

Laboratory Final Project

The final project will be simulation-based; the idea is to design a simple system and, given that there is no access to a physical lab, to check its behavior using the LTspice similator.

Detailed instructions

- 1) Look at the attached list to find which project you have been assigned and what group code you have; you'll work in groups of two like in the "normal" lab.
- 2) Find the project attached the number of the project is stated on the top right of the page.
- 3) Solve the problem, designing the part that you have to design, and simulate the circuit with LTspice; attending the laboratory online classes on April 17th and 24th the instructors will help you.
- 4) write a report, PDF format, named groupcode-report.pdf which must contain:
 - a) the full diagram of the circuit;
 - b) the theoretical derivation of the values of the components, where appropriate (resistors, capacitors, voltage sources, and so on);
 - c) the simulation of the circuit, with a description of how you checked the correct behavior (as a minimum, the simulation of the amplifier and the low-pass filter).

The part *a* and *b* of the report have a total maximum permitted length of **3 pages**; the simulation report (part *c*, consisting of screenshots of LTspice circuits and result) must be at most **4 pages**. The whole file must not exceed 10 Mbytes of size.

- 5) Prepare a zip file (or similar) with the simulation files (the .asc files used by LTspice, and name it groupcode-spice.zip.
- 6) Submit the report and the zipped .asc LTspice files on Moodle **before April 30**, **midnight**, **Madrid time**.

Evaluation

The final evaluation will be based on the submitted report, on the quality of the simulation tests performed, and on the participation (either on the forum, or in online classes) during the second part of the virtual laboratory course.

Student (alphabetically) Group Code Project Second member Achkar , Jean Marc M2-4 4 Cabrera Capiro, Daniel Applewhite , Branden J M1-4 4 Taylor , Talbot C Ballard, Hannah Grace M2-2 2 Mazuera , Laura Basak , Debarshi M2-3 3 Momi, Jaspreet Kaur Bilow Makler, Elior Abraham F1-6 2 Paliwal , Anjali Bryja , Bozena Izabela F0-1 1 Halleran , Bridget Rose Burke , Connor P M2-5 1 Wu , Kevin D Carracciolo , James Timothy F0-6 2 Banovic , Josip Ante Chiao Bellamy, Rachael M1-2 2 Veraksa , Darya A Chisman , Hannah Belle F2-3 3 Davidson Chazen , Zachariah F0-5 1 Wagner , Madeline Elizabeth Davidson Chazen , Zachariah F0-5 1 Wagner , Madeline Elizabeth Davidson Chazen , Zachariah F0-5 1 Wan , Benjamin DeGuzman , Taylor F1-4 4 Ennis , Megan R <	2		Assigned	
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Ballard , Hannah Grace M2-2 2 Mazuera , Laura Banovic , Josip Ante F0-6 2 Caracciolo , James Timothy Basak , Debarshi M2-3 3 Momi, Jaspreet Kaur Bilow Makler, Elior Abraham F1-6 2 Paliwal , Anjali Bryja , Bozena Izabela F0-1 1 Halleran , Bridget Rose Burke , Connor P M2-5 1 Wu , Kevin D Cabrera Capiro, Daniel M2-4 4 Achkar , Jean Marc Caracciolo , James Timothy F0-6 2 Banovic , Josip Ante Chisana , Hannah Belle F2-3 3 Davarapalli , Nidhi Sri F2-5 1 Wagner , Madeline Elizabeth Davidson Chazen , Zachariah F0-5 1 Iven , Benjamin DeGuzman , Taylor F1-4 4 Ennis , Megan R DilMarco , Connor Charles F0-3 3 Hunt , Frances Emily Harriet Duphiney , Catherine F1-3 3 Lebrija Huerta, Marcela Ennis , Megan R F1-4 4 De Guzman , Taylor Ghraye				·
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Hari , Lucas Benjamin F1-2 2 Rynne , Josiah Daniel Herby , Katherine F2-4 4 Ocampo , Armando Holder , Sydney M0-1 1 Siegel , Allison Hunt , Frances Emily Harriet F0-3 3 DiMarco , Connor Charles Inirio , Jason David M1-5 1 Gupta , Arnav Iven , Benjamin F0-5 1 Davidson Chazen , Zachariah Kathe , Kevin F0-4 4 Sachdev , Sagar Kelman , Benjamin M0-2 2 Nierman , Cory Michael Lebrija Huerta, Marcela F1-3 3 Duphiney , Catherine Mazuera , Laura M2-2 2 Ballard , Hannah Grace McGovern , Brigid M1-1 1 Valdiviezo , Zenia McLeod , Shane M0-3 3 Niezyniecki , Gillian Melsheimer , Trevor A M0-4 4 Mikulskis , John Mikulskis , John M0-4 4 Melsheimer , Trevor A Momi , Jaspreet Kaur M2-3 3 Basak , Debarshi Narayanan , Santhosh F1-5 1 Rifai , Wesley Nasir , Aala G M1-3 3 Strauther , Ethan Newman , Jewel Ling Diao F0-7 3 Sander , Allison Michelle Nierman , Cory Michael M0-2 2 Kelman , Benjamin Niezyniecki , Gillian M0-3 3 McLeod , Shane Ocampo , Armando F2-4 4 Herby , Katherine Paliwal , Anjali F1-6 2 Bilow Makler , Elior Abraham Pardo González , Germán Roberto F0-2 Robinson , Grant Everett Pineiro Gonzalez , Alexandra M M0-5 1 Ramos Espinoza , Rosangel Pretti , Caio Ruzene M2-1 1 Wang , Joanne	Gupta , Arnav	M1-5	1	Inirio , Jason David
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Hunt , Frances Emily Harriet F0-3		F2-4	4	Ocampo , Armando
Inirio , Jason David M1-5 Iven , Benjamin F0-5 I Davidson Chazen , Zachariah Kathe , Kevin F0-4 Kathe , Kevin F0-4 Kelman , Benjamin M0-2 Lebrija Huerta, Marcela F1-3 Mazuera , Laura M2-2 McGovern , Brigid M1-1 McLeod , Shane M0-3 Mikulskis , John M0-4 Mikulskis , John M0-4 Mikulskis , John M0-4 Moni , Jaspreet Kaur M2-3 Narayanan , Santhosh F1-5 I Rifai , Wesley Nasir , Aala G M1-3 Newman , Jewel Ling Diao F0-7 Nierman , Cory Michael Nieryniecki , Gillian Melseiner , Trevor A Mo-2 Relman , Benjamin Grace McGovern , Brigid M1-1 Valdiviezo , Zenia Mikulskis , John Mo-4 Melsheimer , Trevor A Moni , Jaspreet Kaur M2-3 Basak , Debarshi Narayanan , Santhosh F1-5 I Rifai , Wesley Nasir , Aala G M1-3 Strauther , Ethan Newman , Jewel Ling Diao F0-7 Sander , Allison Michelle Nierman , Cory Michael M0-2 Kelman , Benjamin Niezyniecki , Gillian M0-3 Niezyniecki , Gillian M0-3 Sander , Allison Michelle Paliwal , Anjali F1-6 Bilow Makler, Elior Abraham Pardo González, Germán Roberto F0-2 Robinson , Grant Everett Pineiro Gonzalez, Alexandra M M0-5 Ramos Espinoza, Rosangel Pretti , Caio Ruzene M2-1 Nierman , Cory Michael M0-5 Ramos Espinoza, Rosangel				Siegel , Allison
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Nasir , Aala GM1-33Strauther , EthanNewman , Jewel Ling DiaoF0-73Sander , Allison MichelleNierman , Cory MichaelM0-22Kelman , BenjaminNiezyniecki , GillianM0-33McLeod , ShaneOcampo , ArmandoF2-44Herby , KatherinePaliwal , AnjaliF1-62Bilow Makler, Elior AbrahamPardo González, Germán RobertoF0-22Robinson , Grant EverettPineiro Gonzalez, Alexandra MM0-51Ramos Espinoza, RosangelPretti , Caio RuzeneM2-11Wang , Joanne	· · · · · · · · · · · · · · · · · · ·	M2-3	3	
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Ocampo , ArmandoF2-44Herby , KatherinePaliwal , AnjaliF1-62Bilow Makler, Elior AbrahamPardo González, Germán RobertoF0-22Robinson , Grant EverettPineiro Gonzalez, Alexandra MM0-51Ramos Espinoza, RosangelPretti , Caio RuzeneM2-11Wang , Joanne	Nierman , Cory Michael	M0-2	2	Kelman , Benjamin
Paliwal , Anjali F1-6 2 Bilow Makler, Elior Abraham Pardo González, Germán Roberto F0-2 2 Robinson , Grant Everett Pineiro Gonzalez, Alexandra M M0-5 1 Ramos Espinoza, Rosangel Pretti , Caio Ruzene M2-1 1 Wang , Joanne	Niezyniecki , Gillian		3	McLeod , Shane
Pardo González, Germán Roberto F0-2 2 Robinson , Grant Everett Pineiro Gonzalez, Alexandra M M0-5 1 Ramos Espinoza, Rosangel Pretti , Caio Ruzene M2-1 1 Wang , Joanne	Ocampo , Armando	F2-4	4	
Pineiro Gonzalez, Alexandra M M0-5 1 Ramos Espinoza, Rosangel Pretti , Caio Ruzene M2-1 1 Wang , Joanne	Paliwal , Anjali	F1-6	2	Bilow Makler, Elior Abraham
Pretti , Caio Ruzene M2-1 1 Wang , Joanne	Pardo González, Germán Roberto	F0-2	2	Robinson , Grant Everett
·	Pineiro Gonzalez, Alexandra M	M0-5	1	Ramos Espinoza, Rosangel
Przybylski , Sydney A F2-6 2 Slowik , Stephanie	Pretti , Caio Ruzene	M2-1	1	Wang , Joanne
	Przybylski , Sydney A	F2-6	2	Slowik , Stephanie

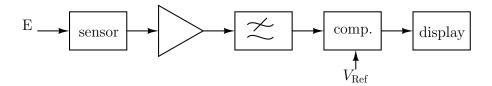
Pulvermacher , Elizabeth	F1-1	1 Florin , Courtney
Ramos Espinoza, Rosangel	M0-5	 Pineiro Gonzalez, Alexandra M
Rifai , Wesley	F1-5	1 Narayanan , Santhosh
Robinson , Grant Everett	F0-2	2 Pardo González, Germán Roberto
Rynne , Josiah Daniel	F1-2	2 Hari , Lucas Benjamin
Sachdev , Sagar	F0-4	4 Kathe , Kevin
Sander , Allison Michelle	F0-7	3 Newman , Jewel Ling Diao
Siegel , Allison	M0-1	1 Holder , Sydney
Slowik , Stephanie	F2-6	2 Przybylski , Sydney A
Strauther, Ethan	M1-3	3 Nasir , Aala G
Taylor , Talbot C	M1-4	4 Applewhite , Branden J
Ubeid , Arman A	F2-1	1 Yun , Dana
Valdiviezo , Zenia	M1-1	1 McGovern , Brigid
Veraksa , Darya A	M1-2	2 Chiao Bellamy, Rachael
Wagner , Madeline Elizabeth	F2-5	1 Davarapalli , Nidhi Sri
Wang , Joanne	M2-1	1 Pretti , Caio Ruzene
Wu , Kevin D	M2-5	1 Burke , Connor P
Yun , Dana	F2-1	1 Ubeid , Arman A

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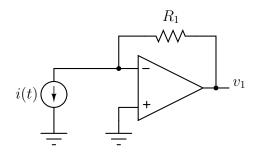
1. Design problem

The light intensity E in a room has two components: a DC and a AC (100 Hz) components. We want to design a circuit to turn an LED diode on when the DC component of the light intensity E drops below a certain threshold E_{\min} .

The figure below shows the block diagram of the proposed circuit. Some amplification is needed because the signal from the sensor is weak. Also, because the light in the room has an AC component, a low-pass filter is used to cancel it. Finally, a comparator is used to turn the LED diode on (the display) when its input voltage is less than the **reference voltage** $V_{\rm Ref}$ (which is related to threshold level $E_{\rm min}$). The comparator output drives the LED circuit.



The circuit in the figure below is an implementation of the first two blocks of the diagram. The current source is a model for the light sensor (that is, the current i(t) is proportional to the light intensity E). The amplifier stage is used to convert the current signal i(t) into a voltage signal $v_1(t)$, amplifying the sensor output signal.



Assume that the current source produces a signal with a DC component in the range $[5, 20] \mu A$ and an AC component with an amplitude of $2 \mu A$. Then,

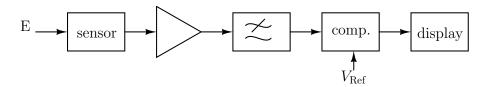
- 1. Design the amplifier stage so that the DC component of $v_1 = 10 \, \mathrm{V}$ when the DC input current is maximum, that is $20 \, \mu \mathrm{A}$.
- 2. Design the low-pass filter, the comparator, and the LED circuit. Find the values of all the components in the circuit so that the LED is on when the DC component of the current i(t) is less than $10 \,\mu\text{A}$. The current in the diode should be in the $[10, 20] \, \text{mA}$ range.
- 3. Use SPICE to test the circuit.
- 4. Write up a brief report explaining your work. Include the final circuit design and simulation results.

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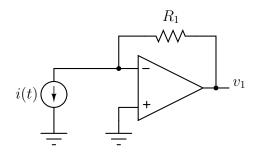
2. Design problem

The light intensity E in a room has two components: a DC and a AC ($400\,\mathrm{Hz}$) components. We want to design a circuit to turn an LED diode on when the DC component of the light intensity E drops below a certain threshold E_{\min} .

The figure below shows the block diagram of the proposed circuit. Some amplification is needed because the signal from the sensor is weak. Also, because the light in the room has an AC component, a low-pass filter is used to cancel it. Finally, a comparator is used to turn the LED diode on (the display) when its input voltage is less than the **reference voltage** $V_{\rm Ref}$ (which is related to threshold level $E_{\rm min}$). The comparator output drives the LED circuit.



The circuit in the figure below is an implementation of the first two blocks of the diagram. The current source is a model for the light sensor (that is, the current i(t) is proportional to the light intensity E). The amplifier stage is used to convert the current signal i(t) into a voltage signal $v_1(t)$, amplifying the sensor output signal.



Assume that the current source produces a signal with a DC component in the range $[5, 20] \mu A$ and an AC component with an amplitude of $2 \mu A$. Then,

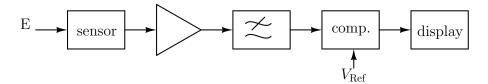
- 1. Design the amplifier stage so that the DC component of $v_1 = 10 \, \mathrm{V}$ when the DC input current is maximum, that is $20 \, \mu \mathrm{A}$.
- 2. Design the low-pass filter, the comparator, and the LED circuit. Find the values of all the components in the circuit so that the LED is on when the DC component of the current i(t) is less than $15 \,\mu\text{A}$. The current in the diode should be in the $[10, 20] \, \text{mA}$ range.
- 3. Use SPICE to test the circuit.
- 4. Write up a brief report explaining your work. Include the final circuit design and simulation results.

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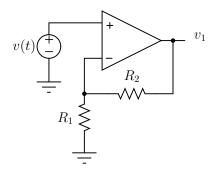
3. Design problem

The light intensity E in a room has two components: a DC and a AC (200 Hz) components. We want to design a circuit to turn an LED diode on when the DC component of the light intensity E drops below a certain threshold E_{\min} .

The figure below shows the block diagram of the proposed circuit. Some amplification is needed because the signal from the sensor is weak. Also, because the light in the room has an AC component, a low-pass filter is used to cancel it. Finally, a comparator is used to turn the LED diode on (the display) when its input voltage is less than the **reference voltage** $V_{\rm Ref}$ (which is related to threshold level $E_{\rm min}$). The comparator output drives the LED circuit.



The circuit in the figure below is an implementation of the first two blocks of the diagram. The voltage source v(t) is a model for the light sensor (that is, the voltage v(t) is proportional to the light intensity E). The amplifier stage is needed because the signal v(t) is weak.



Assume that the voltage source produces a signal with a DC component in the range $[50, 200] \, \mathrm{mV}$ and an AC component with an amplitude of $20 \, \mathrm{mV}$. Then,

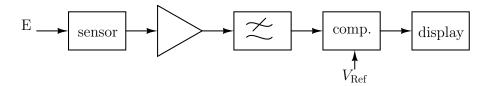
- 1. Design the amplifier stage so that the DC component of $v_1 = 10 \, \mathrm{V}$ when the DC input current is maximum, that is $200 \, \mathrm{mV}$.
- 2. Design the low-pass filter, the comparator, and the LED circuit. Find the values of all the components in the circuit so that the LED is on when the DC component of the voltage v(t) is less than $100 \, \mathrm{mV}$. The current in the diode should be in the $[10, 20] \, \mathrm{mA}$ range.
- 3. Use SPICE to test the circuit.
- 4. Write up a brief report explaining your work. Include the final circuit design and simulation results.

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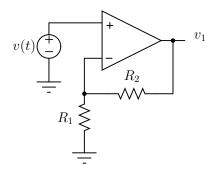
4. Design problem

The light intensity E in a room has two components: a DC and a AC (1000 Hz) components. We want to design a circuit to turn an LED diode on when the DC component of the light intensity E drops below a certain threshold E_{\min} .

The figure below shows the block diagram of the proposed circuit. Some amplification is needed because the signal from the sensor is weak. Also, because the light in the room has an AC component, a low-pass filter is used to cancel it. Finally, a comparator is used to turn the LED diode on (the display) when its input voltage is less than the **reference voltage** $V_{\rm Ref}$ (which is related to threshold level $E_{\rm min}$). The comparator output drives the LED circuit.



The circuit in the figure below is an implementation of the first two blocks of the diagram. The voltage source v(t) is a model for the light sensor (that is, the voltage v(t) is proportional to the light intensity E). The amplifier stage is needed because the signal v(t) is weak.



Assume that the voltage source produces a signal with a DC component in the range $[50, 200] \, \mathrm{mV}$ and an AC component with an amplitude of $20 \, \mathrm{mV}$. Then,

- 1. Design the amplifier stage so that the DC component of $v_1=10\,\mathrm{V}$ when the DC input current is maximum, that is $200\,\mathrm{mV}$.
- 2. Design the low-pass filter, the comparator, and the LED circuit. Find the values of all the components in the circuit so that the LED is on when the DC component of the voltage v(t) is less than $150\,\mathrm{mV}$. The current in the diode should be in the $[10,20]\,\mathrm{mA}$ range.
- 3. Use SPICE to test the circuit.
- 4. Write up a brief report explaining your work. Include the final circuit design and simulation results.