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# Theory

The purpose of this exercise is to measure the reactance of a capacitor at a specified frequency. We will also compare the reactances of two capacitors in series and parallel. In addition, we will gain some experience in breadboarding, current and voltage measurements and the use of an oscilloscope and signal generator.

# CIRCUIT:

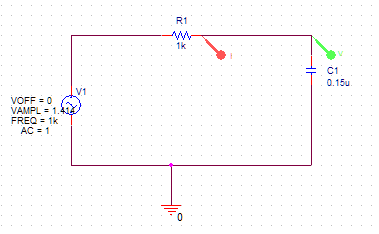


Figure 1.The basic circuit.

# Introduction

If a resistor is connected across a sine wave generator, the current is in phase with the applied voltage. If instead of a resistor, we connect a capacitor across the generator, the current is not in phase with the voltage, see below.

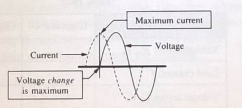


Figure 2. Current and voltage across a capacitor

Note that the current and voltage have the same frequency, but the current is leading the voltage by 1/4 cycle. The current in the capacitor is directly proportional to the capacitance and the rate of change of voltage. The largest current is when the voltage change is a maximum.

If the capacitance is increased or the frequency is increased, there is more current. This is why a capacitor is sometimes thought of as a high-frequency short.

Reactance is the opposition to AC current and is measured in ohms, like resistance. Capacitive reactance is written with the symbol Xc. It can be defined as:

Where *f* is the generator frequency in hertz and C is the capacitance in farads.

Ohm's law can be generalized to ac circuits. For a capacitor, we can find the voltage across the

capacitor using the current and the capacitive reactance. Ohm's law for the voltage across a capacitor is

## **PROCEDURE**

1. Use 2 capacitors with nominal values of 0.22 µF. Mark one with a pen and call it C1, the unmarked component is C2
2. Set a Function generator to produce a sine wave voltage of frequency 1kHz and 1 Vrms. Use a digital multimeter (DMM) to measure AC RMS voltages. Do not change these settings during the Lab.
3. Open MS Excell and copy the table below to the worksheet
4. Build the circuit using C1. Measure RMS voltages across the resistor (VR) and capacitor (VC) with DMM.
5. Fill in column C1 in the worksheet.
6. Repeat for C2., C1 in series with C2 and C1 in parallel with C2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | C1 | C2 | C1 ser C2 | C1 || C2 |
| RMS Voltage across R, VR [Vrms] |  |  |  |  |
| Total current I = VR/R |  |  |  |  |
| RMS Voltage across C, Vc [Vrms] |  |  |  |  |
| Reactance Xc=Vc/I |  |  |  |  |
| Calculated Capacitance |  |  |  |  |

Table 1. Results

1. Copy the complete Table from the Excel worksheet to your word file.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | C1 | C2 | C1 ser C2 | C1 || C2 |  |
| RMS Voltage across R, VR [Vrms] | 0.8 | 0.767 | 0.568 | 0.89 |  |
| Total current I = VR/R | 0.8 | 0.767 | 0.568 | 0.89 |  |
| RMS Voltage across C, Vc [Vrms] | 0.525 | 0.57 | 0.79 | 0.317 |  |
| Reactance Xc=Vc/I | 0.65625 | 0.743155 | 1.390845 | 0.35618 |  |
| Calculated Capacitance | 242.64 | 214.26 | 114.48 | 447.06 |  |
|  |
| **Table 1. Results** |  |  |  |  |  |
| |  | | --- | |  | |  |  |  |  |  |
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1. Write one comment below on the work you have done

We build the circuit using two capacitors and one resistor component. In the class, we calculate the values of capacitance in series and parallel using a Multimeter. Using an excel graph we only had to enter two digits for each calculation, the calculation was done automatically using a formula by the excel program. We saw that capacitors in parallel had double the capacitance of the individual components. In series, the total capacitance was half the individual for one capacitor.