Resistors and Diodes Re-submission

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1 Introduction

In this lab we set out to explore the world of diode controlled transistors.

2 Experiments

2.1 Experiment 1: Diode-Connected Transistor Characteristics

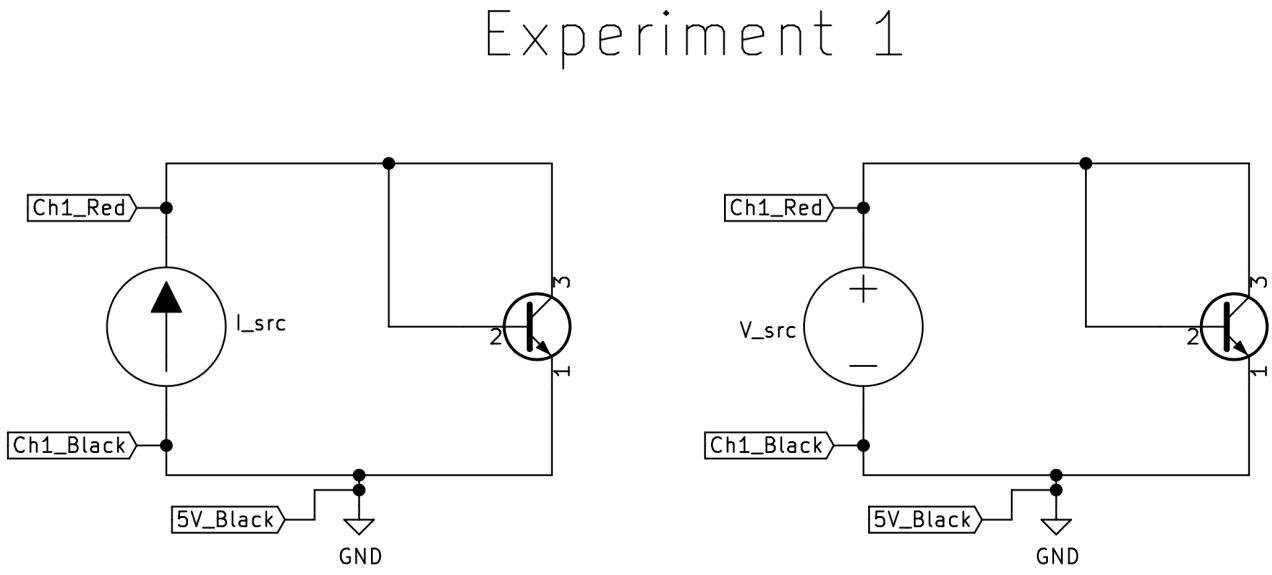

Figure 1: Schematic for Experiment 1

The V-I characteristic and I-V characteristic are very similar. The only noticeable difference is in the slightly larger variance at lower voltage inputs for the I-V characteristic. This may be due to less available precision in sourcing small voltages of sensing small currents.

For this diode-connected transistor, we found $I_s = 2.26 \cdot 10^{-15} A$ and $U_T = 0.0255V$

The exponential fits reasonably well. There is slight deviation as it approaches higher voltages in the shown range.

The theoretical fit matches the extracted data really well. See Figure 3.

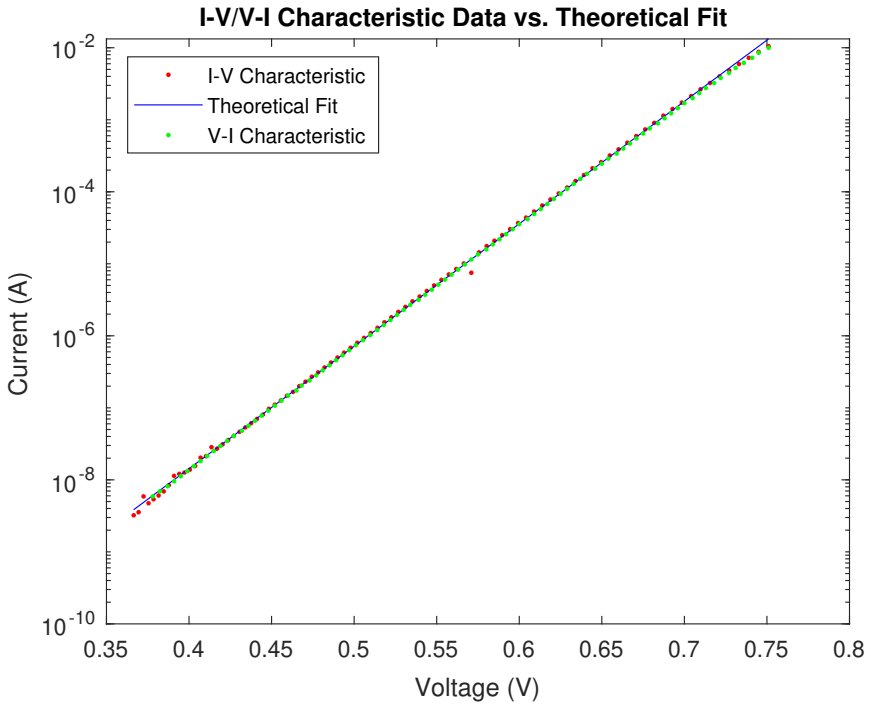

Figure 2: Measured I-V/V-I characteristics vs. theoretical fit of $U_T = 0.0255$ V & $I_s = 2.26 \cdot 10^{-15}$ A

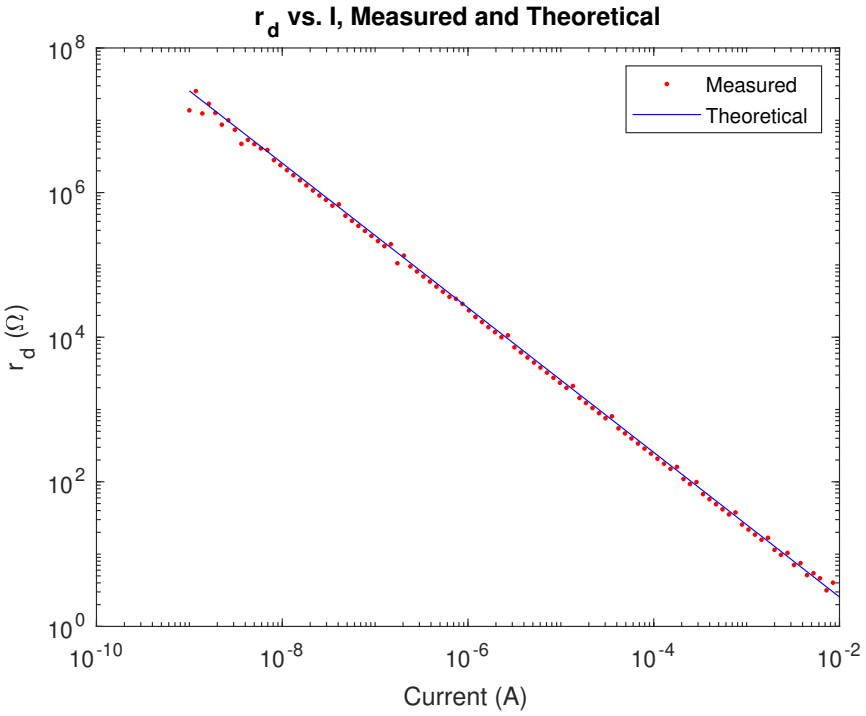

Figure 3: r_d as a function of I, measured and theoretical.

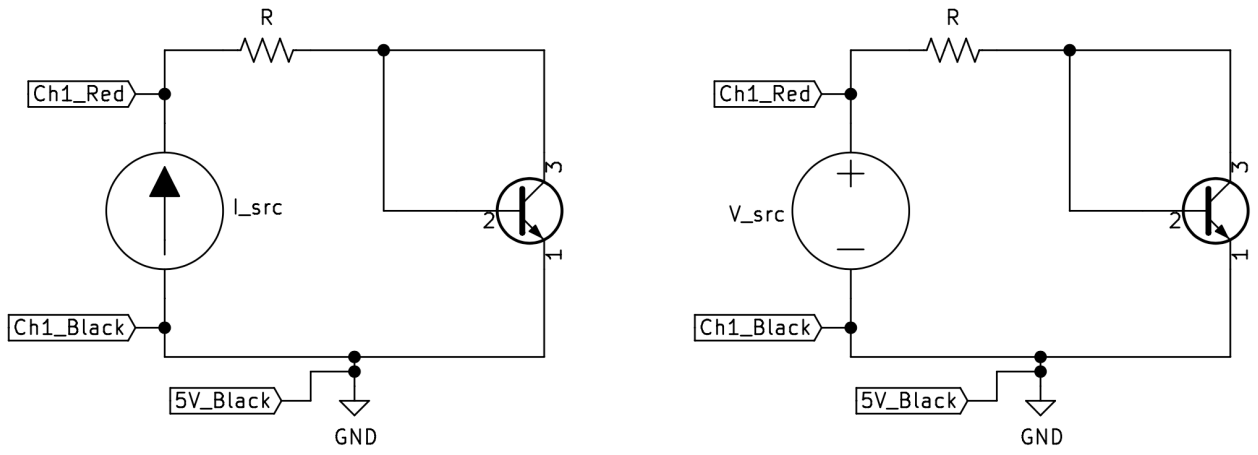

Figure 4: Schematic for Experiment 2

2.2 Experiment 2: Characteristics of a Resistor and Diode in Series

We found that the circuit behaves qualitatively as expected from the prelab assignment. For $V_{in} << V_{on}$, small increases in V_{in} result in large changes on V_{diode}. For $V_{in} >> V_{on}$, increases in V_{in} does not have as much of an effect on V_{diode}.

All the theoretical fits in the plots below use the values found in Experiment 1 for U_T and I_s.

R(Ω)	$I_{on}(A)$	$V_{on}(V)$
301Ω	$8.4869 \cdot 10^{-5} A$	$0.6220V$
3001Ω	$8.5124 \cdot 10^{-6} A$	$0.5632V$
30001Ω	$8.5149 \cdot 10^{-7} A$	$0.5044V$

In the prelab, we derived that

$$I_{on} = \frac{U_T}{R}. \tag{1}$$

This same relation is seen in the log-log plot of Figure 10 - the plot shows a highly linear character, something we expect from the log of an inverse relationship. We also derived a similar equation for V_{on}:

$$V_{on} = U_T \log(\frac{I_{on}}{I_s}) \tag{2}$$

As we've already shown that $\log I_{on}$ varies linearly with $\log R$, this shows that V_{on} varies linearly with $\log R$. This is seen in the semilog-x plot seen in Figure 11.

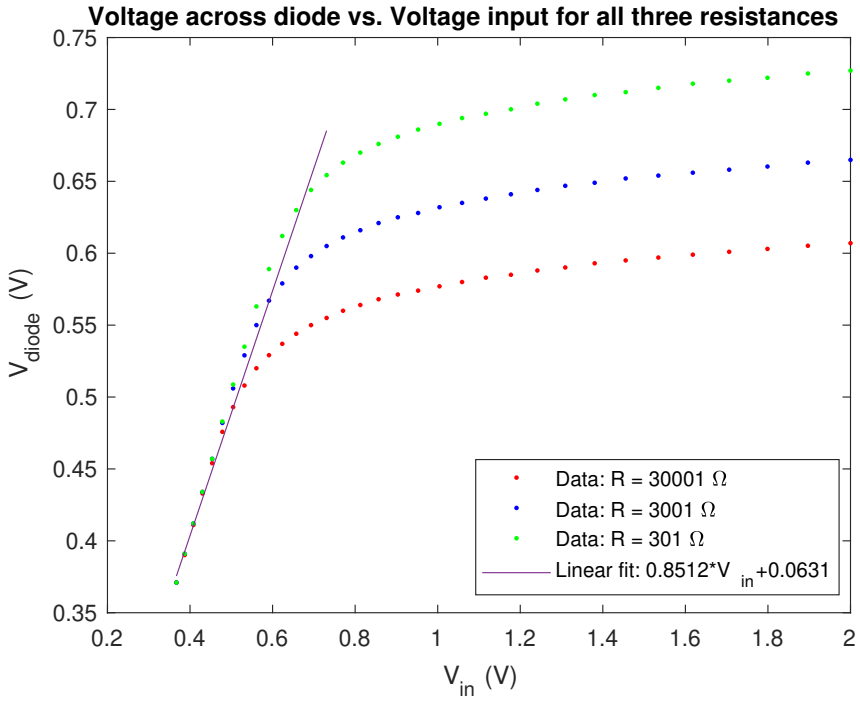

Figure 5: V_{diode} as a function of V_{in}, with accompanying theoretical fits.

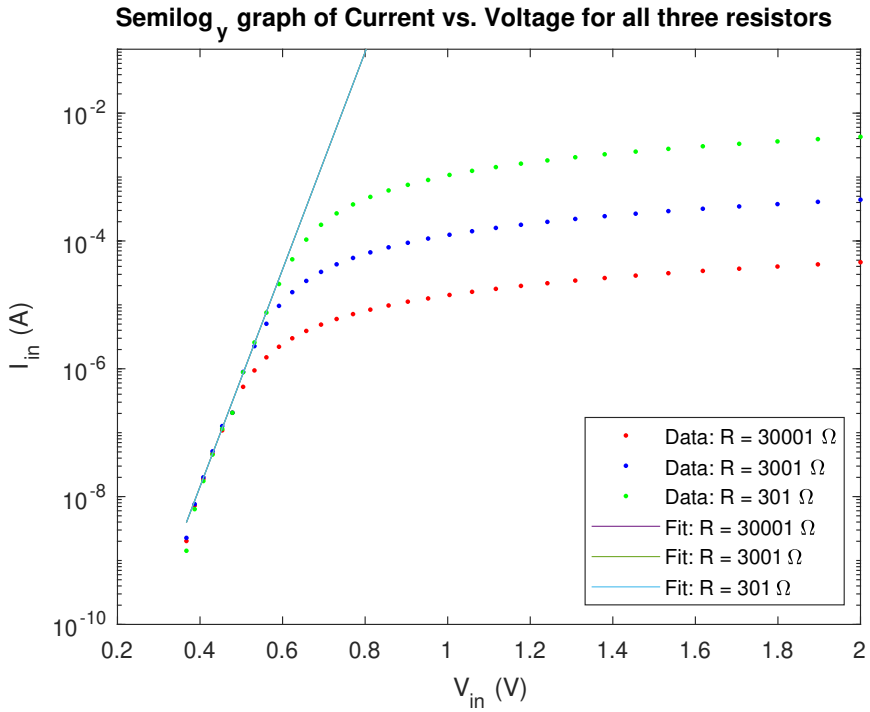

Figure 6: Semilog plot of I as a function of V_{in}, with accompanying theoretical fits for portion where I is primarily due to V_{diode}.

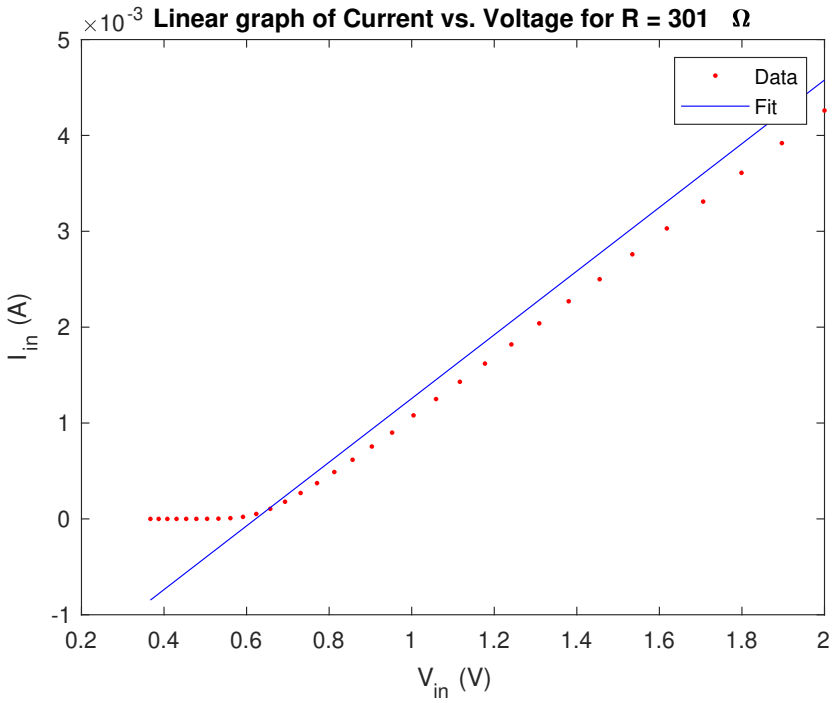

Figure 7: Linear plot of I as a function of V_{in}, with accompanying theoretical fits for portion where I is primarily due to V_R with a resistor value of 301Ω

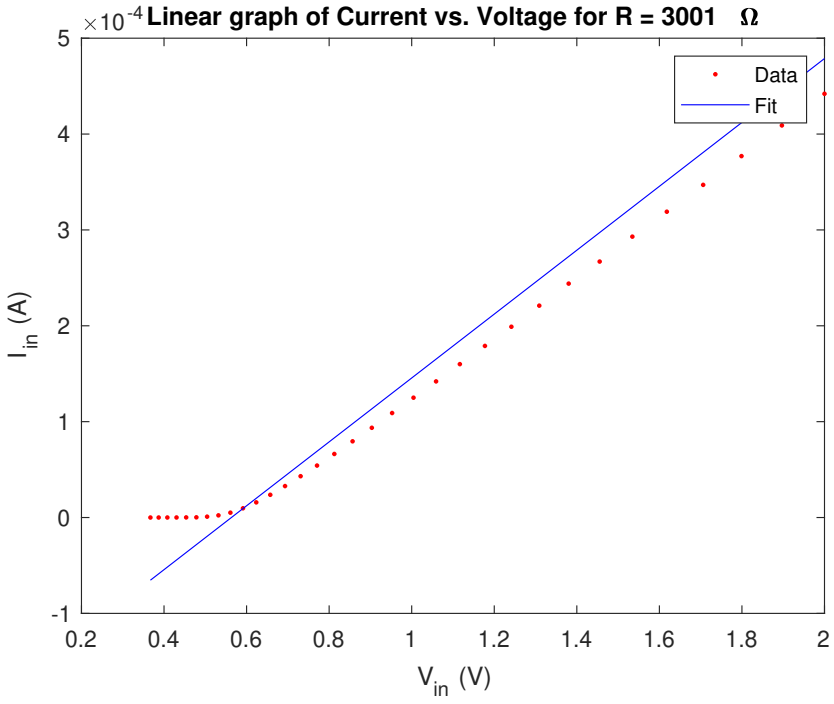

Figure 8: Linear plot of I as a function of V_{in}, with accompanying theoretical fits for portion where I is primarily due to V_R with a resistor value of 3001Ω

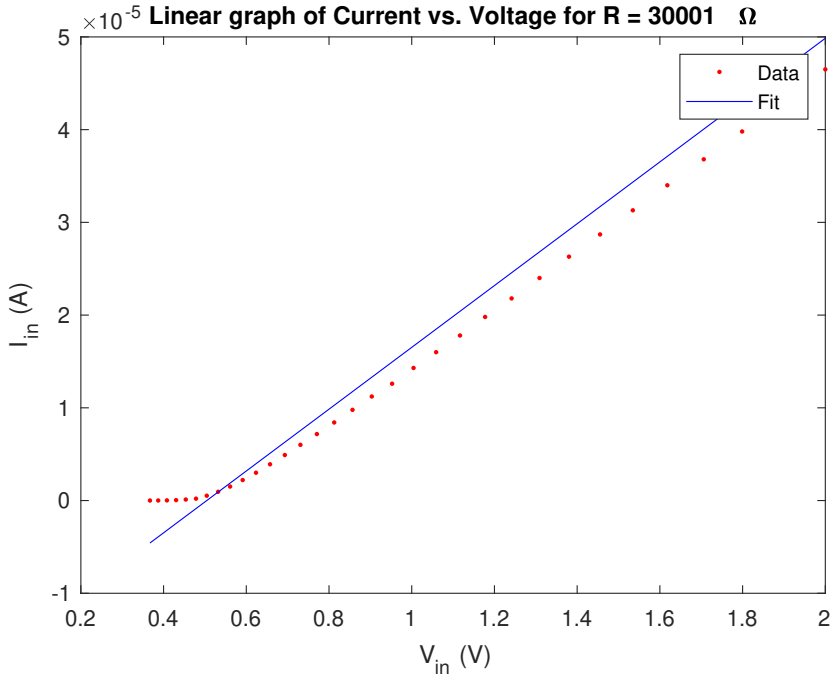

Figure 9: Linear plot of I as a function of V_{in}, with accompanying theoretical fits for portion where I is primarily due to V_R with a resistor value of 30001Ω

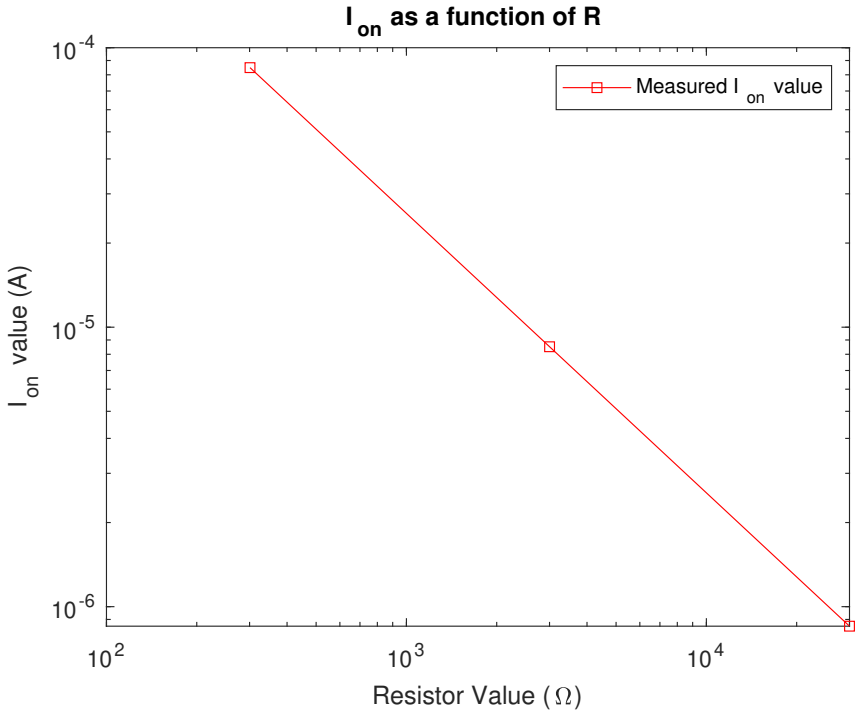

Figure 10: I_{on} as a function of R, demonstrating an inverse relationship.

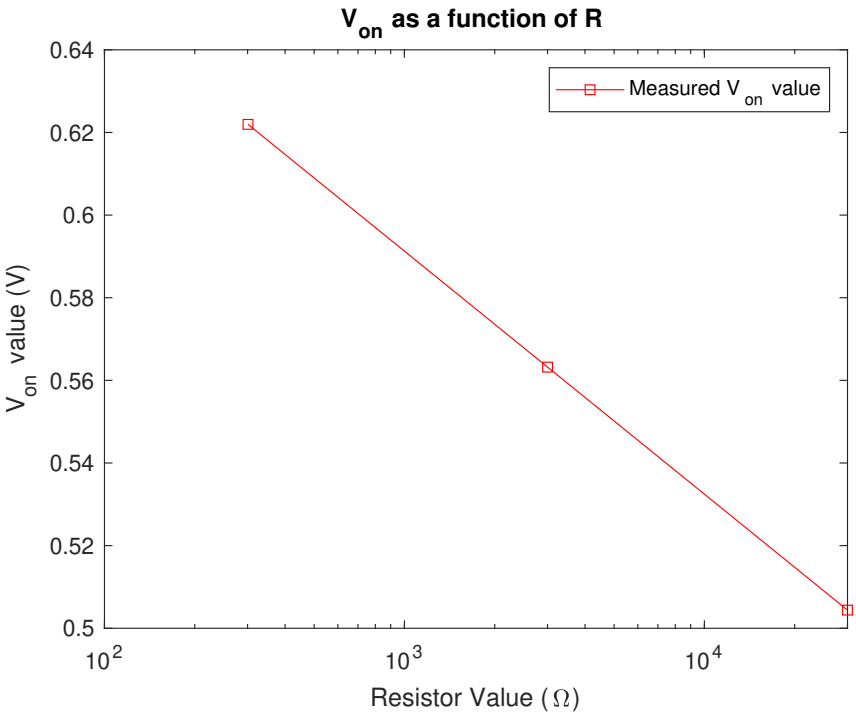

Figure 11: V_{on} as a function of R, demonstrating an inverse relationship.