

## Lab 1 FYSS 585

### Getting up to speed with LabView: Measurement of the ideality factor of semiconductor diodes.

The goal of this lab is to refresh your basic knowledge of LabView graphic environment for data analysis and control. In this lab we (i) construct a two terminal analyser and (ii) use the analysis capabilities of LabView to measure the ideality factor of a semiconductor diode.

The Shockley<sup>1</sup> diode equation describes the relation between the current flowing through a diode,  $I$  and the applied voltage,  $V$ :

$$I = I_0 \left[ \exp\left(\frac{V}{nkT}\right) - 1 \right] \quad (1)$$

Here,  $I_0$  is the saturation reverse current,  $n$  is the ideality factor  $k$  is Boltzman's constant and  $T$  is absolute temperature. This can be written in linear form:

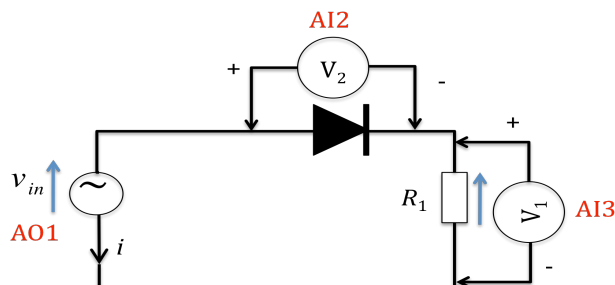
$$\log_e(I + I_0) = \log_e I_0 + V \left( \frac{1}{nkT} \right) \quad (2)$$

The ideality factor, which depends on the fabrication process, is an important parameter for circuit simulation. Typical values are 1-2. We also have that  $I_0 \ll I$  under forward bias conditions.

In this Lab exercise we seek to make analyser that measures  $n$  for different diodes.

The measurement requires accurate determination of the current and voltage. For this reason we use differential voltage measurement with zero subtraction is used to correct each measurement from errors associated with thermoelectric voltages etc and also rectification of e-m waves.

1. Connect the diode test circuit with the NI USB-6009 as shown below.

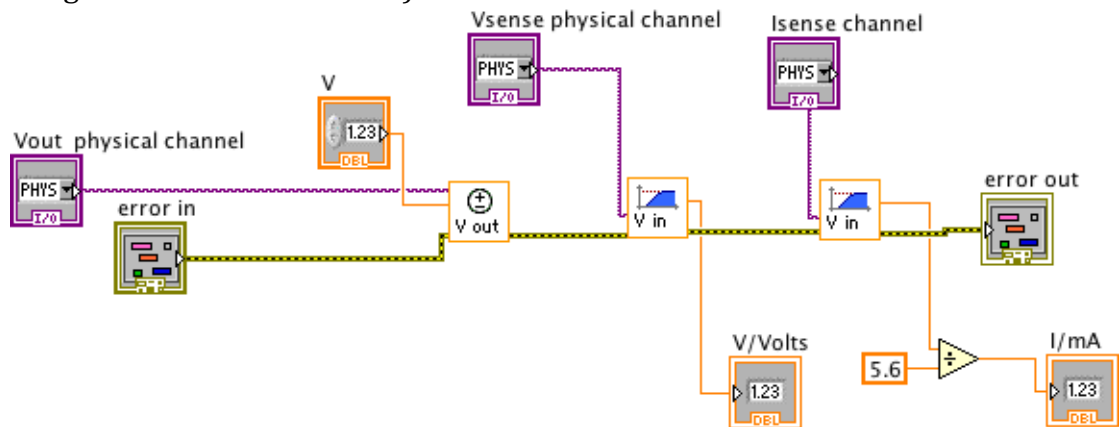


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<sup>1</sup> Co-inventor of the transistor. It is less known that Shockley also held controversial views on race and genetics and even lesser known that he once published an article in Playboy.

The resistance,  $R_1$  is  $5.6\text{ k}\Omega$ . The current is measured from the voltage,  $V_1$  over this resistance.

- Study the VI: V-I.vi below. It can be downloaded from the course web-site along with the generic Vis for handling the NI USB-6009 interface. (Note that different generic Vis must be downloaded depending on if you are using Windows or Mac-OS X.)



- Using V-I.vi as a basis, make changes so that the zero offset voltage and current are measured first by setting  $V$  to zero and subtracting the zero errors from the measured value with  $V$  non-zero.
- Make a VI that plots the current  $I$  though the diode vs. voltage across the diode  $V$ . Note the form of the curve. Is this what you expect?
- Modify the VI so that when,  $I$  exceeds a given threshold, (say:  $50\text{ }\mu\text{A}$ ) the voltage and current  $I$  are written to a pair of 1-D arrays. Why is this needed?
- Plot  $\text{Log}_e(I)$  vs. voltage  $V$  using the above VI and use a straight line fit to determine the slope of the straight line. Use this to calculate and display the ideality factor,  $n$ .