Steps for Analyzing Limiter Circuits

The junction diodes in most limiter circuits can/will be in forward bias, **or** reverse bias, **or** breakdown modes! Thus, the distinction between a Zener diode and a "normal" junction diode is essentially **meaningless**.

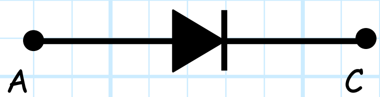
But, this presents us with a **big problem**—what diode **model** do we use to analyze a limiter? Recall that **none** of the diode models that we studied will provide accurate estimates for **all three** junction diode modes!

The **solution** we will use is to **change** the diode model we implement, as we consider **each** of the possible junction diode modes. Specifically:

Junction Diode Mode	*Junction Diode Model*
Forward Bias	CVD model with ideal diode f.b.
Reverse Bias	Ideal diode model with ideal diode r.b
Breakdown	Zener CVD model with ideal diode f.b.

Step 1:

Assume that the limiter diode is **forward biased**, so replace



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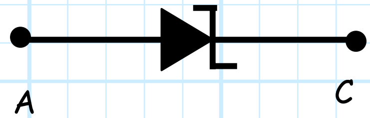
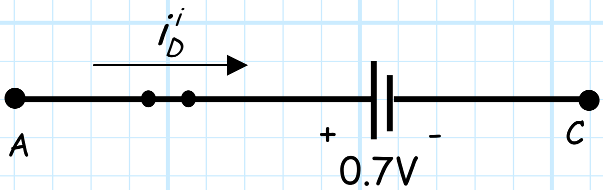


with a **CVD model**, where the **ideal** diode is **forward biased**:



Now, using this model, **determine**:

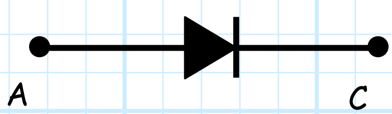
1. The **output voltage** v_O in terms of input voltage v_I .

2. The **ideal diode current** i_D' in terms of input voltage v_I.

Finally, we solve the **inequality** $i_D' > 0$ for v_I, thus determining **when** (i.e., for what values of v_I) this assumption, and thus the derived expression for output voltage v_O, is true.

Step 2:

Assume that the limiter diode is in **breakdown**, so replace



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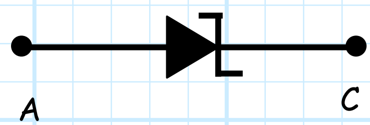
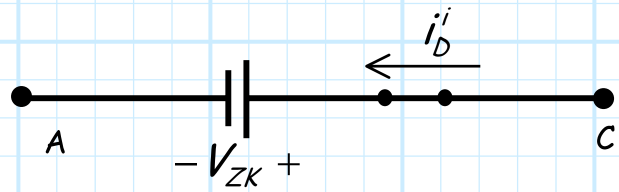


with a **Zener CVD model**, where the **ideal** diode is **forward biased**:



Now, using this model, **determine**:

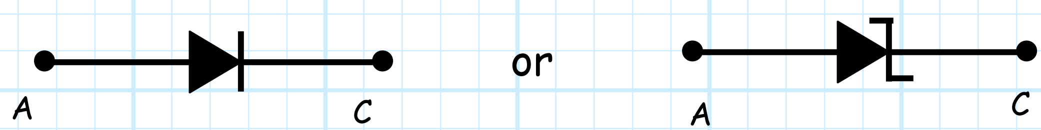
1. The **output voltage** v_O in terms of input voltage v_I .

2. The **ideal diode current** i_D^i in terms of input voltage v_I.

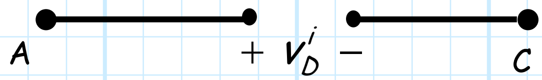
Finally, we solve the **inequality** $i_D^i > 0$ for v_I, thus determining **when** (i.e., for what values of v_I) this assumption, and thus the derived expression for output voltage v_O, is true.

Step 3:

Assume that the limiter diode is **reverse biased**, so replace



with an **Ideal Diode model**, where the ideal diode is **reversed biased**:



Now, using this model, determine the **output voltage** v_O in terms of input voltage v_I.

Q: *What about v_D^i? Don't we need to **likewise** determine its value, and then determine **when** $v_D^i < 0$?*

A: Actually, **no**. If the junction diode is **not** forward biased and it is **not** in breakdown, then it **must** be reverse biased! As **obvious** as this statement is, we can use it determine **when** the junction diode is reverse biased—it's **when** the junction diode is **not** in forward bias **and** **when** it is **not** in reverse bias.

For **example**, say that we find that the junction diode is **forward biased** when:

$$v_I > 20 \text{ V},$$

and that the junction diode is **in breakdown** when:

$$v_I < -15 \text{ V}.$$

We can thus **conclude** that the junction diode is **reverse biased** when:

$$-15 \text{ V} < v_I < 20 \text{ V}$$

Step 4:

We take the result of the **previous 3 steps** and form a continuous, piecewise linear **transfer function** (make sure it's **continuous**, and that it's a **function**!).