
	Transistor, NPN, silicon, type CDQ10449	4805-153551	L
Q1102	Transistor, PNP, silicon, type SM4144, selected	4805-188938	
Q1103	Transistor, PNP, germanium, type 2N1187	4805-117150	
Q1104	Transistor, PNP, germanium, type 2N1372	4805-116129	
Q1105	Transistor, NPN, silicon, type 2N2270	4805-117135	A
	Transistor, NPN, silicon, type CDQ10449	4805-153551	B
Q1106	Transistor, NPN, silicon, type TI496	4805-117218	A
	Transistor, NPN, silicon, type CDQ10449	4805-153551	B
Q1107	Transistor, PNP, germanium, type 2N2869	4825-152868	
Q1108	Transistor, PNP, silicon, type SM4144, selected	4805-188938	
R1101	Resistor, composition, 27K ±10%, 2W	4704-110098	
R1103	Resistor, deposited carbon, 200Ω ±1%, 1/2W	4703-107060	
R1104	Resistor, composition, 5.6K ±10%, 1/2W	4704-108324	
R1105	Resistor, composition, 6.8K ±10%, 2W	4704-110064	
R1106	Resistor, composition, 2.2K ±10%, 1/2W	4704-108605	
R1107	Resistor, composition, 27K ±10%, 1/2W	4704-108878	
R1108	Resistor, composition, 510Ω ±5%, 1/2W	4704-108951	
R1113	Resistor, composition, 220Ω ±10%, 1/2W	4704-108191	C
	Resistor, composition, 100Ω ±10%, 1/2W	4704-108100	D
R1114	Resistor, composition, 820Ω ±10%, 1/2W	4704-108423	
R1115	Resistor, composition, 330Ω ±10%, 1/2W	4704-108589	
R1116	Resistor, variable, wirewound, 1K ±20%, 1-1/4W	4702-111575	
R1117, R1118	Resistor, composition, 22Ω ±10%, 1/2W	4704-108670	
R1119	Resistor, composition, 220K ±10%, 1/2W	4704-108217	

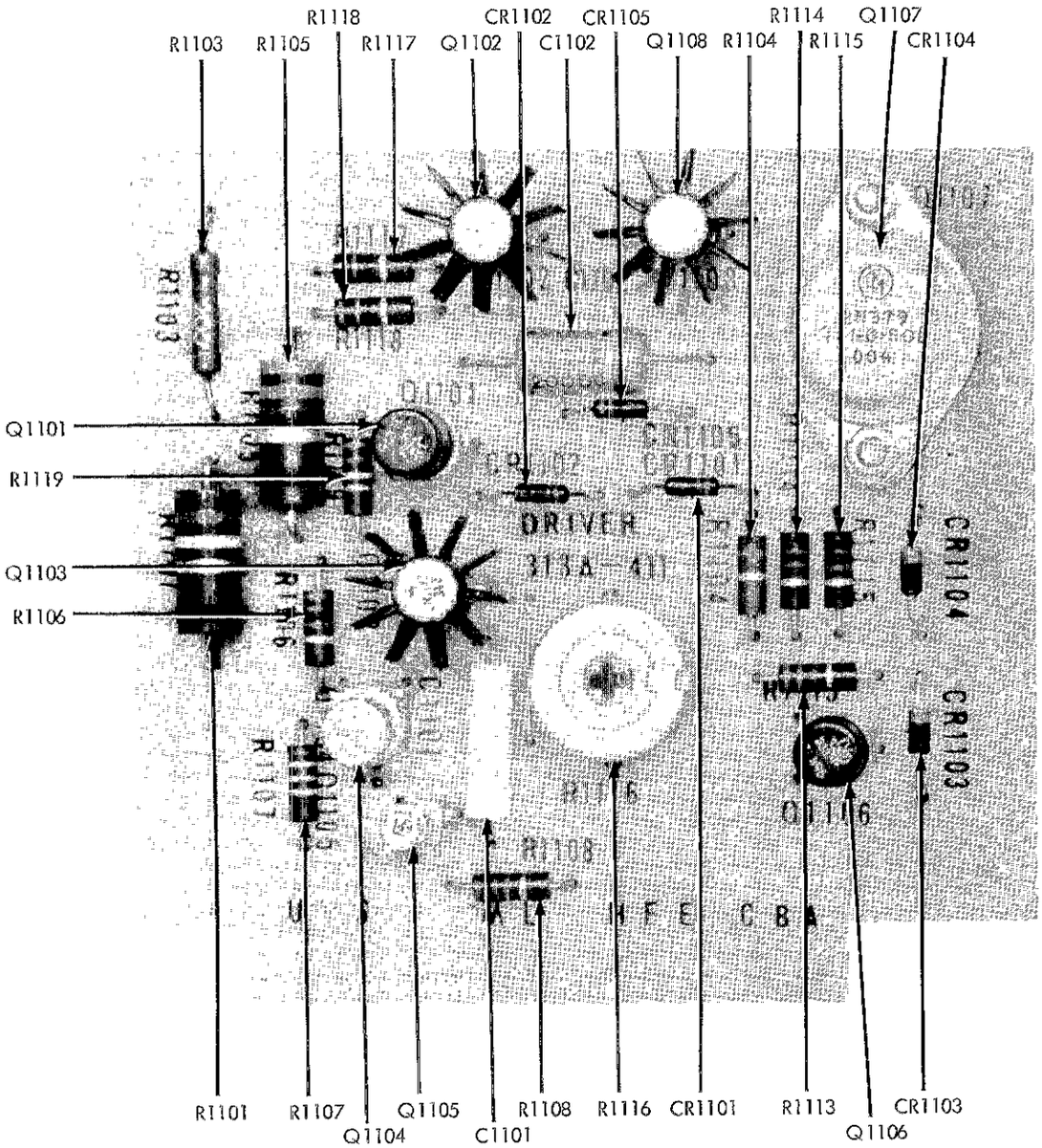


Figure 5-12. DRIVER ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Rectifier Assembly	*125906 (313A-412)	
C1202	Capacitor, ceramic, 0.05 uf -20/+80%, 500V	1501-105676	
C1203, C1204	Capacitor, ceramic, 0.001 uf ±20%, 3000V	1501-105635	
C1205	Capacitor, ceramic, 0.05 uf -20/+80%, 500V	1501-105676	
C1206	Capacitor, ceramic, 0.001 uf ±20%, 3000V	1501-105635	
C1207	Capacitor, ceramic, 0.01 uf -20/+80%, 500V	1501-105668	
CR1201 thru CR1204	Diode, silicon, 200 PIV, 1.5A Diode, silicon, 200 PIV, 12A	4802-113357 4802-188854	V W
CR1205	Diode, silicon, 600 PIV, 0.75A	4802-112383	
CR1206	Diode, silicon, 600 PIV, 0.75A	4802-112383	
L1201	Choke, RF	2511-125963	
L1202, L1203	Choke, RF, 100 uh ±5%, 1/2W	1801-111542	
Q1201	Silicon controlled rectifier, 7A, 150V breakover Type C-15G	4802-113472	
R1202	Resistor, composition, 470Ω ±10%, 1/2W	4704-108415	
R1203	Resistor, composition, 180Ω ±10%, 1/2W	4704-108571	

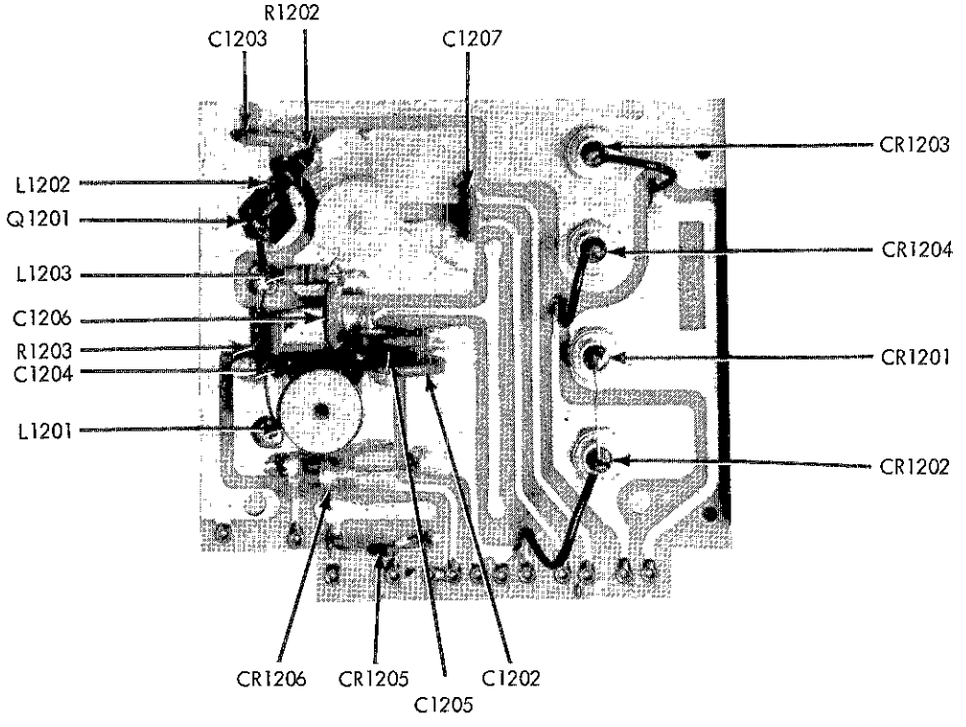


Figure 5-13. RECTIFIER ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Reference Oven Assembly	*145029 (313A-418)	
CR1401	Diode, zener, 9.0V, 7.5 ma	4803-113373	O
	Diode, zener, 6.3V, 7.5 ma	4803-172148	P
CR1402	Diode, zener, 6.3V, 7.5 ma	*4803-147520	
Q1401	Transistor, PNP, germanium, type 2N1372	4805-116129	O
	Transistor, PNP, silicon, type SM4144	4805-159491	P
R1401	Resistor, metal film, 2.15K, ±1%, 1/2W	4705-144733	O
	Resistor, metal film, 2.55K ±1%, 1/2W	4705-176362	P

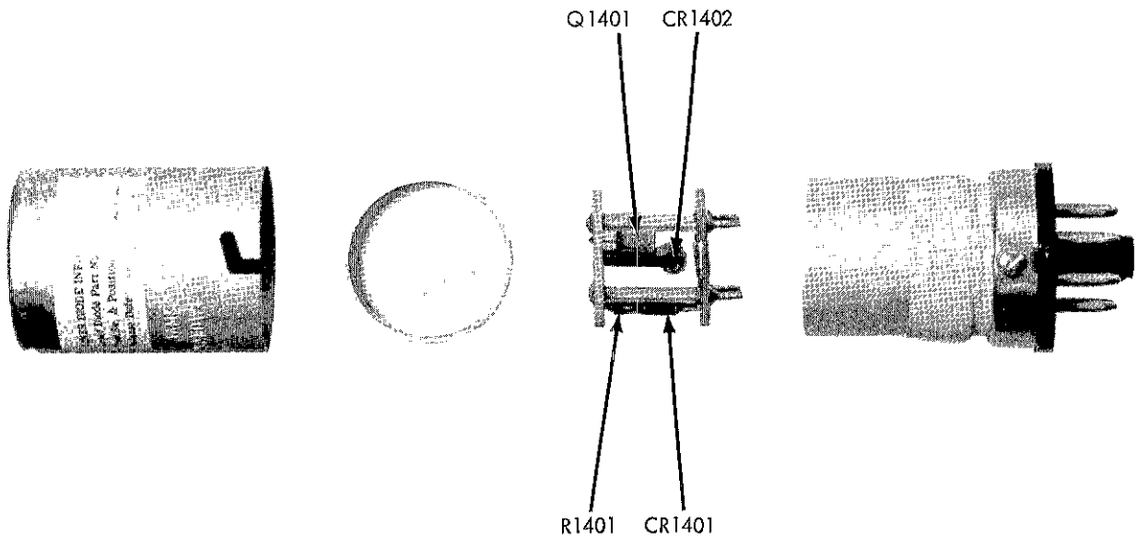


Figure 5-14. REFERENCE OVEN ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Current Shunt Assembly	*153619 (382A-451)	
R5101	Resistor, variable, wirewound, 25Ω ±10%, 1-1/4W	4702-113431	
R5102	Resistor, metal film, 21.5Ω ±1%, 1/2W	4705-151035	
R5103	Resistor, wirewound, 6Ω ±0.1%, 0.05W	*4707-153841	
R5104	Resistor, wirewound, 975Ω ±0.01%, 0.025W	*4707-153833	
R5105	Resistor, variable, wirewound, 25Ω ±10%, 1-1/4W	4702-113431	
R5106	Resistor, metal film, 10Ω ±1%, 1/2W	4705-151043	
R5107	Resistor, wirewound, 1.05Ω ±0.1%, 0.05W	*4707-153817	
R5108	Resistor, wirewound, 97Ω ±0.01%, 1/4W	*4707-153825	
R5109	Resistor, variable, wirewound, 3K ±20%, 1-1/4W	4702-149781	
R5110	Resistor, metal film, 2150Ω, ±1%, 1/2W	4705-144733	
R5112	Resistor, variable, wirewound, 300Ω ±10%, 1-1/4W	4702-154583	
R5113	Resistor, metal film, 215Ω ±1%, 1/2W	4705-150862	

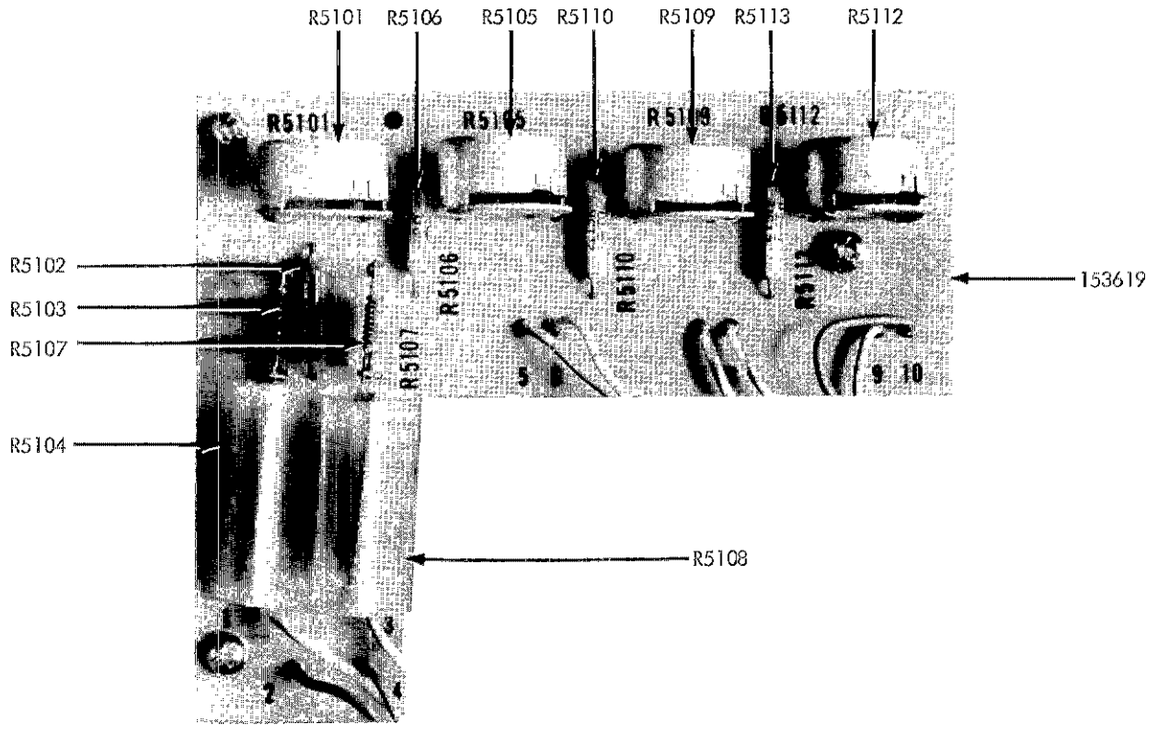


Figure 5-15. CURRENT SHUNT ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Voltage Limit Assembly	*153627 (382A-452)	
C5201	Capacitor, ceramic, 0.005 uf ±20%, 500V	1501-105650	
CR5201, CR5202	Diode, silicon, 600 PIV, 0.75A	4802-112383	
DS5201	Lamp, neon, type 55ST2A	3902-153205	T
CR5203	Diode, zener, 56V, 7ma	4803-187757	U
Q5201	Transistor, PNP, germanium, type 2N2042	4805-117226	
R5201	Resistor, composition, 2.7K, ±10%, 1/2W	4704-108837	
R5202	Resistor, composition, 5.1K ±5%, 1/2W	4704-109108	R
	Resistor, wirewound, 1K ±0.04%, 1/2W	4707-131706	S
R5203, R5204	Resistor, composition, 5.1K ±5%, 1/2W	4704-109108	
R5205	Resistor, wirewound, 120Ω ±0.05%, 1/2W	*4707-154948	R
	Resistor, wirewound, 1K ±0.04%, 1/2W	*4707-131706	S
R5206	Resistor, variable, wirewound, 25Ω ±10%, 1-1/4W	4702-113431	R
	Resistor, variable, wirewound, 500Ω ±20%, 1-1/4W	4702-113258	S
R5207	Resistor, metal film, 80.6K ±1%, 1/2W	4705-150680	O
	Resistor, metal film, 54.9K ±1%, 1/2W	4705-176669	P
R5208	Resistor, variable, wirewound, 10K ±10%, 1/4W	4702-111641	
R5209	Resistor, composition, 1K ±5%, 1/2W	4704-108597	

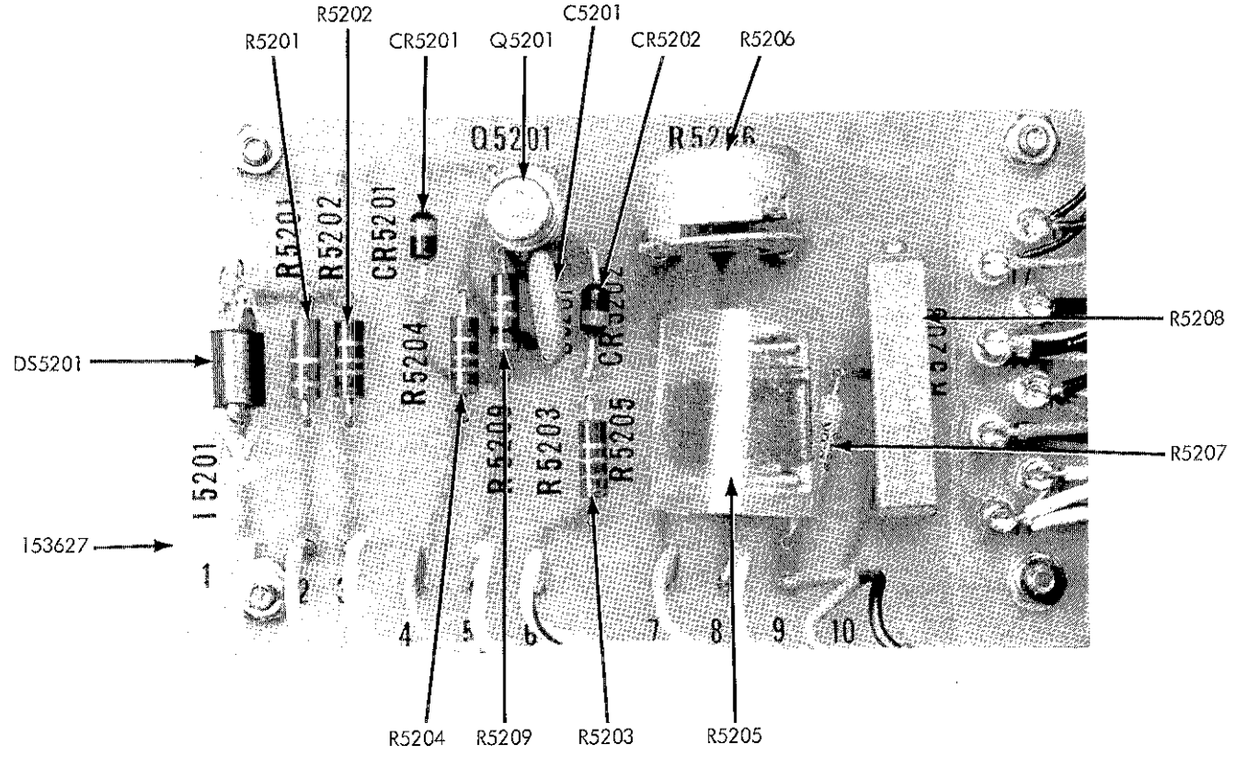


Figure 5-16. VOLTAGE LIMIT ASSEMBLY

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Bucking Oven Assembly	*153635 (382A-453)	
CR5301	Diode, zener, 9.0V, 7.5 ma	4803-113373	O
	Diode, zener, 6.3V, 7.5 ma	4803-172148	P
Q5301	Transistor, NPN, silicon, type NS734	4805-117192	H
	Transistor, NPN, silicon, type CDQ10449	4805-153551	J
R5301	Resistor, metal film, 806Ω ±1%, 1/2W	4705-150698	O
	Resistor, metal film, 1.15K ±1%, 1/2W	4705-155010	P

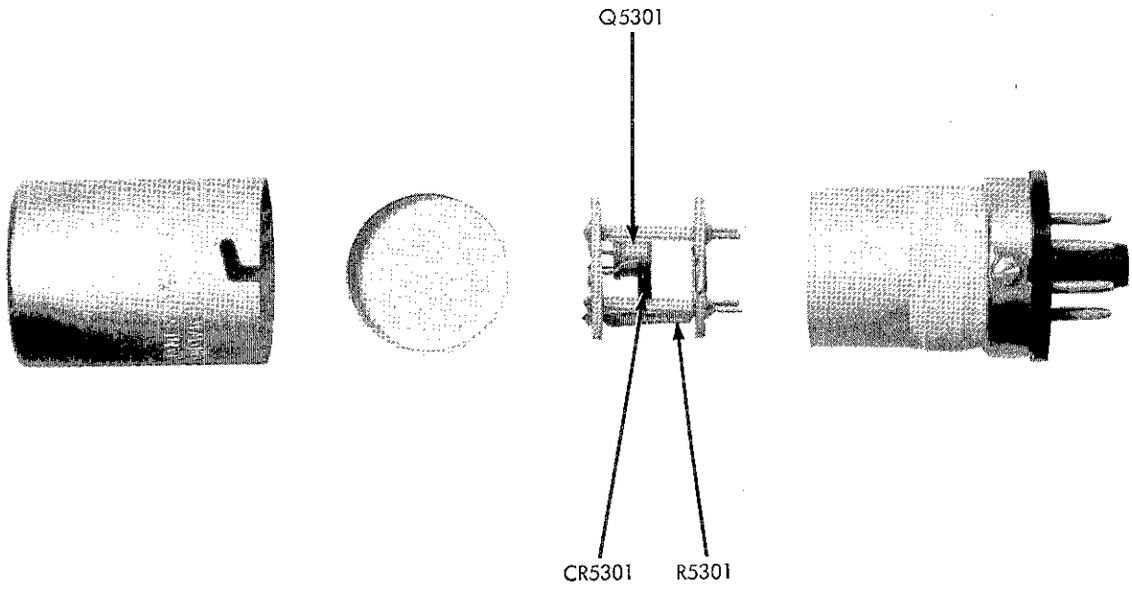


Figure 5-17. BUCKING OVEN ASSEMBLY

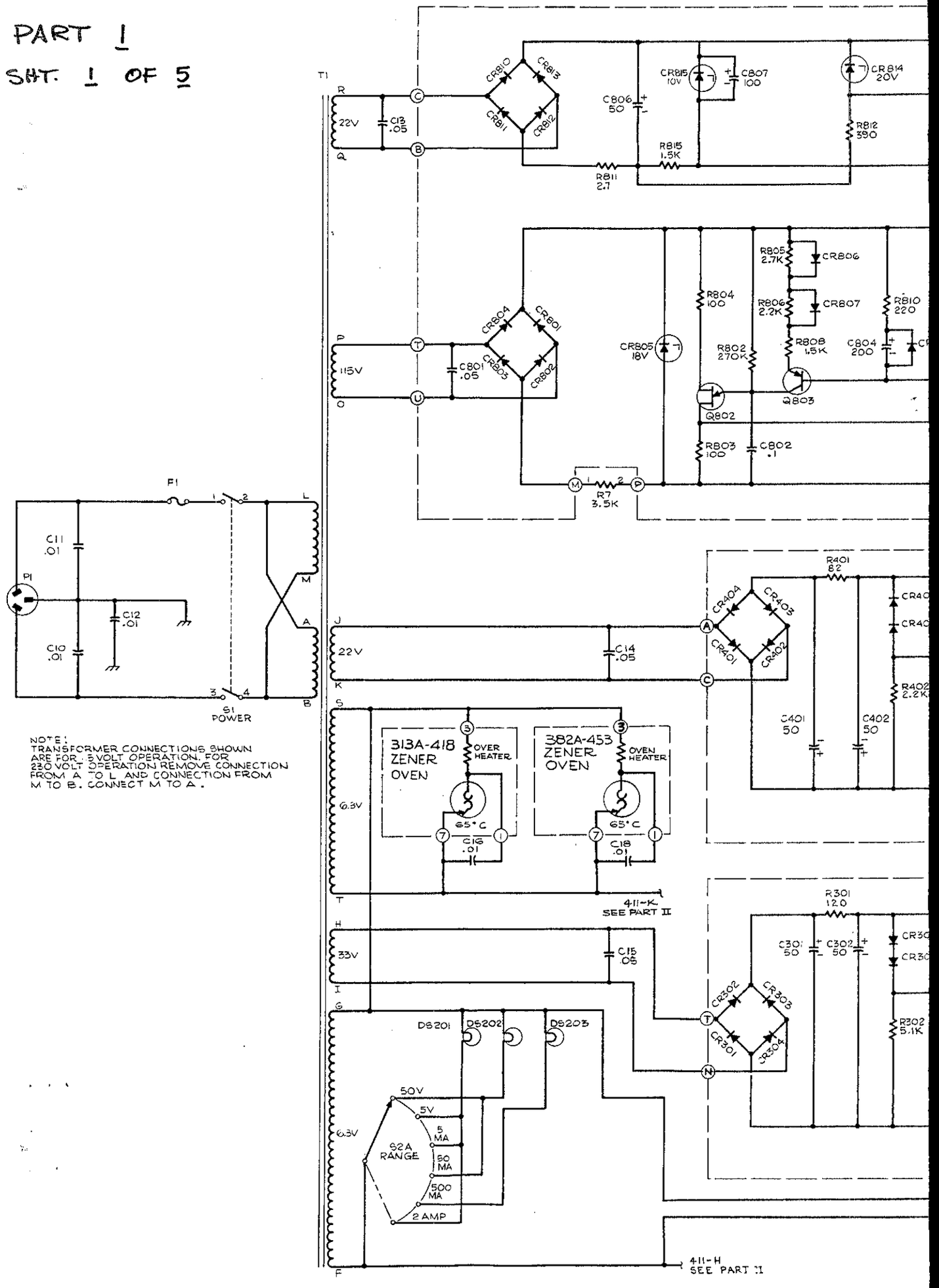
5-7. USE CODE EFFECTIVITY

5-8. The following list of use codes allows the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments having serial number 123 and on. New codes will be added as required by changes to the instrument.

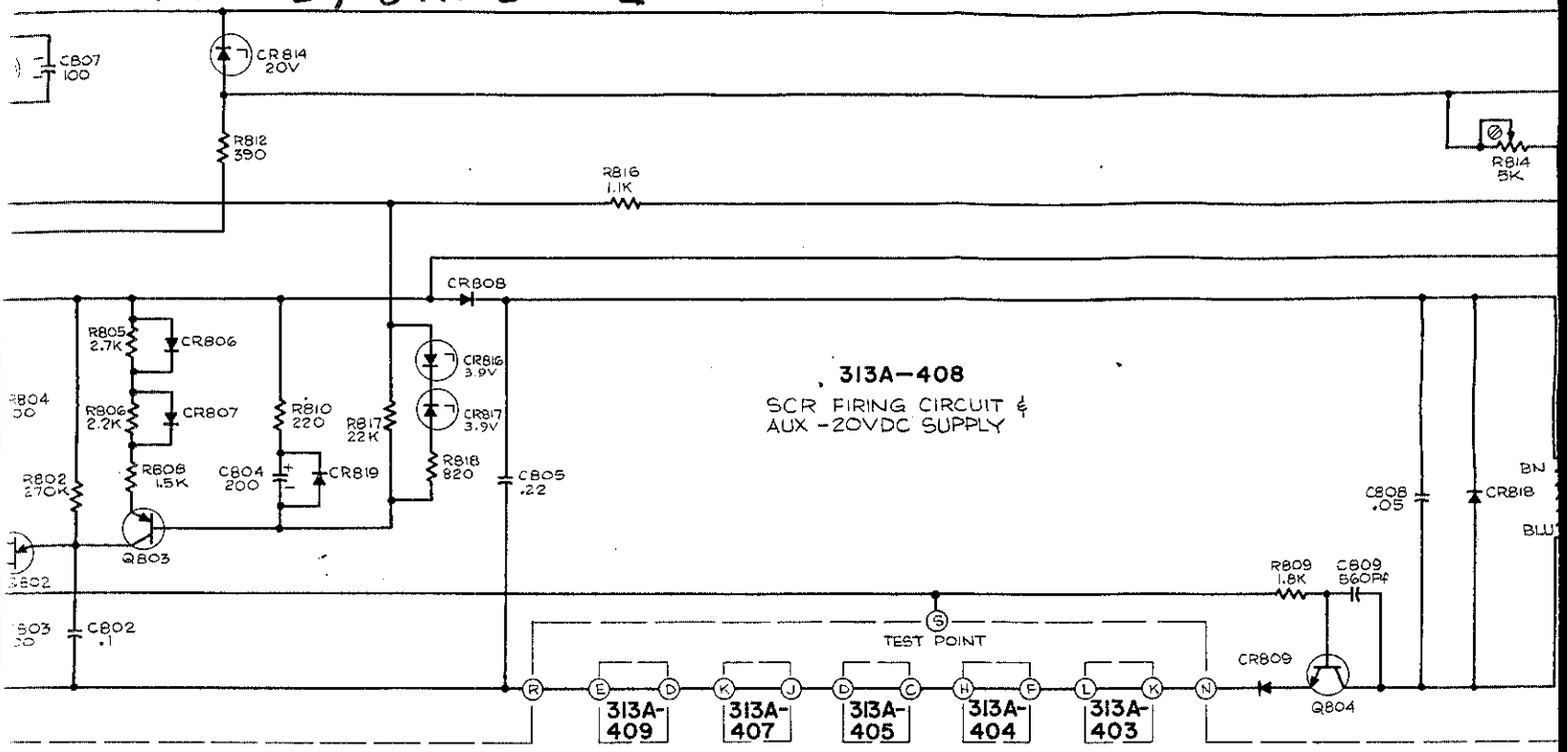
USE CODE	EFFECTIVITY
No Code	Model 382A, serial number 123 and on.
A	Model 382A, serial number 123 thru 157.
B	Model 382A, serial number 158 and on.
C	Model 382A, serial number 123 thru 132.
D	Model 382A, serial number 133 and on.
E	Model 382A, serial number 123 thru 139.
F	Model 382A, serial number 140 and on.
G	Model 382A, serial number 126, 127, 134 to 136, 138, 143, and on.
H	Model 382A, serial number 123 thru 199.
J	Model 382A, serial number 200 and on.
K	Model 382A, serial number 123 thru 209.
L	Model 382A, serial number 210 and on.
M	Model 382A, serial number 123 thru 225.
N	Model 382A, serial number 226 and on.
O	Model 382A, serial number 123 thru 239.
P	Model 382A, serial number 240 and on.
Q	Model 382A, serial number 200 thru 239.
R	Model 382A, serial number 123 thru 274.
S	Model 382A, serial number 275 and on.
T	Model 382A, serial number 123 thru 324.
U	Model 382A, serial number 325 and on.
V	Model 382A, serial number 123 thru 299.
W	Model 382A, serial number 300 and on.

PART 1

SHT. 1 OF 5



NOTE:
TRANSFORMER CONNECTIONS SHOWN ARE FOR 5 VOLT OPERATION. FOR 230 VOLT OPERATION REMOVE CONNECTION FROM A TO L AND CONNECTION FROM M TO B. CONNECT M TO A.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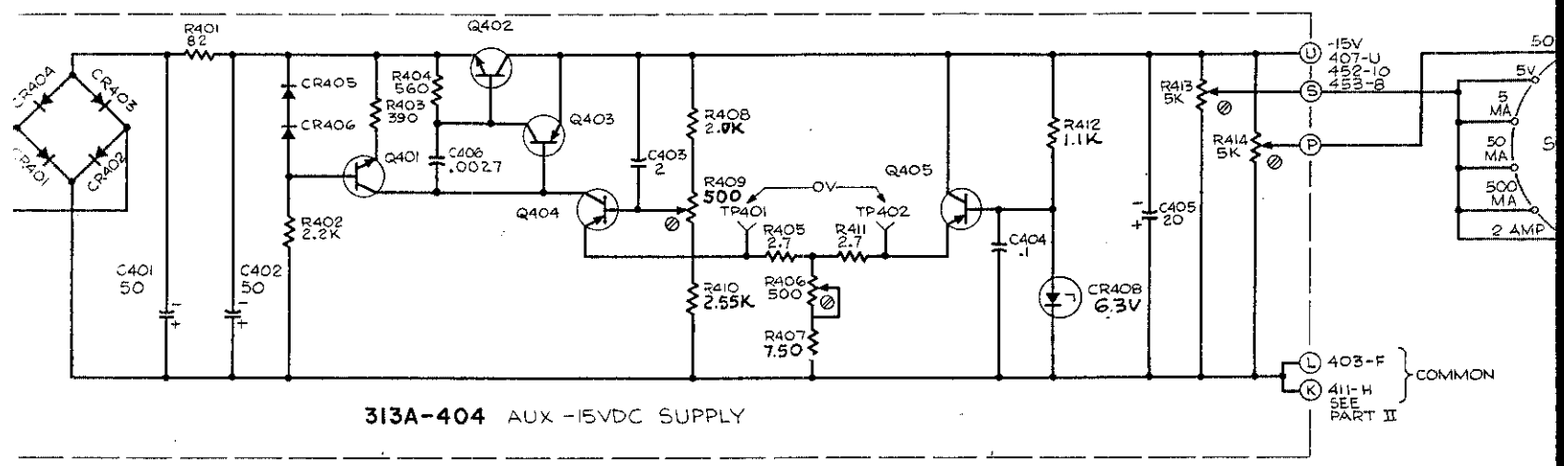
CR814 20V
R812 390
R816 1.1K
R814 5K
CR808
R805 2.7K
CR806
R806 2.2K
CR807
R808 1.5K
R802 27K
Q803
C804 200
CR819
R810 220
R817 22K
CR816 3.9V
CR817 3.9V
R818 820
C805 .22
C802 .1
313A-408
SCR FIRING CIRCUIT & AUX -20VDC SUPPLY
C808 .05
CR818
R809 1.8K
C809 560PF
TEST POINT
CR809
Q804
313A-409
313A-407
313A-405
313A-404
313A-403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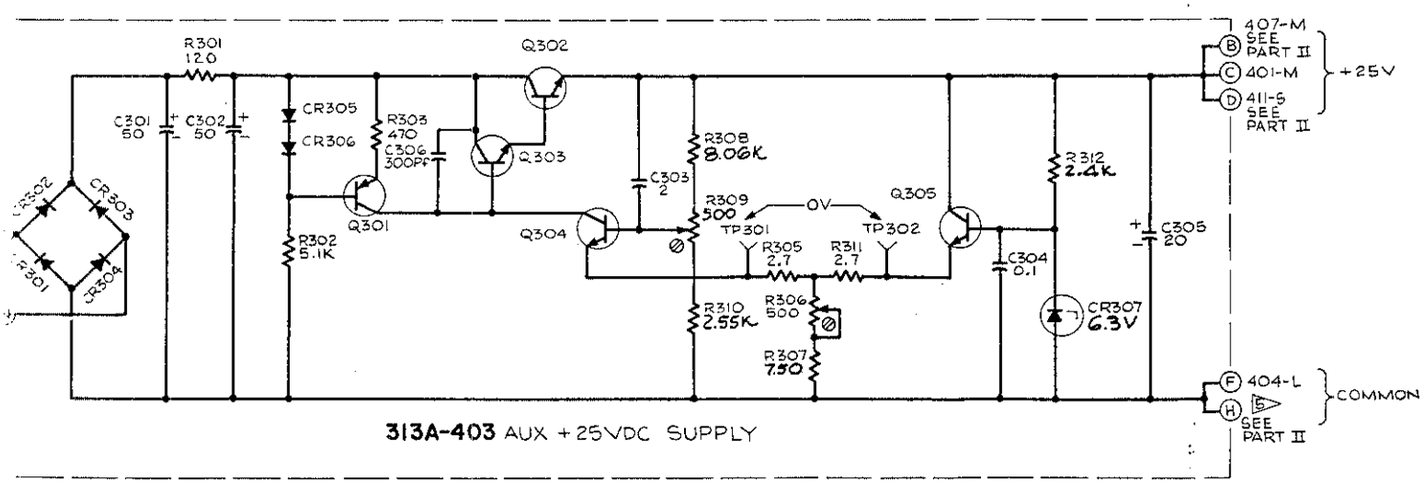
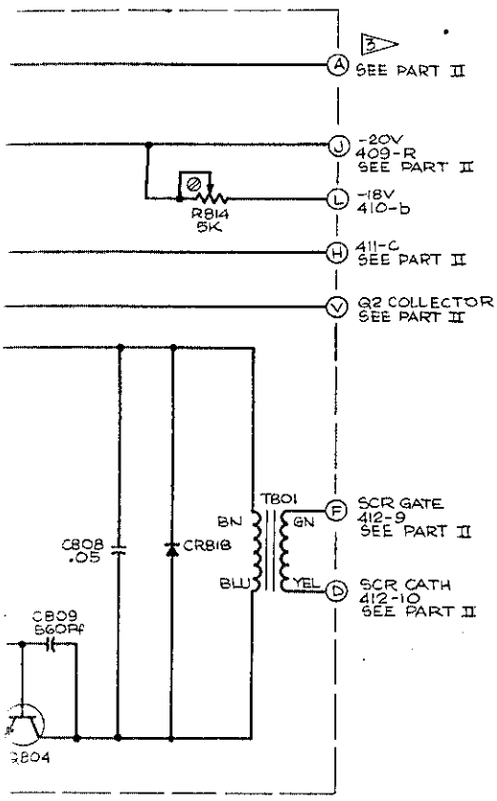
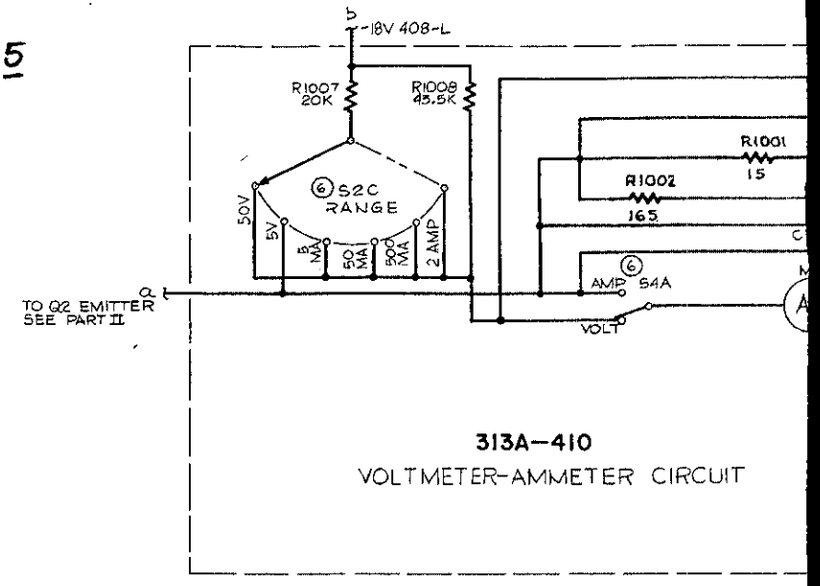
Q402
CR404
CR403
CR401
CR402
CR405
CR406
R404 560
R403 390
Q401
C406 .0027
Q403
Q404
R408 2.0K
C403 2
R409 500
TP401
TP402
Q405
R405 2.7
R411 2.7
R402 2.2K
C401 50
C402 50
R410 2.55K
R406 500
R407 7.50
C404 .1
CR408 6.3V
R412 1.1K
C405 20
R413 5K
R414 5K
-15V
407-U
452-10
453-8
5V
5 MA
50 MA
500 MA
2 AMP
403-F
411-H
SEE PART II
COMMON
313A-404 AUX -15VDC SUPPLY

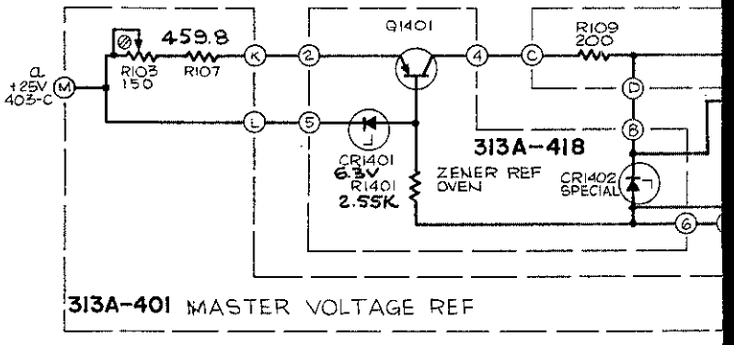

R301 12.0
Q302
C301 50
C302 50
CR305
CR306
R303 470
C306 300PF
Q303
Q301
Q304
R308 8.06K
C303 2
R309 500
TP301
TP302
Q305
R305 2.7
R311 2.7
R302 5.1K
R310 2.55K
R306 500
R307 7.50
C304 0.1
CR307 6.3V
R312 2.4K
C305 20
CR302
CR303
CR301
CR304
407-M
SEE PART II
401-M
411-S
SEE PART II
+25V
404-L
SEE PART II
COMMON
313A-403 AUX +25VDC SUPPLY

PART 1
SHT. 3 OF 5

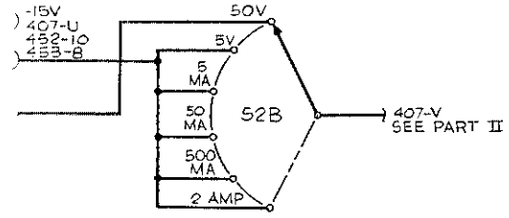


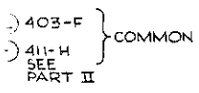


313A-410
VOLTMETER-AMMETER CIRCUIT



313A-401 MASTER VOLTAGE REF

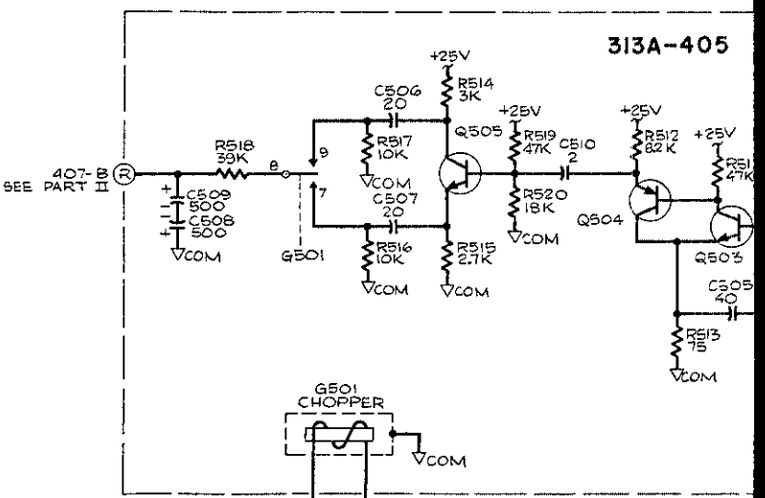


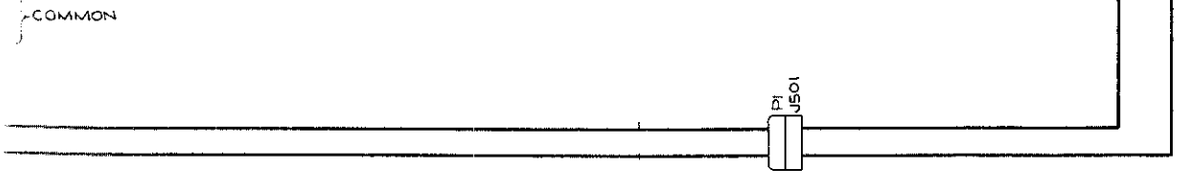


+25V

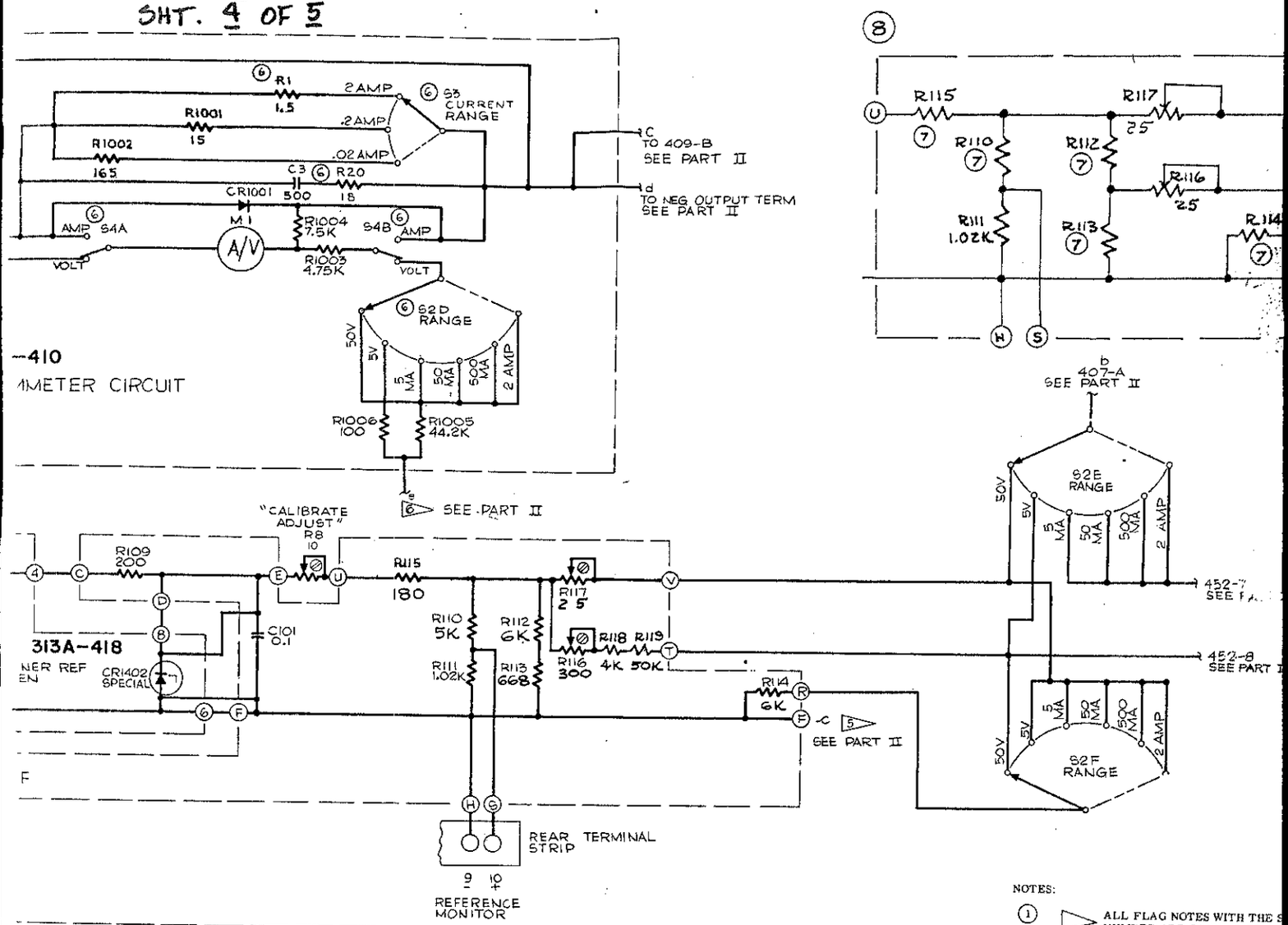
COMMON

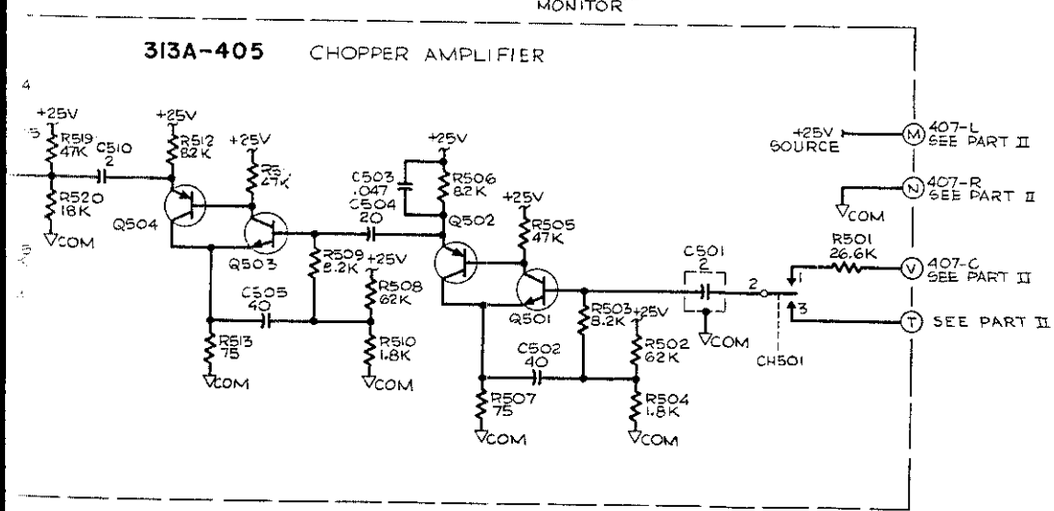
313A-405





PART 1
SHT. 4 OF 5





NOTES:

1. ALL FLAG NOTES WITH THE S NUMBER ARE CONNECTED.
2. RESISTANCE IN OHMS, CAPACITANC MICROFARADS UNLESS OTHERWISE N
3. ALL VOLTAGES ARE DC UNLESS OTH NOTED.
4. INDICATES INTERNAL ADJUST
5. INDICATES CHASSIS GROUND.
6. THESE PARTS NOT LOCATED ON THIS BOARD.
7. FACTORY SELECTED.
8. FOR SER. NO. 240 274: USE CIRCUIT CONFIGURATI SHOWN.

FUNCTIONAL SCHEMATIC

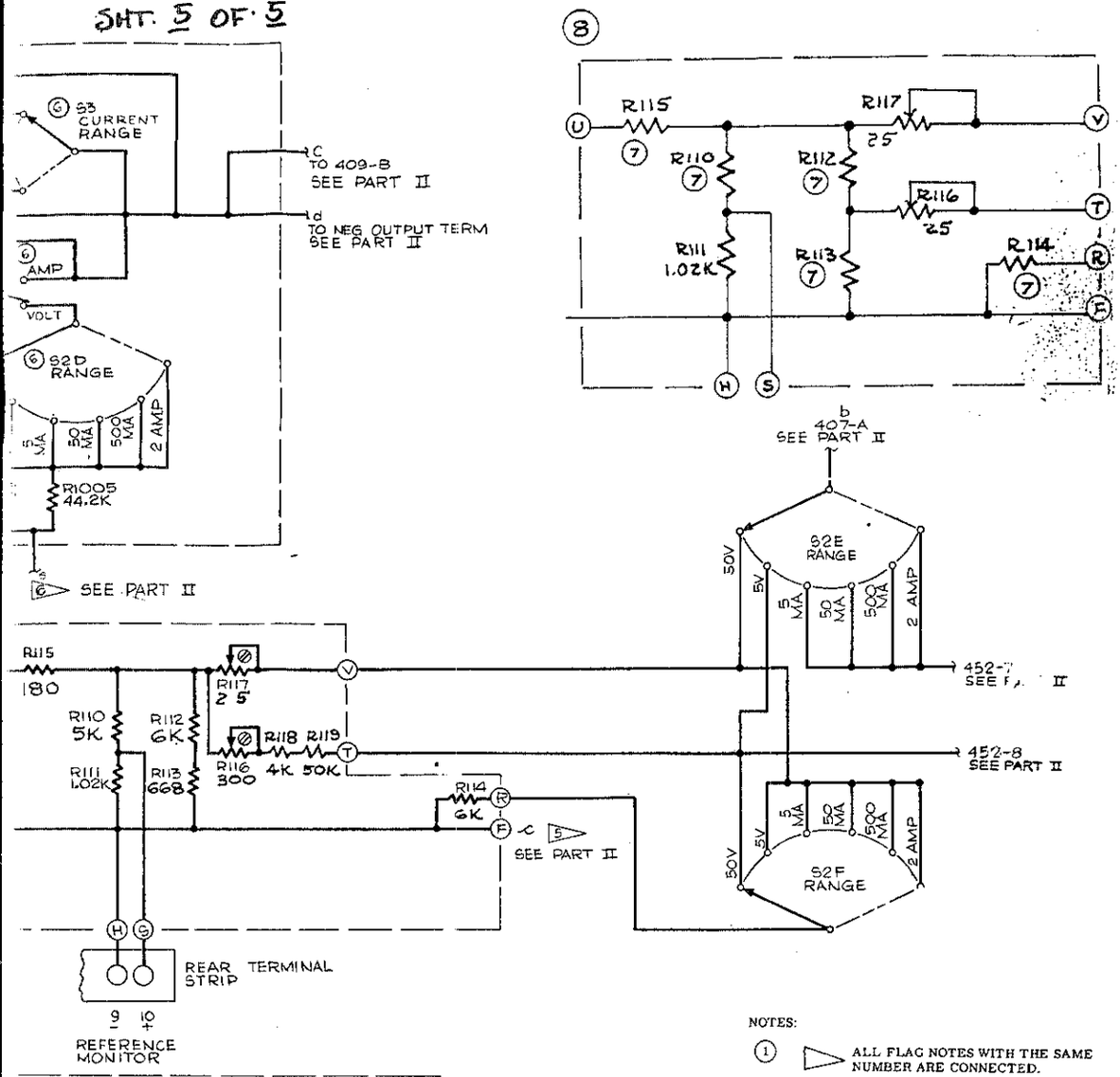
VOLTAGE & CURRENT CALIBRATOR

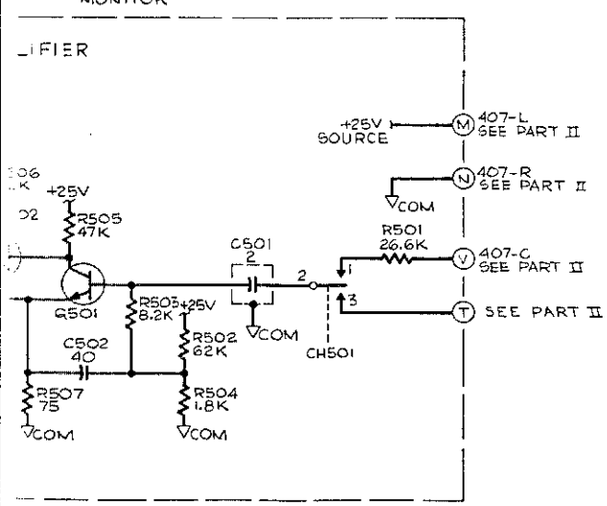
MODEL 382A PART 1

382A SER. NO. 240 & ON

FLUKE JOHN FLUKE MFG. CO., P.O. Box 7428 Seattle, Washingto

PART 1
SHT. 5 OF 5





NOTES:

1. ALL FLAG NOTES WITH THE SAME NUMBER ARE CONNECTED.
2. RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS UNLESS OTHERWISE NOTED.
3. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
4. INDICATES INTERNAL ADJUSTMENT.
5. INDICATES CHASSIS GROUND.
6. THESE PARTS NOT LOCATED ON THIS BOARD.
7. FACTORY SELECTED.
8. FOR SER. NO. 240 THRU 274: USE CIRCUIT CONFIGURATION SHOWN.

FUNCTIONAL SCHEMATIC

VOLTAGE & CURRENT CALIBRATOR

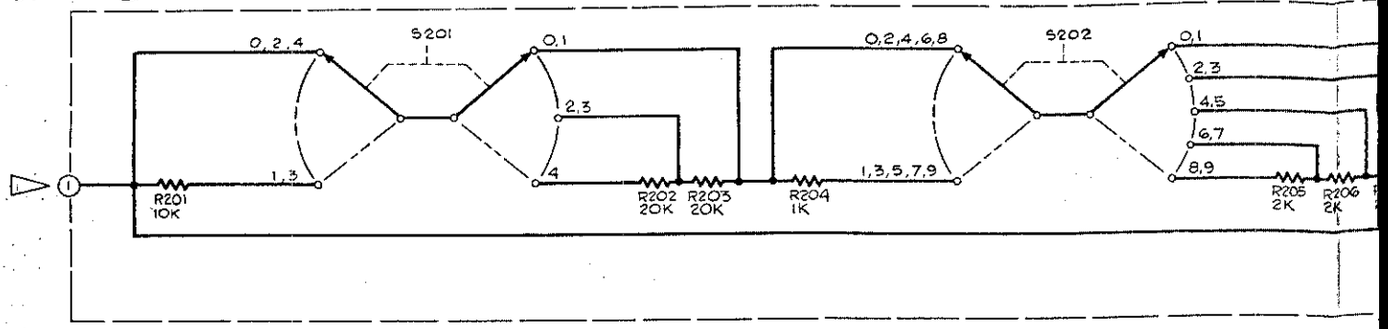
MODEL 382A PART I

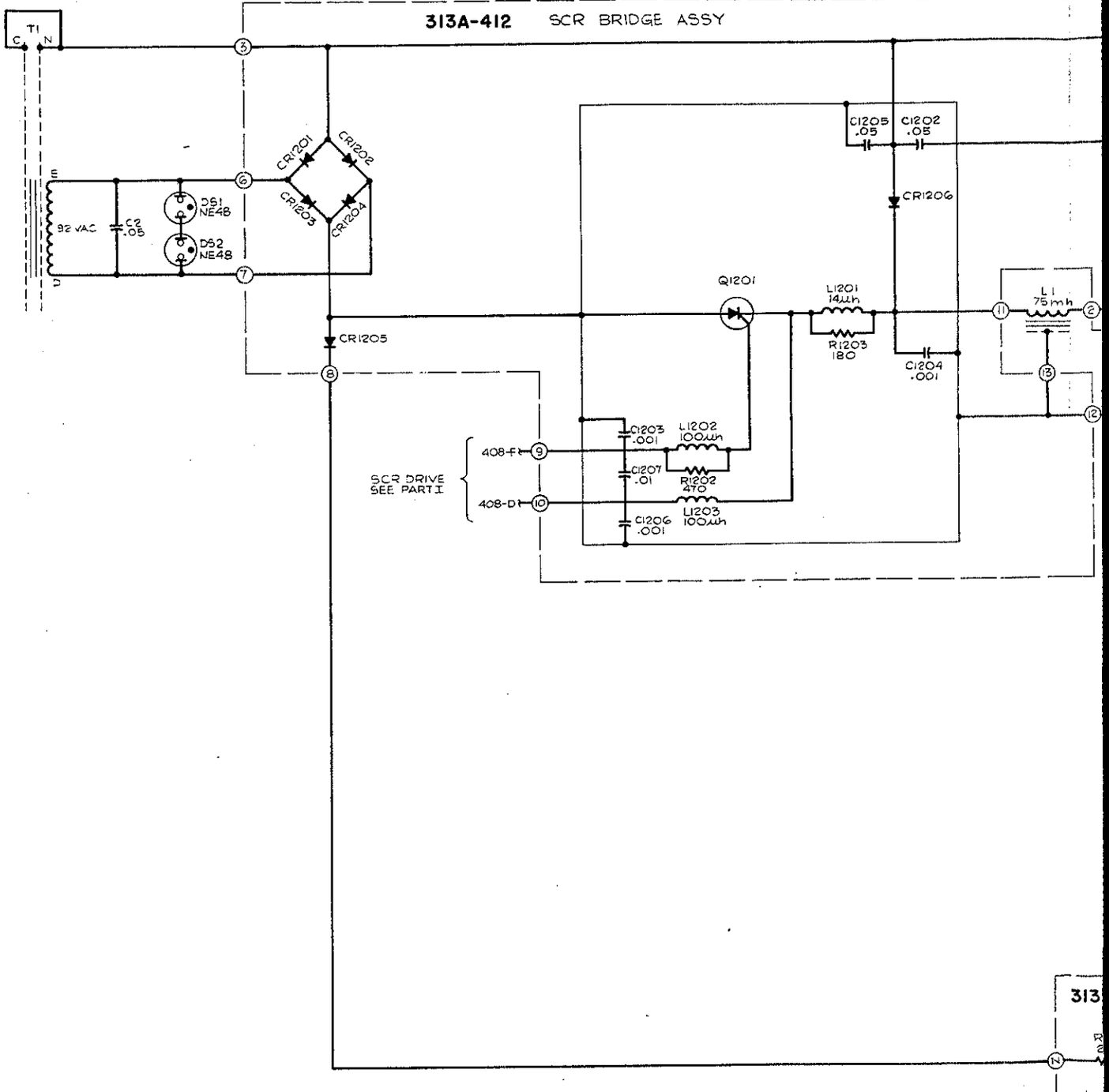
9

382A SER. NO. 240 & ON

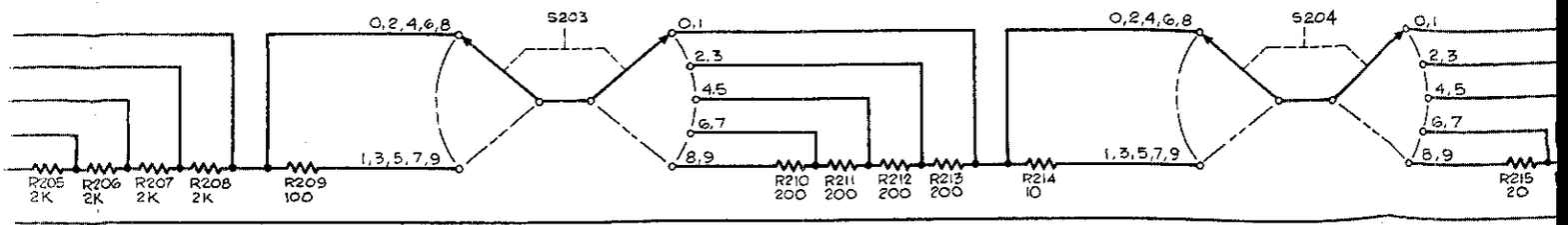
FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

PART 2
SHT. 1 OF 6

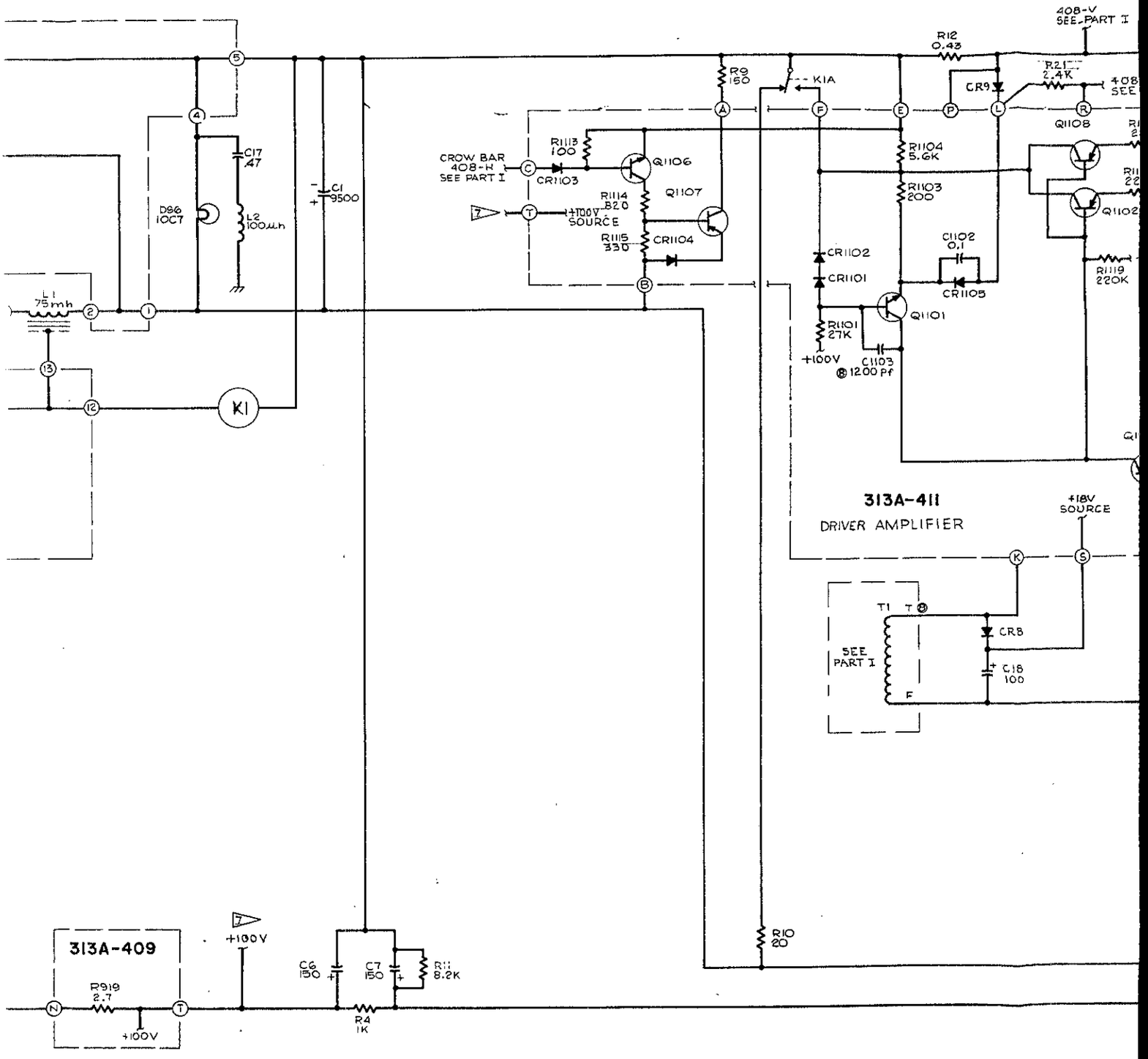




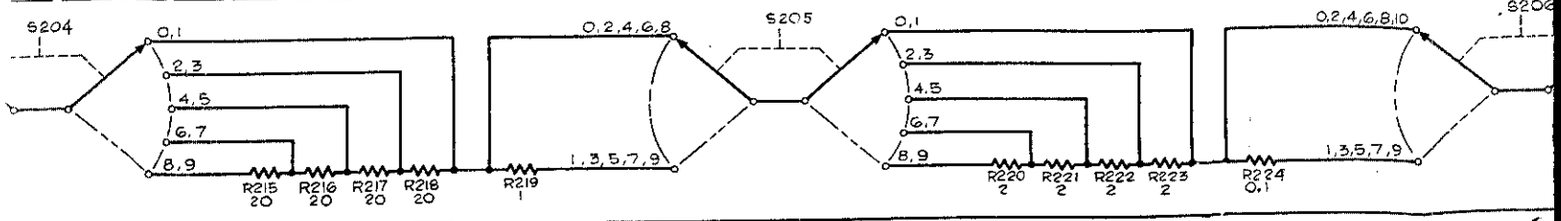
PART 2, SHT. 2 OF 6



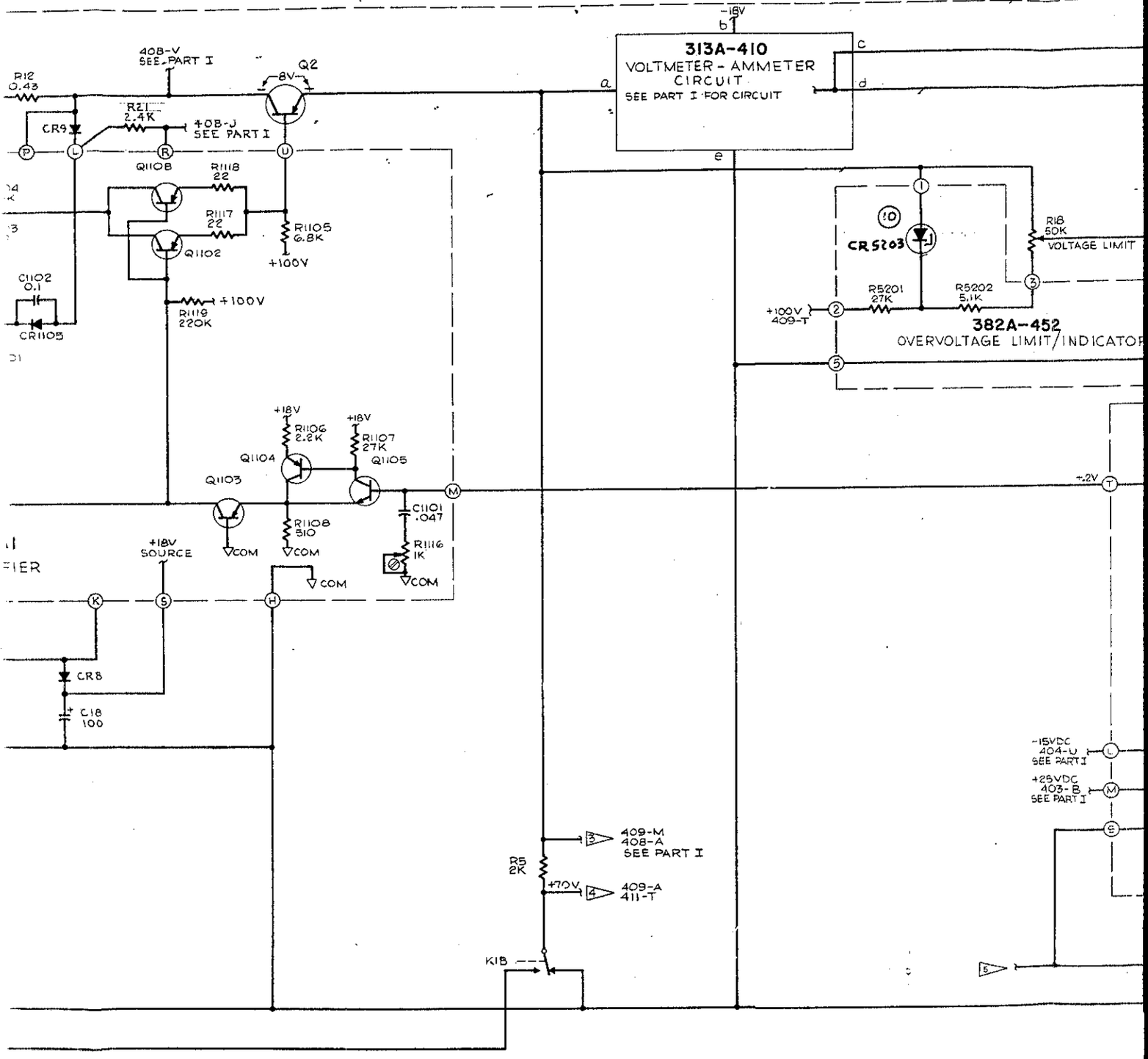
313A-402
VOLTAGE & CURRENT CONTROL

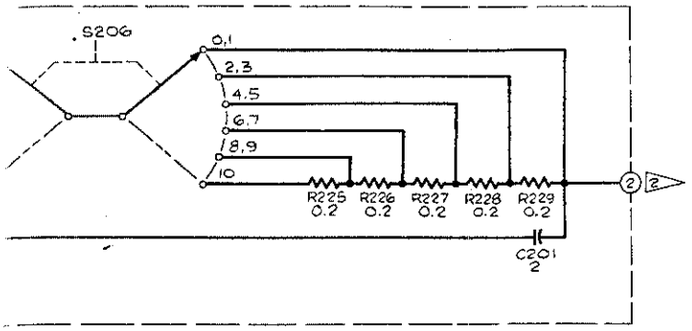


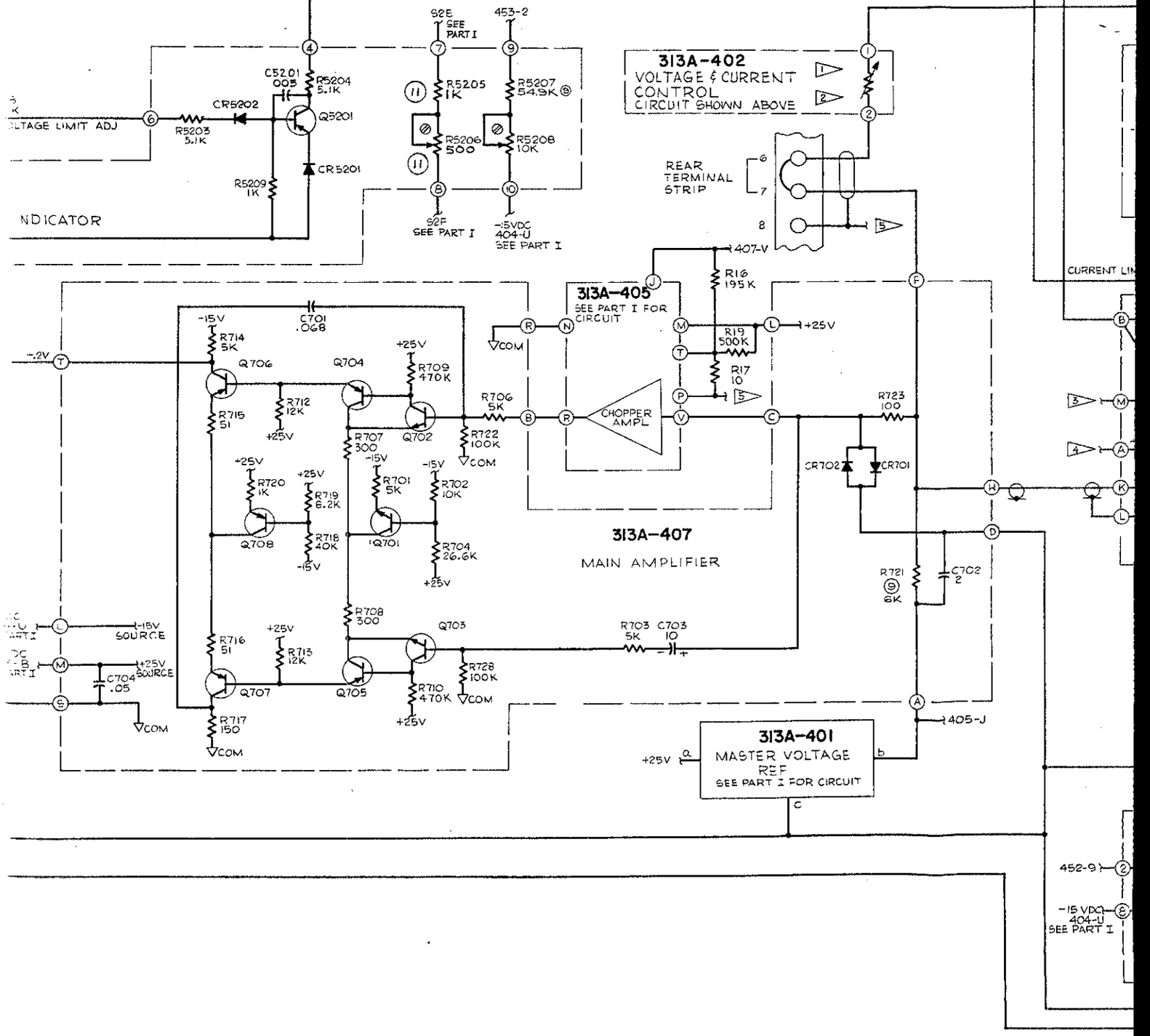
PART 2, SNT. 3 OF 6



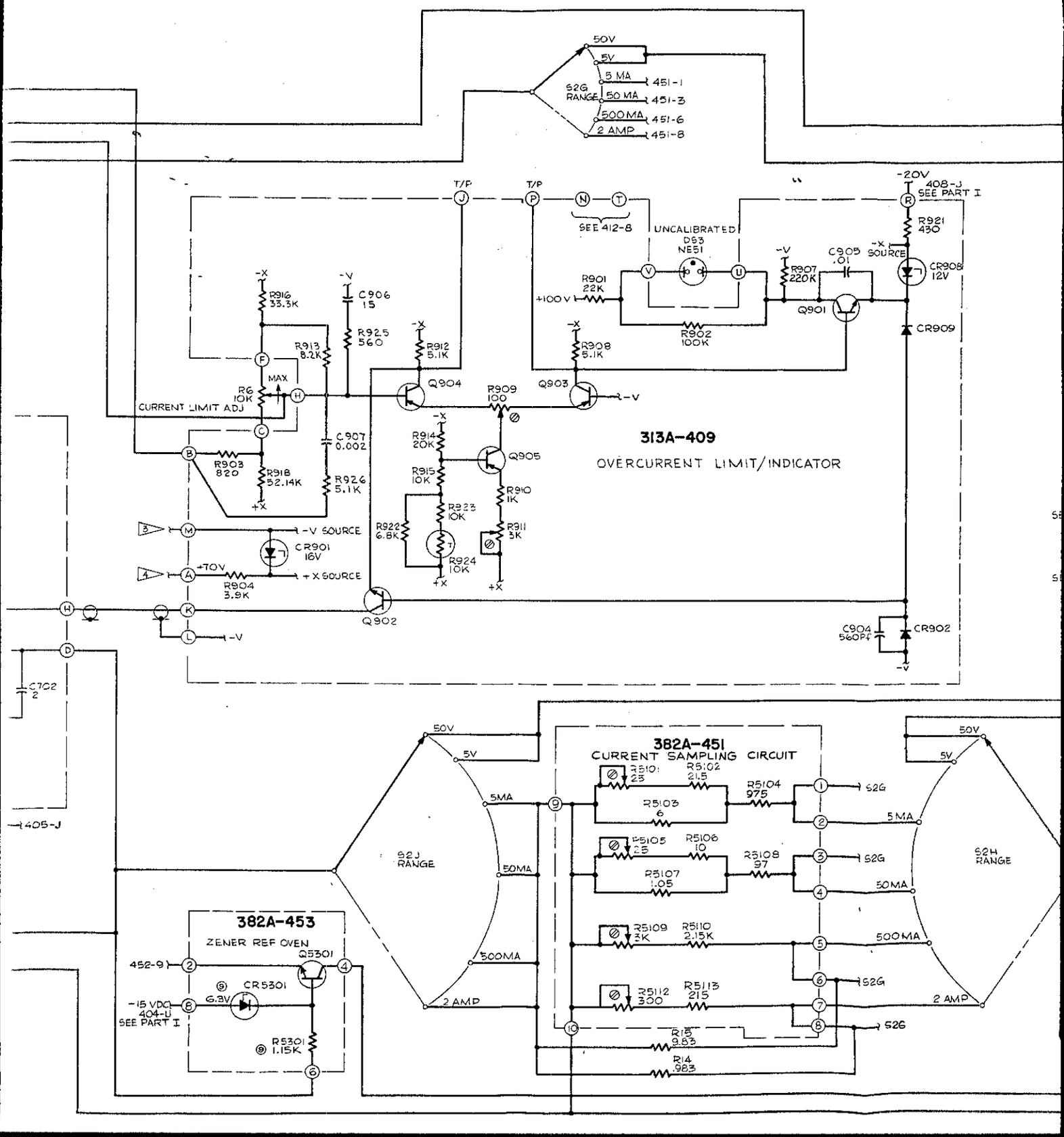
ROL




S206
0,1
2,3
4,5
6,7
8,9
10
R225 0.2
R226 0.2
R227 0.2
R228 0.2
R229 0.2
C201 2


92E SEE PART I
453-2
313A-402 VOLTAGE & CURRENT CONTROL CIRCUIT SHOWN ABOVE
REAR TERMINAL STRIP
C5201 005
R5204 5.1K
CR5202
Q5201
CR5201
R5203 5.1K
R5209 1K
R5205 1K
R5206 500
R5207 54.9K
R5208 10K
92F SEE PART I
-15VDC 404-U SEE PART I
NDICATOR
407-V
R16 195K
313A-405 SEE PART I FOR CIRCUIT
R19 500K
R17 10
+25V
COM
R706 5K
CHOPPER AMPL
R723 100
CR702
CR701
C701 .068
R714 5K
Q706
Q704
R709 470K
R712 12K
R715 51
R707 300
Q702
R722 100K
R720 1K
R719 6.2K
R701 5K
R702 10K
Q708
R718 40K
Q701
R704 26.6K
313A-407 MAIN AMPLIFIER
R721 6K
C702 2
R708 300
Q703
R703 5K
C703 10
R716 51
R713 12K
Q707
Q705
R710 470K
R728 100K
C704 .05
R717 150
-15V SOURCE
+25V SOURCE
313A-401 MASTER VOLTAGE REF SEE PART I FOR CIRCUIT
405-J
452-9
-15 VDC 404-U SEE PART I
CURRENT LIM

PART 2,
SHT. 5 OF 6

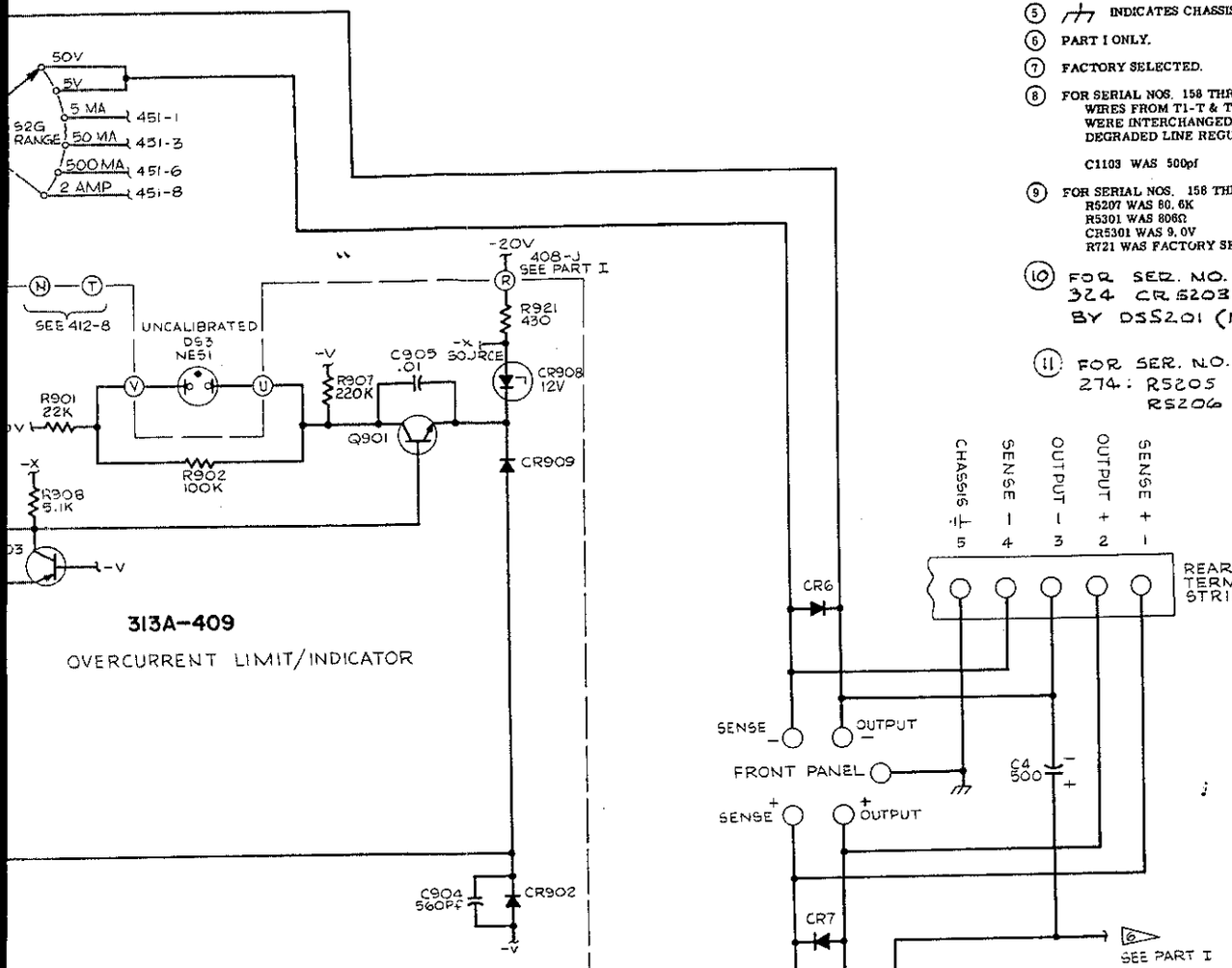


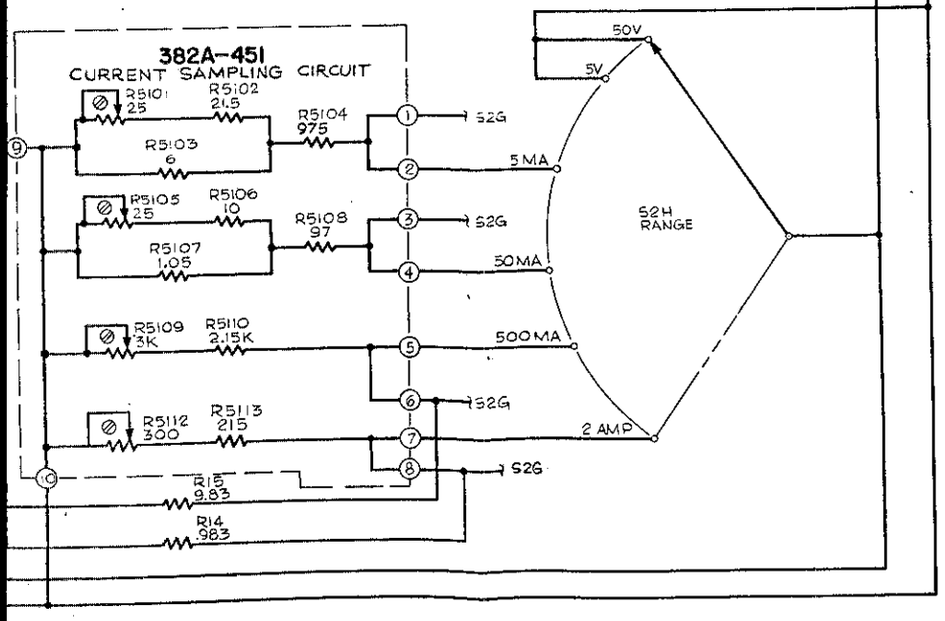
PART 2
SHT 6 OF 6

NOTES:

1. ALL FLAGNOTES WITH THE SAME NUMBER ARE CONNECTED.
2. RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS UNLESS OTHERWISE NOTED
3. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
4. INDICATES INTERNAL ADJUSTMENT.
5. INDICATES CHASSIS GROUND.
6. PART I ONLY.
7. FACTORY SELECTED.
8. FOR SERIAL NOS. 158 THRU 225:
   WIRES FROM T1-T & T1-F TO 411 BOARD WERE INTERCHANGED WHICH SOMETIMES DEGRADED LINE REGULATION.

   C1103 WAS 500pf
9. FOR SERIAL NOS. 158 THRU 239:
   R5207 WAS 80.6K
   R5301 WAS 806Ω
   CR5301 WAS 9.0V
   R721 WAS FACTORY SELECTED
10. FOR SER. NO. 158 THRU 324 CR5203 REPLACED BY DS5201 (NEON)
11. FOR SER. NO. 158 THRU 274: R5205 WAS 120 Ω. R5206 WAS 25Ω POT





FUNCTIONAL SCHEMATIC

VOLTAGE & CURRENT CALIBRATOR

MODEL 382A PART II

382A SER. NO. 158 & ON

FLUKE JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133