EECS 312 – Electronic Circuits I – Notes
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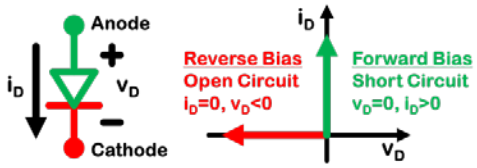
The Ideal Diode

The ideal diode is a simple model (does not physically exist) that exhibits the ideal behavior of a physical diode (or rectifier). As a simple explanation, the ideal diode allows current flow unrestricted in the **forward** direction or **bias (R=0Ω, short)** and blocks current flow in the **reverse bias (R=∞Ω, open)**.

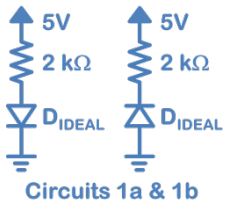
The figure below shows the diode symbol and the ideal i-v characteristic. Although it is usually a single color (black), the symbol and plot here are color coded to show forward bias in green, and reverse in red. Some notes: it is non-symmetrical; the terminals have labels; and there are specific directions for positive voltage and current. The table summarizes characteristics & terminology of the ideal diode.



Bias State	Equivalent Circuit	Equality Variable	Equality Condition	Inequality Variable	Inequality Condition
Forward	Short	v_D	v_D=0	i_D	i_D>0
Reverse	Open	i_D	i_D=0	v_D	v_D<0

Solving a Simple Circuit:

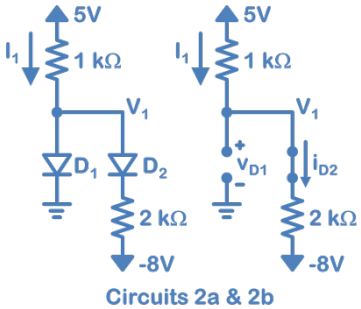
Using what we know about ideal diodes, try to find i_D and v_D for circuits 1a and 1b. Circuit 1a appears to push positive current through the ideal diode, so it is FB, v_D=0, and i_D=5/2k=2.5mA. Circuit 1b appears to apply a negative voltage across the diode, so i_D=0 and v_D=0-5=-5V. We can breakdown how we deduced the answers as: (1) guessed (assumed the bias), (2) enforced the bias with the equivalent circuit or equality condition, and (3) solved for the answer. How do we know we assumed the correct bias state? … by (4) checking the inequality condition with the value of the inequality variable. In 1a, i_D>0 for FB, which it is; and in 1b, v_D<0 for FB, which it also is; so both solutions are correct. (5) We can stop here if the inequality condition is satisfied, or we choose another bias and go back to (1) if not.



Steps to solving Diode Circuits:

1. Guess the bias (educated guess based on the circuit) for each diode in the circuit.
2. Enforce the bias equality conditions (replace each diode with short for FB and open for RB).
   **make sure to label the direction of the ineq. var. (i_D for FB and v_D for RB) for each diode to help with step 4.*
3. Solve the circuit for the answer plus the find the values of the inequality variables.
4. Check the inequality condition with the value of the inequality variable.
5. If the check is good, done; otherwise, go back to (1) and choose another set of bias states.

Solving a More Complicated Circuit (2a):



(1): Assume/Guess a bias for each ideal diode: D_1:RB and D_2:FB.
(2): Enforce each bias with the inequality variables labeled: Circuit 2b.
(3): Solve for I_1, V_1, V_{D1}, and I_{D2}.
I_1 = (5--8)/3k = 4.33 mA; V_1 = -8 + 4.33m×2k = 0.667V
V_{D1} = 0.667-0 = 0.667 V; I_{D2} = 4.33 mA.
(4): Inequality conditions: V_{D1}<0 does not check out; I_{D2}>0 does check.
(5): Since V_{D1} is incorrect, need to start over with a different Guess.

Note: The correct answer if both FB, with V_1 = 0 and I_1 = 5mA.