Notebooks:
YOUR MOST POWERFUL DEBUGGING TOOL
YOUR LEGAL PROTECTION
YOUR INTELLECTUAL PROPERTY PROTECTION
AN INDUSTRY STANDARD
What Is an Acceptable Notebook?

- Sewn and Numbered Pages
- Carbonless copy is not acceptable
- NOT a spiral bound notebook (pages not sewn)
- NOT a composition book (pages not numbered)

Good!

Bad!
What More is an Acceptable Notebook?

- The very best reference when writing the final report
- A record of all of your ideas and your test results
- A record of pertinent portions of datasheets
- A timeline of your project
- A way for your TA to ensure you are on schedule
- A chronicle of your design process, from brainstorming to final implementation.
How Does One Maintain a Notebook?

- Entries are to be written in PEN – preferably with blue or black ink
- **NO PENCIL.**
- Inserts (code snippets, simulation results, etc.) are to be glued in, signed in, and dated in
- Each member of the group maintains an individual notebook of individual work – Extensive copying is prohibited
- The notebook should be written legibly
- **The notebook is to be brought to every single TA meeting without exception. We need to see steady and strong progress week to week!**
What is Written in the Notebook?

- **Everything.**
- The notebook is to be a chronological catalogue of the design process.
- Everything, from brainstorming to final testing results, is to be recorded.
- This includes all sketches, all proposed designs and their test results, including those that fail, and all calculations.
- It is okay to be wrong! The notebook will help you debug!
What is on Each Page of the Notebook?

- Your name
- The date of your work
- Your signature at the end of each entry
- Mistakes should be crossed out
The new $R_1$ value can be calculated as follows:

\[ I_a = \frac{E}{R_a} = \frac{40 \text{ mA}}{0.65 \text{ kΩ}} = 61.5 \text{ mA} \]

\[ R_{1a} = \frac{V_{ia} - 0.25}{I_a} = 6.05 \text{ kΩ} \]

With this $R_1$, the current through the LED's was increased as 60 mA, which implies that $R_1$ did really:

\[ R_i = \frac{I_c}{V_{oc}} = \frac{60 \text{ mA}}{5 \text{ V}} = 97.3 \text{ kΩ} \]

Therefore, $R_2$ needs to be:

\[ R_2 = \frac{V_{oc}}{I_c} = \frac{5 \text{ V}}{60 \text{ mA}} = \frac{5 \text{ kΩ}}{0.06} \approx 83.3 \text{ kΩ} \]

With $R_2 = 5 \text{ kΩ}$, $I_c = 46 \text{ mA}$, $V_{oc} = 5 \text{ V}$. These are the actual operating conditions from the LED's. The following table presents the shifted output in both

<table>
<thead>
<tr>
<th>$V_e$ (V)</th>
<th>$I_e$ (mA)</th>
<th>$V_{oc}$ (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.55</td>
<td>46</td>
<td>5.5</td>
</tr>
<tr>
<td>5.05</td>
<td>46</td>
<td>5.0</td>
</tr>
<tr>
<td>4.55</td>
<td>46</td>
<td>4.5</td>
</tr>
</tbody>
</table>

\[ R_2 = 5 \text{ kΩ} \]

\[ I_e = \frac{V_e}{R_2} = \frac{5 \text{ V}}{5 \text{ kΩ}} = 1 \text{ mA} \]

Conclusion: The $R_1$ value given in the table should be corrected for the given operating conditions. The actual value is 100 Ω (with $\frac{E}{R_1} = 100 \text{ mΩ}$). The reason is that $R_1$ is probably a piecewise non-linear (constant-thermal) type. The design needs to be updated to include that $R_1 = 5 \text{ kΩ}$.

Reverse Polarity Protection circuit experimental setup

- Since the MOSFET in our actual design is silicon-based, I will be testing the circuit with a different MOSFET (IGFET 5210). The relevant device parameters are given below:

  \[ R_{on} = 0.06 \text{ Ω}, \quad V_{th} = -2 \text{ to } -4 \text{ V} \]

  - the power supply will deliver a variable voltage (controlled by a potentiometer);
  - the multimeter will measure current through the MOSFET;
  - the oscilloscope will measure voltage of the output.

  \[ R_2 = 5 \text{ kΩ} \]
Selection of Mosfet for reverse polarity protection

From analysis in the design on Pg. 7, we drew that:

\[ V_{th} > -3.5 \text{ V} \]
\[ I_{on} \text{max} > 50 \text{ mA} \]
Rs, on must be as small as possible (preferably 0, but realistic 0.01 ohm range)

Must be able to block \( V_{DS} = \text{4.5 V} \), at least

Set chosen: 7800PBF

Result:

A polarity circuit diagram:

2/12/12

Design Brainstorming - Reverse Polarity Protection

Objective: Come up with a viable design that can be tested.

PSPICE

Normal operation: \( V_{in} = 4.5 \text{ V} \)

Body diode is on \( \Rightarrow V_{DS} = 0 \text{ V} \)

\[ V_{DS} = -3.5 \text{ V} \leq V_{c} \text{ (VE is usually a resistor) \Rightarrow Transformer is on} \]

Reverse Polarity operation: \( V_{in} = -4.5 \text{ V} \)

Assume body diode is on \( \Rightarrow V_{DS} = -5.5 \text{ V} \)

\[ V_{DS} = 5.5 > V_{c} \text{ \Rightarrow transformer off} \text{ \Rightarrow contradicted} \]

Reminder: Get help from TA about explanation for Power Mosfet. What allows current to flow from \( A \to B \)? How to power Mosfet circuits?

Tell Ryan about not being able to attend March 5th meeting.
Why All the Fuss Over a Notebook?

- The notebook is a chronological record of your work
- Maintaining a professional notebook is a critical skill for industry
- The notebook protects your intellectual property
- The notebook provides legal protection in the event of a lawsuit
- The notebook greatly simplifies the writing of the final report
- The notebook is 10% of your final grade for the course (50 points of 500 points)
- Your TA can help push you in the right direction with the help of your notebooks

**DO NOT NEGLECT THE INFINITELY IMPORTANT NOTEBOOK!**
Go Build (and Document) Something Cool!