FLUKE 332A

JOHN FLUKE MFG. CO., INC.

P. O. Box 7428, Seattle, Washington 98133

Preliminary Instruction Manual

for

FLUKE MODEL 332A

VOLTAGE STANDARD

October 1, 1965

332A VOLTAGE STANDARD

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SECTION I

SPECIFICATIONS

1-1. ELECTRICAL

OUTPUT VOLTAGE: 0 to 1111.1110 volts dc.

VOLTAGE RANGES: 10, 100, and 1000 volt ranges with outputs as follows:

10V range: 0 to 11.111110V (1uv steps)
100V range: 0 to 111.11110V (10uv steps)
1000V range: 0 to 1111.1110V (100uv steps)

OUTPUT CURRENT: 0 to 50 millamperes in any range.

OVERCURRENT PROTECTION: Current limit continuously variable from 1ma to 60ma. Panel lamp indicates current-limited operation. Normal operation is restored upon removal of the overload.

OVERVOLTAGE PROTECTION: Voltage trip continuously variable from 10% to 110% of each range. Manual reset.

CALIBRATION ACCURACY:

10V range: ±(0.003% of setting + 10uv)
100V range: ±(0.003% of setting + 20uv)
1000V range: ±(0.003% of setting + 40uv)

NOTE: The above calibration accuracies apply at standard reference conditions of 23 (±1)°C, constant line voltage, 30% to 60% relative humidity, and constant external load.

STABILITY (at above standard reference conditions):

±(0.0015% of setting + 0.0001% of range) per week.
±(0.0025% of setting + 0.0001% of range) per 6 months.

RIPPLE AND NOISE:

10V range: less than 20uv rms.
100V range: less than 30uv rms.
1000V range: less than 40uv rms.

OUTPUT RESISTANCE at dc: Less than 0.0005 ohms or $0.0001E_o$ ohms, whichever is greater.

LINE REGULATION: 0.0005% of setting or 25uv for a 10% line voltage change from nominal.

LOAD REGULATION: 0.0005% of setting or 25uv for full load change.

TEMPERATURE COEFFICIENT: Less than (0.0002% of setting + 1uv) per degree Centigrade from +20°C to +40°C.

INPUT POWER: 115/230 (±10%) vac, 50-60 cycles, single phase. Approximately 130 VA at full load.

1-2. MECHANICAL

STORAGE TEMPERATURE: -40°C to +65°C.

SIZE: 7" high x 19" wide x 18" behind panel.

MOUNTING: Standard EIA relay rack; resilient feet are provided for bench use.

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

2-2. The function of external controls, terminals, and indicators on the 332A is as follows:

a. POWER switch (S1). Applies line power to the circuits of the instrument when set from OFF to STANDBY/RESET. When set from STANDBY/RESET to ON, a reed relay is actuated which connects the OUTPUT terminals to the internal circuitry.

b. Output voltage controls (S2101 through S2701). Select and indicate the output voltage. The recessed numbers directly above each dial provide an in-line readout of the output voltage. The lamps between the recessed numbers indicate the correct decimal place. Note that each dial can be set to 10. When a dial is set to 10, the digit it represents is 0, and a 1 must be added to the next higher order digit. For example, 10 10 10. 10 10 10 10 represents 1111. 1110 volts.

c. STANDBY/RESET lamp (DS4). This lamp illuminates when the POWER switch is set to STANDBY/RESET, indicating that the OUTPUT terminals are not connected to the internal circuitry. This lamp also illuminates when the trip circuit has been activated by an abnormal output condition.

d. VOLTAGE RANGE switch (S2). Selects the output voltage range of 10, 100, or 1000 volts, and changes the meter to a corresponding range.

e. CURRENT LIMIT control (R4). Used to set the current limit level; variable from 1 to 60 milliamperes, approximately.

f. LIMIT ON lamp (DS5). Indicates when the current limit circuit is actuated. This indicates that the calibrated output voltage controls no longer indicate the correct output voltage.

g. VOLTAGE TRIP (R3). Varies the point at which the output voltage will be removed from the OUTPUT terminals, variable from 0 to 110%, approximately, of each voltage range.

h. METER switch (S3). Selects a meter indication of either output voltage or output current.

i. Meter (M1). Indicates the output voltage or output current, depending on the position of the METER switch. The meter voltage range corresponds to the position of the VOLTAGE RANGE switch, and provides approximately 10% overrange on a 0 to 12 scale. The meter current range is from 0 to 60 milliamperes.

j. The following terminals are provided on the front panel of the 332A: A ground terminal for grounding either the positive or negative output to power line ground, along with the instrument case; OUTPUT terminals for connecting to the load; SENSE terminals for connecting to the point requiring voltage regulation; and a GUARD terminal for eliminating the effects of circulating ground currents. Connect the GUARD terminal only when the POWER switch is set to STANDBY/RESET or to OFF.

2-3. PREPARATION FOR USE

2-4. Ventilation space. Heat producing transistors in the 332A are mounted on heat sinks in the rear of the chassis. 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 air flow is not restricted by covering the chassis perforations. The instrument is normally supplied with rubber feet for bench-top operation which raise the chassis above the bench to permit air circulation. If the feet have been removed, the chassis must be raised by some other means to provide the necessary path for airflow.

CAUTION

Before the instrument is turned on, verify that the SENSE terminals are connected to the OUTPUT terminals.

2-5. BASIC OPERATION

a. Connect the line plug to a 115 vac power source. If the instrument has been wired for operation from 230 vac, connect to 230 vac.

WARNING

The round pin on the three-prong plug connects the instrument case to power system ground. When using a three-to-two pin adapter to connect to a two-contact outlet, connect the ground lead from the adapter to a suitable ground.

b. Connect the + SENSE terminal to the + OUTPUT terminal, and connect the -SENSE terminal to the -OUTPUT terminal. Shorting links are provided for this purpose.

c. Set the VOLTAGE TRIP control and the CURRENT LIMIT control fully clockwise, unless these controls have previously been set to specific points. (See paragraphs 2-9 and 2-13.)

d. Set the VOLTAGE RANGE switch to the appropriate range. For greatest accuracy, use the lowest range which will provide the required output voltage.

e. Set the output voltage controls to the desired output voltage. For greatest accuracy and best stability, the first digit should always be used in the event of two or more possible combinations for selecting the output voltage.

f. Connect the load to the OUTPUT terminals, and set the POWER switch to ON.

g. To monitor the output voltage or current, set the METER switch to VOLTAGE or CURRENT, as desired.

2-6. REMOTE SENSING

2-7. When a load is connected to the output of the 332A, there may be an appreciable voltage drop between the instrument and the load. The nomograph of Figure 2-1 can be used to determine the approximate voltage drop in the wires from the 332A to the load.

2-8. In Figure 2-1, 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 AWG #30 wire is used to connect a load which requires 0.050 amperes. The voltage drop in the wires is 5.4 mv per foot of wire. If two wires, each 3 feet long, are used to connect the load, this represents a voltage drop of 32 mv, which is several times the published load regulation of the 332A at 1000V output. Consequently, the advantage of remote sensing is that specified load regulation is maintained at the load, the voltage drop in the connecting wires then having no effect. Proceed as follows:

a. With the POWER switch set to OFF, remove the front-panel connections between the SENSE and OUTPUT terminals.

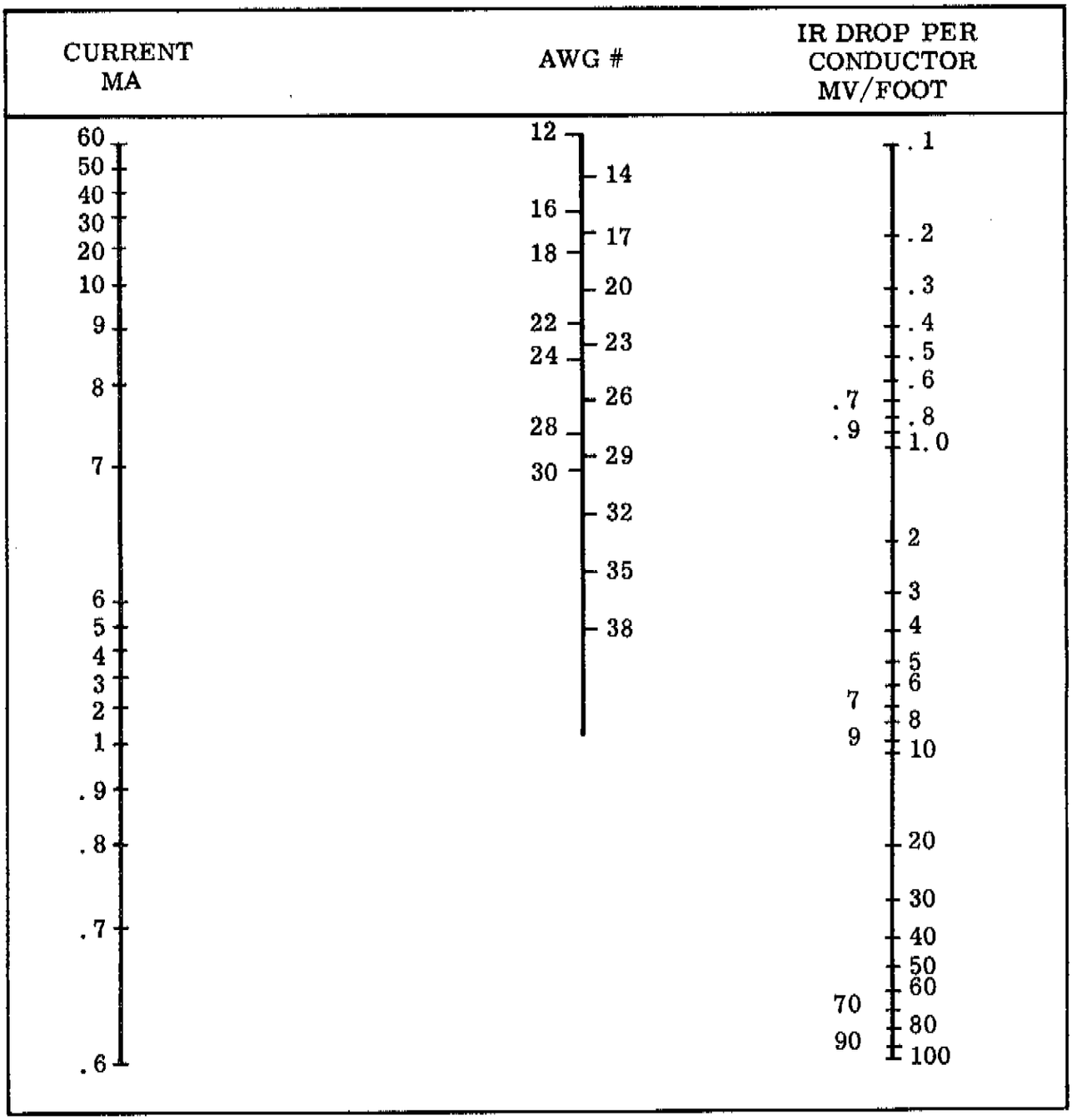


Figure 2-1. VOLTAGE DROP IN LOAD WIRES

b. Using a twisted pair of wire, connect the +SENSE terminal to the positive load terminal, and connect the -SENSE terminal to the negative load terminal.

CAUTION

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.

c. Proceed with steps c. through g. of paragraph 2-5.

2-9. CURRENT LIMIT CONTROL

2-10. The current limit is designed to protect the equipment connected to the 332A from damage which might be caused by excessive current. Set the current limit as follows:

a. Set the controls on the 332A as follows:

VOLTAGE RANGE switch	As desired
VOLTAGE TRIP control	As desired
CURRENT LIMIT control	Fully clockwise
METER switch	CURRENT
Output voltage controls	1 volt output
POWER switch	STANDBY/RESET

b. Short across the OUTPUT terminals.

c. Set the POWER switch to ON.

d. Set the output current limit by rotating the CURRENT LIMIT control counterclockwise until the panel meter indicates the desired limiting current.

e. Remove the short from the OUTPUT terminals, and proceed with steps d. through g. of paragraph 2-5.

2-11. CURRENT TRIP

2-12. The 332A is provided with a current trip to protect the instrument from damage due to excessive output current, in the event that the current limit

circuit should fail to operate. This current trip will automatically place the 332A in standby operation at an output current of approximately 120 ma. After correcting the overload, the instrument can be returned to normal operation by setting the POWER switch to STANDBY/RESET, and then to ON.

2-13. VOLTAGE TRIP CONTROL

2-14. The voltage trip is designed to protect the equipment connected to the 332A from damage which might be caused by excessive voltage. Set the voltage trip as follows:

a. Set the controls on the 332A as follows:

VOLTAGE RANGE switch	As desired
VOLTAGE TRIP control	Fully clockwise
CURRENT LIMIT control	As desired
METER switch	VOLTAGE
POWER switch	ON

b. Set the output voltage controls to the required output voltage.

c. Slowly rotate the VOLTAGE TRIP control counterclockwise until the STANDBY/RESET lamp illuminates.

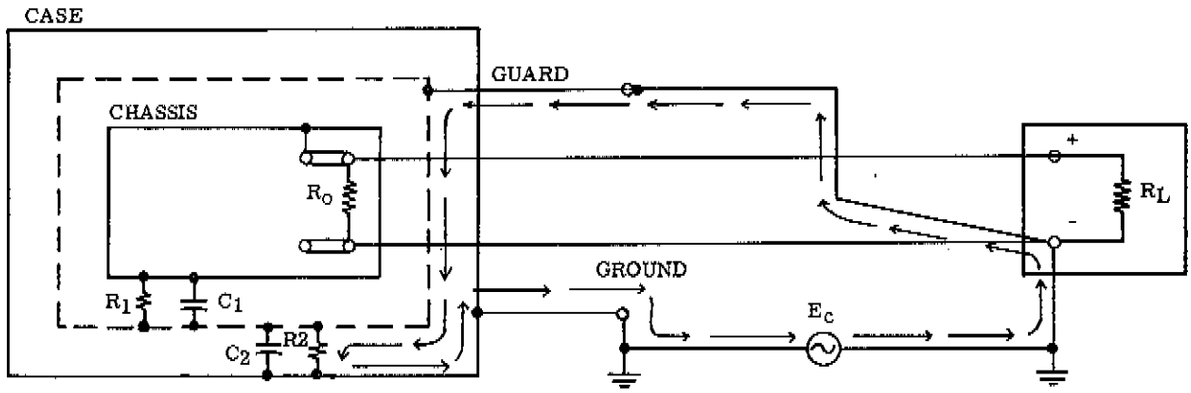
d. Set the POWER switch to STANDBY/RESET, and then to ON.

e. During operation of the instrument, if the selected trip voltage is exceeded, the instrument will automatically switch to standby operation, as indicated by the illumination of the STANDBY/RESET lamp. If this occurs, normal operation can be restored by repeating step d.

2-15. USE OF GUARD TERMINAL

2-16. The 332A is provided with a guard chassis between the inner chassis and the outside chassis (case) of the instrument. The inner chassis is electrically connected to the +SENSE terminal and is always at the same potential as the +SENSE terminal. The guard chassis completely surrounds the inner chassis, and is isolated from it, the only electrical path between the two chassis being leakage. The outside chassis (case) of the instrument completely surrounds the guard chassis, and is isolated from it, the only

electrical path between these two chassis also being leakage. The outside chassis is connected to ground through the line cord. It should be noted that the ac ground of two instruments isn't usually at the same exact potential. Consequently, when the 332A output is connected to another instrument, both of which are grounded through their respective power cords, a path exists for circulating ground currents. These circulating ground currents can cause errors in the load voltage. The correct way to route these circulating ground currents so they will not cause error in the load voltage is to connect the GUARD terminal directly to the grounded load terminal, as in Figure 2-2. As noted in this drawing, the path of the ground current bypasses the load and the output leads of the 332A, and thus causes no error. Two incorrect methods of connecting the GUARD terminal are illustrated in Figure 2-3, in which the GUARD terminal is connected to the ground terminal, and to the +OUTPUT terminal. In each of these cases, part of the circulating ground current flows through the load, and can cause error in the load voltage. Similiar paths that can cause error will be noted if the GUARD terminal is connected to the -OUTPUT terminal, or to any terminal other than the grounded load terminal.



Where: R_1 & C_1 = leakage resistance & capacitance from chassis to guard.

R_2 & C_2 = leakage resistance & capacitance from guard to instrument case.

E_c = potential difference between power line ground points.

R_O = output resistance of 332A (very low in any constant voltage instrument).

R_L = load resistance.

Figure 2-2. CORRECT GUARD CONNECTION

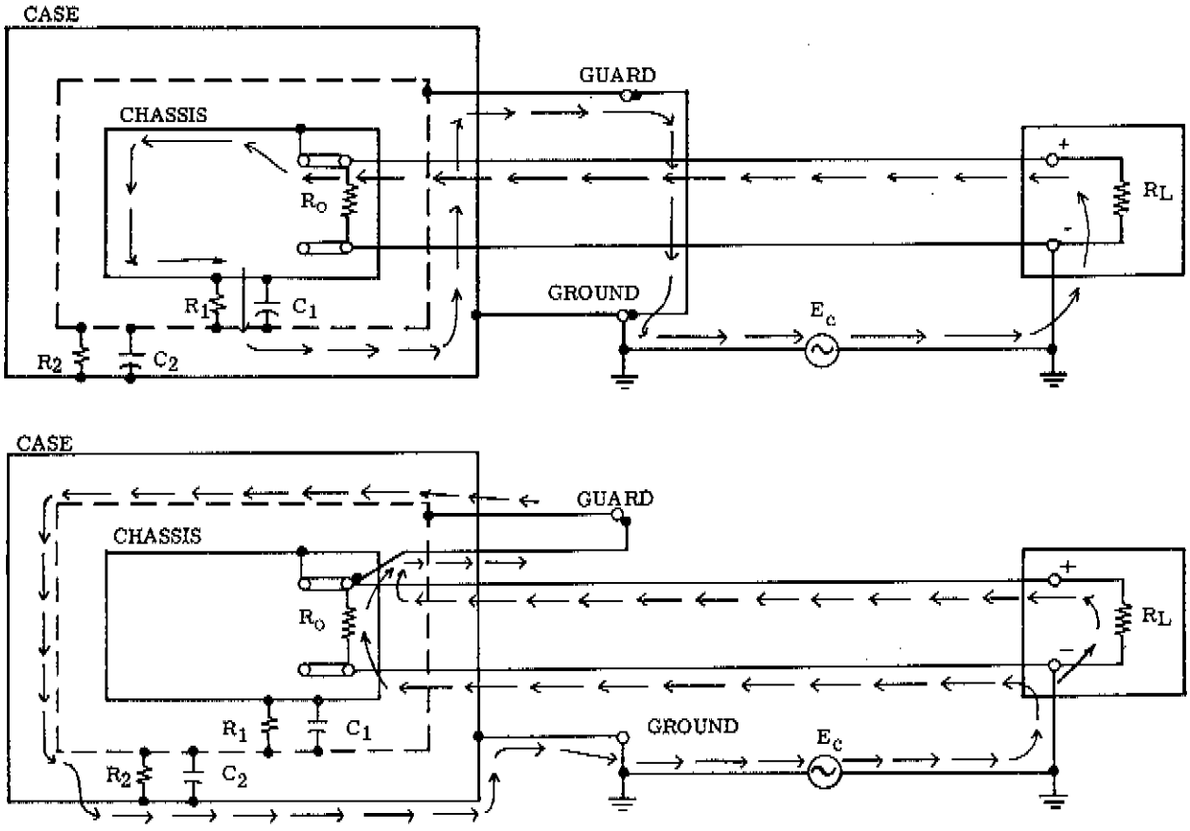


Figure 2-3. INCORRECT GUARD CONNECTIONS

SECTION III

CALIBRATION

3-1. INTRODUCTION

3-2. The stability of the 332A is specified for a six month period. Calibration may be easily checked at more frequent intervals, if desired. The equipment required for calibration is listed in Figure 3-1. Calibration of the 332A consists of three steps; (1) Setting the zero output of each range, (2) Setting the control resistors for ratio accuracy, and (3) Setting the range resistors for absolute output accuracy. The instrument should be allowed to warm-up for a minimum of 30 minutes and should be in an environment of 23 (±1)°C, and 30% to 60% relative humidity. Line voltage should be constant. Proceed as follows:

3-3. ZERO OUTPUT ADJUSTMENT

a. Connect the 885A Differential Voltmeter to the OUTPUT terminals. Connect the GUARD terminal to the voltmeter ground terminal.

b. Set the VOLTAGE TRIP and the CURRENT LIMIT controls fully clockwise, and set the METER switch to VOLTAGE. These controls may remain in these positions during the entire calibration procedure.

c. Set the VOLTAGE RANGE switch to 1000 volts.

d. Set the output voltage dials to 000.0000.

e. The 885A should indicate 0 (±0.000040) volts. If necessary, adjust R112 for minimum indication of the 885A.

f. Set the VOLTAGE RANGE switch to 100 volts.

g. The 885A should indicate 0 (±0.000020) volts. If necessary, adjust R110 for a minimum indication of the 885A.

h. Set the VOLTAGE RANGE switch to 10 volts.

i. The 885A should indicate 0 (±0.000010)volts. If necessary, adjust R108 for a minimum indication of the 885A.

3-4. RATIO ACCURACY ADJUSTMENT

a. Set the VOLTAGE RANGE switch to 1000 volts.

b. Set the third output voltage dial to 10, for an output of 10 volts. Using the 10V range of the 885A, record the exact output voltage.

c. Set the second dial to 1, and set the third dial to zero. The voltage indicated by the 885A should be identical to the voltage measured in step b. If not, adjust R907 as necessary.

d. Repeat steps b. and c. according to the following table:

Step	2nd dial Setting	3rd dial Setting	
e.	1	10	Record exact voltage of 885A
f.	2	0	Adjust R908 for exact voltage measured in step e.
g.	3	10	Record exact voltage of 885A
h.	4	0	Adjust R909 for exact voltage measured in step g.
i.	5	10	Record exact voltage of 885A
j.	6	0	Adjust R910 for exact voltage measured in step i.
k.	7	10	Record exact voltage of 885A
l.	8	0	Adjust R911 for exact voltage measured in step k.
m.	9	10	Record exact voltage of 885A
n.	10	0	Adjust R912 for exact voltage measured in step m.

o. Set all output voltage dials to zero, and set the VOLTAGE RANGE switch to 100 volts.

p. Set the second dial to 10, and record the exact voltage indicated by the 885A.

q. Set the first dial to 1, and set the second dial to zero. Adjust R901 so that the voltage indicated by the 885A is identical to the voltage measured in step p.

r. Repeat steps p. and q. according to the following table:

Step	1st dial Setting	2nd dial Setting	
s.	1	10	Record exact voltage of 885A.
t.	2	0	Adjust R902 for exact voltage measured in step s.
u.	3	10	Record exact voltage of 885A
v.	4	0	Adjust R903 for exact voltage measured in step u.
w.	5	10	Record exact voltage of 885A
x.	6	0	Adjust R904 for exact voltage measured in step w.
y.	7	10	Record exact voltage of 885A
z.	8	0	Adjust R905 for exact voltage measured in step y.
aa.	9	10	Record exact voltage of 885A.
ab.	10	0	Adjust R906 for exact voltage measured in step aa.

3-5. RANGE RESISTOR ADJUSTMENT

3-6. Due to the possibility that the zener reference voltage may change slightly, it is usually desirable to check the instrument for absolute output accuracy at more frequent intervals than checking for output ratio accuracy. Proceed as follows:

a. Connect the 885A across the test points on printed circuit board 332A-408.

b. Adjust R802 so that voltmeter indicates 6.02 (±0.0001)V.

c. Connect the test equipment according to Figure 3-1. The 885A will be used as a null detector.

d. Set the VOLTAGE RANGE switch to 10 volts.

e. Set the output voltage dials to the exact certified value of the standard cell.

f. Adjust R804 for a null indication on the 885A (within ±0.000002V of zero is sufficient). The 885A may be set to more sensitive null ranges as null is approached.

g. Disconnect the standard cell, and connect the 885A across the OUTPUT terminals. Connect the GUARD terminal to the 885A ground terminal.

h. With the VOLTAGE RANGE switch set to 10, set the first output voltage dial to 10. Record the exact voltage indicated by the 885A.

i. Set the VOLTAGE RANGE switch to 100, and set the second dial to 10. Adjust R806 so that the 885A indicates the exact voltage measured in step h.

j. Set the second dial to zero, and set the first dial to 10. Record the exact voltage indicated by the 885A.

k. Set the VOLTAGE RANGE switch to 1000, and set the first dial to 1. Adjust R808 so that the 885A indicates the exact voltage measured in step j.

l. Due to slight interaction, adjustment of the 1000 volt range may affect the setting of the 10 volt and 100 volt ranges. Consequently, it is necessary that steps d. through i. be repeated.

RECOMMENDED EQUIPMENT	
Differential Voltmeter, Fluke Model 885A, or equivalent.	Minimum null detector resolution of 0.0002%. Minimum short-term stability of 0.0005%.
Standard Cell Bank Julie SCO-106, or equivalent.	Minimum stability of 0.0002% and minimum accuracy of 0.0002%.

Figure 3-1. EQUIPMENT REQUIRED FOR CALIBRATION

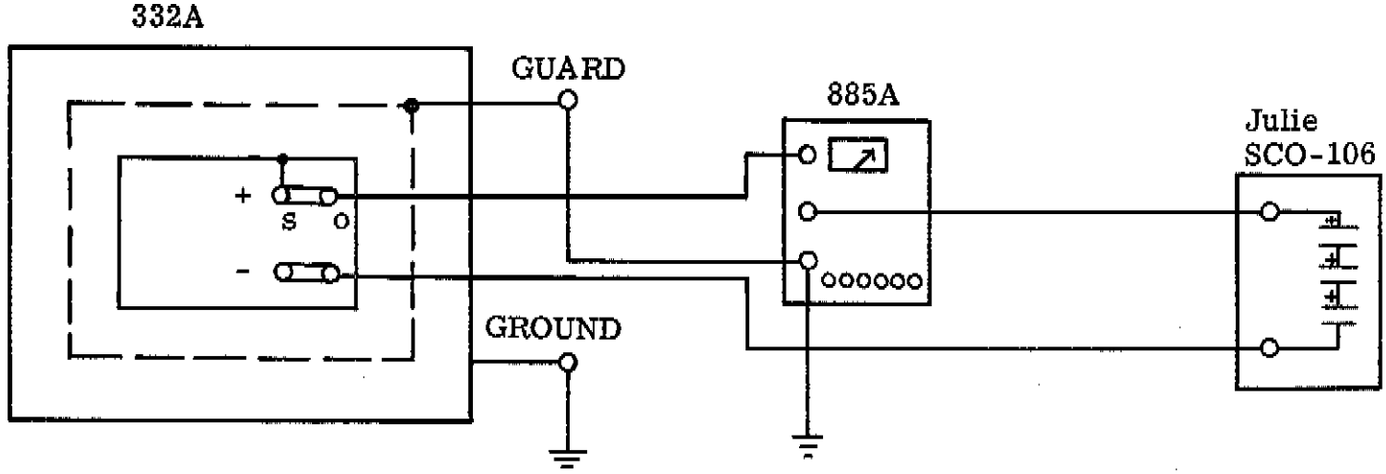
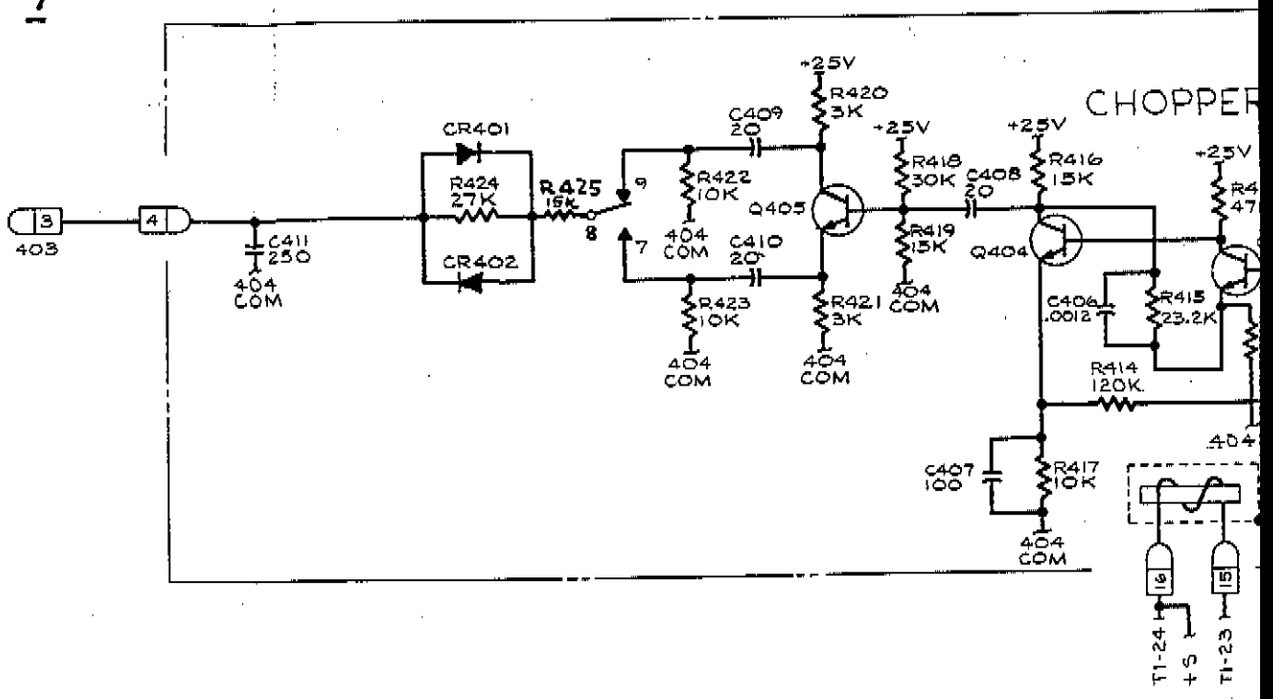
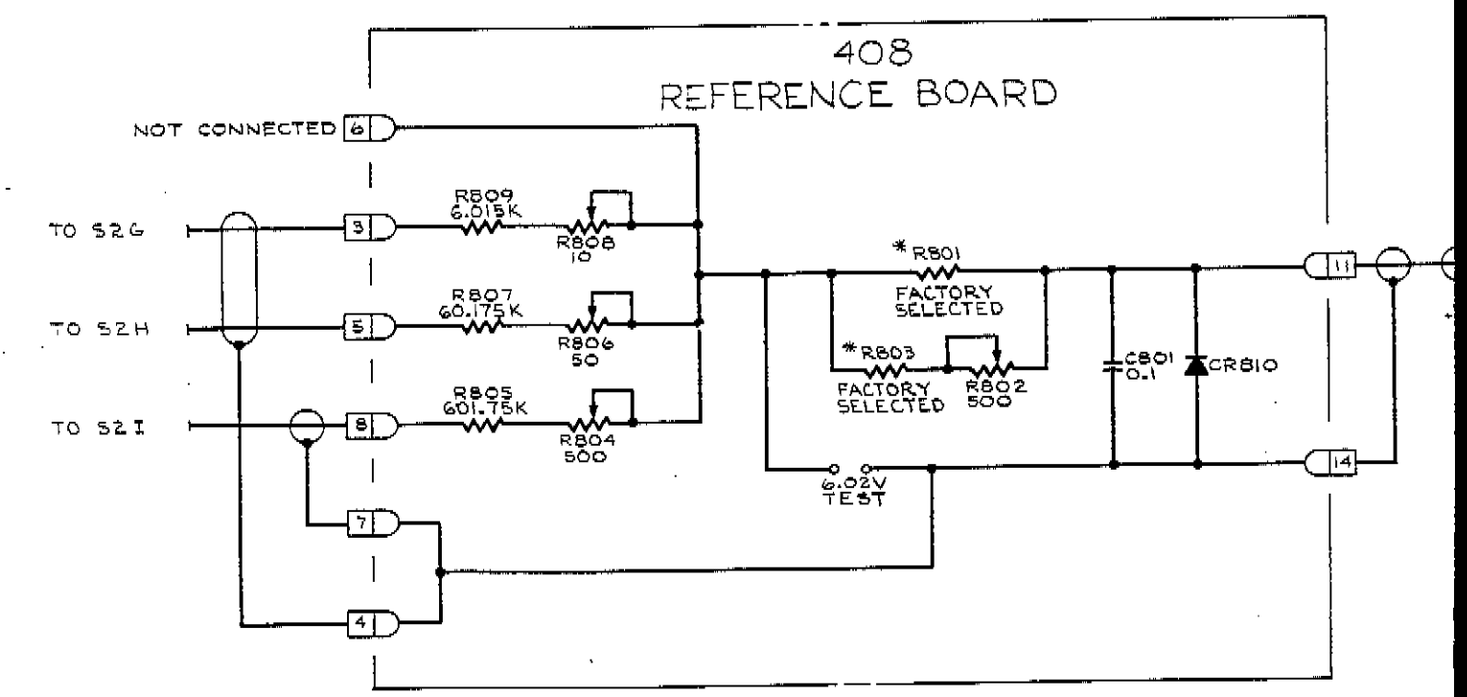


Figure 3-2. CONNECTION FOR RANGE ADJUSTMENT

SCHEMATIC 2

SHT. 1 OF 7





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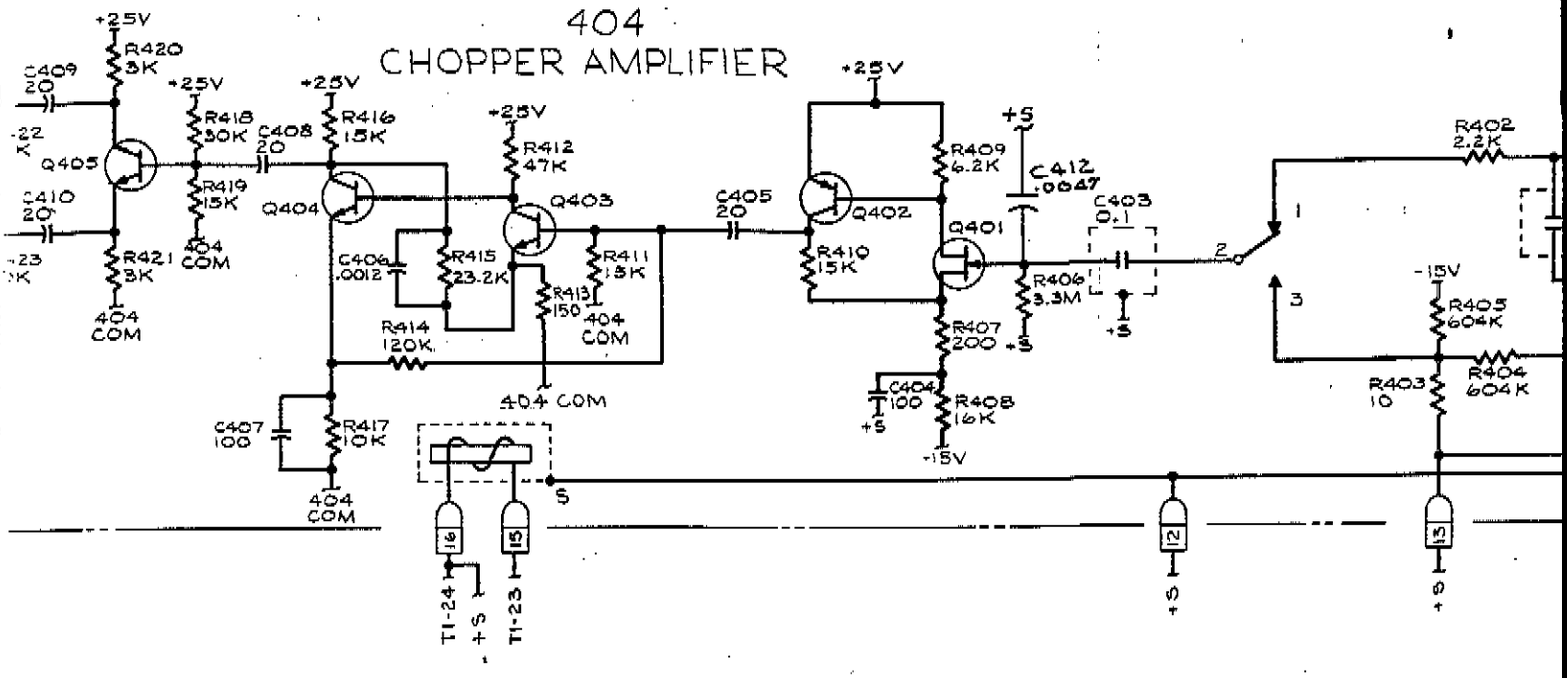

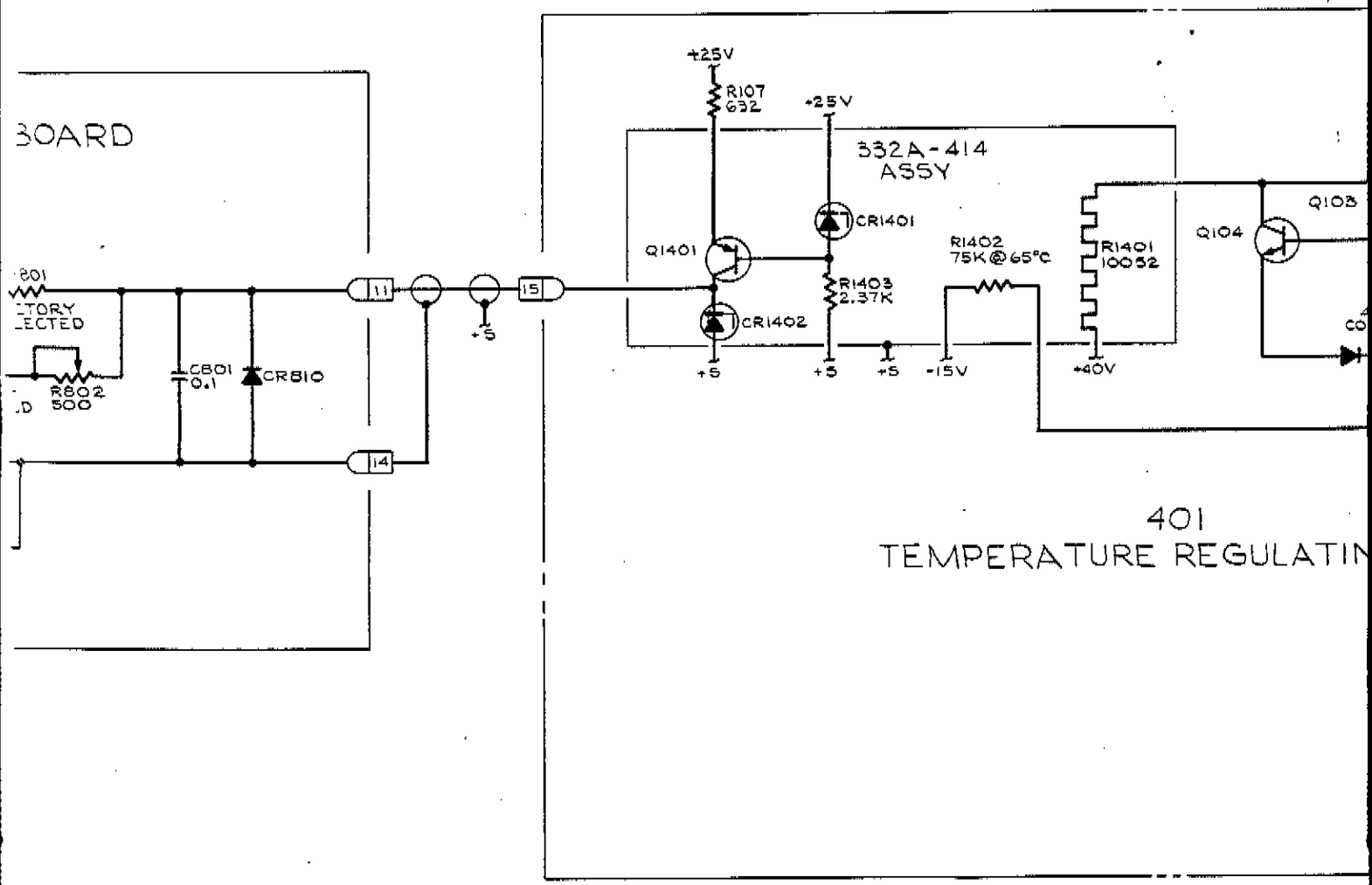

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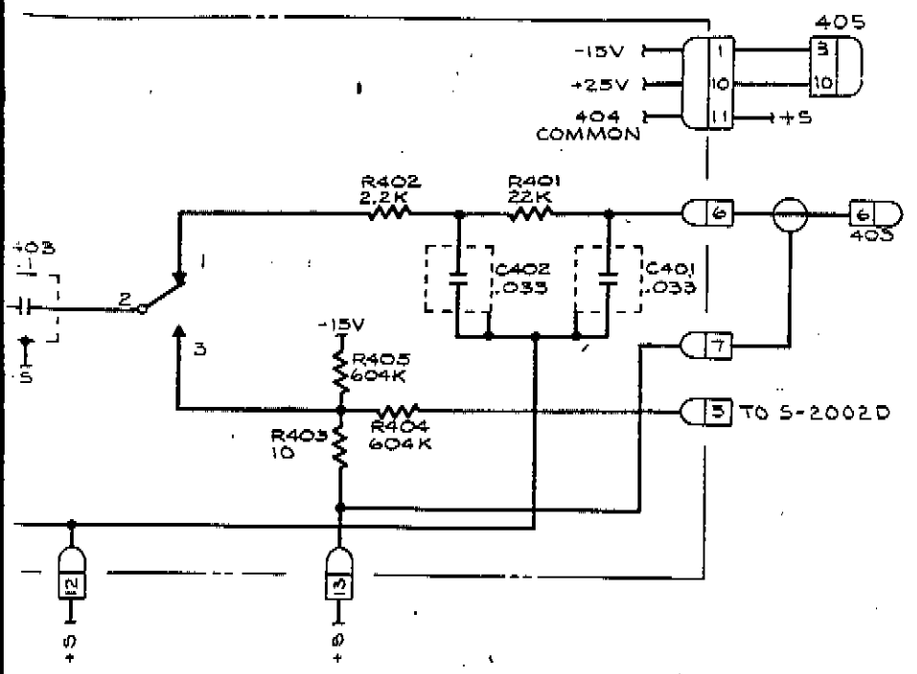

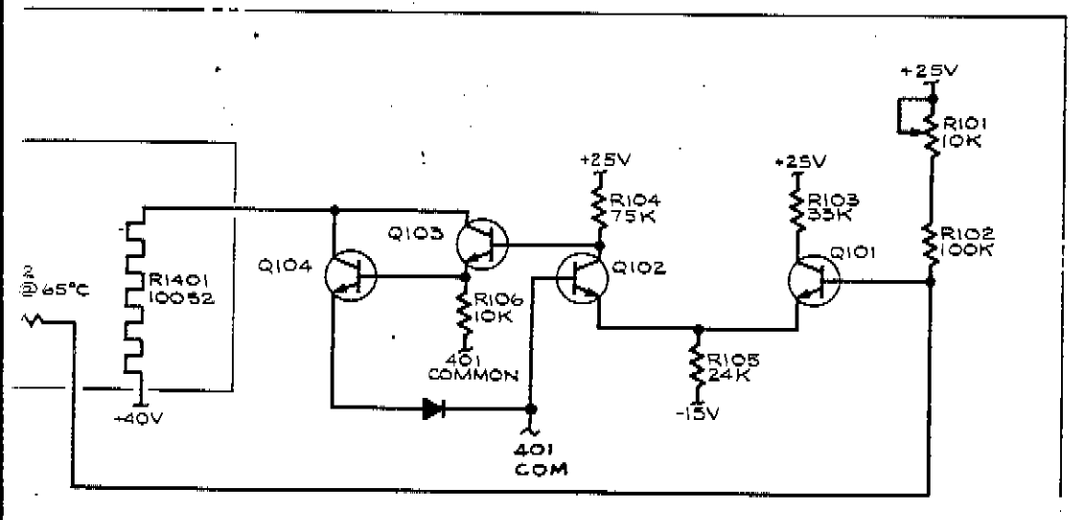

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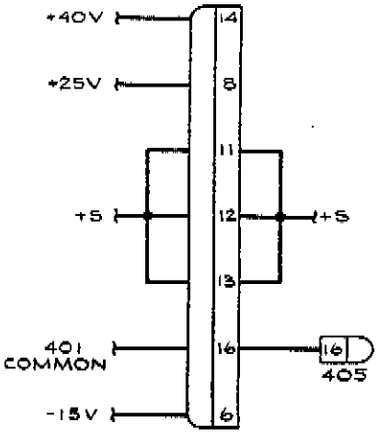

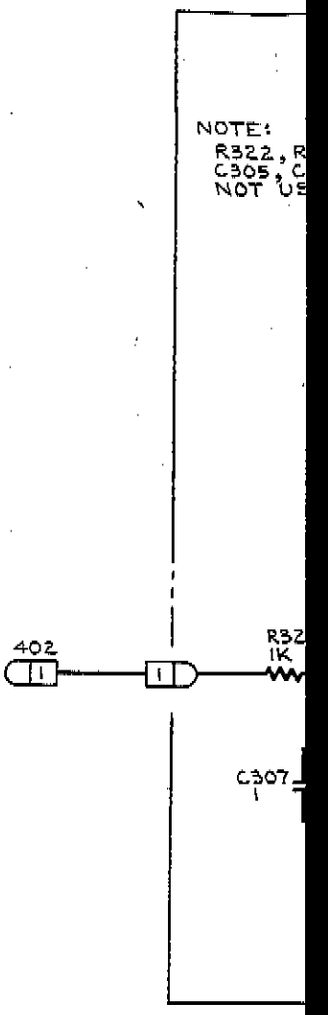

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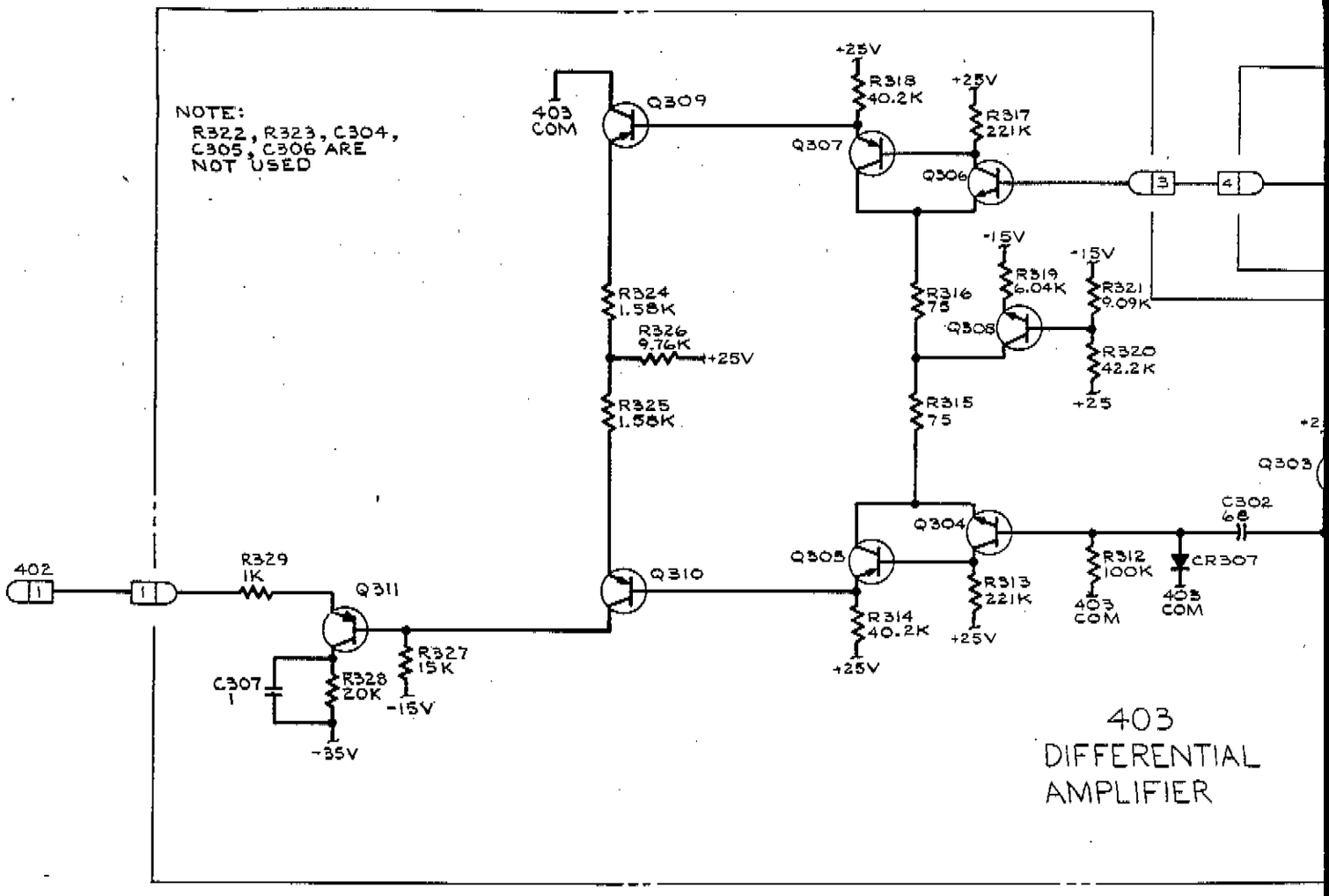

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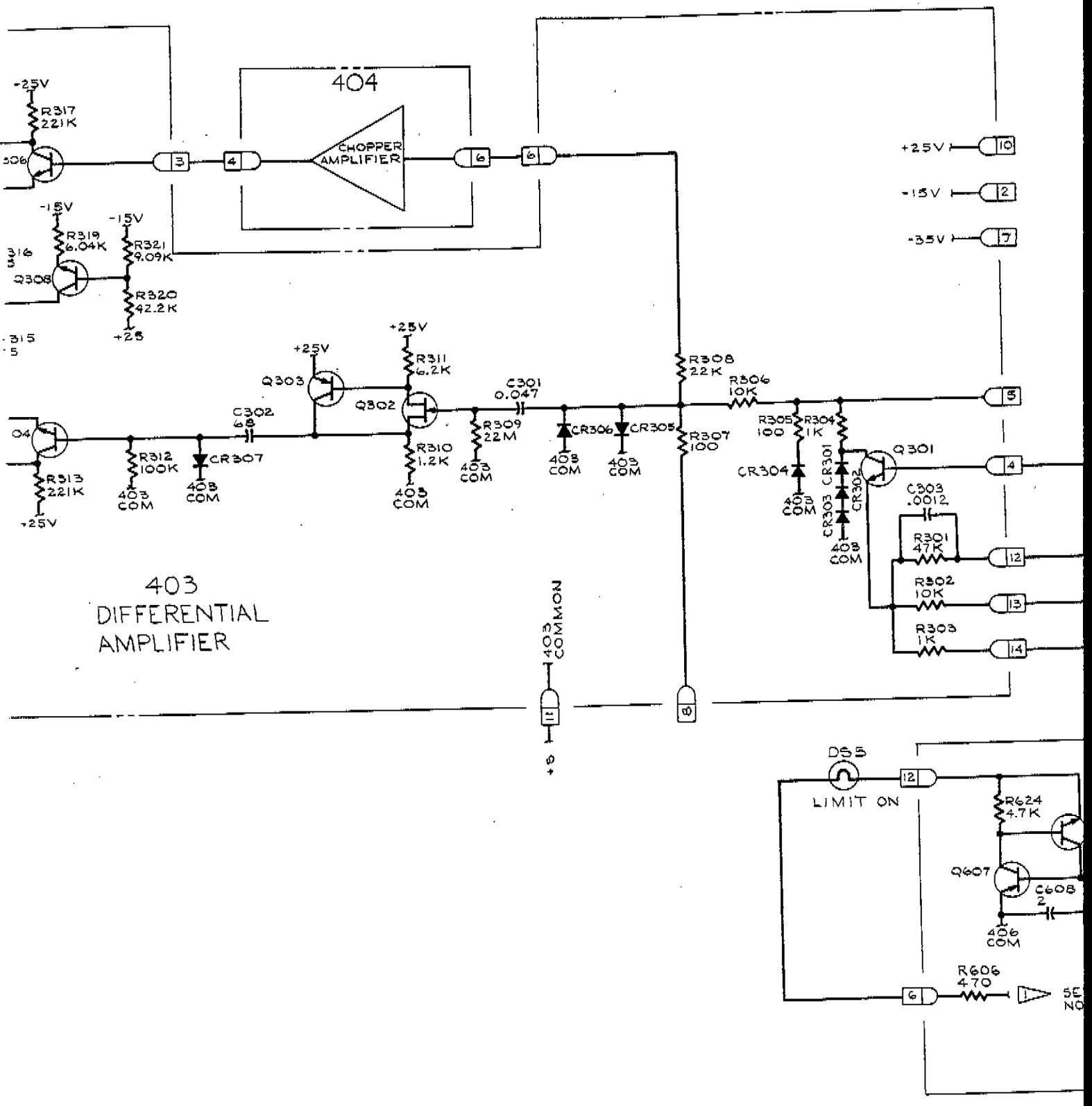

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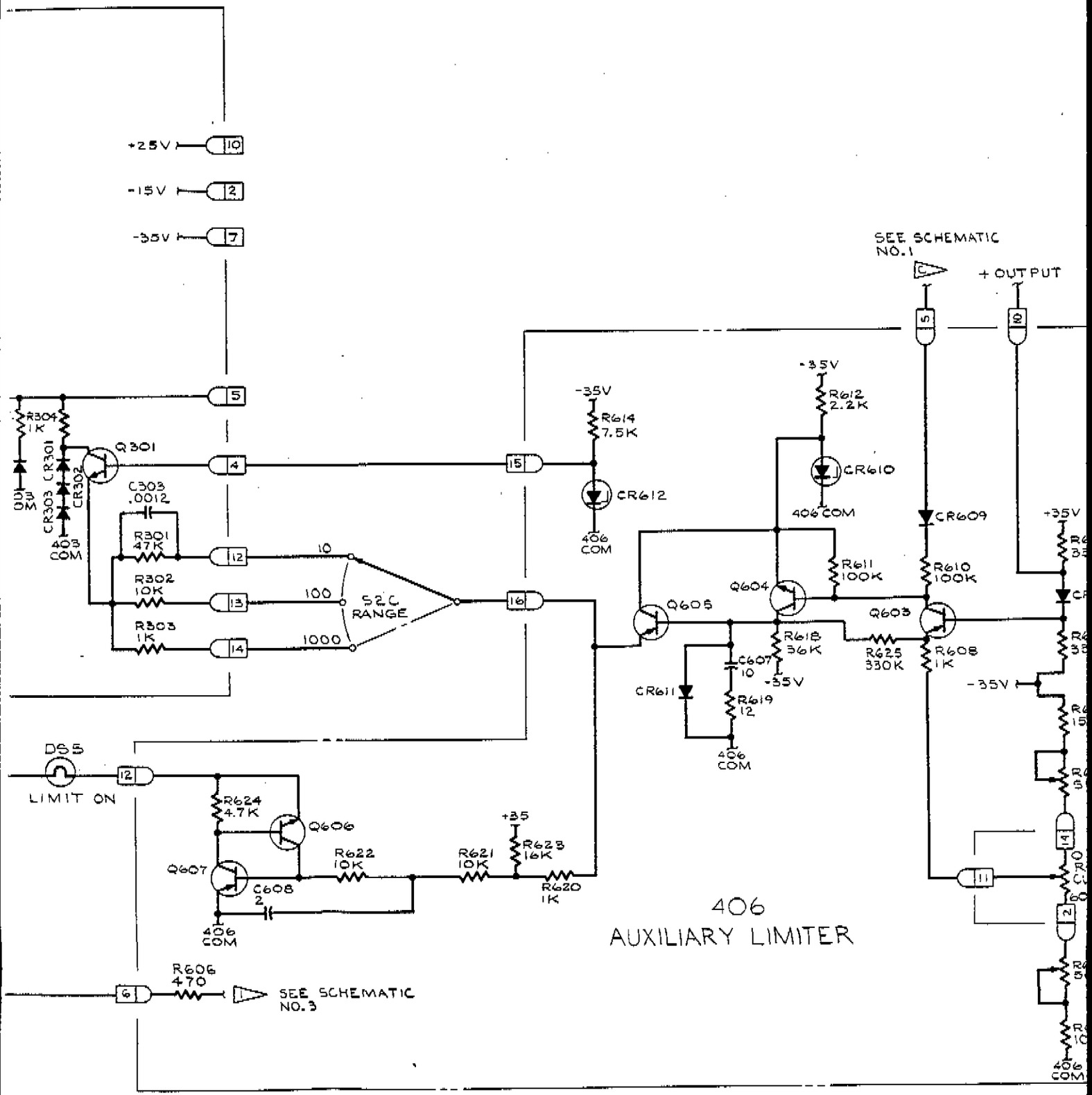

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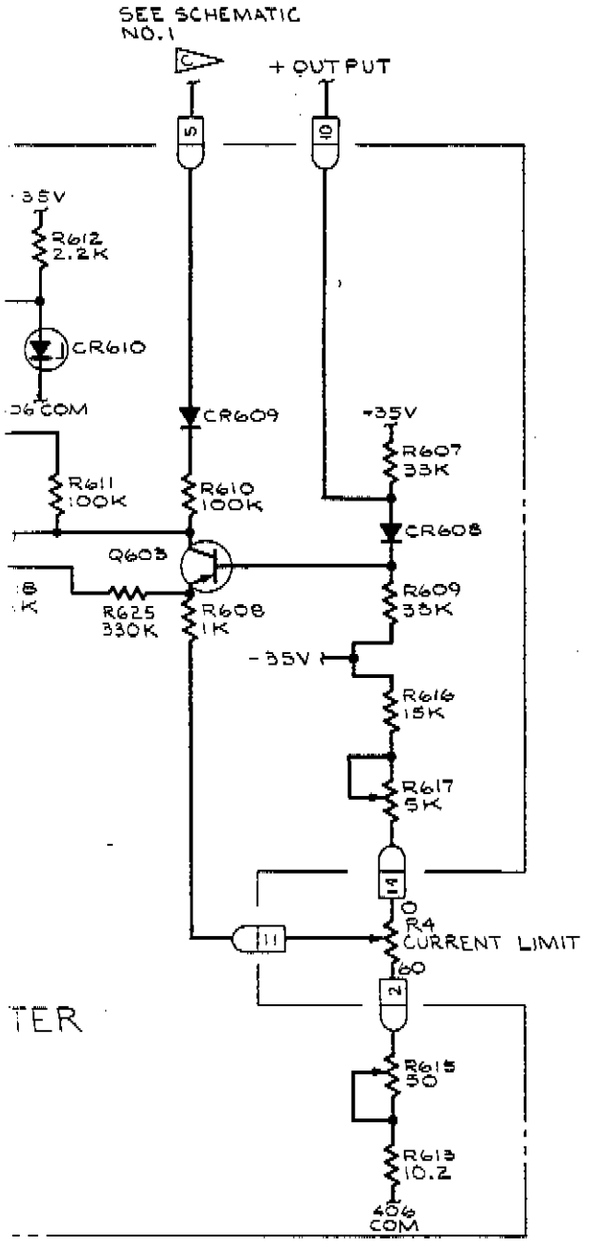


FUNCTIONAL SCHEMATIC b

SCHEMATIC NO. 2 — SUPPORT MODULES

VOLTAGE STANDARD

MODEL 332A

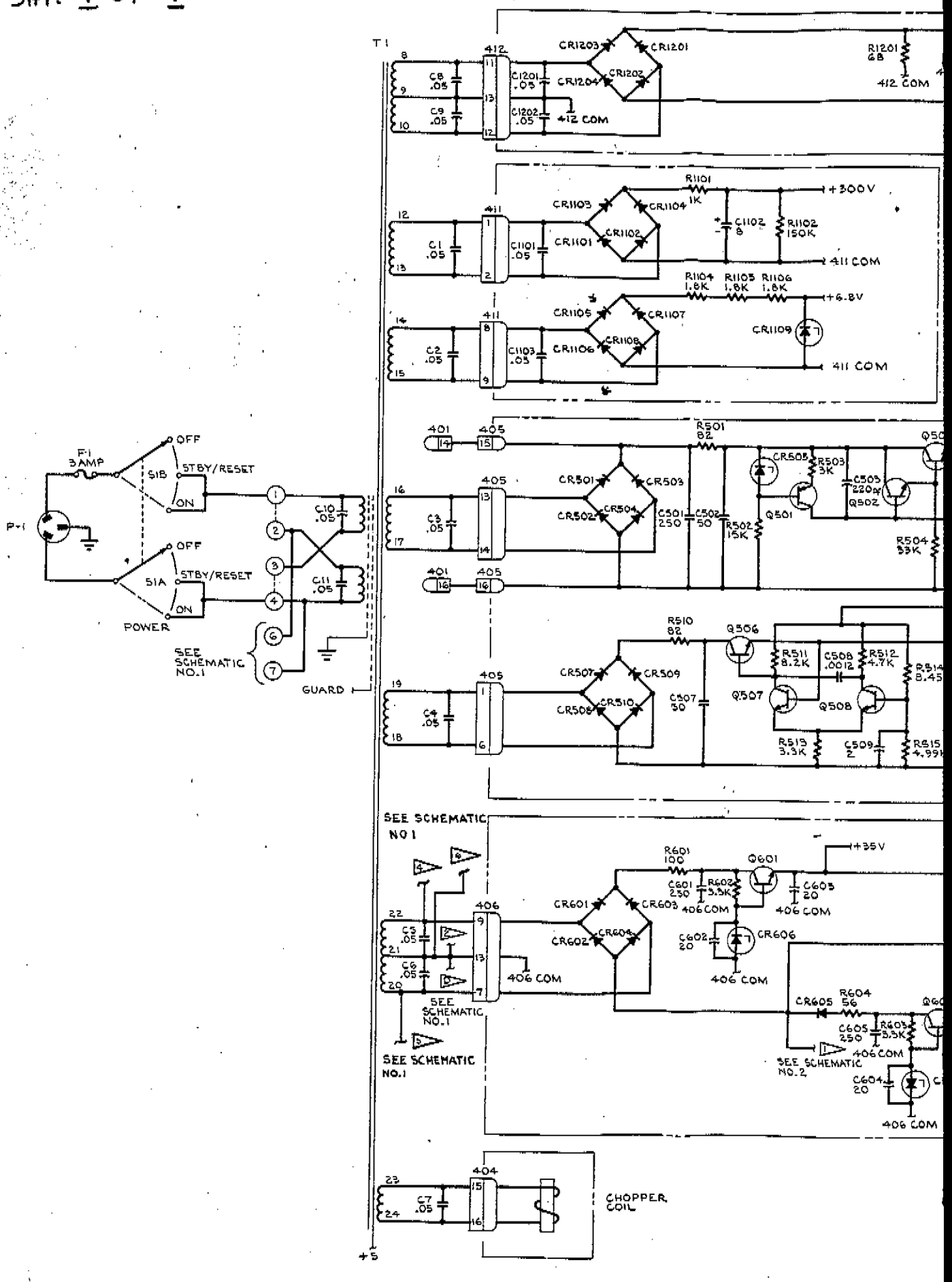
332A SER. NO. 123 & ON

FLUKE JOHN FLUKE MFG. CO., INC.

P.O. Box 7428 Seattle, Washington 98133

SCHEMATIC 3

SHT. 1 OF 4



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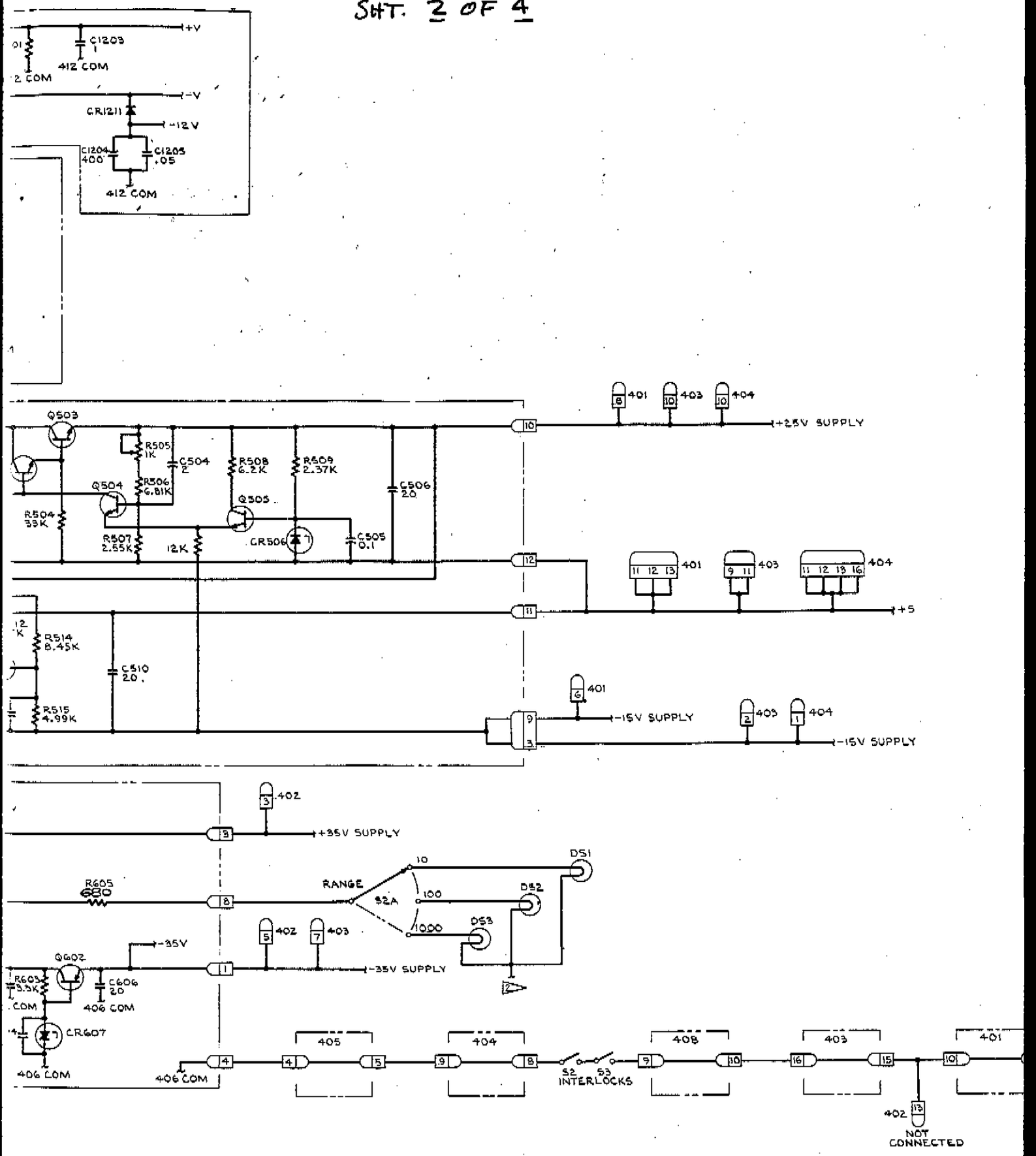

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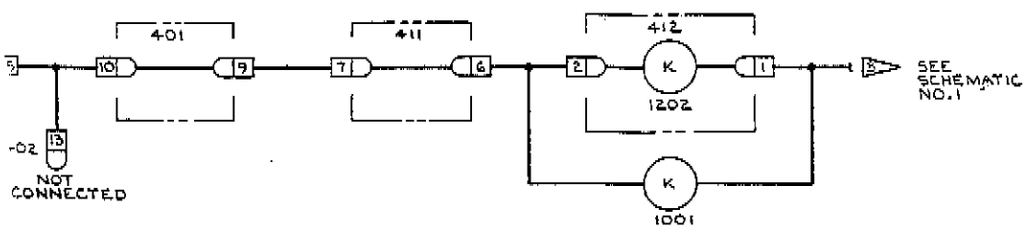

FUNCTIONAL SCHEMATIC

SCHEMATIC NO. 3 TI POWER DIST

VOLTAGE STANDARD

MODEL 332A

332A SER. NO. 123 [illegible]

JOHN FLUKE MFG. C

P.O. Box 7428 Seattle, Washi

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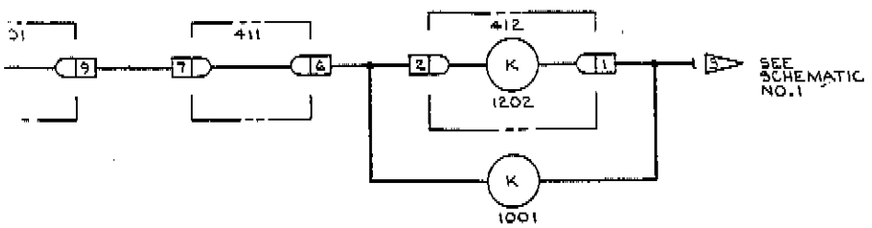


FUNCTIONAL SCHEMATIC
SCHEMATIC NO. 3 TI POWER DISTRIBUTION

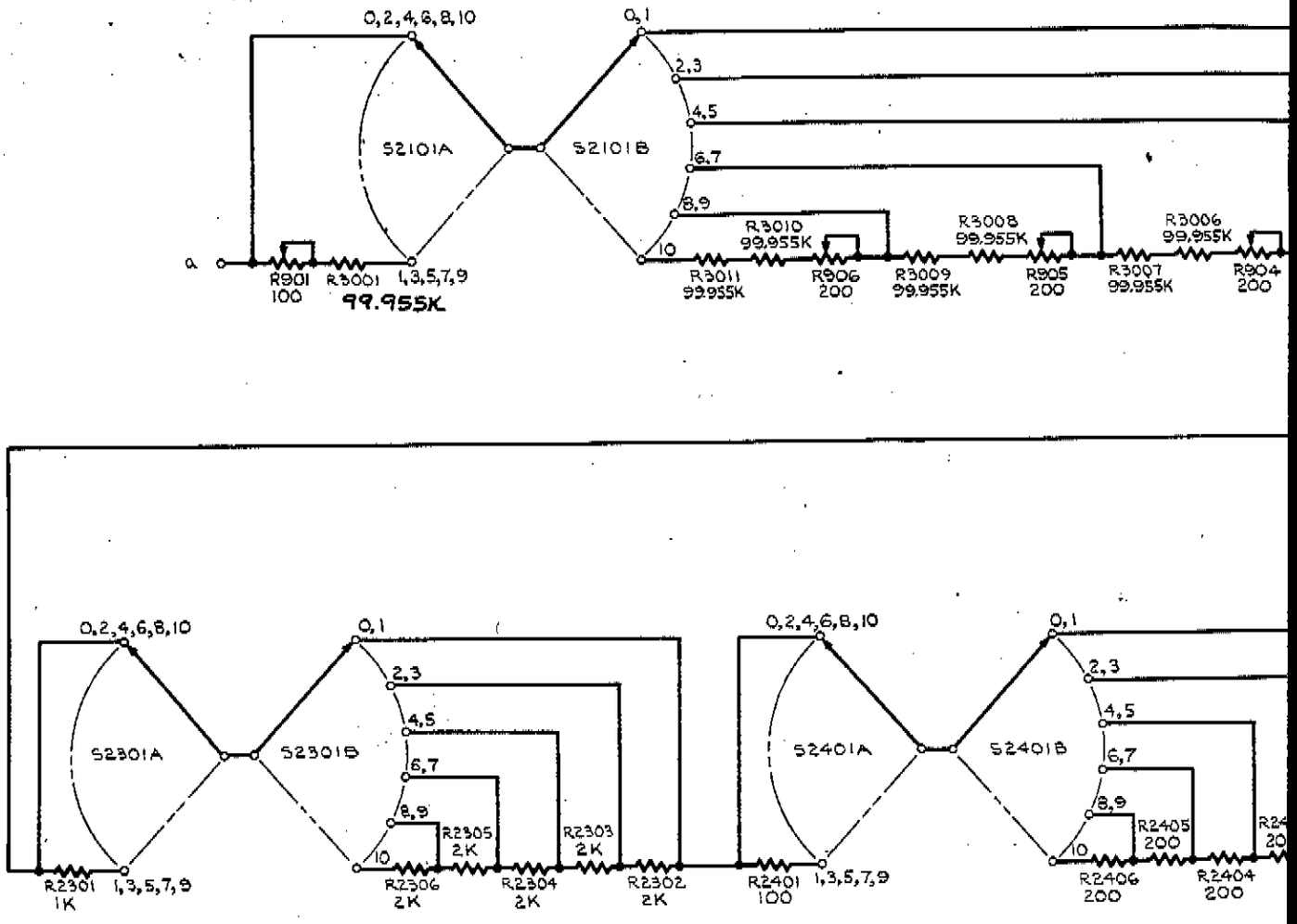
VOLTAGE STANDARD

MODEL 332A

332A SER. NO. 125 & ON

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

SCHEMATIC 4
SHT. 1 OF 3



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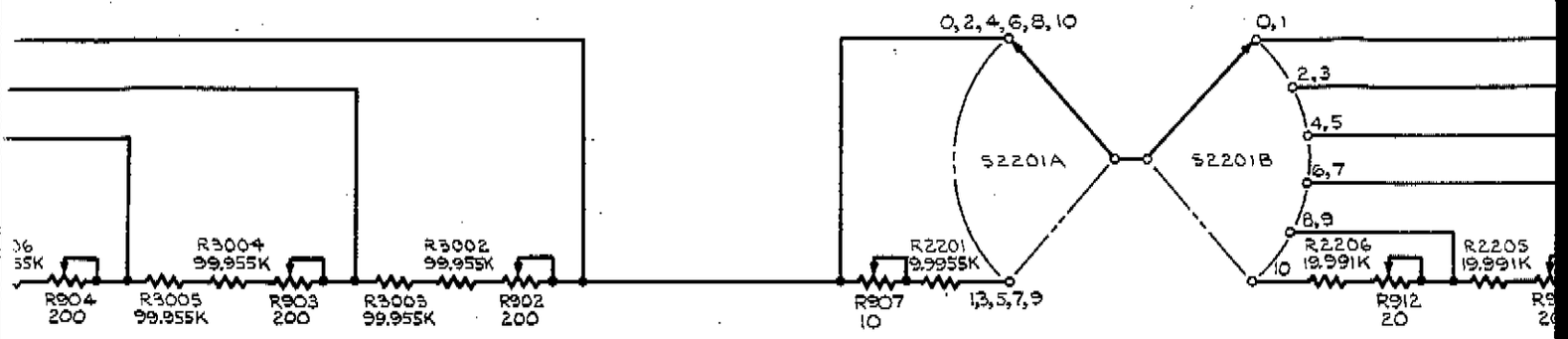
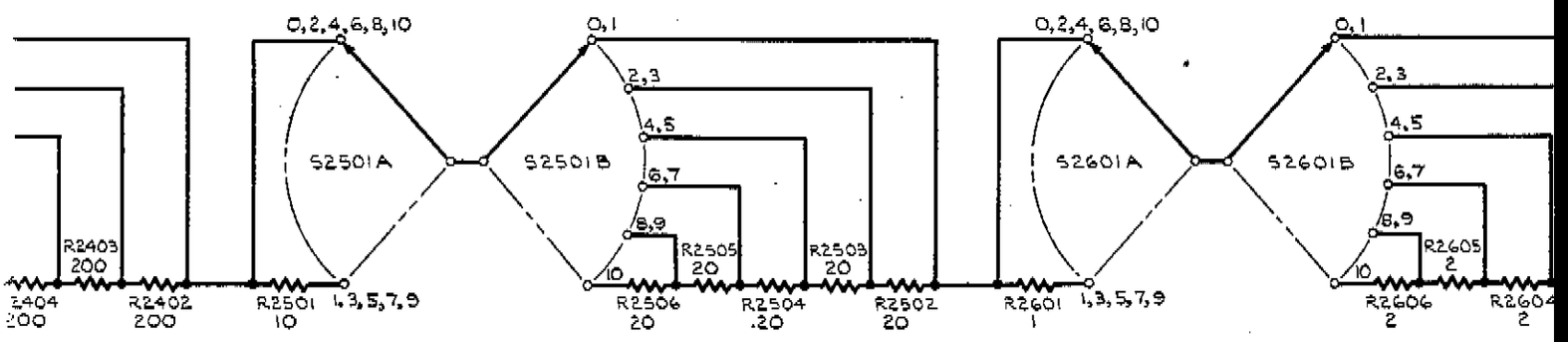
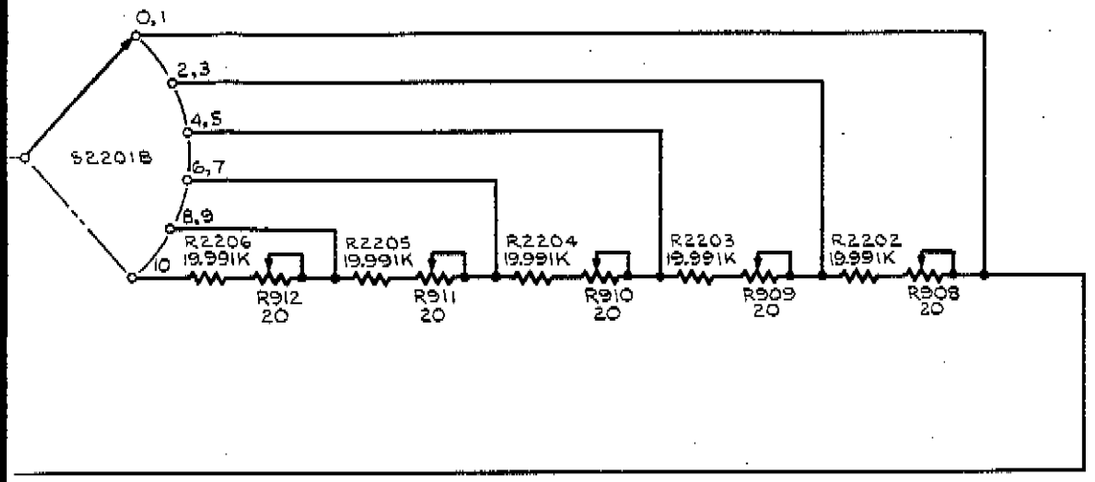
SHT. 2 OF 3

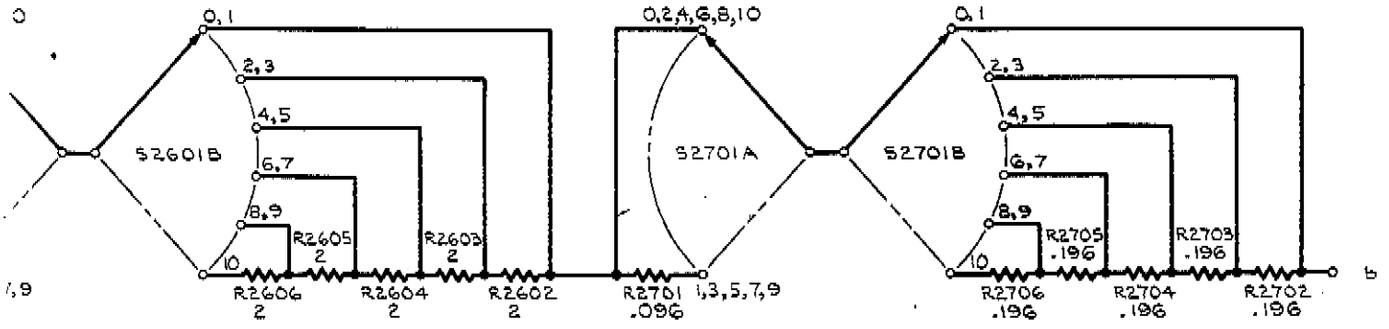




SCHEMATIC 4

SHT. 3 OF 3





FUNCTIONAL SCHEMATIC b

SCHEMATIC NO. 4 SAMPLE STRING

VOLTAGE STANDARD

MODEL 332A

332A SER. NO. 123 & ON

FLUKE JOHN FLUKE MFG. CO., INC.

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