

1418-1, Capacitors and Capacitive Circuits

**Experiment 8: Using Polarized
Capacitors in a-c Circuits**

- To verify that a combination of two polarized capacitors connected back to back can be used in a-c circuits.

Objective

- We have previously indicated that polarized or electrolytic capacitors have a special application due to the polarization of the dielectric material.
- This type of capacitor is usually used in d-c power supply filter circuits.

Introduction

- In special circumstances, electrolytic capacitors may be used in a-c circuits, provided special precautions are used.
 - There are three precautions that must be followed
 - The following slide illustrates the precautions both in writing and schematically.
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1. The capacitors must be connected back to back

a) Both positive leads are connected

b) Both negative leads are connected

2. There are two capacitors

3. Capacitors must have the same value

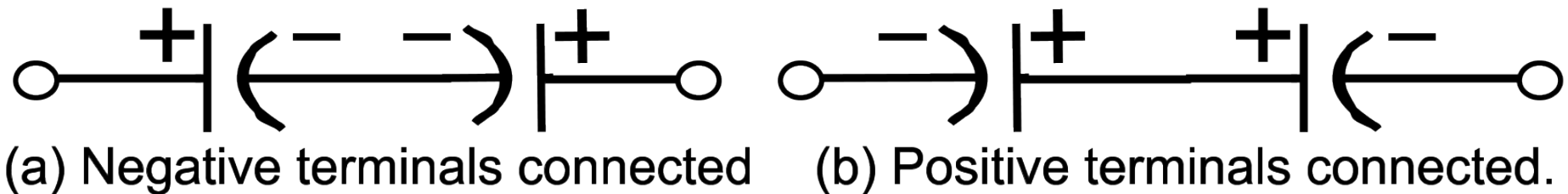


Fig. 41 Polarized capacitors connected back to back.

- The leakage resistance of polarized capacitors will change with the polarity of the sign wave.
 - The sign wave alternates between a positive polarity and a negative polarity, since this is an a-c circuit.
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- There will always be a high leakage resistance of the capacitor that has the correct polarity, even though there is a low resistance of the capacitor connected in series with it.
 - Therefore, the leakage resistance of this special circuit remains high regardless of the polarity of the voltage applied to it.
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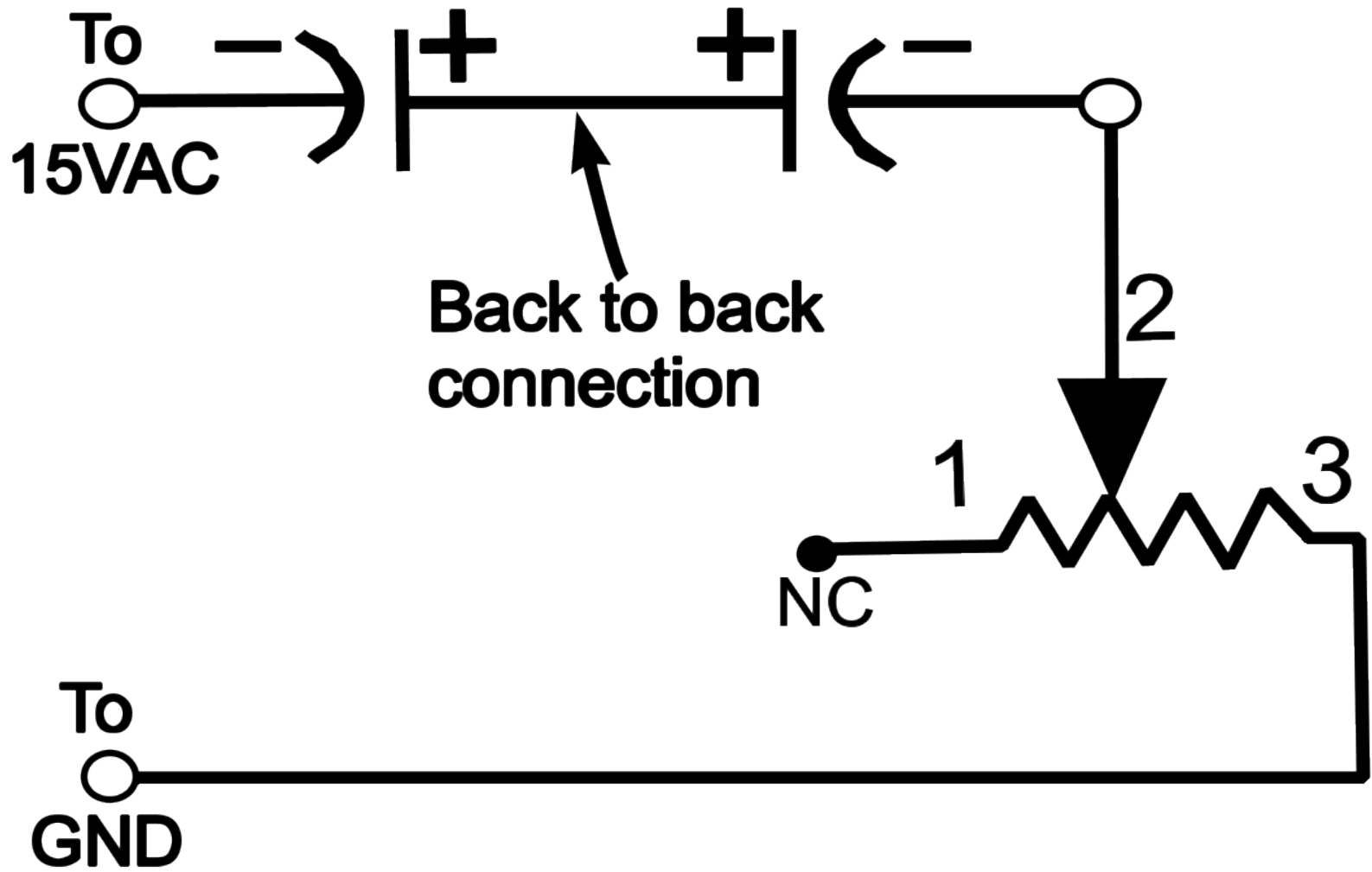
- The total capacitance may be calculated using the same method used to find the total resistance of two resistors connected in parallel, since there are two capacitors in series.

$$C_T = \frac{C_1 \times C_2}{C_1 + C_2}$$

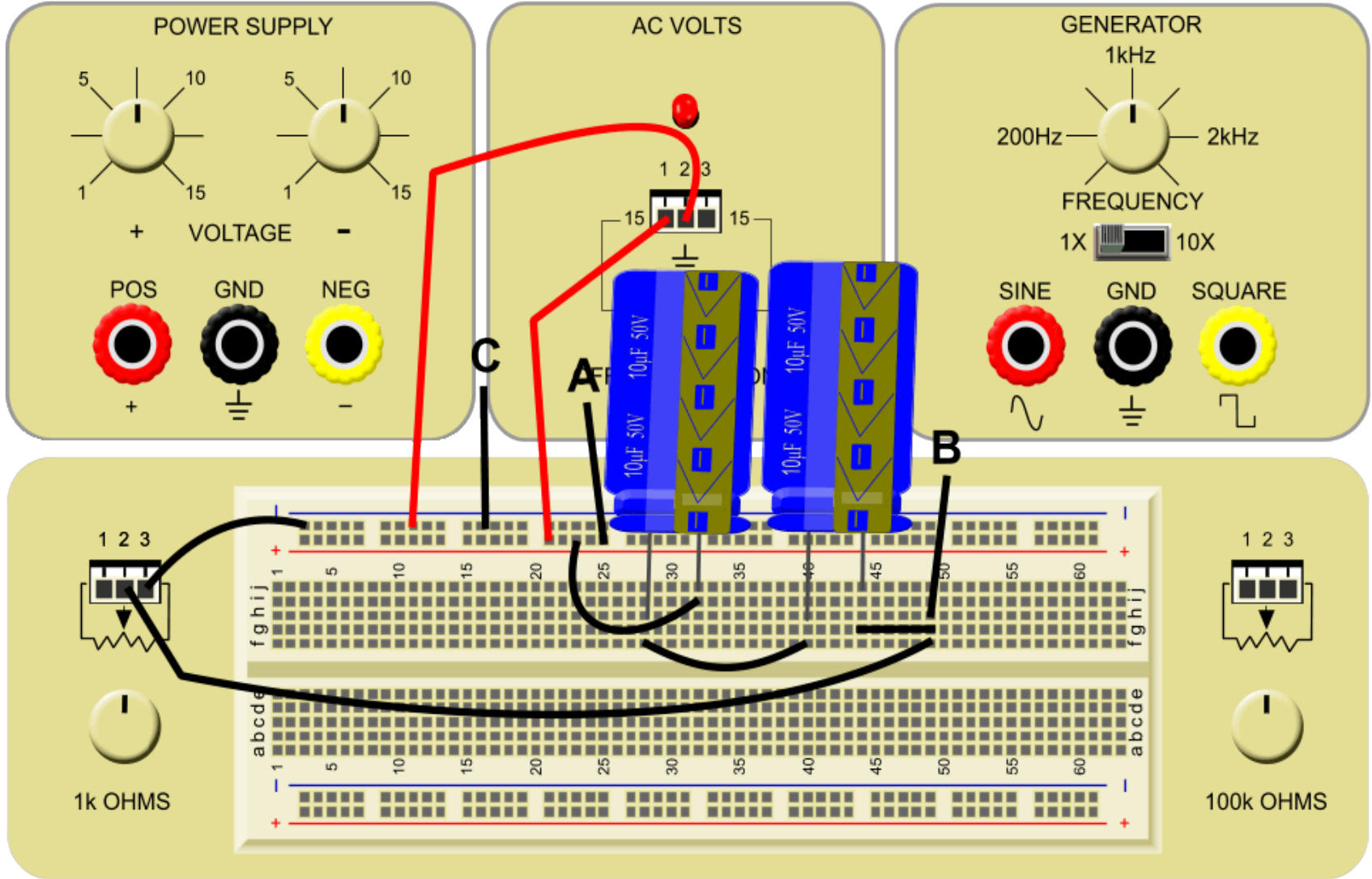
- Remember, all three conditions must be met to connect electrolytic capacitors in an a-c circuit: There are two capacitors, *they have the same value*, and are connected back to back
 - There is a shortcut to calculate the total capacitance if all three conditions are met.
 - **Divide the value of one of the capacitor's capacitance by 2**
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- This experiment will use the same procedure we used in previous experiments.
- The main emphasis is to obtain the same or equal voltage drops across the pair of capacitors and the potentiometer.
 - Once completed, the value of the resistance will equal the X_C of the capacitor

Suggested Procedure



- 1. Construct the circuit**
 - I. Connect two $10\mu\text{F}$ capacitors between terminals A and B.**
 - 2. Apply the 15VAC signal to terminal A**
 - I. Your goal is to have V_C equal to V_R**
 - a. Place Common (Black) lead at Terminal B.**
 - b. Place a jumper post at point B in your circuit.**
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- c. Clip the Black meter probe lead to post “B” with an alligator clip or lead.**
 - d. Move the Red lead/meter probe between Terminals A and C.**
 - i. Make small adjustments on the pot.**
 - a. 1st Measure Voltage across capacitor**
 - b. Then the Pot, adjust pot to match**
 - ii. Keep making fine adjustments by measuring the AC voltage at points A and C until $A = C$.**
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- e. Turn off the trainer after the measurements have been made and the voltages are the same.**
 - f. Disconnect the leads from the Pot, measure and record the measurement in Fig/table 44 of the lab.**
- 3. While we are listing DC voltage (not AC effective) measurements in our results, these results are not really important to the experiment.**
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- Next you will use the following formula to calculate the total capacitance of the back to back pair of capacitors.


$$C = \frac{1}{2\pi fX_c}$$

X_c = the measured value of the Pot.

$$\%error = \frac{(\text{sum of } E_{c1} + E_{c2}(\text{measured value})) - (\text{sum of } E_{c1} + E_{c2}(\text{calculated value}))}{(\text{sum of } E_{c1} + E_{c2}(\text{measured value}))} \times 100$$

Calculate the %error

- Verify similar results occur with negative terminals connected by repeating the experiment with the negatively connected capacitors.
 - Again, calculate the %error.
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$$\%error = \frac{(\text{sum of } E_{c1} + E_{c2} (\text{measured value})) - (\text{sum of } E_{c1} + E_{c2} (\text{calculated value}))}{(\text{sum of } E_{c1} + E_{c2} (\text{measured value}))} \times 100$$

Calculate the %error

- The %error was 12% for both circuits. This is acceptable since the manufacture of polarized capacitors is difficult and the usual polarized capacitor has wider tolerances.
- The same techniques can be used with non-polarized capacitors made of Mylar, mica or film dielectrics.

CIE Results and Final Discussion



Questions?

Resources

- Rubenstein. (2001). *Lesson 1418: Capacitors and capacitive circuits*. Cleveland: Cleveland Institute of Electronics.
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The End

**Developed and Produced by the
Instructors in the CIE Instruction
Department.**

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