Name *Roll#*

Laboratory Assignment 3 : I/V characteristics

Suggested reading and connection time: 20 min.

Goal:

In this assignment we will learn a useful technique to *characterize* an electronic part, i.e. obtain it's I/V characteristics. We will use some of the more advanced features of a DSO to make such possibly tedious measurements easier. No graph papers will be used.
You have already learnt the basic operation of a Function Generator and Digital Storage Oscilloscope in Lab 2.
In this lab, we will use the *differential* voltage signal provided by the function generator on a red cable connected from its back panel. This cable has three connectors – the red and white present a differential voltage which swings between +V and –V and the green connector presents the halfway point: it is always at (+V-V)/2 = 0. Note that this 0V is <u>not</u> related to the 'earth-ground' potential.
For this entire experiment, connect a circuit in the configuration shown in Fig 1.

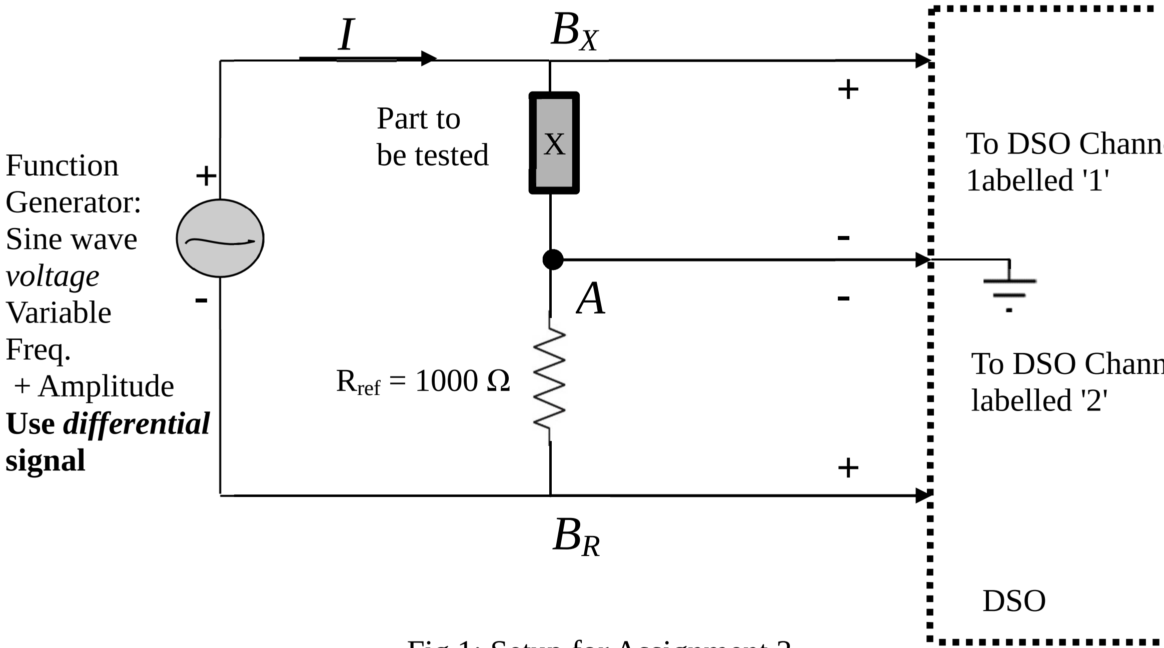

Fig 1: Setup for Assignment 3

Here are a few things you should notice when making the connections:

- The function generator is producing a *differential voltage* signal swinging between +V and -V: (the amplitude is set by the knob on the front panel). The green wire is not used for this setup.
- On the DSO both channels have their negative terminals (the outer shields of the BNC connector) internally connected to earth ground for safety.
- You must learn to keep track of this distinction between a differential (+/-) signal, and a signal whose negative terminal is fixed at ground potential (a single-ended signal). It is very important in analog electronics – we will use it many times during the semester.
- <u>The number of connections to be made in the above circuit is very small: however, you must make sure that the connections are secure. A loose wire can inject a lot of noise into your measurement and lead you off into completely wrong conclusions</u>

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Part 1: The Diode *Suggested times: Part A: 40 min, Part B: 30 min*

Put in a diode as Part X in Fig 1. Use input signal frequency of 100 Hz.

Part A) By adjusting the various controls on the DSO, obtain the I/V characteristics of the diode. Normally, the DSO plots the signals measured on channels 1 and 2. However, it can be put into a mode which plots channel 1 v/s 2 (it's called X-Y mode). Determine which control button does this.

Observe and note the following:

1. From the markings on the DSO probe, what is the input resistance seen by the points $(B_X\text{-}A)$ i.e. device X and $(B_R\text{-}A)$ i.e R_{ref} looking into the DSO? _________________________
2. Based (1), what is the path of current I at the junction A? ____________________________
3. Accordingly, what does channel 1 measure? _______________________________________
4. What does channel 2 measure? ____

Using Ohm's law and the above information, assuming R_{ref} is a perfect resistor, one axis of the X-Y measurement plot can be simply converted into a different quantity

5. What is this quantity? ____

Based on the answers to all the above questions, draw a plot of the measured I-V characteristic of the diode here:

Hint: Consider carefully the voltage polarities applied to Part X and R_{ref} with respect to the junction point A: you need to invert one of the channels to get a sensible V/V graph. You can go into the Channel menus of the DSO to invert the signal.

6. What is the voltage at which the diode just starts conducting? ______________________
7. What is the voltage at which the diode reaches full conduction? _____________________

Part B) Keeping the above setup same, change the input function generator signal to high frequency: Redraw the new observed I-V characteristics here, and state a hypothesis to explain your observations

i) For frequency = 1 kHz

ii) For frequency = 10 kHz

Note: you will have to magnify the scale and examine the traces around the origin to notice peculiarities.
Hint: Normally, diodes are specified to operate at AC line voltage (60 Hz) as rectifiers. For high frequency operation, a different type of diode, called a 'Fast Recovery' diode must be used.

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Part 2: The Resistor *Suggested times: Part A: 20 min, Part B: 30 min, Part C: 30 min*

Put in a resistor of *unknown* value $R_{unknown}$ in place of Part X in Fig 1.

Part A) (You are *not allowed* to use a DMM!)
Repeat the technique developed for Part 1A to obtain the I-V characteristic of the resistor.
At first try a sine wave input of ~ 2V amplitude at frequency ~ 200Hz..
This should let you make a straightforward measurement.
Draw your observed I-V characteristic here, making careful note of the slope:

Based on your observations, determine $R_{unknown}$=____________________

Part B) Keeping the amplitude low, increase the frequency of the input signal up to ~ 10 kHz
Q.1) Redraw the observed I-V characteristic:

Q.2) If the observation is different from Part A, state a hypothesis that accounts for the difference:

1.A	1.B	2.A	2.B.1	2.B.2	Total
/6	/2+2	/3	/1	/1	/15