

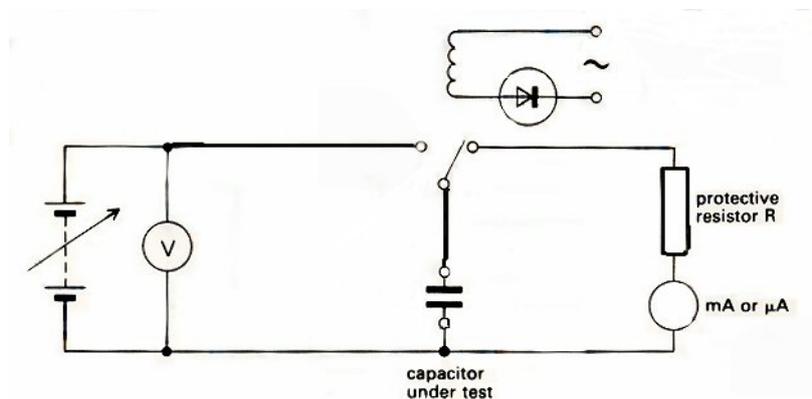
TAP 126- 3: Using a reed switch to measure capacitance

Relating quantities

You will use a reed switch with a capacitor to investigate how charge varies with the applied voltage. This leads to measurements of capacitance.

You will need

- ✓ reed switch (change-over type in coil)
- ✓ signal generator
- ✓ low voltage power supply and smoothing unit dc (up to 20 V), or twelve 1.5 V cells. If commercial smoothing units are not available a high-ripple electrolytic capacitor (in parallel with the supply output) will do.
- ✓ 1 pair capacitor plates 25 cm x 25 cm with sixteen 1cmx1cm polythene spacers about 1mm thickness
- ✓ 100 k Ω protective resistor
- ✓ clip component holders
- ✓ milli or micro ammeter.
- ✓ Voltmeter that reads to 20 V
- ✓ 4 mm leads



The activity

With a diode rectifying the ac from the signal generator the reed switch charges and discharges once per cycle. The capacitor discharge current is measured.

Charge per second = I = current = $Q f$ where f is the frequency of the signal generator.

$$C = Q / V = I / f V$$

Find I and V from the meter readings.

Vary the voltage and measure the current. Record the results and calculate the charge.

Drawing a graph of charge against voltage enables the capacitance to be found.

Practical advice

Frequency should be about 400 Hz and the protective resistance about 100 k Ω . The capacitor plates must not touch whilst the reed switch is working nor should the switch operating pd be exceeded. The signal generator pd should be raised until the switch is heard vibrating.

If a stock capacitor is used rather than the plates then a 220 Ω protective resistor is required for capacitances of a few microfarads and a milliammeter will be required

To protect the reed switch, the capacitor plates should never touch whilst the switch is working. Switch off and disconnect the power supply before adjusting the plates. For accuracy, keep hands and earthed objects well away from the plates whilst taking readings.

Extension

The can be extended to investigate the factors determining capacitance of a parallel plate capacitor if this is needed for your specification.

(N.B. The graph from a reed switch experiment will not pass through the origin so the effect of stray capacitance in the experiment will have to be explained. This is particularly important if you vary the area of the plates. Suggested areas are 3/4, 2/3, 1/2, 1/3. A weight will be needed to counterbalance the part of the plate sticking out. This should be over the edge of a bench to try to reduce stray capacitance with the bench.)

If the plates are used the effect of different materials between the plates can be demonstrated, e.g. plastic sheet, cardboard, rubber, a newspaper for example as well as increasing the number of spacers and so increasing the gap

If fixed capacitors are used then the effect of adding capacitors in series and parallel can be demonstrated. Be aware that the marked value on a capacitor may be correct only to within say 50%.

External references

This activity is taken from an adaptation of Revised Nuffield Advanced Physics experiment E7.