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RC Circuit with Signal Generator and Oscilloscope

Equipment:

oscilloscope	BK function generator	
resistor(4.7kΩ)	capacitor (0.1μF)	3 BNC to banana

Purpose:

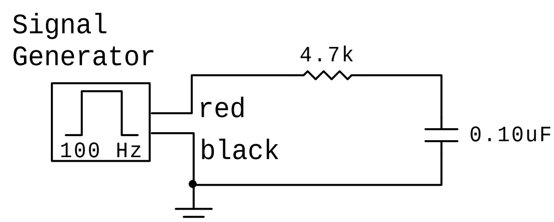
To become familiar with the use of a signal generator and oscilloscope applied to a familiar situation-the charging and discharging of a capacitor through a resistor.

Introduction:

Previously you charged and discharged a capacitor manually by making connections to a battery and then switching the connection to allow discharge through the resistor. In this lab a signal generator will do the "switching" for you, and you will use an oscilloscope to "look" at the voltage across the capacitor.

Procedure:

Circuit construction: Construct the circuit as shown using a 4.7 kΩ resistor and a 0.10 μF capacitor. The signal generator is the BK Precision function generator. The black lead from the signal generator is already grounded electrically inside the signal generator. (This is indicated by the ground symbol in the diagram.)

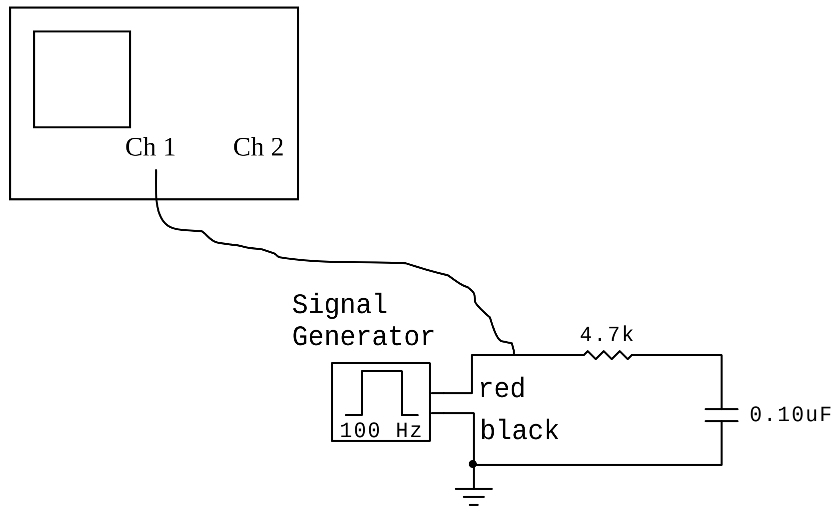


Select the square wave output from the signal generator by pushing the FUNCTION button that looks like a square wave. Set the frequency for 100 Hz by pushing the 100 button and adjusting the dial.

Using the oscilloscope to display voltage as a function of time:
Attach the oscilloscope probe as shown below to record the voltage from the signal generator. (You don't need to attach the alligator clip to the grounded side of the signal generator since the clip is already grounded at the oscilloscope.)

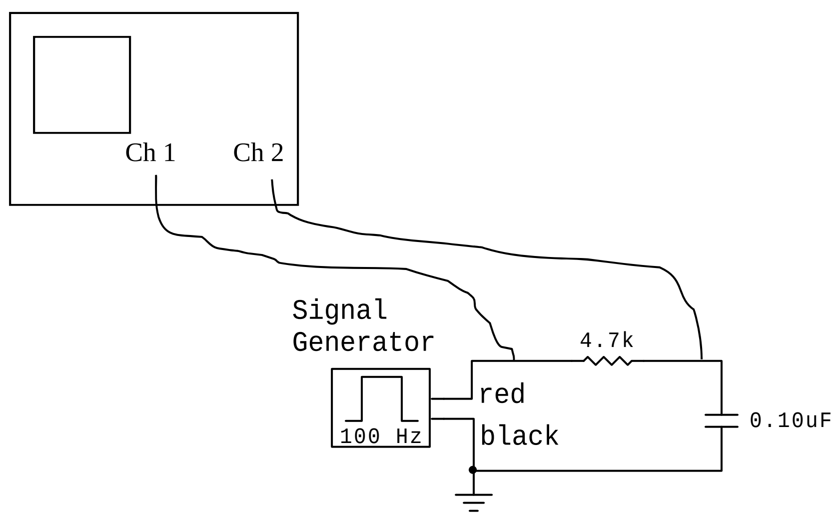
Set the TIME/DIV to 1 ms, the VOLTS/DIV to 0.1, the MODE (at bottom middle) to CH1, the INT TRIG to CH1, the MODE (upper right) to AUTO, and the SOURCE to INT. Make sure the switches next to the INPUTs are set to DC.

Adjust the LEVEL knob (upper right) and hopefully you will see the square wave appear. If you can't get it ask for help.

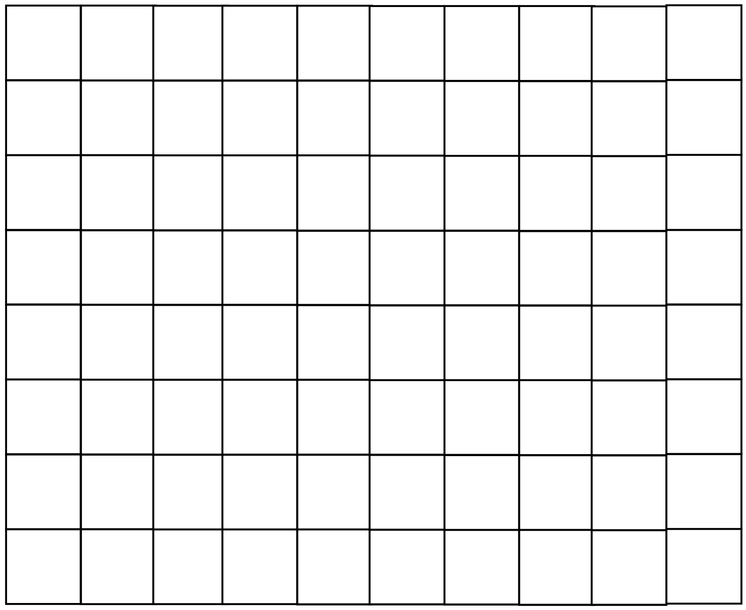


When you get the square wave on the scope, change its frequency and amplitude by adjusting those knobs on the signal generator. Make sure that the result you see on the screen makes sense to you. If the square wave is not centered use the POSITION knob so that it goes above and below the center line by equal amounts. Set the frequency to 100 Hz and the amplitude to 3 divisions.

Now attach the channel 2 probe to show the voltage across the capacitor. Set the MODE (bottom middle) to CHOP. Center the signal on the screen. You should see both signals.



Carefully sketch the signals below and label the time axis.



Analysis:

1. Use your graph to measure the time constant for both charging and discharging. Recall that the time constant for charging is the time to get to $\left(1-e^{-1}\right)=0.632=63.2\%$ of the final voltage, and for discharging it is the time to decay to $e^{-1}=0.368=36.8\%$ of the initial voltage.

Clearly indicate on the graph how you determine the time constants.

Time constant for charging:

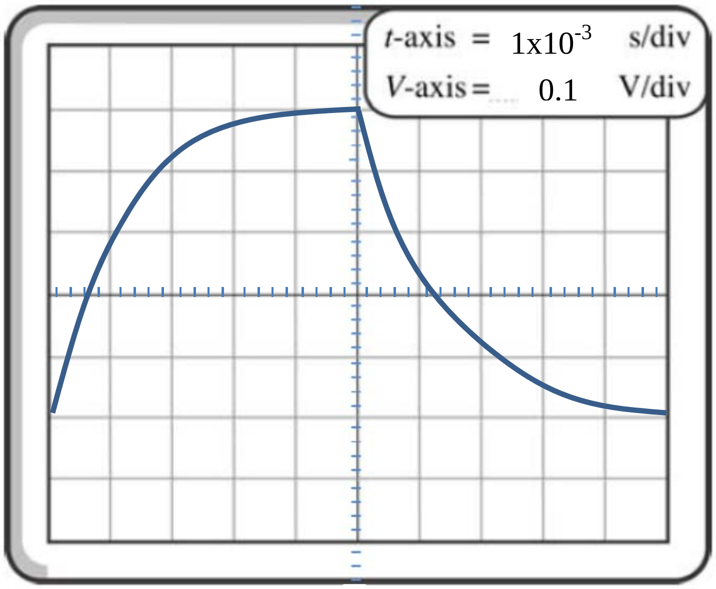
Time constant for discharging:

What is the predicted value for the time constants?

2. How might you make a more accurate measurement of the time constant? (Think about changing some of the settings on the oscilloscope.)

HOMEWORK

H1. Here is an oscilloscope trace of an RC circuit.



What is the time constant for –

A. Charging ____________________ B. Discharging_____________________

H2. If the resistance included in the circuit is 1000Ω, what is the capacitance of the parallel-plate capacitor in the circuit?

H3. If, by some means, the distance between the parallel plates of the capacitor is reduced to half of what it was before, would the time constant change? If yes, then what would be the new time constant?

H4. The distance between the parallel plates is now restored to its original value. However, we want the time constant to be the same as in H3. How can this be achieved without changing the capacitor?